NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS
BEAVER CREEK MEADOWS DISTRICT, WATERLOO

Preliminary
Stormwater Management Report

Project Location:
East of Erbsville Road
West of Beaver Creek Road
South of Conservation Drive
Waterloo, Ontario

Prepared for:
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July 5, 2017

MTE File No.: 39502-104

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1.0 INTRODUCTION

1.1 Overview

MTE Consultants Inc. (MTE) was retained by Mr. Brian Groff, on behalf of 1017081 Ontario Limited and Gabriella Groff (Northgate Subdivision) and Mr. Steve Fries, on behalf of 1455136 Ontario Inc. (Erbsville Kartway Subdivision), to prepare this Preliminary Stormwater Management (SWM) Report in support of draft plan approval of the proposed Northgate and Erbsville Kartway Subdivisions. The Northgate property (49.290 ha) and the Erbsville Kartway property (6.424 ha) encompass approximately 55.714 ha of land within the City of Waterloo (City). Note that the Northgate property (49.290 ha) consists of 33.159 ha of land located within the proposed subdivision and 16.131 ha along Beaver Creek, identified as "additional lands", to be protected as open space. The Northgate and Erbsville Kartway properties are collectively referred to as the "subject lands".

The subject lands are part of the Beaver Creek Meadows District, which abut the intersection of Beaver Creek Road and Conservation Drive, East of Erbsville Road and being 550m south of the municipal boundary between the City of Waterloo and the Township of Woolwich. The lands are entirely within the Laurel Creek Watershed, specifically areas 391, 309, and 310 as defined in the *Laurel Creek Watershed Study - GRCA et al (1993)* (LCWS).

The location of the subject lands is illustrated in **Figure 1.0**, along with the general extent of the Beaver Creek Meadows District. The subject lands are surrounded by the Laurel Creek Conservation Area, Reservoir, and Nature Centre to the south, Creekside Church and rural residential homes to the north, an existing mobile trailer park to the east (Green Acre Park – aka Martin Lands), and Laurel Creek and a woodlot to the west.

It is our understanding that the Mattamy/Cook lands (28.647 ha) and Activa lands (7.363 ha) located immediately north and north-east of the Northgate Subdivision have or are in the process of submitting subdivision application.

A Draft Plan of Subdivision for the proposed development has been prepared by MHBC Planning (dated July 4, 2017) and forms the basis for the proposed servicing concepts. The Draft Plan of Subdivisions includes single family residential blocks, multiple residential blocks, stormwater management blocks, sanitary pumping station blocks, park blocks, open space blocks, walkways, emergency access and service corridor blocks, and municipal right-of-ways. A full-size drawing of the Draft Plan is enclosed at the back of this report.

This report should be read in conjunction with the following other reports; *Northgate and Erbsville Kartway Subdivisions Functional Servicing Report - MTE (July 2017),* and the *Northgate and Erbsville Kartway Subdivisions Hydrogeology Study - MTE (July 2017)*



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1.2 Background Information

Subwatershed Study
The *North Waterloo Scoped Subwatershed Study - Stantec et al (2013)* (NWSSS) was undertaken for the Beaver Creek Meadows District by the City of Waterloo and area landowners. The Study Area was broken down into 2 portions, the Primary Study Area is the area located within the northwest portion of the City of Waterloo urban area, and the Secondary Study Area which is primarily the agricultural lands within the township areas. The Study Area is wholly contained with the Laurel Creek Watershed.

The specific goals of the NWSSS were to:

- Provide recommendations and approaches to manage resources to protect, maintain and, where possible, enhance the natural environment within the Study Area.

- Establish a Primary and Secondary Study Area.

- Provide information and recommendations to the land-use decision making process and assist in setting specific direction for subsequent planning processes with the Primary Study Area.

- Determine how future development can be planned and designed according to the targets set out in the Laurel Creek Watershed Study (LCWS) and implement the City of Waterloo Official Plan requirements for subwatershed planning.

Specific recommendations that pertain to the subject site with respect to stormwater management include a combination of lot-level, conveyance and end-of-pipe infiltration facilities, as well as end-of-pipe peak flow targets for return period design storms for end-of-pipe SWM facility design.

The subject lands are located within the Laurel Creek Watershed, specifically within portions of Subwatershed Areas 391, 309, and 310 as defined within the LCWS. Drainage is directed to Beaver Creek (subwatershed area 391), Laurel Creek (subwatershed area 309), and directly to the Laurel Creek Reservoir (subwatershed area 310) due to topographic conditions within the subject lands. It should be noted that this report presents the stormwater management quality, quantity, and water balance measures that are proposed to be provided for the Northgate and Erbsville Kartway Subdivisions that are within Subwatershed Areas 391 and 309 (i.e. the central and western portions of the development lands). The eastern portion of the Northgate lands, along with other development lands within Subwatershed Area 310 will utilize a communal stormwater management facility located adjacent to Beaver Creek Road. A separate Preliminary Stormwater Management Report will be prepared in support of the communal stormwater management facility.

Municipal Class Environmental Assessment
A Municipal Class Environmental Assessment (EA) was undertaken for the upgrading of Beaver Creek Road and Conservation Drive within the North Waterloo lands by Stantec Consulting on behalf of the City of Waterloo, and completed December 14, 2015. The EA was completed in order to review and implement infrastructure upgrades required for the proposed developments within the North Waterloo lands. The landowners are continuing to work with the City on implementation of the Class EA.

1.3 Purpose of Study

The purpose of this study is to develop a comprehensive stormwater management strategy for the current development proposal, taking the findings of previous studies into consideration, and that is acceptable to the City of Waterloo, Region of Waterloo, the Grand River Conservation Authority (GRCA), and the Ministry of the Environment and Climate Change (MOECC).

1.4 Objectives

The objective of this stormwater management plan is to ensure that the proposed development includes the necessary controls to protect the hydrology and water quality of the receiving water systems. Further, this plan also ensures that the proposed draft plan provides the necessary blocks and corridors for stormwater management measures. The primary objectives of this study are as follows:

- Document criteria for the management of stormwater runoff from the study area.
- Recommend a comprehensive plan for controlling the quality of stormwater runoff from the study area (including temperature mitigation as required).
- Recommend a comprehensive plan for controlling the quantity of stormwater runoff from the study area.
- Recommend a comprehensive plan for balancing infiltration to groundwater and surface water inputs to existing features.
- Prepare preliminary designs for the recommended stormwater management infrastructure.

2.0 EXISTING CONDITIONS AND BACKGROUND INFORMATION

2.1 Topographical Information

The proposed Northgate Subdivision consists of approximately 49.290ha of land. The majority of the property is currently used for agricultural purposes, with the exception of a 16ha forested area that also contains Beaver Creek. Beaver Creek flows from north to south across the middle of the property and confluences with Laurel Creek just south of the southern property boundary. The Erbsville Kartway Subdivision is currently being used primarily as a Go-Kart business, with a single residence located along Conservation Drive and the western edge being in the floodplain of Laurel Creek. The soils are generally sandy and well-drained, as the area is located along the eastern flank of the Waterloo Moraine or Waterloo Sand Hills (NWSSS, 2013).

MTE conducted a detailed topographical survey of the property in May 2015, with some supplemental topo completed in 2016. Existing topographic conditions for the subject lands as well as the surrounding lands are shown on attached MTE **Drawing 39502-104 EC1.1** at the back of this report.

The subject lands are moderately sloped throughout the majority of the site, generally between 2% and 10%. Existing elevations range between 345m near the southern edge of the property where Beaver Creek exits the subject lands and 360m on the hill located in the northwest corner.

2.2 Pre-Development Conditions

The subject lands are located within the Laurel Creek Watershed, specifically within portions of Subwatershed Areas 391, 309, and 310 as defined within the LCWS. Drainage is directed to Beaver Creek (subwatershed area 391), Laurel Creek (subwatershed area 309), and directly to the Laurel Creek Reservoir (subwatershed area 310) due to topographic conditions within the subject lands. The pre-development drainage areas are illustrated on **Figure 2.0**.

The western portion of the site (including lands outside of the plans of subdivision) drains to Laurel Creek to the southwest. Laurel Creek is the main water feature within the Laurel Creek Watershed, and it turns to flow east approximately 200m south of the site before its confluence with Beaver Creek and outlets into the Laurel Creek reservoir.

The central portion of the site (including lands outside of the plans of subdivision) drains to Beaver Creek, which flows from north to south through the middle of the site. Beaver Creek has a main branch approximately 6.1km long, and drains a 697ha watershed consisting of mainly agricultural land. Beaver Creek joins Laurel Creek immediately to the south of the site, upstream of the Laurel Creek reservoir.

A fluvial geomorphological assessment was undertaken on Beaver Creek by Paris Geomorphic in 2011. The erosion threshold analysis included 2 reaches within the Primary Study Area, identified as BC-2 and BC-4. As BC-2 is located upstream of the subject lands, BC-4 will only be assessed for the purposes of this study.

The eastern portion of the site (including lands outside of the plans of subdivision) drains overland directly to the Laurel Creek reservoir. The Laurel Creek reservoir is an engineered flood control for the City which is managed by the GRCA.

The GRCA's GAWSER (version 6.9.12) hydrologic model of Laurel Creek was updated by Stantec for the NWSSS. As part of the NWSSS, the current conditions model was run in continuous mode to estimate streamflow conditions and water balance information for the water features within and surrounding the study area. The continuous model utilized a 54-year meteorological data set from the Waterloo Wellington airport.

2.3 Geotechnical and Hydrogeological Information

As noted in the NWSSS, the subject lands are located along the eastern flank of the physiographic region referred to as the Waterloo Moraine. The surficial geology in the Beaver Creek study area predominantly consists of sandy glaciofluvial deposits with areas of clay to silt-textured till. Modern alluvial deposits exist in the low lying areas associated with Beaver Creek and Laurel Creek.

To further understand the surficial geology within the study area, 6 monitoring wells, 7 test pits and 3 soil permeability tests were completed as part of the NWSSS in 2010, within the subject lands. Based on the results of this investigation, there were additional areas of clay to silt-textured till found along the south-west edge of the subject lands, as well as, just south of Conservation Drive within the Beaver Creek valley. Also, ice-contact stratified deposits of sand and gravel were found in the central area of the west half of the subject lands, west of Beaver Creek. For more detail of the Surficial Geology of the subject area refer to Figure 5.5 of the NWSSS.

From 2014 to 2017, MTE carried out further hydrogeological investigation of the subject lands. The fieldwork for this investigation included 14 boreholes to depths ranging 5.18m to 24.99m on site completed as 50mm monitoring wells, collection of soil samples, hydraulic 'slug' tests at the monitoring wells, and measurement of groundwater levels.

Based on the results of the hydrogeological investigation, the subsurface stratigraphy is generally described as topsoil underlain by a layer of fine sand interspersed with till and/or clay silt material, which was interpreted as Regional Aquifer 1/2 material, underlain at depth by deposits of silty clay, distinguished as the Lower Maryhill Till. Groundwater flow within the subject lands is generally towards the southeast to Beaver Creek.

For further information, refer to **Appendix G** for on-site borehole and monitoring well logs.

CONSERVATION DRIVE

BEAVER CREEK ROAD

391
101.6

309
10.8

310
70.1

309
10.8

Beaver Creek Floodline

Laurel Creek Floodline

Laurel Creek

LEGEND

– SUBJECT LANDS (55.714 ha)

– DRAINAGE DIVIDE

391 / 101.6 — SUB-CATCHMENT NUMBER / AREA (ha.)

NOTE: CATCHMENT NUMBERING AS SHOWN ON FIGURE 6.1 IN THE NWSSS.

FIGURE 2.0

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NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

PRE-DEVELOPMENT DRAINAGE AREAS

MTE
Engineers | Scientists | Surveyors

Project No.: 39502-104

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3.0 STORMWATER MANAGEMENT CRITERIA

New developments are required to provide stormwater management in accordance with provincial and municipal policies including:

- Stormwater Management Practices, Planning and Design Manual (MOE, March 2003).
- GRCA Policies for the Administration of Ontario Regulation 150/06 (GRCA, October, 2015).
- City of Waterloo Development Engineering Manual (2013).
- North Waterloo Scoped Subwatershed Study (Stantec et al., November 2013).

Based on the above policies, the following stormwater management criteria have been established for Subwatershed 309 and 391 within this study area:

- **Quality Control** - provide an *Enhanced* (MOE, 2003) level of stormwater quality control for all developing areas.

- **Quantity and Erosion Control**
  - *Subwatershed 309* – surface drainage should be incorporated into subwatershed 391 area during development.

  - *Subwatershed 391* – post-development peak flows must be controlled to unit flow rate targets for a variety of return period design storm events.

- **Water Balance**
  - *Surface Water* – maintain existing surface water inputs to key natural features.

  - *Infiltration* - maintain or enhance existing recharge rates across the development area, to maintain existing groundwater recharge and discharge characteristics.

- **Thermal Mitigation** – provide temperature mitigation measures prior to discharge to the receiving systems.

3.1 Quality Control

All new stormwater management facilities proposed for the development will need to provide an Enhanced Level of water quality protection prior to discharge to a surface or groundwater feature. This is established in Table 3.2 of the MOE *Stormwater Management Planning and Design Manual* (MOE, 2003).

3.2 Quantity and Erosion Control

As an alternative to post-to-pre control, a target unit flow rate approach was applied to Subwatershed 391 to manage development of the subwatershed without causing increases in Beaver Creek peak flows. The target is in the form of L/s/ha of existing drainage area. This method was applied as it was found that typical post-to-pre SWM strategy would increase the magnitude of flows in the lower reaches of Beaver Creek. The unit flow rates for the 2, 5, and 100 year events are listed in **Table 3.1**.

An erosion assessment was completed as part of the NWSSS, and identified 2 sensitive reaches on Beaver Creek (BC-2 and BC-4). This assessment confirmed erosion thresholds and the duration of erosive flows under existing conditions (Table 8.1 of the NWSSS). These limits should be incorporated into proposed SWM measures to ensure existing erosion conditions are maintained under future developed conditions.

Additionally, all stormwater management facilities which outlet to a creek will incorporate 24 hour extended detention for a 25mm, 4-hour Chicago storm event.

TABLE 3.1 - UNIT FLOW TARGETS FOR SUBWATERSHED 391

Return Period Storm Event	Unit Flow Target (L/s/ha)
2 year	1.1
5 year	10
100 year	55

3.3 Water Balance

The existing conditions hydrologic model (GAWSER) was run for a 54-year simulation period to determine the average annual evapotranspiration, runoff and infiltration values for each catchment within the Beaver Creek subwatershed. The results for the catchments containing the subject site are summarized in **Table 3.2**.

TABLE 3.2 - EXISTING CONDITIONS ANNUAL WATER BALANCE

Condition	Hydrologic Component Values (mm/yr)		
	Catchment 3914	Catchment 3915	Catchment 3917
Precipitation	844.8	844.8	844.8
Evapotranspiration	553.0	551.9	551.0
Runoff	*79.9*	*69.9*	*116.7*
Infiltration	211.9	222.9	177.0

Surface Water

Existing annual surface water volume contributions from lands within the PSA to wetlands will be required to be met in post-development conditions.

Infiltration

Infiltration rates / volumes are required to be maintained in order to preserve existing groundwater recharge for the protection of natural features (eg. groundwater fed wetlands, and creek base flow) and the Region's water supply. The proposed conditions hydrologic model (GAWSER) was run for a 54-year simulation period to determine the average annual evapotranspiration, runoff and infiltration values for each catchment within the Beaver Creek subwatershed. The proposed conditions water balances are illustrated on Table 11.5 of the NWSSS, and have been summarized in **Table 3.3** below.

TABLE 3.3 - POST-DEVELOPMENT WATER BALANCE VALUES BY CATCHMENT

Condition	Hydrologic Component Values (mm/yr)		
	Catchment 3914	**Catchment 3915**	**Catchment 3917**
Precipitation	844.8	844.8	844.8
Evapotranspiration	348.2	346.2	352.4
Runoff	234.5	231.9	251.6
Infiltration	*262.2*	*266.7*	*240.8*

4.0 PROPOSED DEVELOPMENT AND STORMWATER MANAGEMENT STRATEGY

4.1 Proposed Area Grading

A preliminary finished grade contour plan illustrating road grades is enclosed (**MTE Drawing 39502-104 AG1.1**). The grading design of the site was controlled by many factors which include servicing constraints (both sanitary and storm), matching existing grades along the adjacent properties and environmental features, maintaining appropriate separation between existing high groundwater and proposed house footings and infiltration facilities, as well as limiting the import of fill for the development.

4.2 Post-Development Conditions

The proposed SWM plan, to be further discussed within this report, incorporates a variety of SWM infrastructure under a treatment train approach. The plan has been designed to meet the criteria presented in Section 3.0 of this report.

The development lands are comprised of mainly residential land use with some park blocks, stormwater management facilities and two sanitary pumping station blocks. As discussed in Section 1.2, the subject lands are located within the Laurel Creek Watershed, specifically within portions of Subwatershed Areas 391, 309, and 310. This report presents the stormwater management strategy for the lands that are within Subwatershed Areas 391 and 309 (i.e. the central and western portions of the development lands). The eastern portion of the Northgate lands, along with other development lands within Subwatershed Area 310 will utilize a communal stormwater management facility located adjacent to Beaver Creek Road. A separate Preliminary Stormwater Management Report will be prepared in support of the communal stormwater management facility.

For the lands within Subwatershed Areas 391 and 309, three (3) Stormwater Management Facilities (SWMF/LID) are proposed to be integrated into the proposed development servicing three distinct drainage areas. It should be noted that, the proposed draft plans of subdivision for the subject lands contain a number of Blocks that will be developed through a Site Plan Approval process. As part of that process, a detailed Stormwater Management Plan will be prepared showing how the stormwater control measures will adhere to the NWSSS criteria and be implemented within the Block. Two of these Blocks will contain future stormwater management facilities. It should be noted that the stormwater management controls within these Blocks have been conceptually designed and modeled as part of this study to confirm overall adherence to the NWSSS criteria/targets. These facilities have been identified as SWMF 5915 and 5917 in this report and figures.

The location of the proposed facilities along with the drainage areas contributing to each facility are illustrated on **Figure 4.1** and **4.2**. Storm sewers will convey minor flows to the SWMF. Major flows are to be contained within the right-of-ways and blocks and will also be directed to the SWMF.

At the lot level, amended topsoil (increased depth of topsoil) and infiltration facilities are proposed within the development. Amended topsoil is a lot level stormwater management practice that has received considerable attention is recent years. This practice involves adjusting the sub-grade of pervious areas to be landscaped, such that a deeper layer of topsoil (and amending it with compost to increase organic matter content) can be applied. Previous studies have demonstrated that amended topsoil can significantly reduce runoff volumes by

absorbing, retaining, infiltrating and evapotranspiring a greater amount of precipitation than standard landscaping practices in new developments. In addition, roof runoff from a number of the lots adjacent to the wetland will provide surface water input to the wetland.

Lot-level infiltration galleries have been proposed for a number of multi-residential blocks. The condominium blocks will contain “common element” infiltration facilities, located and designed within the parameters of the individual block designs. These galleries have been designed to accept 25mm of runoff.

A number of conveyance controls (infiltration facilities located along the conveyance route) will also be provided to infiltrate treated non-roof (road, front/rear yard) runoff. This will include a conveyance infiltration facility located within the northwest Park Block, and permeable pavement for the road surface for Condo Block (east leg of Stage 5). The conveyance facility has been designed such that the contributing area produces no runoff during the 4 hour, 25 mm storm event. This facility will have an oil-grit separator (such as a Stormceptor unit) upstream to treat stormwater runoff prior to entering the facility.

The end-of-pipe facilities will consist of a wet pond for subcatchment 3914, a volume reduction pond for subcatchment 3915, and a bio-swale (as part of a treatment train approach) for subcatchment 3917. These facilities will be further discussed in Section 5.0.

The drainage area contributing to each of the proposed end-of-pipe SWM facilities was delineated into several catchments consisting of either roof area or non-roof development area, draining to either conveyance/block infiltration facilities or directly to SWM facilities. Soil parameters within each catchment were assigned based on the fraction of the post-development catchment located within each pre-development catchment area.

Reservoir commands were included in the hydrologic model to reflect the lot-level infiltration facilities, the conveyance/block infiltration facilities, the SWM facilities, and the end-of-pipe infiltration facilities.

The design of each of the proposed SWM measures is discussed in detail Section 5 of this report.

The development plans for the overall post-development stormwater management scheme includes approximately 114 ha of land, which includes land outside of the Northgate and Erbsville Kartway Plans of Subdivision. Of this total 114 ha, 49.8 ha is within Subwatershed Area 391 and 64.2 ha is within Subwatershed Area 310.

As per the NWSSS (Section 11.2.2, page 232), the areas of the development lands within Subwatershed Area 309, draining west to Laurel Creek and the Erbsville tributary, will be partially redirected into Subwatershed Area 391 in the post-development condition, draining to Beaver Creek. Of the 4.4 ha in subcatchment 3091 to be directed to Beaver Creek through the subject lands, 2.2 ha of rear yards along the west portion of the development and a small portion of the northwest corner of the site will still discharge surface runoff overland towards Laurel Creek.

The surrounding post-development drainage areas are shown on **Figure 4.1** and the detailed post-development site drainage areas are shown on **Figure 4.2**. The post-development modeling parameters and impervious calculations have been included in **Appendix A**.

3910
Subcatchment 3910 consists of Beaver Creek and its immediate wetland north of Conservation Drive, totals 17.6ha, and is proposed to remain unchanged from its pre-development condition. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3911
Subcatchment 3911 consists of Beaver Creek and its immediate wetland south of Conservation Drive through the subject property, totals 20.299ha, and is proposed to remain unchanged from its pre-development condition.

3912
Subcatchment 3912 consists of developable lands north of Conservation Drive and west of Beaver Creek, totals 16.8ha, and shall remain the site of the Creekside Church. This area is outside of the subject property for this stormwater management report but within the overall

North Waterloo study area, and has therefore been conceptually modeled. Subcatchment 3912 receives an additional 1.4ha from subcatchment 3091 (which has been removed) in the post-development condition.

3913
Subcatchment 3913 consists of developable lands north of Conservation Drive and east of Beaver Creek, totals 11.0ha, and is proposed to drain to a stormwater management facility (SWMF 5913) in its southwest corner which will outlet to Beaver Creek. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3914
Subcatchment 3914 consists of developable lands south of Conservation Drive and west of Beaver Creek, totals 16.821ha, and is proposed to drain to a stormwater management facility (SWMF 5914) in its northeast corner which will outlet to Beaver Creek. This area comprises the west end of the subject property for this report, and contains multiple residential blocks, park blocks, and the stormwater management facility block. Subcatchment 3914 receives an additional 2.2ha from subcatchment 3091 (which has been removed) in the post-development condition. The balance of subcatchment 3091 (2.140ha) remains draining to Laurel Creek as subcatchment 9914 in the proposed modeling.

3915
Subcatchment 3915 consists of developable lands south of Conservation Drive and east of Beaver Creek, totals 2.651ha, and is proposed to drain to a small stormwater management facility (SWMF 5915) in its southwest corner which will outlet to Beaver Creek. This area comprises the north-central portion of the subject property for this report, and contains a multiple residential block.

3916
Subcatchment 3916 consists of lands northwest of subcatchment 3912, totals 2.6ha, drains to subcatchment 3912, and is proposed to remain unchanged from its pre-development condition. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3917
Subcatchment 3917 consists of developable lands southwest of Beaver Creek, totals 2.573ha, and is proposed to implement LID features to treat stormwater runoff. This area comprises the south-central portion of the subject property for this report, and consists of vacant land condominium blocks.

3918
Subcatchment 3918 consists of lands along the southern edge of the subject property which drain north to subcatchments 3914 and 3917, totals 0.6ha, and is proposed to remain unchanged from its pre-development condition.

3919
Subcatchment 3919 consists of lands northeast of Beaver Creek, totals 13.6ha, drains to subcatchment 3910, and is proposed to remain unchanged in the post-development condition. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3092
Subcatchment 3092 consists of Laurel Creek and its immediate wetland along the west side of the subject property, totals 4.036ha, drains west to Laurel Creek, and is proposed to remain unchanged from its pre-development condition.

3093
Subcatchment 3093 consists of Laurel Creek wetland along the south edge of the subject property, totals 0.7ha, drains south to Laurel Creek, and is proposed to remain unchanged from its pre-development condition.

3101
Subcatchment 3101 consists of developable lands north of Conservation Drive and east of Beaver Creek Road, totals 10.2ha, and is proposed to drain to a stormwater management facility (SWMF 5106) east of Beaver Creek Road and north of the Laurel Creek Reservoir, which will outlet to the Laurel Creek Reservoir. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3102
Subcatchment 3102 consists of developable lands south of Conservation Drive and west of Beaver Creek Road, totals 8.434ha, and is proposed to drain to a stormwater management facility (SWMF 5106) east of Beaver Creek Road and north of the Laurel Creek Reservoir, which will outlet to the Laurel Creek Reservoir. This area comprises the eastern portion of the subject property for this report, and contains multiple residential blocks, vacant land condominium blocks and park blocks. Subcatchment 3102 receives an additional 1.8ha from subcatchment 3915 in the post-development condition.

3103
Subcatchment 3103 consists of Laurel Creek wetland along the south edge of the subject property, totals 0.2ha, drains southeast to the Laurel Creek Reservoir, and is proposed to remain unchanged from its pre-development condition. .

3104

Subcatchment 3104 consists of lands along the east and south edges of the North Waterloo study area, totals 5.4ha, drains west to subcatchment 3106, and is proposed to remain unchanged from its pre-development condition. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3105

Subcatchment 3105 consists of lands in the northeast corner of the North Waterloo study area, totals 3.5ha and is proposed to remain unchanged from its pre-development condition. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3106

Subcatchment 3106 consists of lands south of Conservation Drive and east of Beaver Creek Road, totals 32.6ha, and is proposed to drain to a future stormwater management facility (SWMF 5106) in its southwest corner which will outlet through an existing drainage draw south

to the Laurel Creek Reservoir. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled.

3107

Subcatchment 3107 consists of lands north of Conservation Drive and north/northwest of Beaver Creek Road, totals 13.0ha, and is proposed to drain to a stormwater management facility (SWMF 5106) east of Beaver Creek Road and north of the Laurel Creek Reservoir, which will outlet to the Laurel Creek Reservoir. This area is outside of the subject property for this stormwater management report but within the overall North Waterloo study area, and has therefore been conceptually modeled. Subcatchment 3107 receives an additional 1.3ha from subcatchment 3913 in the post-development condition.

301
265.1

NOTE:
AREA 301 IS UPSTREAM OF AREA 381.

381
331.1

3916
2.6

3912
16.8

3919
13.6

3105
3.5

3913
11.0

3107
13.0

3910
17.6

5912

5913

5914

5915

CONSERVATION DRIVE

NOTE:
AREA 3101 WAS INCREASED FROM 9.3 to 10.2 ha IN THE PROPOSED MODEL.

3101
10.2

3914
16.821

3915
2.651

3102
8.434

3911
20.299

BEAVER CREEK ROAD

3106
32.6

3104
5.4

NOTE:
SEE FIGURE 4.2
FOR SITE DETAILS.

3092
4.036

3911
-

3918
0.6

3917
2.573

3093
0.7

3103
0.2

NOTE:
SWM FACILITY 5106 IS PROPOSED ON THE MARTIN LANDS AND WILL PROVIDE STORMWATER MANAGEMENT FOR FOUR DIFFERENT DEVELOPERS.
(3101, 3102, 3104/3106 AND 3107)

5106

3104
-

Laurel Creek

Bonnie Creek

STREET FOUR

STREET THREE

STREET FIVE

STREET SIX

STREET ONE

Stage 1

Stage 2

Stage 3

Stage 4

Stage 5

Stage 6

LEGEND

- SUBJECT LANDS (55.714 ha)
- EXISTING CONTOURS (REGION OF WATERLOO) — 305.0
- EXISTING DRIPLINE
- POST DEVELOPMENT DRAINAGE AREAS
- 5914 — PROPOSED SWM FACILITY
- 3101 / 10.2 — SUB-CATCHMENT NUMBER / AREA (ha.)

SHADED AREAS MODELLED AS DEVELOPED

N

FIGURE 4.1

Date: JUL.05/17
Scale: 1:6000

NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

POST DEVELOPMENT CATCHMENT AREAS

MTE
Engineers | Scientists | Surveyors

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NOTE: EXTERNAL ARES 3101 & 3017 WILL DRAIN TO OFF-SITE SWM FACILITY 5106, NOTED BELOW.

CONSERVATION DRIVE

2004 *

MULTI-RES BLOCK

STREET FOUR

STREET THREE

STREET FIVE

STREET SIX

PARK

SWM FACILITY 5914

SWMF 5915

LID 5917

STREET ONE

STREET TWO

STREET SEVEN

STREET EIGHT

BEAVER CREEK ROAD

Stage 1

Stage 2

Stage 3

Stage 4

Stage 5

Beaver Creek

Laurel Creek

Floodline

Surveyed Wetland

NOTE:
AREA 3102 WILL DRAIN TO OFF-SITE SWM FACILITY 5106.

SWM FACILITY 5106 (TO BE DESIGNED)

2009 *

3914	12.088
3915	1.895
4915	0.756
3102	8.434
3911	20.299
3092	4.036
4914	2.593
9914	2.140
4917	1.436
3917	1.137
3911	-
3093	0.7
3103	0.2

LEGEND

- SUBJECT LANDS (55.714 ha)
- MAJOR OVERLAND FLOW ROUTE
- * EROSION HOURS NODE
- 391x / 1.000 – AREAS DRAINING TO SWM OR LID FACILITIES
- 491x / 1.000 – AREAS DRAINING TO BEAVER CREEK UNCONTROLLED
- 9914 / 2.140 – AREA DRAINING TO LAUREL CREEK UNCONTROLLED

FIGURE 4.2

Date: JUL.05/17
Scale: 1:3000

NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

DETAILED POST DEVELOPMENT SITE CATCHMENT AREAS

MTE
Engineers | Scientists | Surveyors

Project No.: 39502-104

July 5, 2017 — 10:49 a.m. — Plotted By: ktaylor

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5.0 STORMWATER MANAGEMENT DESIGN

5.1 Hydrologic Modeling

In order to quantify the hydrologic characteristic of the Primary Study Area (PSA) and the surrounding areas, an existing conditions hydrologic model was prepared as part of the NWSSS using the GAWSER (version 6.9.12) modeling platform. This model was then updated to reflect assumed proposed conditions and SWM strategies in the PSA to create a proposed hydrologic model. Both continuous and single event simulations were run. The proposed development conditions were modeled for the:

- Quality event (25mm depth, 4hr Chicago distribution)
- 2yr, 5yr and 100yr return period 24 hour SCS Type II distribution hyetographs derived from historical data from the Guelph Arboretum.
- Regional storm event (48hr, 285mm depth - Hurricane Hazel)
- 54-year continuous simulation period (meteorological data set from Waterloo Wellington Airport 1951-2005)

Refer to **Appendix A** for the relevant design parameters and design sheet calculations. The post-development design event modeling is included in **Appendix B**, and the post-development continuous simulation modeling is included in **Appendix C**.

5.2 Stormwater Quality Control

Stormwater Management Facility 5914 has been designed as a wet pond with a permanent pool depth of 1.5m. The wet facility will incorporate a sediment forebay with a depth of 1.5m, which offer benefits of dilution and settling of sediment. A planting scheme will be prepared that carefully selects plant species and their location in and around the basins to stabilize banks, mitigate temperate increases, deter waterfowl from nesting within the area, and provide aesthetics and safety benefits.

Since the majority of annual rainfall occurs in storms less than or equal to a 25mm event, the majority of water borne sediment is also transported to the stormwater management facilities in these less intense events[1]. Therefore, the sediment forebay is designed targeting the smaller flows. Furthermore, since larger storm events will have greater peak flows, there is potential for re-suspension of accumulated sediment. Thus, the smaller flows into the forebay should be separated from the larger flows which should enter the main pond directly. To achieve this objective, an appropriately sized splitter structure upstream of the forebay is proposed.

Sizing of a splitter structure by simply sizing the outlet pipes based on their free flowing (Manning's) capacities often results in 'washout' of the forebay (and costly remediation) due to larger flows that result from surcharging of the splitter structure. The design of the splitter structure for this project incorporates both free flowing pipe capacities (i.e. assuming no surcharge and using Manning's equation) as well as the effects of head buildup within the splitter structure and associated discharge pipes.

1 From MOE-1994, Figure C.1: 62% less than 5mm, 78% < 10mm, 90% < 15mm and 97% < 25mm

The forebay design is based on classic particle settling and flow dispersion equations as presented in the MOE 2003 *Stormwater Management Planning and Design Manual*. The methodology presented in that document suggests that the design flow for the forebay should be taken as the peak outflow from the facility. A forebay is typically designed to treat minor storm flows. Therefore, the main pond will essentially be empty (or at its permanent pool level) and there will be no mass of water at the outlet of the forebay that would control the flow through the forebay to the main pond's discharge rate.

This being the case, the design of the forebay should be based on the notion that the flow into the forebay equals the flow through the forebay, which equals the flow out of the forebay. In using this approach, the recommended settling velocity of 0.0003m/s (from MOE 2003) results in extremely large and un-achievable forebay lengths. Therefore, the forebay is designed to satisfy the following four conditions:

- Settling length based on a settling velocity of 0.0003m/s using the main pond peak discharge for the 25mm event (as per MOE 2003).
- Settling length based on a settling velocity of 0.0055m/s using the forebay inflow/outflow for the 25mm event.
- Dispersion length such that, based on flow and depth of water, the velocity through the forebay is less than 0.5m/s.
- Velocity based on flow divided by cross-sectional area is less than 0.15m/s to prevent scouring.

The 2003 MOE document suggests that the clean-out frequency for a stormwater management facility be based on the sediment loading within the entire pond, however, it is recommended that the clean-out frequency be based on the loadings within the forebay only. While this typically results in more frequent clean-out, it is restricted to the forebay area only and avoids disturbance of the main pond. The clean-out frequency for the proposed SWM facilities can be found in the respective forebay design calculations in **Appendix A**.

5.2.1 Facility 5914

Overall catchment area 3914 totals 16.821 ha, as shown on **Figure 4.1**. Of this total, the drainage area to Facility 5914 is 12.088 ha at 61.0% imperviousness. Additionally, due to site grading, the rear yards and back half of the roofs do not drain to the pond and are included in catchment 9914 (2.140 ha at 35.2% impervious to Laurel Creek catchment 3092) and in catchment 4914 (2.593 ha at 38.9% impervious to Beaver Creek catchment 3911), as shown on **Figure 4.2**.

MOE requires 204m^3/ha of total storage for an enhanced wet pond, 40 m^3/ha of which is extended detention, so the required permanent pool and extended detention volumes for Facility 5914 are therefore 1,982.4m^3 and 483.5m^3, respectively.

The forebay and main pond have permanent pool volumes of 372m^3 and 2,401m^3, respectively, for a total permanent pool volume provided of 2,773m^3. In order to provide 48-hour extended detention for 483.5m^3 of storage, an 80mm orifice was utilized.

BEAVER CREEK

30m WETLAND SETBACK

10m DRIPLINE SETBACK

FLOODLINE

DICBMH 207
T/G-345.5

MH 206

PROVIDE MIN. 1% OUTLET DITCH

50m-DUAL COOLING TRENCH

375mmØ COOLING TRENCH PIPE

HW208
INV=345.85
450mmØ OUTLET PIPE

CONTROL MH 205
T/G=348.00

INV=345.00
450mmØ BOTTOM DRAW PIPE

INV=344.50

15m-OUTLET WEIR
INV=347.45m

SWM BLOCK 22
P.P=346.00

6m-FOREBAY WEIR
w/CUT-OFF WALL
INV=346.00m

FOREBAY

PUMPING STATION BLOCK 21

PARK BLOCK 18

SINGLE FAMILY LOTS

3m TRAIL

200m HIGH CURB (BOTH SIDE OF ACCESS AS SHOWN)

HW 204

1050mmØ @ 0.5%

HW 203

750mmØ @ 1.25%

SPMH 202

1050mmØ @ 0.8%

450mmØ @ 0.5%

MH 201

825mmØ @ 0.5%

900mmØ @ 0.35%

STREET SIX

DEPRESSED CSW & BLVD.

MULTIPLE RESIDENTIAL BLOCK 15

SINGLE FAMILY LOTS

'A'

LEGEND

- SWM BLOCK BOUNDARY
- EXISTING CONTOURS
- PROPOSED CONTOURS
- (346.00)EX — EXISTING SPOT ELEVATIONS
- (346.00) — PROPOSED SPOT ELEVATIONS
- GABION MAT
- PERMANENT POOL ELEV=346.00
- MAJOR OVERLAND FLOW ROUTE
- ACCESS ROAD

NOTE:
THIS FIGURE TO BE READ IN CONJUNCTION WITH FIGURE 4.2

FIGURE 5.1 Scale: 1:500

NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

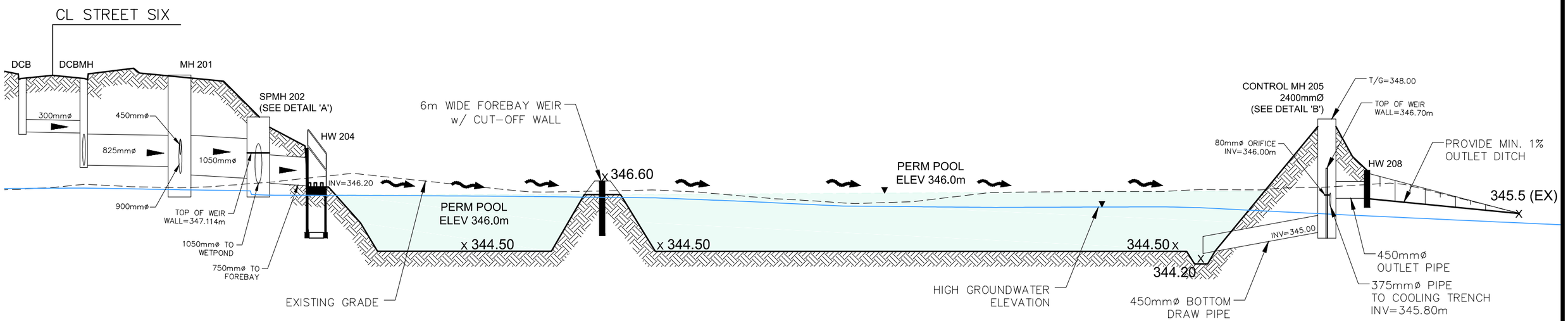
PRELIMINARY SWM FACILITY 5914 DESIGN

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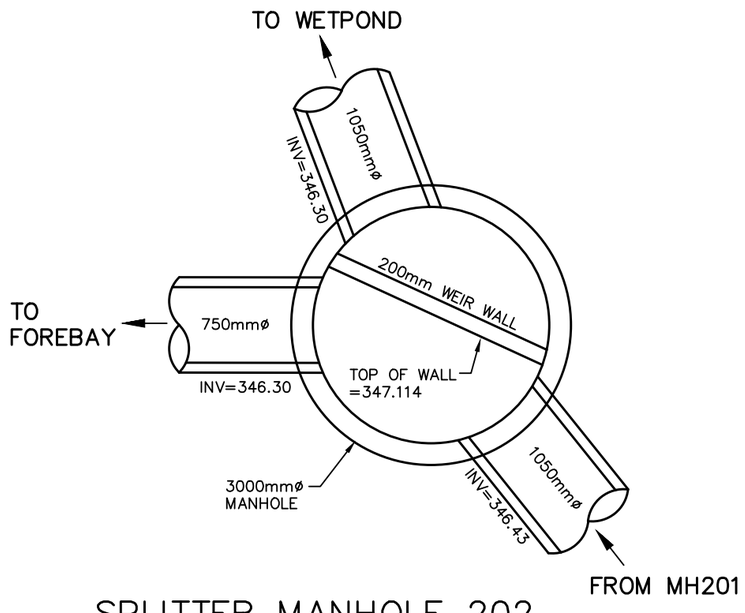
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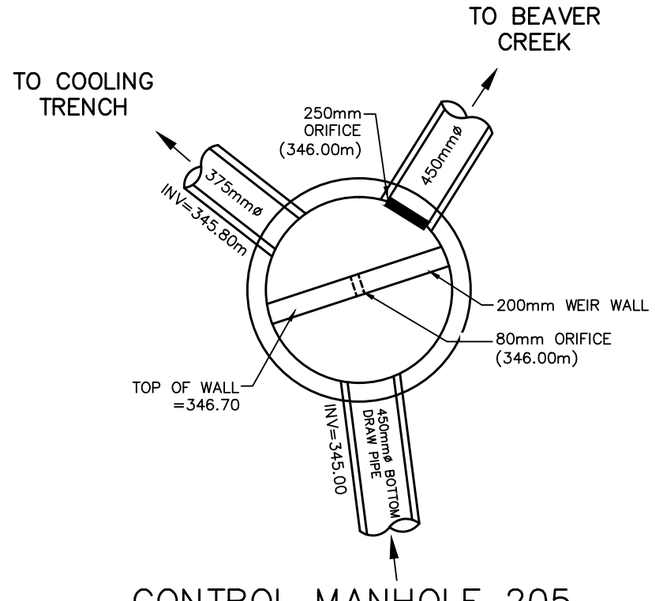


SWM FACILITY SECTION 'A-A'

SCALE H=1:500
V=1:100



SPLITTER MANHOLE 202
DETAIL 'A'
N.T.S.



CONTROL MANHOLE 205
DETAIL 'B'
N.T.S.

NOTE:
THIS FIGURE TO BE READ IN
CONJUNCTION WITH FIGURE 4.1

FIGURE 5.2 Scale: AS NOTED

NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

PRELIMINARY SWM FACILITY 5914 DESIGN

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Project No.: 39502-104

Stormwater Management Facility 5914 design characteristics are summarized in **Table 5.2**. Refer to **Figure 5.1** and **Figure 5.2** for details of Facility 5914.

5.3 Stormwater Quantity Control

Flows for all storm events will be conveyed to the stormwater management facilities by a combination of storm sewer and overland flow route (road right-of-way). The post-development GAWSER design event modeling output is included in **Appendix B**.

5.3.1 Facility 5914

A multi-stage outlet structure has been proposed for use in this facility. A 450mm diameter reverse sloped bottom-draw outlet pipe, complete with an 80mm diameter orifice inside control MH205, will provide extended detention control, as well as, peak flow control for the 2 and 5 year storm events. A 250mm diameter orifice is provided inside control MH205 on the 450mm diameter storm pipe to HW 208. This orifice will provide peak flow control for the storm events larger than the 5 year. An emergency overflow weir (15m wide) will allow the Regional Storm to pass through SWMF 5914.

The peak ponding elevation, storage, and outflow for Facility 5914 for the various design storms are shown in **Table 5.1**.

TABLE 5.1 - PROPOSED EVENT MODEL OUTPUT – FACILITY 5914

Storm Event	Maximum Ponding Elevation (m)	Peak Storage Requirement (m^3)	Allowable Peak Outflow (L/s)	Peak Outflow (L/s)
25 mm Storm Event	346.09	240	-	2.9
2 Year Storm Event	346.49	1,475	13.30	9.3
5 Year Storm Event	346.74	2,372	120.88	50.9
100 Year Storm Event	347.38	5,052	664.84	159.1
Regional Storm Event	347.62	6,166	-	1687.9

It should be noted that there are significant areas around the outer boundary of the multi-residential blocks that could not be directed to the proposed stormwater management facilities due to grading constraints. These areas (4915 and 4917), specifically rear yards and embankments, were included in the post-development model as draining un-controlled towards Beaver Creek catchment area 3911, thus ensuring valid water balance and erosion hour values. Refer to **Figure 4.2** for these catchment areas.

TABLE 5.2 - DESIGN CHARACTERISTICS – FACILITY 5914

General	Facility Characteristics
Stormwater Management Facility Type	Wet Pond
Required MOE Water Quality Protection	Enhanced
Total Contributing Area	12.088 ha
Imperviousness	61.0%
Bottom Elevation (of main facility)	344.50m
Storage	
Unit Area Storage Volume Requirements as per SWMMP (MOE 2003)	204 m^3/ha
Required Total Volume	2,466m^3
Permanent Pool	
Required Permanent Pool Volume	1,982m^3
Permanent Pool Volume Provided	2,773m^3
Permanent Pool Elevation	346.00m
Extended Detention (MOE)	
Minimum Required Volume	483.5m^3
Approximate Drawdown Time (for MOE Table 3.2 requirement)	47 hr
Extended Detention Elevation	346.18m
Peak Release Rate for Extended Detention	0.0052 m^3/s
Forebay	
Required Forebay Length	18.3m
Actual Forebay Length	27.5m
Permanent Pool Elevation	346.00m
Bottom Elevation	344.50m
Outlet Controls	
Orifice 1 Diameter (Extended Detention)	80mm
Orifice 1 Invert Elevation (MH205)	346.00m
Orifice 2 Diameter	250mm
Orifice 2 Invert Elevation (MH205)	345.90m
Outlet Weir Length	15m
Outlet Weir Elevation (Quantity Control)	347.45m

5.4 Erosion Exceedance Analysis

As previously discussed, an erosion threshold analysis was completed on two sensitive reaches (BC-2 and BC-4) of Beaver Creek. BC-4 is located at the downstream extend of the primary study area, immediately prior to the confluence with Laurel Creek. As discussed in the NWSSS, the threshold flows related to bank destabilization are lower the those for the creek bed, so the use of the bank flows as targets was used as a more conservative approach.

The critical bank and bed threshold exceedance flows for reach BC-4 are 310 L/s and 660L/s respectfully, and their existing conditions hours of exceedance (per year) are 188 and 83, respectively (Table 11.6 - NWSSS, 2013). From the post-development continuous model, the post-development yearly hours of exceedance under the proposed stormwater management scheme are 192 and 82, respectively. *Is should be noted that the proposed conditions modeling completed as part of the NWSSS predicted yearly hours of exceedance for BC-4 of 196 and 83*. As described above, the revised proposed development continuous modeling (including the Northgate lands SWM strategy) has slightly lowered the NWSSS erosion exceedance duration.

5.5 Water Balance Analysis

During urban development, the conversion of pervious, vegetated area to impervious surfaces leads to a decrease in evapotranspiration and infiltration volumes and an increase in runoff volumes. The NWSSS established that both existing infiltration rates and existing surface water inputs to key natural features were to be maintained in the post-development condition.

Surface Water

The purpose of the surface water balance analysis is to identify potential impacts of the proposed development on the existing wetland feature (PSW) located near the central portion of the subject property. The balance is to address the potential concern that changes in catchment area limits and surface cover may interfere with the surface conditions. The hydrologic components (ET/R/I) used for the analysis were taken from Table 11.5 of the NWSSS.

Figure 5.3 illustrates the existing surface water catchment areas for the central wetland. The pre-development surface water catchment area for the subject wetland was delineated into a western and eastern portion and also into catchments with similar existing topography, cover, and soil conditions. The on-site contributing area for the western and eastern portions was determined to be approximately 20.3ha and 12.7ha respectively, generating a total average annual runoff volume of 15,972m^3 and 10,756m^3 respectively. Calculations have been included in **Appendix D.**

Figure 5.4 illustrates the proposed conditions contributing drainage areas. Under post-development conditions, surface water contributions to the wetland include:

- runoff from the forested wetland and wetland setback.
- the open space areas adjacent to the wetland outside of the wetland setback.
- roof and rear yard runoff from adjacent lots directed to the wetland (39 lots adjacent to the western wetland and 8 lots adjacent to the eastern wetland).

A total post-development runoff volume for the western and eastern wetlands of approximately 15,986m^3 and 10,906m^3 respectively was calculated based on the contributions from these areas. This represents a slight increase in total average annual runoff volume directed to the western and eastern wetland, of approximately 14m^3 (an increase of 0.1% annually) and 150m^3 (an increase of 1.4% annually).

Infiltration

The infiltration strategy identified for the subject development area is an enhancement over the current average annual volumes for the respective catchments. To that end, there are a variety of SWM practices that will be implemented within the development lands to achieve the infiltration targets that will include Lot Level Controls, Conveyance Controls, and End-of-Pipe Controls.

Lot Level Controls

The lot level system will include amended topsoil (increased depth of topsoil) and infiltration facilities connected to roof areas.

Amended Topsoil

Amended topsoil is a lot level, non-structural stormwater management practice that involves directing roof downspouts to gently sloping landscaped areas that contain topsoil of sufficient permeability, depth (a topsoil depth of 450mm has been proposed) and quality to infiltrate and evaporate a significant portion of runoff during wet weather. The majority of the single family lots have been proposed with this practice, with the exception of lots adjacent to the central wetland that are required for surface water inputs to the wetland.

Multi-Residential Block Infiltration Facilities (Catchment 3914)

The multi-residential Block facilities have been designed to accept 25mm of runoff from the contributing roof area, which at preliminary design is assumed to be a total of 2750m^2. The volume to area relationship modeled in GAWSER assumes a 0.4 void ratio. The facilities are to be oversized by 15% to provide some volumetric and infiltration capacity redundancy to allow for potential loss in performance over time. Runoff is to be directed to the infiltration facilities through direct connection of the roof leaders, and each facility will contain overflows to the storm sewer system.

Lot level infiltration galleries located within condominium blocks will be placed in a “common element”, and will likely consist of a series of independent infiltration galleries located within appropriate areas of the site (pervious areas, under parking lots, etc.). Given the relatively small size of the rear yard areas, the galleries will likely be constructed using a commercial subsurface storage system in order to provide the necessary volumetric efficiency. Runoff will enter the galleries through direct connection of roof leaders. The common element infiltration facilities are also to be oversized by 15%.

Conveyance Controls

Conveyance controls will include an infiltration gallery located with Park Block 20, and permeable pavement located in the future Condo Block (east leg of Stage 5).

Conveyance Infiltration Facility (Catchment 3914)

Figure 5.5 illustrates the catchment area for the proposed conveyance gallery. This facility has been designed such that the contributing area (Area 88914 - 2.556 ha) produces no runoff during the 4 hour, 25 mm design storm event. The design of the facility will use a flow-based design approach whereby the volume and contact area of the infiltration galleries will need to be such that the 4 hour, 25 mm design storm event can be contained within the facility with no overtopping. The post-development hydrologic modeling that accompanies this report reflects this design philosophy. To add a factor of safety to the proposed design, a 15% increase in volume is to be provided in the final design over the volume required per the hydrologic modeling. A typical arrangement for the conveyance infiltration facility has been illustrated on Figure E1 in **Appendix E**. The facility will include a pre-treatment device (oil-grit separator).

Permeable Pavement
Permeable pavement is a variation on traditional pavement design that utilizes pervious paving material underlain by a uniformly graded stone reservoir. The pavement surface may consist of permeable asphalt, permeable concrete, or permeable interlocking concrete pavers and prevents the generation of runoff by allowing precipitation falling on the surface to infiltrate into the stone reservoir, and then into the underlying soil. Although there is some concern with permeable pavements for groundwater contamination, this practice has only been proposed for future Condo Block (east leg of Stage 5), as the condominium road will have very low traffic volumes.

Since this conveyance control is located within a Block that will go through a Site Plan Approval process (and has only been conceptually designed and modeled as part of this study), sizing criteria has been included in Section 5.8.

End-of-Pipe Controls
The end-of-pipe facilities will consist of a volume reduction pond for sub-catchment 3915, and a bio-swale for sub-catchment 3917. The volume reduction pond has been proposed downstream of a quality control device (oil-grit separator), and has been designed to produce no runoff during a 4 hour, 25mm design storm event. Also, a bio-swale has been proposed for future Condo Block (east leg of Stage 5), to infiltrate any excess runoff from front yards/driveways within the future cul-de-sac.

Again, since these stormwater management controls are located within Blocks that will go through a Site Plan Approval process (and has only been conceptually designed and modeled as part of this study), sizing criteria has been included in Section 5.8.

The post-development GAWSER modeling has been utilized in order to determine whether the specified infiltration measures will achieve the criteria within the subject site. Table 5.3 summarizes the post-development water balance resulting from the implementation of the proposed design measures.

TABLE 5.3 - POST-DEVELOPMENT INFILTRATION VALUES BY CATCHMENT

Condition	Hydrologic Component Values (mm/yr)		
	Catchment 3914	**Catchment 3915**	**Catchment 3917**
Precipitation	844.8	844.8	844.8
Existing Conditions Infiltration	211.9	222.9	177.0
NWSSS Infiltration Value	262.2	266.7	240.8
Proposed Infiltration Value	*280.3*	*371.4*	*305.6*

As can be seen from the summary table, implementation of the proposed infiltration measures results in an annual average infiltration depth of that exceeds the pre-development values and the NWSSS values for all catchments.

CONSERVATION DRIVE

CROPLAND

B1
10.65

WESTERN
WETLAND

A
7.22

Surveyed Wetland

Laurel Creek

Floodline

Beaver Creek

Floodline

Surveyed Wetland

CROPLAND

B2
1.21

CROPLAND

E2
1.13

CROPLAND

C1
0.62

WOODLOT

C2
0.57

WOODLOT

D
9.86

EASTERN
WETLAND

Surveyed Wetland

CROPLAND

E1
1.68

BEAVER CREEK ROAD

Laurel Creek

N

– SUBJECT LANDS
(55.714 ha)

WEST LOBE (A, B & C)

– PRE–DEVELOPMENT
WATER BALANCE AREA

– TOTAL 20.27 ha

EAST LOBE (D & E)

– PRE–DEVELOPMENT
WATER BALANCE AREA

– TOTAL 12.67 ha

FIGURE 5.3

Date: JUL.05/17
Scale: 1:3000

NORTHGATE & ERBSVILLE
KARTWAY SUBDIVISIONS

Pre-Development
Surface Water Balance Areas

MTE
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Project No.: 39502-104

July 5, 2017 — 10:57 a.m. — Plotted By: ktaylor

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CONSERVATION DRIVE

BEAVER CREEK ROAD

REAR YARD

Surveyed Wetland

Beaver Creek Floodline

Laurel Creek Floodline

WESTERN WETLAND

EASTERN WETLAND

WOODLOT

* 4 ROOFS (200m2)
4 ROOFS (240m2)
REQUIRED TO MEET SURFACE WATER BALANCE FOR THE EASTERN LOBE.

* 17 ROOFS (200m2)
22 ROOFS (240m2)
REQUIRED TO MEET SURFACE WATER BALANCE FOR THE WESTERN LOBE.

SOUTH SIDE OF ROAD TO DRAIN THROUGH CULVERTS UNDER PROPOSED CONDITION.

1	7.31
2.1	1.44
2.2	0.49
3.1	1.39
3.2	0.57
4	9.93
5	0.68
6	0.42

– SUBJECT LANDS (55.714 ha)

WEST LOBE (1, 2 & 3)

– POST–DEVELOPMENT WATER BALANCE AREA

– NON–ROOF 11.20 ha – ROOF 0.87 ha

EAST LOBE (4, 5 & 6)

– POST–DEVELOPMENT WATER BALANCE AREA

– NON–ROOF 11.03 ha – ROOF 0.18 ha

FIGURE 5.4

Date: JUL.05/17
Scale: 1:3000

NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

Post-Development Surface Water Balance Areas

MTE Engineers | Scientists | Surveyors

Project No.: 39502-104

July 5, 2017 — 11:13 a.m. — Plotted By: ktaylor

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5.6 Thermal Mitigation

The main methodology of the thermal mitigation plan that was proposed as part of the NWSSS, was to infiltrate warmed stormwater below ground level where cold groundwater and/or relatively colder ambient temperatures will cool the stormwater, lowering the average stormwater temperatures prior to discharge to natural features.

The following measures have been proposed for the subject lands, and in combination will achieve the specified criteria.

Lot Level Infiltration
The majority of the stormwater runoff that is generated at the lot-level via roofs, driveways, and yards will be effectively disconnected from the creek during all rain events up to a 25 mm depth through the proposed at-source infiltration measures (amended topsoil and infiltration galleries).

Conveyance Infiltration
Approximately 2.5 ha of the development will be designed to be completely disconnected from the creek during all rain events up to a 25 mm depth by means of subterranean manufactured infiltration chambers located within the Park Block.

SWM Facility Design Features
The final component to address temperature concerns will be the design features that are incorporated into the end-of-pipe SWM facility. For Facility 5914, MTE is proposing a cooling trench as part of the thermal mitigation plan. The cooling trench will be located downstream of the SWM facility (to ensure maximum water quality treatment) and will take the form of a rock filled trench that will treat all flows from a 25mm storm event. To obtain maximum cooling effects, the proposed cooling trench will be located below the water table. MTE has completed monitoring of several cooling trenches designed and constructed over the past few years. Generally, if cooling trenches can be constructed in the water table and sized sufficiently large enough, and the inlet flows are restricted, then cooling of the surface discharge will be mitigated to achieve the target temperatures for frequent storm events.

Cooling infrastructure is to be designed to achieve an average discharge temperature that is equal to or less than the average stream temperature, for all storms up to the 25mm design storm event for normal climatic conditions. However, note that anomalous climatic conditions (i.e. ambient temperatures exceeding historical average temperatures, storm events larger than 25mm or back-to-back storms with sufficient volume) may influence discharge temperatures.

A conceptual heat transfer model has been prepared to estimate the performance of the cooling trenches during the 25mm storm event. A hard copy of portions of the model (to show the relevant parameters and pertinent design iteration) has been included in **Appendix F**. The model estimates a reduction in discharge temperature across the cooling trench, with an average flow-weighted discharge of approximately 22°C, and a maximum discharge temperature of 23.5°C. This model assumes that the inflow will be sent to a single cooling trench at 1m width, 1m height, and 50m long.

Other features to assist in reducing the temperature of surface runoff from the site are:

- Bottom draw outlet for cooling benefits resulting from thermal stratification within the facility.
- SWM facility perimeter plantings to be incorporated in the landscaping design for the facility.

MULTI-RESIDENTIAL
BLOCK INFILTRATION FACILITY
26.7m³/46m² (4.8x10.9m)

CONSERVATION DRIVE

2004

7914
0.275

MULTI-RESIDENTIAL
BLOCK INFILTRATION FACILITY
41.4m³/67m² (4.8x15.2m)

Roof/550m2

MULTI-RES BLOCK

STREET FOUR

88914
2.556

PARK

STREET THREE

STREET FIVE

STREET SIX

SWM FACILITY 5914

SWMF 5917

END-OF-PIPE CONTROL
VOLUME REDUCTION POND

STREET ONE

STREET TWO

BEAVER CREEK ROAD

CONVEYANCE INFILTRATION FACILITY

73914
4.506

STREET SEVEN

STREET EIGHT

END-OF-PIPE CONTROL
BIO-SWALE

LOT LEVEL CONTROL
AMENDED TOPSOIL
(450mm DEPTH)

CONVEYANCE CONTROL
PERMEABLE PAVEMENT

LID 5917

LOT LEVEL INFILTRATION FACILITY (Stone)
190m³/130m² (5.2x25.0m)

Stage 1
Stage 2
Stage 3
Stage 4
Stage 5

Laurel Creek
Floodline
Beaver Creek
Surveyed Wetland

LEGEND

- SUBJECT LANDS (55.714 ha)
- INFILTRATION GALLERY
- 7914 / 0.275 – ROOF AREAS DRAINING TO MULTI-BLOCK INFILTRAION GALLERIES
- * – EROSION HOURS NODE
- 73914 / 4.506
- 88914 / 2.556 – AREA DRAINING TO PARK BLOCK CONVEYANCE INFILTRATION GALLERY
- AMENDED TOPSOIL; AREA = ROOFS & TOTAL YARDS.

FIGURE 5.5

Date: JUL.05/17
Scale: 1:3000

NORTHGATE & ERBSVILLE
KARTWAY SUBDIVISIONS

DETAILED POST DEVELOPMENT
INFILTRATION MEASURES - 5914

MTE
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2004 *

CONSERVATION DRIVE

END-OF-PIPE CONTROL
Volume Reduction Facility

BIRD CORRIDOR (215m)

MULTI-RES BLOCK

3915
1.895

SWMF
5915
Stage 2

STREET ONE

Stage 2

END-OF-PIPE CONTROL
Bio-swale (320m^2);
0.224 ha Landscape island
1.575m storage depth
202m^3 total volume

CONVEYANCE CONTROL
Permeable Pavement;
0.356 ha Roadway
0.64m storage depth
671m^3 total volume

OPEN SPACE

LID
5917
Stage

3917
1.137

CONDO BLOCK

Beaver Creek

Floodline

Floodline

LOT-LEVEL
Subsurface Infiltration Gallery (7 roofs);
190m^3 total volume (Stone)
5.2m W x 25m L x 1.5m D

STREET TWO

2009 *

Laurel

N

LEGEND

- SUBJECT LANDS (55.714 ha)
- * EROSION HOURS NODE
- VOLUME REDUCTION FACILITY (5917)
- BIO-SWALE (5917)
- PERMEABLE PAVEMENT (5917)

FIGURE 5.6

Date: JUL.05/17
Scale: 1:2500

NORTHGATE & ERBSVILLE
KARTWAY SUBDIVISIONS

CONCEPTUAL BLOCK LEVEL
SWM (5915 & 5917)

MTE
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5.7 Landscape Design

A landscape design for the proposed stormwater management facility (Facility 5914) will be completed during the final design stage of the development. The reasons for landscaping these facilities are aesthetics, erosion protection and long term bank stability, and to limit pedestrian access into their permanent pool components. To that end, the facility will be designed in accordance to the City of Waterloo's Stormwater Management Policies and Guidelines for aesthetics, landscape and safety of stormwater management facilities.

5.8 Block Level Stormwater Management Approach

The proposed draft plans of subdivision for the subject property contains a number of Blocks that will be developed through a Site Plan Approval process. As part of that process, a detailed Stormwater Management Plan will be prepared showing how the stormwater control measures will adhere to the NWSSS criteria and be implemented within the Block. Two of these Blocks will contain future stormwater management facilities. To facilitate this process and ensure adherence with the NWSSS criteria, the following summarizes the overall approach for stormwater management for the two Blocks that will contain future stormwater management facilities:

Water Quality Control
Provide an *Enhanced* level of stormwater quality control. This can be achieved via an oil-grit separator for SWMF 3915. The oil-grit separator will target 80% TSS removal for the storm drainage area draining to the volume reduction basin.

Water Quantity and Erosion Control
Post-development peak flows must be controlled to unit flow rate targets for the 2yr, 5yr and 100yr storm events. Refer to Table 3.1 for allowable unit flow targets

SWMF3915 - Water quantity control is expected to be achieved via a volume reduction pond, complete with a multi-stage outlet structure.
SWMF 3917 – Water quantity control is expected to be achieved via a number of LID practices including permeable pavement and a bio-swale.

Water Balance
Infiltration – maintain or enhance existing recharge rates across the development area.

SWMF 3915 - The volume reduction basin has been preliminarily sized such that no runoff is produced under a 4 hour, 25mm storm event. An infiltration rate within the facility block of 15mm/hr has been assumed as part of this design. Suitable soils must be provided, either through selective filling during area grading or replacement of existing soils that are not acceptable.

SWMF 3917 – Groundwater recharge is expected to be achieved via a number of LID practices including permeable pavement and a bio-swale.

Thermal Mitigation
Provide temperature mitigation measures prior to discharge to the receiving systems.

SWMF 3915 and 3917 - Thermal mitigation is achieved through infiltration of all rainfall occurring up to and including the 4 hour, 25mm storm event.

6.0 MONITORING PROGRAM

In accordance with the recommendations of the NWSSS, a monitoring program is to be designed and implemented by the developer. The plan will serve to ensure that the mitigation measures proposed within the development are implemented and performing at an acceptable level, and will also help to communicate performance and understand potential impacts.

Based on the framework provided in the LCWS, the City of Waterloo has implemented the following monitoring strategy:

1. ***System Monitoring*** – undertaken by the City
2. ***Development / During Construction Monitoring*** – The developer is responsible for monitoring during the development process and includes 3 stages;
   - Pre-Construction Monitoring
   - During-Construction Monitoring
   - Post-Construction Monitoring
3. ***Post-Development Monitoring*** – the City is responsible for monitoring facilities following municipal assumption.

6.1 Pre-Construction Monitoring Program

With reference to the NWSSS, the pre-construction monitoring program consists of stream temperature monitoring, water quality sampling (surface and ground water), ground water level monitoring, and streamflow rate monitoring. This stage of the monitoring program has been completed by Stantec with annual monitoring reports prepared since 2014.

6.2 During-Construction Monitoring Program

This stage will begin at the commencement of area grading of the subdivision and will continue until 90% stabilization of the SWM Facility contributing catchment area is achieved (buildings are constructed, lots are sodded). Monitoring will include:

- **Stormwater Management Facility** - Standard inspection of vegetation, structures, and general operation of hydraulic controls (observations of drawdown) within the Stormwater Management Facility. These inspections are to occur seasonally and typically after a significant rainfall event.
- **Erosion and Sediment Control** – per ESC Plans.
- **Groundwater** – monitoring will include levels and quality.

6.3 Post-Construction Monitoring Program

This period of the monitoring will begin following full build-out of the subdivision (i.e. houses are constructed, lots are sodded, open spaces are stabilized) for a duration of 2 years. The purpose of this stage of the monitoring is to ensure that the SWM Facility continues to operate as designed and that the groundwater elevations within the site are within acceptable levels of what was predicted. Monitoring during this stage will include:

- **Stormwater Management Facility** - Standard inspection of vegetation, structures, and general operation of hydraulic controls (observations of drawdown) within the Stormwater Management Facility. These inspections are to occur seasonally and typically after a significant rainfall event.
- **Groundwater** – monitoring will include levels and quality.

CONSERVATION DRIVE

NOR-MW8-10D
NOR-MW8-10S
NOR-MW101-14
NOR-MW103-14
NOR-MW105a-14
NOR-MW105b-14
NOR-MW102-14
NOR-MW111-14
NOR-MW104-14
NOR-MW10-10
NORTHGATE SUBDIVISION
NOR-MW106-14
NOR-MW108-14
NOR-MW110-14
NOR-MW17-14
NOR-MW109a-15
NOR-MW109b-14
NOR-MW12-10D
NOR-MW12-10S
NOR-MW13-10
NOR-MW100-14

Beaver Creek
Laurel Creek
BEAVER CREEK ROAD

LEGEND

- SUBJECT LANDS (55.714 ha)
- WATER LEVEL MONITORING
- NOR-MW100-14 – WELL IDENTIFICATION

FIGURE 6.0

Date: JUL.05/17
Scale: 1:3000

NORTHGATE & ERBSVILLE KARTWAY SUBDIVISIONS

PRE-CONSTRUCTION GROUNDWATER MONITORING

MTE
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7.0 EROSION AND SEDIMENT CONTROL MEASURES

Precautions will be taken during construction to limit erosion and sedimentation. The final details of the erosion and sediment control plan will follow the *Erosion & Sediment Control Guideline for Urban Construction* document and will be provided during final design. The plans will illustrate the erosion and sediment control measures to be implemented during construction, which will limit impacts associated with site development.

Typically, the recommended construction sequence for erosion and sediment control measures will be as follows:

- Placement of all sediment control fencing where required.
- Stripping and strategic placement of topsoil stockpiles. Placement of sediment control fencing around all stockpile areas.
- Construction of temporary sediment control ponds which will serve as sedimentation basins for the site during construction.
- Construction of temporary swales to direct runoff to sedimentation basins, with rock check dams as required to control velocities.
- Re-vegetation of completed areas as soon as possible after construction, including those areas not slated for construction within 60 days.

Where rock check dams are proposed to promote sedimentation and reduce velocities, clean aggregate is to be placed perpendicular to the direction of flow in the swale, with a small volume of excavation on the upstream side to provide storage for accumulated sediment.

Sediment control fencing shall consist of filter fabric attached to page wire fencing and sealed at ground level. It will be installed at the perimeter of the work areas and intermittently on sloped areas where required. Sediment control fencing will be placed around all topsoil stockpiles.

Storage consistent with the GRCA's requirement of 125m^3/ha of live and dead storage respectively (total 250 m^3/ha), will be provided. This storage will be provided to ensure that suspended material will have ample time to settle out. In addition, the sediment basin will be sized with sufficient capacity to allow flows to pass without breaching. Once the active construction and grading activities have been completed, the sedimentation basins can be cleaned out.

Access to topsoil or fill storage areas will be located on the upstream side of storage piles. This practice will ensure continuity of the sediment control fencing in the downslope direction which is most vulnerable to erosion and sediment deposition. Further, topsoil and hydroseed will be placed on all exposed areas following the completion of grading activities.

It is recommended that during construction, monitoring and inspection of the erosion and sediment controls be conducted to ensure the satisfactory performance of these measures. Reporting of the inspection and monitoring results should be distributed to the City of Waterloo and the GRCA. If it is found that the erosion and sediment control measures are not working adequately, they shall be augmented to the satisfaction of the City of Waterloo and the GRCA, based on field decisions.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the foregoing analyses, it is concluded that:

1. The storm water management strategy outlined herein will provide the Northgate and Erbsville Kartway developments with appropriate levels of quality, quantity, erosion, water balance and temperature control.

2. “Enhanced” quality control of storm water runoff can be provided in the proposed stormwater management facility.

3. Quantity control targets for post-development peak flows as identified through the current conditions GAWSER modeling can be achieved in the proposed stormwater management facility for the 2 year through the 100 year storm events.

4. Adequate storage and release rate control has been provided to meet the extended detention storage and drawdown requirements for the 25 mm storm events.

5. Implementing erosion and sediment controls during construction will minimize any negative impacts of construction activities on the adjacent properties and the receiving watercourse.

6. Water Balance targets can be satisfactorily met through the use of the prescribed lot-level, conveyance, and end-of-pipe infiltration measures as described within this report.

The findings of this report, and the above conclusions, lead to the following recommendations:

1. That a quality/quantity control stormwater management facility be constructed to provide control of storm water as described in **Sections 4** and **5** of this report.

2. That the Water Balance, as calculated in this report, be reviewed and re-confirmed during final design.

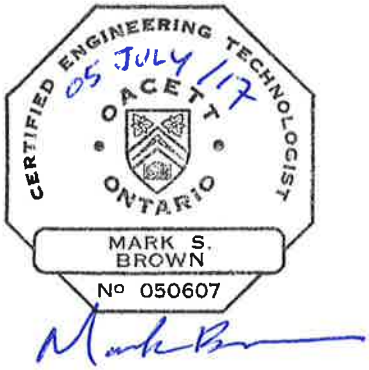
3. That during the site grading operations, soils be selectively excavated and placed, under the supervision of a geotechnical engineer, in order to maximize the post-development areas suitable for infiltration.

4. That erosion and sediment controls during construction as described in **Section 6** of this report be implemented.

5. That the conceptual design and modeling of the future stormwater management facilities contained within the subwatershed model, but beyond the scope of the report, be reviewed and re-confirmed at the time of preliminary design for those lands.

All of which is respectfully submitted,

MTE CONSULTANTS INC.



Mark Brown, C.E.T.
Designer



Garett Korber, P.Eng.
Design Engineer

APPENDIX A

SWM DESIGN CALCULATIONS

Northgate, North Waterloo

PRELIMINARY SWM DESIGN NORTHGATE LANDS POND - 5914

Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
File: Q:\39502\104\Prelim SWM\39502-104 SWM Design - Msb.xlsx

Step 1: Choose Level of Water Quality Control

Enhanced 80% long-term S.S. removal

Step 2: Choose Type of Facility

Wet Pond

Step 3: Define Catchment area and Imperviousness

Catchment Area (ha)	Imperviousness (%)
12.088	61.0

Interpolated Storage Volume Requirement (m^3/ha)

204.0

Permanent Pool Required (m^3)

1982.4

Extended Detention Volume Required (m^3)

483.5

Table 3.2 Water Quality Storage Requirements based on Receiving Waters (from MOE Stormwater Management Planning and Design Manual, March 2003)

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35	55	70	85
Enhanced 80% long-term S.S. removal	*Wetlands*	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term S.S. Removal	*Wetlands*	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term S.S. Removal	*Wetlands*	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

Northgate, North Waterloo
PRELIMINARY SWM DESIGN NORTHGATE LANDS POND - 5914
Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
File: Q:\39502\104\Prelim SWM\39502-104 SWM Design - Msb.xlsx

STAGE-STORAGE RELATIONSHIP

Stage	Active Depth	Forebay (Permanent Pool)			Main Pond			Total Pond Volume	Active Storage Volume	Volume Summary		Comments	Stage
		Area	Volume	Cumulative Volume	Area	Volume	Cumulative Volume						
m	*m*	m^2	m^3	m^3	m^2	m^3	m^3	m^3	m^3	m^3			*m*
344.50		71	0	0	1048	0	0	0					344.50
344.60		91	8	8	1116	108	108	116					344.60
344.70		111	10	18	1184	115	223	241					344.70
344.80		132	12	30	1252	122	345	375					344.80
344.90		153	14	45	1321	129	474	518					344.90
345.00		175	16	61	1391	136	609	670					345.00
345.10		197	19	80	1462	143	752	832					345.10
345.20		220	21	100	1534	150	902	1002					345.20
345.30		245	23	124	1613	157	1059	1183					345.30
345.40		274	26	150	1698	166	1225	1374					345.40
345.50		305	29	179	1784	174	1399	1577					345.50
345.60		337	32	211	1871	183	1581	1792					345.60
345.70		369	35	246	1959	192	1773	2019					345.70
345.80		403	39	285	2048	200	1973	2258					345.80
345.90		438	42	327	2137	209	2183	2509					345.90
346.00		475	46	**372**	2228	218	**2401**	2773		**2773**		Permanent Pool	346.00
346.00	0.00	475	0	0	2228	0	0	2773	0				346.00
346.10	0.10	516	50	50	2333	228	228	3051	278	240	346.09	25mm Event	346.10
346.20	0.20	559	54	103	2440	239	467	3343	570	484	346.18	MOE Extended Detention	346.20
346.30	0.30	602	58	161	2548	249	716	3651	877				346.30
346.40	0.40	647	62	224	2659	260	976	3973	1200				346.40
346.50	0.50	694	67	291	2772	272	1248	4312	1539	1475	346.49	1:2yr Event	346.50
346.60	0.60				3678	323	1571	4634	1861				346.60
346.70	0.70				3792	374	1944	5008	2235	2372	346.74	1:5yr Event	346.70
346.80	0.80				3905	385	2329	5393	2620				346.80
346.90	0.90				4016	396	2725	5789	3016				346.90
347.00	1.00				4128	407	3132	6196	3423				347.00
347.10	1.10				4240	418	3551	6614	3841				347.10
347.20	1.20				4354	430	3980	7044	4271				347.20
347.30	1.30				4469	441	4421	7485	4712	5052	347.38	1:100yr Event	347.30
347.40	1.40				4585	453	4874	7938	5165				347.40
347.50	1.50				4702	464	5338	8402	5629	6166	347.62	Regional Event	347.50
347.60	1.60				4821	476	5815	8879	6105				347.60
347.70	1.70				4940	488	6303	9367	6593				347.70
347.80	1.80				5061	500	6803	9867	7094				347.80
347.90	1.90				5180	512	7315	10379	7606		347.90	Top of Pond	347.90

Northgate, North Waterloo
PRELIMINARY SWM DESIGN NORTHGATE LANDS POND - 5914 (MAIN Wetpond)
Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
Design By: MSB
File: Q:\39502\104\Prelim SWM\39502-104 SWM Design - Msb.xlsx

Orifice Calculations

$Q_o=C_d*A_o*(2*g*H_o)^{0.5}$

	Orifice 1	Orifice 2	Orifice 3
C_d	0.63	0.63	0.63
Invert (m)	346.00	345.90	500
Width (m)	0.00	0.00	0.00
Diameter/Height (m)	0.080	0.250	0.00
Type (H/V)	V	V	V

*** Orifice 2 accepts flow at 346.700 from DICB205.1

Cd	Description
0.63	Orifice Plate
0.82	Eccentric Reducer

Weir Calculations

$Q_w = 2/3*C_d*(2g)^{1/2}*L*H_w^{3/2} + 8/15*C_d*(2g)^{1/2}*\tan\theta*H_w^{5/2}$

Cw	0.50
Invert (m)	347.45
Length (m)	15
Side Slope (H:V)	3
Side Slope (rad)	1.249

STAGE-DISCHARGE RELATIONSHIP

			Orifice 1			Orifice 2			Orifice 3							25mm event	2 year event
																Extended Detention	Erosion Control
	Stage	Active Volume	Area	H_o	Flow	Area	H_o	Flow	Area	H_o	Flow	Weir Flow	Total Flow		Average Discharge	Increment Volume	Increment Dewatering Time	Cumulative Dewatering Time	Cumulative Dewatering Time
	m	m^3	m^2	*m*	m^3/s	m^2	*m*	m^3/s	m^2	*m*	m^3/s	m^3/s	m^3/s		m^3/s	m^3	*hours*	*hours*	*hours*
	346.00	0	0.00	0.00	0.0000				0.00	0.00	0.0000	0.0000	0.00000		0.0015	240	44.81	61.34	119.49
25mm	346.09	240	0.01	0.04	0.0030				0.00	0.00	0.0000	0.0000	0.00298		0.0032	38	3.26	16.53	74.68
	346.10	278	0.01	0.06	0.0034				0.00	0.00	0.0000	0.0000	0.00344		0.0043	207	13.27	13.27	71.42
Ext.Det.	346.18	485	0.01	0.14	0.0052				0.00	0.00	0.0000	0.0000	0.00525		0.0054	85	4.35		58.15
	346.20	570	0.01	0.16	0.0056				0.00	0.00	0.0000	0.0000	0.00561		0.0064	307	13.38		53.80
	346.30	877	0.01	0.26	0.0072				0.00	0.00	0.0000	0.0000	0.00715		0.0078	323	11.52		40.42
	346.40	1200	0.01	0.36	0.0084				0.00	0.00	0.0000	0.0000	0.00842		0.0089	275	8.59		28.90
2 yr	346.49	1475	0.01	0.45	0.0094				0.00	0.00	0.0000	0.0000	0.00936		0.0094	64	1.88		20.31
	346.50	1539	0.01	0.46	0.0095				0.00	0.00	0.0000	0.0000	0.00951		0.0100	323	8.95		18.43
	346.60	1861	0.01	0.56	0.0105				0.00	0.00	0.0000	0.0000	0.01050		0.0109	374	9.48		9.48
	346.70	2235	0.01	0.66	0.0114				0.00	0.00	0.0000	0.0000	0.01140		0.0338	137	1.13		
5 yr	346.74	2372				0.05	0.72	0.0562	0.00	0.00	0.0000	0.0000	0.05620		0.0884	248	0.78		
	346.80	2620				0.05	0.78	0.1206	0.00	0.00	0.0000	0.0000	0.12059		0.1244	396	0.88		
	346.90	3016				0.05	0.88	0.1281	0.00	0.00	0.0000	0.0000	0.12813		0.1317	407	0.86		
	347.00	3423				0.05	0.98	0.1353	0.00	0.00	0.0000	0.0000	0.13526		0.1386	418	0.84		
	347.10	3841				0.05	1.08	0.1420	0.00	0.00	0.0000	0.0000	0.14202		0.1453	430	0.82		
	347.20	4271				0.05	1.18	0.1485	0.00	0.00	0.0000	0.0000	0.14848		0.1516	441	0.81		
	347.30	4712				0.05	1.28	0.1547	0.00	0.00	0.0000	0.0000	0.15467		0.1576	340	0.60		
100 yr	347.38	5052				0.05	1.36	0.1595	0.00	0.00	0.0000	0.0000	0.15945		0.2877	113	0.11		
	347.40	5165				0.05	1.38	0.1606	0.00	0.00	0.0000	0.0000	0.16062		0.1600	464	0.81		
	347.50	5629				0.05	1.48	0.1664	0.00	0.00	0.0000	0.2496	0.41596		0.9527	476	0.14		
	347.60	6105				0.05	1.58	0.1719	0.00	0.00	0.0000	1.3175	1.48943		2.2729	61	0.01		
Reg.	347.62	6166				0.05	1.59	0.1728	0.00	0.00	0.0000	1.5500	1.72285		3.3740	427	0.04		
	347.70	6593				0.05	1.68	0.1773	0.00	0.00	0.0000	2.8791	3.05642		4.0408	500	0.03		
	347.80	7094				0.05	1.78	0.1825	0.00	0.00	0.0000	4.8427	5.02518		6.1916	512	0.02		
	347.90	7606				0.05	1.88	0.1911	0.00	0.00	0.0000	7.1669	7.35798						

Northgate, North Waterloo
PRELIMINARY SWM DESIGN NORTHGATE LANDS POND - 5914
Waterloo, Ontario

Project Number:	39502-104
Date:	July 5, 2017
Design By:	MSB
File:	Q:\39502\104\Prelim SWM\39502-104 SWM Design - Msb.xlsx

FOREBAY DESIGN CALCULATIONS - POND ON NORTHGATE LANDS
MOE SWM Planning and Design Manual, 2003

Forebay Design Flows

Flow into forebay during the 1:5-year return period event	1.980	m^3/s	(Based on Storm Design Sheet method)
Flow into forebay during the 25 mm - 4 hour design storm event	0.898	m^3/s	(Based on Storm Design Sheet method)
Peak flow from main pond outlet for the 25mm design storm (from MIDUSS)	0.0029	m^3/s	

Forebay Characteristics

b =	3.0	*m*	bottom width
y =	1.5	*m*	depth
z =	4	:1	side slope
w =	9.0	*m*	average width
R =	0.88	*m*	hydraulic radius
A =	13.5	m^2	cross-sectional area

1. Length Calculation Based on Settling Velocity

L = forebay flow length *(m)*
r = length-to-width ratio
Q_p = peak flow rate through forebay *(m^3/s)*
v_s = settling velocity *(m/s)*

$$L = \sqrt{\frac{rQ_p}{v_s}}$$ Equation 4.5: Forebay Settling Length

a) Required Settling Length (assuming Q_p = forebay through-flow & v_s = 0.0055 m/s)

Q_p =	0.90	m^3/s	peak flow rate through forebay
v_s =	0.0055	*m/s*	settling velocity
r =	2.03		length-to-width ratio
L =	18.3	*m*	required settling length
L =	*18.3*	*m*	*trial length*

b) Required Settling Length (assuming Q_p = pond discharge & v_s = 0.0003 m/s)

Q_p =	0.003	m^3/s	peak flow rate through forebay
v_s =	0.0003	*m/s*	settling velocity
r =	0.12		length-to-width ratio
L =	1.1	*m*	required settling length
L =	*1.1*	*m*	*trial length*

Table 1: Average settling velocities

	Mass Removed	Particle Size Range	Average Settling Velocity
	%	μm	m/s
	80 - 100	x ≤ 20	0.00000254
Enhanced:	70 - 80	20 < x ≤ 40	0.00001300
Normal:	60 - 70	40 < x ≤ 60	0.00002540
Basic:	40 - 60	60 < x ≤ 130	0.00012700
Medium Sand:	20 - 40	130 < x ≤ 400	0.00059267
Gross Grit:	0 - 20	400 < x ≤ 4000	0.00550333

2. Length Calculation Based on Flow Dispersion Length

Q =	1.98	m^3/s	inlet flow rate
d =	3	*m*	depth of permanent pool in forebay
V_f =	0.50	*m/s*	desired velocity in forebay (typical value ≤ 0.50 *m/s*)
L =	10.6	m	required length of dispersion

$$L_D = \frac{8Q}{dV_f}$$ Equation 4.6: Dispersion Length

3. Required Forebay Length

L =	**18.3**	***m***	**design length**
r =	2.03		design length-to-width ratio (typical minimum of 2.0)

4. Scour Velocity

v_s =	0.15	*m/s*	scour velocity (typical value = 0.15 *m/s*)
v =	**0.15**	***m/s***	**actual velocity**

OK The actual velocity through the forebay is less than the scour velocity.

5. Weir Flow From Forebay

L =	6	*m*	length of crest of weir
α =	1.65		coefficient
H =	0.4	*m*	head
Q =	**2.50**	***m^3/s***	**discharge**

$$Q = \alpha L H^{1.5}$$ Equation 4.4: Weir Flow

OK The weir flow from the forebay exceeds the flow entering the forebay

6. Estimated Cleanout Frequencies

a) Forebay

Forebay volume	372	m^3
Estimated TSS removal efficiency	50%	
Impervious level	61.0%	
Estimated annual sediment loading	2.3	m^3/ha
Contributing area	12.088	*ha*
Annual sediment volume	14	m^3/yr
Cleanout frequency for 33% volume reduction	**8.8**	***years***

b) Stormwater Management Pond

Wetpond volume (excluding forebay)	2401	m^3
Estimated TSS removal efficiency	30%	
Impervious level	61.0%	
Estimated annual sediment loading	2.3	m^3/ha
Contributing area	12.088	*ha*
Annual sediment volume	8	m^3/yr
Cleanout frequency for 33% volume reduction	**95.0**	***years***

Table 2: Annual sediment loading

Impervious Level	Annual Loading
%	m^3/ha
35%	0.6
55%	1.9
70%	2.8
85%	3.8

NORTHGATE SUBDIVISION
STORMWATER MANAGEMENT
Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
Design By: MSB
File: Q:\39502\104\Prelim SWM\39502-104 Splitter Manhole Design Calculation_Rev1.xls

SPLITTER MANHOLE DESIGN CALCULATION - Facility 5914

	Forebay Inlet Pipe	Pond Inlet Pipe		Manhole Weir		
Number of pipes =	1	1				
Diameter =	750	1050	*mm*	Weir Elevation =	347.114	*m*
Area =	0.442	0.866	m^2	Weir Length =	2.970	*m*
Orifice Coefficient =	0.820	0.820		Weir Coefficient =	1.65	
Invert Elevation =	346.300	346.300	*m*	**Weir Opening**		
Slope =	1.25%	0.50%				
Hydraulic Radius =	0.188	0.263	*m*	Area =	2.638	m^2
Manning's 'n' =	0.013	0.013		Coefficient =	0.63	
Velocity =	2.817	2.230	*m/s*			
Pipe Capacity =	1.245	1.931	m^3/s			

* Q_{25mm} =	0.898	m^3/s	forebay design flow (lower limit)
* Q_{5yr} =	1.98	m^3/s	maximum design flow in sewer pipes

* Based on preliminary Storm Design sheets

Water Elevation *m*	Head Above Invert *m*	Forebay Inflow m^3/s	Weir Head *m*	Weir Flow m^3/s	Weir Opening Flow m^3/s	Pipe Orifice Head *m*	Pipe Orifice Flow m^3/s	Total Pond Flow m^3/s
346.300								
346.400	0.100	0.008						0.008
346.500	0.200	0.052						0.052
346.600	0.300	0.115						0.115
346.700	0.400	0.194						0.194
346.800	0.500	0.286						0.286
346.900	0.600	0.391						0.391
347.000	0.700	0.506						0.506
347.100	0.800	0.879						0.879
347.114	**0.814**	**0.899**						**0.899**
347.200	0.900	1.015	0.086	0.124	2.158	0.900	1.018	1.138
347.300	1.000	1.135	0.186	0.393	3.173	1.000	1.214	1.528
347.398	**1.098**	**1.241**	**0.284**	**0.742**	**3.921**	**1.098**	**1.984**	**1.983**
347.400	1.100	1.243	0.286	0.750	3.935	1.100	1.989	1.992
347.500	1.200	1.343	0.386	1.175	4.571	1.200	2.224	2.518
347.600	1.300	1.435	0.486	1.660	5.129	1.300	2.436	3.096
347.700	1.400	1.522	0.586	2.198	5.632	1.400	2.631	3.721
347.800	1.500	1.605	0.686	2.784	6.094	1.500	2.813	4.389
347.900	1.600	1.683	0.786	3.415	6.523	1.600	2.984	4.667

Water Elevation	Head Above Invert	Forebay Inflow	Weir Head	Weir Flow	Weir Opening Flow	Pipe Orifice Head	Pipe Orifice Flow	Total Pond Flow
m	*m*	m^3/s	*m*	m^3/s	m^3/s	*m*	m^3/s	m^3/s
348.000	1.700	1.758	0.886	4.087	6.926	1.700	3.145	4.903
348.100	1.800	1.830	0.986	4.798	7.306	1.800	3.299	5.128
348.200	1.900	1.899	1.086	5.546	7.668	1.900	3.445	5.344
348.300	2.000	1.965	1.186	6.329	8.013	2.000	3.586	5.551
348.400	2.100	2.030	1.286	7.147	8.344	2.100	3.721	5.751
348.500	2.200	2.092	1.386	7.996	8.662	2.200	3.852	5.944
348.600	2.300	2.153	1.486	8.877	8.969	2.300	3.978	6.131
348.700	2.400	2.212	1.586	9.788	9.266	2.400	4.101	6.313
348.800	2.500	2.269	1.686	10.728	9.554	2.500	4.220	6.489
348.900	2.600	2.325	1.786	11.697	9.833	2.600	4.335	6.661
349.000	2.700	2.380	1.886	12.693	10.104	2.700	4.448	6.828
349.100	2.800	2.434	1.986	13.715	10.369	2.800	4.558	6.991
349.200	2.900	2.486	2.086	14.764	10.627	2.900	4.665	7.151
349.300	3.000	2.537	2.186	15.839	10.878	3.000	4.770	7.307
349.400	3.100	2.587	2.286	16.938	11.125	3.100	4.872	7.460
349.500	3.200	2.637	2.386	18.061	11.365	3.200	4.973	7.609
349.600	3.300	2.685	2.486	19.208	11.601	3.300	5.071	7.756
349.700	3.400	2.733	2.586	20.379	11.832	3.400	5.168	7.900
349.800	3.500	2.779	2.686	21.572	12.059	3.500	5.263	8.042
349.900	3.600	2.825	2.786	22.788	12.281	3.600	5.356	8.181
350.000	3.700	2.870	2.886	24.026	12.499	3.700	5.447	8.318
350.100	3.800	2.915	2.986	25.286	12.714	3.800	5.537	8.452
350.200	3.900	2.959	3.086	26.566	12.925	3.900	5.626	8.585
350.300	4.000	3.002	3.186	27.868	13.133	4.000	5.713	8.715
350.400	4.100	3.045	3.286	29.191	13.338	4.100	5.799	8.844

Notes:

1. Forebay inflow calcuated as: $Q = C \cdot A_o \cdot \sqrt{2g \cdot \left(H - \frac{2}{3} d \right)}$ for H > d

$$Q = f \cdot \frac{H}{d} \cdot C \cdot \sqrt{g} \cdot d^{2.5}$$ for H < d, where

$$f \cdot \frac{H}{d} = 0.494 \left(\frac{H}{d} \right)^{1.57} - 0.04 \left(\frac{H}{d} \right)^{0.5}$$

2. Bypassing inflow calculated as the smallest of

$Q = C_d \cdot L \cdot H^{1.5}$ weir flow

$Q = C \cdot A \cdot \sqrt{2g \cdot H}$ weir opening (orifice) flow

$Q = C \cdot A \cdot \sqrt{2g \cdot \left(H - \frac{2}{3} d \right)}$ pipe opening (orifice) flow

NORTHGATE SUBDIVISION
STORMWATER MANAGEMENT
Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
Design By: MSB
File: Q:\39502\104\Prelim SWM\39502-104 Draw-Down Calculation (Stage Discharge)_Rev1.xls

STAGE DISCHARGE DRAWDOWN CALCULATION
25mm event - Quality Control drawdown

Stage	Elevation *m*	Discharge m^3/s	Volume m^3	Comments
1	346.00	0.00000	0	
2	346.10	0.00344	278	25mm event = 346.09m (240 m3)
3	346.20	0.00561	570	
4	346.30	0.00715	877	
5	346.40	0.00842	1200	
6	346.50	0.00951	1539	

h_1 =	346.090	*m*	starting elevation
h_2 =	346.000	*m*	bottom elevation
V =	240	m^3	starting volume
t =	10.0	*min*	time step

Drawdown Time = 47.00 *hrs*

10 *mm* remaining
29.1 m^3 remaining

Remaining after:	m^3	*mm*
24 *hrs*	81	29
36 *hrs*	48	17
48 *hrs*	28	10
72 *hrs*	10	3
96 *hrs*	3	1

NORTHGATE SUBDIVISION
STORMWATER MANAGEMENT
Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
Design By: MSB
File: Q:\39502\104\Prelim SWM\39502-104 Draw-Down Calculation (Stage Discharge)_Rev1.xls

STAGE DISCHARGE DRAWDOWN CALCULATION
MOE Extended Detention - Quality Control drawdown

Stage	Elevation *m*	Discharge m^3/s	Volume m^3	Comments
1	346.00	0.00000	0	
2	346.10	0.00344	278	
3	346.20	0.00561	570	MOE Ext. Det. = 346.18m (485 m3)
4	346.30	0.00715	877	
5	346.40	0.00842	1200	
6	346.50	0.00951	1539	

h_1 =	346.180	*m*	starting elevation
h_2 =	346.000	*m*	bottom elevation
V =	485	m^3	starting volume
t =	10.0	*min*	time step

Drawdown Time = 49.17 *hrs*

20 *mm* remaining
56.7 m^3 remaining

Remaining after:	m^3	*mm*
24 *hrs*	175	63
36 *hrs*	102	37
48 *hrs*	60	21
72 *hrs*	20	7
96 *hrs*	7	2

NORTHGATE SUBDIVISION
STORMWATER MANAGEMENT
Waterloo, Ontario

Project Number: 39502-104
Date: July 5, 2017
Design By: MSB
File: Q:\39502\104\Prelim SWM\39502-104 Draw-Down Calculation (Stage Discharge)_Rev1.xls

STAGE DISCHARGE DRAWDOWN CALCULATION
2 year event - Quality Control drawdown

Stage	Elevation *m*	Discharge m^3/s	Volume m^3	Comments
1	346.00	0.00000	0	
2	346.10	0.00344	278	
3	346.20	0.00561	570	
4	346.30	0.00715	877	
5	346.40	0.00842	1200	
6	346.50	0.00951	1539	2 year event = 346.49m (1475 m3)

h_1 =	346.490	*m*	starting elevation
h_2 =	346.000	*m*	bottom elevation
V =	1475	m^3	starting volume
t =	10.0	*min*	time step

Drawdown Time = 72.00 *hrs*

40 *mm* remaining
111.9 m^3 remaining

Remaining after:	m^3	*mm*
24 *hrs*	777	267
36 *hrs*	519	183
48 *hrs*	325	116
72 *hrs*	112	40
96 *hrs*	38	14

APPENDIX B

PROPOSED GAWSER DESIGN EVENT MODEL OUTPUT

```
*  Waterloo North Scoped SWS
* ===========================================================================
* August, 2011, M. Trudell
* Located in Waterloo,Ontario
* USE TO MAKE Continuous WAT Files
*
* MTE Event Model (all storms minor/major) June 28, 2017
* ===========================================================================
*
* Response Unit Soil drainage parameters for North Waterloo Scoped SWS
* ===========================================================================


READ SOIL PARAMETERS  NZONE=9
                          IMP  CLAY TILL   SILT TILL  SAND TILL  SND/GRV
                               MED  HIGH   MED  HIGH   MED  HIGH   MED  Swamp
                    DS=    2   8.0  15.0   8.0  15.0   8.0  15.0   8.0   100
                    KEFF=  0   2.0   4.0  10.0  15.0  15.0  40.0  25.0   0.1
                    CS=    0   1.0   2.0   7.5  11.2  11.2  30.0  19.0  0.05
                    D=     0   0.2   0.4   1.0   1.5   1.5   4.0   2.5  0.01
                    SAV=   0   200   200   200   200   200   200   250   200
                    HI=    0   100   100   100   200   100   200   200   200
                    SMCI=  0  0.56  0.56  0.54  0.54  0.46  0.46   0.4  0.56
                    IMCI=  0  0.46  0.46  0.40  0.40  0.23  0.23   0.1  0.46
                    FCAPI= 0  0.46  0.46  0.40  0.40  0.23  0.23   0.1  0.46
                    WILTI= 0  0.27  0.27  0.19  0.19  0.07  0.07  0.04  0.27
                    HII=   0   150   150   300   400   300   600   400     5
                    SMCII= 0  0.56  0.56  0.54  0.54  0.46  0.46   0.4  0.56
                    IMCII= 0  0.46  0.46  0.40  0.40  0.23  0.23   0.1  0.46
                    FCAPII=0  0.46  0.46  0.40  0.40  0.23  0.23   0.1  0.46
                    WILTII=0  0.27  0.27  0.19  0.19  0.07  0.07  0.04  0.27
                    X=     0    1     0     0     0     0     0     0     1
                    FATR=  1    1     1     1     1     1     1     1     1
                    INC =  1    1     5     1     5     1     5     1     5

*
* Go to event file
*
CHANGE INPUT FILE
*
* Main channel, in subcatchment 301                                      7
*
COMPUTE RATING CURVE ID=1  VS=     2.000   NSEGS=3
                      MIN EL=  100.00   MAX EL=  101.30
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      N= 0.100  DIST=   18.90
                      N=-0.080  DIST=   21.10
                      N= 0.100  DIST=   40.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  101.30    18.90  100.80    19.00  100.40
                       20.00  100.00    21.00  100.40    21.10  100.80
                       40.00  101.30
                     RFN=0.0000 PCODE=1
*
*  Typical off-channel (Steep areas)                                     6
*
COMPUTE RATING CURVE ID=5  VS=     1.000   NSEGS=3
                      MIN EL=  100.00   MAX EL=  100.80
                      CHNSLP= 0.01500   FLNSLP= 0.01500
                      N= 0.350  DIST=   24.45
                      N=-0.150  DIST=   25.50
                      N= 0.350  DIST=   50.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
```

```
                      0.00  100.80    24.45  100.30    24.75  100.00
                     25.25  100.00    25.50  100.30    50.00  100.80
                    RFN=0.0000 PCODE=1
*
* Compute runoff hydrograph from area  301
* VS=   2.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD= 301 AREA=   2.6500 Sq km  L=  2910 m  W=   882 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0  50.7 23.3  11.5  2.9   0.0 10.6
                    RATING CURVES: IDMC=1 IDOC=5 QRMC=  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=0.50 GWON=1
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD           ID=1 PCODE=1 MODE=10
*
*  Beaver Creek, in subcatchment 381                                    13
*
COMPUTE RATING CURVE ID=2  VS=     3.000   NSEGS=3
                      MIN EL=  335.00   MAX EL=  354.00
                      CHNSLP= 0.02100   FLNSLP= 0.02100
                      N= 0.080  DIST=   89.00
                      N=-0.080  DIST=   95.00
                      N= 0.080  DIST=  213.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  335.00    16.00  353.00    39.00  352.00
                       53.00  351.50    77.00  351.00    89.00  350.80
                       92.00  350.60    95.00  350.80   102.00  351.00
                      152.00  351.50   185.00  352.00   201.00  353.00
                      213.00  354.00
                     RFN=0.0000 PCODE=1
*
* Beaver Creek through 381
* Using Valley Section      3.000 As channel Rating Curve
*
ROUTE CHANNEL       ID=2 HYD NO= 111 INFLOW=1 LENGTH=  2100 m  SLOPE=0.00210
                    RCID=2 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY=  0.0%
*
*  Main channel, in subcatchment 381                                     6
*
COMPUTE RATING CURVE ID=3  VS=     2.100   NSEGS=3
                      MIN EL=  100.40   MAX EL=  100.80
                      CHNSLP= 0.01700   FLNSLP= 0.01700
                      N= 0.060  DIST=    0.80
                      N=-0.060  DIST=    2.90
                      N= 0.060  DIST=    3.70
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  100.80     0.80  100.60     1.70  100.40
                        2.10  100.40     2.90  100.60     3.70  100.80
                     RFN=0.0000 PCODE=1
*
* Typical off-channel (Flat slopes)                                     6
*
COMPUTE RATING CURVE ID=6  VS=     1.100   NSEGS=3
                      MIN EL=  100.00   MAX EL=  100.60
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      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
*
* Compute runoff hydrograph from area  381
* VS=   2.100 is main channel & VS=   1.100 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD= 381 AREA=   3.3100 Sq km  L=  2340 m  W=   707 m
             SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                    1.0   0.0  0.0  73.4 13.2   1.3  0.5   0.0 10.6
                   RATING CURVES: IDMC=3 IDOC=6 QRMC=  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=0.50 GWON=1
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD           ID=1 PCODE=1 MODE=10
*
* Sum hydr.  111 &  381 call result  281
*
ADD HYD             ID=3 HYD NO= 281 IDA=2 IDB=1 ICODE=0                  AREA=     5.960
*
* Swamp storage reservoir
*
ROUTE RESERVOIR     ID=1 HYD NO= 581 INFLOW=3 PCODE=0 OPTION= 4
                    ILEVEL=   349.500
                     ELEVATION   OUTFLOW     STORAGE
                        (m)       (cms)       (ha*m)
                      349.500      0.0000      0.0100
                      350.000      0.4200      0.6700
                      350.500      3.0400      3.1200
                      351.000      8.8500      8.1100
                      351.500     15.2000     15.8700
                      352.000     21.5000     26.8500
                      352.500     28.7000     41.0200
                      352.800     34.3000     50.7600
*
KEEP HYD            ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD           ID=1 PCODE=1 MODE=10
*
* Beaver Creek in subcatchment 391, to Conservation Drive                11
*
COMPUTE RATING CURVE ID=4  VS=     4.000   NSEGS=3
                      MIN EL=  344.40   MAX EL=  346.02
                      CHNSLP= 0.02600   FLNSLP= 0.02600
                      N= 0.080  DIST=    6.50
                      N=-0.045  DIST=   12.60
                      N= 0.080  DIST=   16.20
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  346.02     3.40  345.96     6.50  345.43
                        7.20  345.01     8.80  344.40     9.60  344.46
                       10.60  344.61    11.00  344.75    11.70  345.00
                       12.60  345.39    16.20  345.90
                     RFN=0.0000 PCODE=1
*
* Beaver Creek through 391, north of Conservation Drive
* Using Valley Section      4.000 As channel Rating Curve
*
ROUTE CHANNEL       ID=2 HYD NO= 121 INFLOW=1 LENGTH=   690 m  SLOPE=0.00310
                    RCID=4 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY=  0.0%
```

```
*
*CHANGE INPUT FILE
*
* Response Unit Soil drainage parameters for North Waterloo Scoped SWS
* ====================================================================


READ SOIL PARAMETERS  NZONE=9
                          IMP  CLAY TILL   SILT TILL  SAND TILL   Roof  SAND
                               MED  HIGH   MED  HIGH   MED  HIGH   IMP   LOW
                    DS=    2   8.0  15.0   8.0  15.0   8.0  15.0   0.5   5.0
                    KEFF=  0   2.0   4.0  10.0  15.0  15.0  40.0   0.0   10.0
                    CS=    0   1.0   2.0   7.5  11.2  11.2  30.0   0.0   7.5
                    D=     0   0.2   0.4   1.0   1.5   1.5   4.0   0.0   1.0
                    SAV=   0   200   200   200   200   200   200   200   200
                    HI=    0   100   100   100   200   100   200     1   100
                    SMCI=  0  0.56  0.56  0.54  0.54  0.46  0.46  0.54  0.46
                    IMCI=  0  0.46  0.46  0.40  0.40  0.23  0.23  0.54  0.23
                    FCAPI= 0  0.46  0.46  0.40  0.40  0.23  0.23  0.40  0.23
                    WILTI= 0  0.27  0.27  0.19  0.19  0.07  0.07  0.40  0.07
                    HII=   0   150   150   300   400   300   600     1   300
                    SMCII= 0  0.56  0.56  0.54  0.54  0.46  0.46  0.54  0.46
                    IMCII= 0  0.46  0.46  0.40  0.40  0.23  0.23  0.54  0.23
                    FCAPII=0  0.46  0.46  0.40  0.40  0.23  0.23  0.40  0.23
                    WILTII=0  0.27  0.27  0.19  0.19  0.07  0.07  0.40  0.07
                    X=     0    1     0     0     0     0     0     0     0
                    FATR=  1    1     1     1     1     1     1     1     1
                    INC =  1    1     5     1     5     1     5     1     1

*
* Go to event file
*
*CHANGE INPUT FILE
*
*  Main channel Parabolic Swale - Flat                                    7
*
COMPUTE RATING CURVE ID=1  VS=     7.000   NSEGS=3
                      MIN EL=  100.70   MAX EL=  103.00
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      N= 0.070  DIST=   20.00
                      N=-0.050  DIST=   30.00
                      N= 0.070  DIST=   50.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  103.00    20.00  101.00    23.00  100.80
                       25.00  100.70    27.00  100.80    30.00  101.00
                       50.00  103.00
                     RFN=0.0000 PCODE=1
*
* Compute runoff hydrograph from area 3916
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=3916 AREA=   0.0260 Sq km  L=   150 m  W=   100 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0  35.0  0.0  64.0  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 WQPCODE=1
                     RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
                     GWFACT=0.00 GWON=0
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD             ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD            ID=1 PCODE=1 MODE=10
```

```
*
* Compute runoff hydrograph from area 3919
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=3919 AREA=   0.1360 Sq km  L=   200 m  W=   180 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0  22.0  3.0  74.0  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 WQPCODE=1
                     RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
                     GWFACT=0.00 GWON=0
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD             ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD            ID=3 PCODE=1 MODE=10
*
* Sum hydr. 3916 & 3919 call result 2000
*
ADD HYD              ID=4 HYD NO=2000 IDA=1 IDB=3 ICODE=0                  AREA=     0.162
*
* Compute runoff hydrograph from area 3910
* VS=   4.000 is main channel & VS=   1.100 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=3910 AREA=   0.1760 Sq km  L=   300 m  W=   200 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  5.0  16.3 38.1  11.9 27.7   0.0  0.0
                     RATING CURVES: IDMC=4 IDOC=6 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
                     GWFACT=0.00 GWON=0
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD             ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD            ID=1 PCODE=1 MODE=10
*
* Sum hydr. 2000 & 3910 call result 2001
*
ADD HYD              ID=3 HYD NO=2001 IDA=4 IDB=1 ICODE=0                  AREA=     0.338
*
*   Typical Urban Cross-Section                                            6
*
COMPUTE RATING CURVE ID=1  VS=     8.000   NSEGS=3
                      MIN EL=  295.00   MAX EL=  295.70
                      CHNSLP= 0.00500   FLNSLP= 0.00500
                      N= 0.015  DIST=  200.00
                      N=-0.015  DIST=  300.00
                      N= 0.015  DIST=  500.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  295.70   200.00  295.50   200.10  295.00
                      299.90  295.00   300.00  295.50   500.00  295.70
                     RFN=0.0000 PCODE=1
*
*   Typical Urban Cross-Section                                            6
*
COMPUTE RATING CURVE ID=6  VS=     8.000   NSEGS=3
                      MIN EL=  295.00   MAX EL=  295.70
                      CHNSLP= 0.00500   FLNSLP= 0.00500
                      N= 0.015  DIST=  200.00
                      N=-0.015  DIST=  300.00
                      N= 0.015  DIST=  500.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
```

```
                      0.00  295.70   200.00  295.50   200.10  295.00
                    299.90  295.00   300.00  295.50   500.00  295.70
                   RFN=0.0000 PCODE=1
*
* Compute runoff hydrograph from area 7912
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=7912 AREA=   0.0270 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0   0.0  0.0   0.0  0.0  99.0  0.0
                   RATING CURVES: IDMC=1 IDOC=6 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7912
*
ROUTE SPECIAL POND  ID=4 HYD NO=6912 INFLOW=1 PCODE=0 OPTION= 5
                   Inflow controls:
                       USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                       GWPCT=  0% GWDIV=0
                   Maximum level for Routing Tables:  ZMAX= 101.300
                   Recharge characteristics for Compartment A
                     LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                     CDA=   0.000 mm/h  DZA= 10.00 m
                   Recharge characteristics for Compartment B
                     LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                     CDB=  15.000 mm/h  DZB= 10.00 m
                   Irrigation Pond Controls: IPOND=0
                   Number of points=  5
                                  Compartment  A          Compartment B
                   Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                      (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                    100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0672
                    100.999     0.000  0.0000  0.0000   0.000  0.0671  0.0672
                    101.000     0.000  0.0000  0.0000   0.001  0.0672  0.0672
                    101.200     0.000  0.0000  0.0000   0.480  0.0900  0.0672
                    101.300     0.000  0.0000  0.0000   0.520  0.1000  0.0672
*
* Compute runoff hydrograph from area 8912
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=8912 AREA=   0.1410 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                      46.4   0.0  0.0  53.6  0.0   0.0  0.0   0.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6912 & 8912 call result 3912
*
ADD HYD             ID=5 HYD NO=3912 IDA=4 IDB=1 ICODE=0                  AREA=     0.168
*
KEEP HYD            ID=5 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=5 IMET=0
PRINT HYD           ID=5 PCODE=1 MODE=10
*
* 1912 End-of-Pipe Infiltration (for Catchment 3912)
*
```

```
ROUTE SPECIAL POND  ID=1 HYD NO=1912 INFLOW=5 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 200.300
                    Recharge characteristics for Compartment A
                      LEVELA= 198.340               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 198.340 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  5
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.800     0.000  0.0000  0.0000   0.000  0.0000  0.0504
                     199.990     0.000  0.0000  0.0000   0.000  0.0839  0.0504
                     200.010     0.000  0.0000  0.0000   0.001  0.0840  0.0504
                     200.100     0.000  0.0000  0.0000   0.400  0.1100  0.0504
                     200.300     0.000  0.0000  0.0000   2.500  0.2200  0.0504
*
KEEP HYD            ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD           ID=1 PCODE=1 MODE=10
*
* 5912 Quantity SWM Basin
*
ROUTE SPECIAL POND  ID=4 HYD NO=5912 INFLOW=1 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 203.600
                    Recharge characteristics for Compartment A
                      LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 200.000 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                      CDB=   0.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points= 10
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.990     0.000  0.0000  0.0000   0.000  0.0000  0.1660
                     200.000     0.000  0.0000  0.0000   0.000  0.0034  0.1660
                     200.500     0.000  0.0000  0.0000   0.010  0.0400  0.2111
                     201.000     0.000  0.0000  0.0000   0.014  0.0616  0.2650
                     201.400     0.000  0.0000  0.0000   0.016  0.2675  0.2700
                     202.400     0.000  0.0000  0.0000   0.155  0.3570  0.3100
                     203.000     0.000  0.0000  0.0000   0.847  0.5680  0.3600
                     203.300     0.000  0.0000  0.0000   1.162  0.6500  0.3683
                     203.300     0.000  0.0000  0.0000   3.000  0.7000  0.3795
                     203.600     0.000  0.0000  0.0000   5.106  0.7200  0.4020
*
* Go to event file: 5912 Quantity SWM Basin
*
*CHANGE INPUT FILE
*
KEEP HYD            ID=4 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=4 IMET=0
PRINT HYD           ID=4 PCODE=1 MODE=10
*
* Sum hydr. 2001 & 5912 call result 2002
*
```

```
ADD HYD            ID=1 HYD NO=2002 IDA=3 IDB=4 ICODE=0                  AREA=     0.506
*
* Compute runoff hydrograph from area 7913
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=7913 AREA=   0.0180 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0   0.0  0.0   0.0  0.0  99.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7913
*
ROUTE SPECIAL POND  ID=4 HYD NO=6913 INFLOW=3 PCODE=0 OPTION= 5
                   Inflow controls:
                       USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                       GWPCT=  0% GWDIV=0
                   Maximum level for Routing Tables:  ZMAX= 101.300
                   Recharge characteristics for Compartment A
                     LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                     CDA=   0.000 mm/h  DZA= 10.00 m
                   Recharge characteristics for Compartment B
                     LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                     CDB=  15.000 mm/h  DZB= 10.00 m
                   Irrigation Pond Controls: IPOND=0
                   Number of points=  5
                                  Compartment  A          Compartment B
                   Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                      (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                    100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0440
                    100.999     0.000  0.0000  0.0000   0.000  0.0439  0.0440
                    101.000     0.000  0.0000  0.0000   0.001  0.0440  0.0440
                    101.200     0.000  0.0000  0.0000   0.450  0.0500  0.0440
                    101.300     0.000  0.0000  0.0000   0.500  0.0600  0.0440
*
* Compute runoff hydrograph from area 8913
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=8913 AREA=   0.0920 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                      46.4   0.0  0.0  18.4  0.0  35.2  0.0   0.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6913 & 8913 call result 3913
*
ADD HYD            ID=5 HYD NO=3913 IDA=4 IDB=3 ICODE=0                  AREA=     0.110
*
KEEP HYD           ID=5 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=5 IMET=0
PRINT HYD          ID=5 PCODE=1 MODE=10
*
* 1913 End-of-Pipe Infiltration
*
ROUTE SPECIAL POND  ID=3 HYD NO=1913 INFLOW=5 PCODE=0 OPTION=15
                   Inflow controls:
```

```
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 200.300
                    Recharge characteristics for Compartment A
                      LEVELA= 198.340               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 198.340 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  5
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.800     0.000  0.0000  0.0000   0.000  0.0000  0.0330
                     199.990     0.000  0.0000  0.0000   0.000  0.0549  0.0330
                     200.010     0.000  0.0000  0.0000   0.001  0.0550  0.0330
                     200.100     0.000  0.0000  0.0000   0.400  0.0800  0.0330
                     200.300     0.000  0.0000  0.0000   2.100  0.2000  0.0330
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
*
* 5913 Quantity SWM Basin
*
ROUTE SPECIAL POND  ID=4 HYD NO=5913 INFLOW=3 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 202.950
                    Recharge characteristics for Compartment A
                      LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 200.000 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                      CDB=   0.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points= 10
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.990     0.000  0.0000  0.0000   0.000  0.0000  0.1660
                     200.000     0.000  0.0000  0.0000   0.000  0.0022  0.1660
                     200.500     0.000  0.0000  0.0000   0.010  0.0400  0.2111
                     201.000     0.000  0.0000  0.0000   0.011  0.0616  0.2650
                     201.500     0.000  0.0000  0.0000   0.013  0.1700  0.2700
                     202.600     0.000  0.0000  0.0000   0.123  0.2052  0.3100
                     202.700     0.000  0.0000  0.0000   0.676  0.3080  0.3600
                     202.800     0.000  0.0000  0.0000   1.162  0.4000  0.3683
                     202.900     0.000  0.0000  0.0000   2.382  0.5284  0.3795
                     202.950     0.000  0.0000  0.0000   4.106  0.7685  0.4020
*
* Go to event file: 5913 Quantity SWM Basin
*
*CHANGE INPUT FILE
*
KEEP HYD            ID=4 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=4 IMET=0
PRINT HYD           ID=4 PCODE=1 MODE=10
*
* Sum hydr. 2002 & 5913 call result 2003
*
ADD HYD             ID=3 HYD NO=2003 IDA=1 IDB=4 ICODE=0                  AREA=     0.616
*
```

```
* Beaver Creek at Conservation Drive
*
ADD HYD             ID=1 HYD NO=2004 IDA=2 IDB=3 ICODE=0                  AREA=     6.576
*
* Go to event file: Beaver Creek at Conservation Drive
*
*CHANGE INPUT FILE
*
* Beaver Creek in subcatchment 391, from Conservation Drive to            19
*
COMPUTE RATING CURVE ID=4  VS=     5.000   NSEGS=3
                      MIN EL=  342.02   MAX EL=  343.63
                      CHNSLP= 0.02600   FLNSLP= 0.02600
                      N= 0.100  DIST=    8.25
                      N=-0.045  DIST=   13.28
                      N= 0.100  DIST=   20.67
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  343.63     2.03  343.62     4.62  343.55
                        6.99  343.56     8.25  343.43     8.51  343.03
                        8.62  342.91     9.44  342.90    10.02  342.85
                       10.39  342.82    11.57  342.91    12.16  342.88
                       12.40  342.94    12.63  342.02    12.98  343.17
                       13.28  343.33    14.36  343.36    17.52  343.46
                       20.67  343.40
                     RFN=0.0000 PCODE=1
*
* Beaver Creek through 391, south of Conservation Drive
* Using Valley Section      5.000 As channel Rating Curve
*
ROUTE CHANNEL       ID=2 HYD NO= 131 INFLOW=1 LENGTH=   870 m  SLOPE=0.00250
                    RCID=4 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY=  0.0
*
* Compute runoff hydrograph from area 7914 (MTE Development)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
* 7914 is multi-residential roof areas to rooftop infiltration gallery
*
COMPUTE FLOWRATE    ID=1 NHD=7914 AREA=   0.00275 Sq km  L=   20 m  W=   10 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       100.0   0.0  0.0   0.0  0.0   0.0  0.0  0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7914 (sized for 25mm @ 1m deep galleries)
*
ROUTE SPECIAL POND  ID=3 HYD NO=6914 INFLOW=1 PCODE=0 OPTION= 5
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 101.100
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000                EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  3
                                   Compartment  A          Compartment B
```

```
                  Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                     (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                   100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0113
                   101.000     0.000  0.0000  0.0000   0.000  0.0068  0.0113
                   101.100     0.000  0.0000  0.0000   1.000  0.0075  0.0113
*
* Compute runoff hydrograph from area 77914 (house roofs to amended topsoil)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=77914 AREA=   0.02150 Sq km  L=   16.5 m  W=   12.1 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     100.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Compute runoff hydrograph from area 78914 (yard areas to amended topsoil)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=4 NHD=78914 AREA=   0.02474 Sq km  L=   30 m  W=    14 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     29.4   0.0  0.0  32.1  0.0  37.1  1.3  0.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 77914 & 78914 call result 73914 (total flow to amended topsoil)
*
ADD HYD             ID=5 HYD NO=73914 IDA=4 IDB=1 ICODE=0                  AREA=     0.04624
*
* AMENDED TOPSOIL Infiltration for 73914 (450mm @ 30% void space = 135mm "volume")
*
ROUTE SPECIAL POND  ID=1 HYD NO=914 INFLOW=5 PCODE=0 OPTION= 5
                   Inflow controls:
                       USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                       GWPCT=  0% GWDIV=0
                   Maximum level for Routing Tables:  ZMAX= 100.200
                   Recharge characteristics for Compartment A
                     LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                     CDA=   0.000 mm/h  DZA= 10.00 m
                   Recharge characteristics for Compartment B
                     LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                     CDB=  15.000 mm/h  DZB= 10.00 m
                   Irrigation Pond Controls: IPOND=0
                   Number of points=  3
                                 Compartment  A          Compartment B
                   Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                      (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                    100.000     0.000  0.0000  0.0000   0.000  0.0000  0.5680
                    100.135     0.000  0.0000  0.0000   0.000  0.0767  0.5680
                    100.200     0.000  0.0000  0.0000   1.000  0.0844  0.5680
*
* Water balance on amended topsoil only
*
KEEP HYD            ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD           ID=1 PCODE=1 MODE=10
*
```

```
* Sum hydr. 914 & 6914 call result 1914 (flow to SWM Pond after all lot-level infiltration)
*
ADD HYD             ID=4 HYD NO=1914 IDA=3 IDB=1 ICODE=0                  AREA=     0.04899
*
* Compute runoff hydrograph from area 88914 (area to conveyance infiltration)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=88914 AREA=   0.02579 Sq km  L=   150 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     52.8   0.0  0.0  21.5  0.0  24.8  0.9  0.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Conveyance infiltration to meet water balance
*
ROUTE SPECIAL POND  ID=3 HYD NO=814 INFLOW=1 PCODE=0 OPTION= 5
                   Inflow controls:
                       USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                       GWPCT=  0% GWDIV=0
                   Maximum level for Routing Tables:  ZMAX= 100.600
                   Recharge characteristics for Compartment A
                     LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                     CDA=   0.000 mm/h  DZA= 10.00 m
                   Recharge characteristics for Compartment B
                     LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                     CDB=  15.000 mm/h  DZB= 10.00 m
                   Irrigation Pond Controls: IPOND=0
                   Number of points=  3
                                  Compartment  A          Compartment B
                   Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                      (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                    100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0307
                    100.500     0.000  0.0000  0.0000   0.000  0.0118  0.0307
                    100.600     0.000  0.0000  0.0000   1.000  0.0130  0.0307
*
* Sum hydr. 814 & 1914 call result 14
*
ADD HYD             ID=1 HYD NO=14 IDA=3 IDB=4 ICODE=0                    AREA=     0.07478
*
* Compute runoff hydrograph from area 8914 (remaining area to SWM facility)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=4 NHD=8914 AREA=   0.04647 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     62.9   0.0  0.0  16.9  0.0  19.5  0.7  0.0  0.0
                   RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                   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
                   SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 14 & 8914 call result 3914 (all flows going to SWM facility)
*
ADD HYD             ID=3 HYD NO=3914 IDA=4 IDB=1 ICODE=0                  AREA=     0.12125
*
* 5914 Quantity SWM Basin (Wetpond, no EoP infiltration)
*
ROUTE SPECIAL POND  ID=1 HYD NO=5914 INFLOW=3 PCODE=0 OPTION=15
```

```
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 347.900
                    Recharge characteristics for Compartment A
                      LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 346.000 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                      CDB=   0.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points= 20
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     346.000     0.000  0.0000  0.0000   0.0000 0.0000  0.2228
                     346.100     0.000  0.0000  0.0000   0.0034 0.0277  0.2333
                     346.200     0.000  0.0000  0.0000   0.0056 0.0569  0.2440
                     346.300     0.000  0.0000  0.0000   0.0072 0.0876  0.2548
                     346.400     0.000  0.0000  0.0000   0.0084 0.1199  0.2659
                     346.500     0.000  0.0000  0.0000   0.0095 0.1537  0.2772
                     346.600     0.000  0.0000  0.0000   0.0105 0.1860  0.3678
                     346.700     0.000  0.0000  0.0000   0.0114 0.2233  0.3792
                     346.800     0.000  0.0000  0.0000   0.1206 0.2618  0.3905
                     346.900     0.000  0.0000  0.0000   0.1281 0.3014  0.4016
                     347.000     0.000  0.0000  0.0000   0.1353 0.3421  0.4128
                     347.100     0.000  0.0000  0.0000   0.1420 0.3840  0.4240
                     347.200     0.000  0.0000  0.0000   0.1485 0.4269  0.4354
                     347.300     0.000  0.0000  0.0000   0.1547 0.4711  0.4469
                     347.400     0.000  0.0000  0.0000   0.1606 0.5163  0.4585
                     347.500     0.000  0.0000  0.0000   0.4160 0.5628  0.4702
                     347.600     0.000  0.0000  0.0000   1.4894 0.6104  0.4821
                     347.700     0.000  0.0000  0.0000   3.0564 0.6592  0.4940
                     347.800     0.000  0.0000  0.0000   5.0252 0.7092  0.5061
                     347.900     0.000  0.0000  0.0000   7.3580 0.7604  0.5100
*
* Go to event file: 5914 Quantity SWM Basin
*
*CHANGE INPUT FILE
*
*
* Compute runoff hydrograph from area 4914 (remaining uncontrolled area to B.C., NOT to SWM facilty)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=4 NHD=4914 AREA=   0.02520 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     34.7   0.0  0.0  29.7  0.0  34.4  1.2  0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 4914 & 5914 call result 2914 (all flows leaving X914 area)
*
ADD HYD             ID=3 HYD NO=2914 IDA=4 IDB=1 ICODE=0                  AREA=     0.14645
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
*
* MTE Development
* Compute runoff hydrograph from rooftop area 7915
```

```
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=4 NHD=7915 AREA=   0.00390 Sq km  L=   20 m  W=    10 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       100.0   0.0  0.0   0.0  0.0   0.0  0.0  0.0  0.0
                     RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                     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
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration galleries for 7915 eliminated due to high ground water
*
*
* Compute runoff hydrograph from area 8915 (non-rooftop area to SWM facility)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=8915 AREA=   0.01505 Sq km  L=   200 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                        65.0   0.0  0.0  12.4  0.0  22.6  0.0   0.0  0.0
                     RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                     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
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 7915 & 8915 call result 3915
*
ADD HYD             ID=5 HYD NO=3915 IDA=4 IDB=1 ICODE=0                  AREA=     0.01895
*
KEEP HYD            ID=5 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=5 IMET=0
PRINT HYD           ID=5 PCODE=1 MODE=10
*
* 5915 Quantity SWM Basin (volume reduction pond)
*
ROUTE SPECIAL POND  ID=1 HYD NO=5915 INFLOW=5 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 352.000
                    Recharge characteristics for Compartment A
                      LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 349.50 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                      CDB=   15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  16
                                  Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     350.500     0.000  0.0000  0.0000   0.0000  0.0000  0.0795
                     350.600     0.000  0.0000  0.0000   0.0000  0.0082  0.0839
                     350.700     0.000  0.0000  0.0000   0.0000  0.0168  0.0885
                     350.800     0.000  0.0000  0.0000   0.0000  0.0259  0.0931
                     350.900     0.000  0.0000  0.0000   0.0000  0.0354  0.0978
                     351.000     0.000  0.0000  0.0000   0.0004  0.0454  0.1027
                     351.100     0.000  0.0000  0.0000   0.0038  0.0560  0.1076
                     351.200     0.000  0.0000  0.0000   0.0245  0.0670  0.1127
                     351.300     0.000  0.0000  0.0000   0.0496  0.0785  0.1178
                     351.400     0.000  0.0000  0.0000   0.0663  0.0905  0.1231
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```
                    351.500     0.000  0.0000  0.0000   0.0795  0.1031  0.1285
                    351.600     0.000  0.0000  0.0000   0.2249  0.1162  0.1339
                    351.700     0.000  0.0000  0.0000   0.8180  0.1299  0.1395
                    351.800     0.000  0.0000  0.0000   1.6973  0.1441  0.1452
                    351.900     0.000  0.0000  0.0000   2.8211  0.1590  0.1510
                    352.000     0.000  0.0000  0.0000   4.1734  0.1744  0.1569
*
* Compute runoff hydrograph from area 4915 (remaining area to Beaver Creek)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=6 NHD=4915 AREA=   0.00756 Sq km  L=   50 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     5.0   0.0  0.0  33.6  0.0  61.4  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 4915 & 5915 call result 2915
*
ADD HYD             ID=4 HYD NO=2915 IDA=1 IDB=6 ICODE=0                  AREA=     0.02651
*
* Go to event file: 5915 Quantity SWM Basin
*
*CHANGE INPUT FILE
*
KEEP HYD            ID=4 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=4 IMET=0
PRINT HYD           ID=4 PCODE=1 MODE=10
*
* Sum hydr. 2914 & 2915 call result 2005
*
ADD HYD             ID=1 HYD NO=2005 IDA=3 IDB=4 ICODE=0                  AREA=     0.17296
*
* Typical off-channel (Flat slopes)                                      6
*
COMPUTE RATING CURVE ID=6  VS=     1.100   NSEGS=3
                     MIN EL=  100.00   MAX EL=  100.60
                     CHNSLP= 0.01000   FLNSLP= 0.01000
                     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
*
* Compute runoff hydrograph from area 3911 (undeveloped)
* VS=   5.000 is main channel & VS=   1.100 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=3911 AREA=   0.20299 Sq km  L=   400 m  W=   250 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     1.0   3.0 27.0   3.0 12.0  11.0 43.0   0.0  0.0
                    RATING CURVES: IDMC=4 IDOC=6 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
                    GWFACT=0.00 GWON=0
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
```

```
*
* Sum hydr. 2005 & 3911 call result 2006
*
ADD HYD             ID=4 HYD NO=2006 IDA=1 IDB=3 ICODE=0                  AREA=     0.37595
*
*
* MTE Development
* Compute runoff hydrograph from area 7917 - Some rooftops to Infiltration gallery (approx 7 lots)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=7917 AREA=   0.00168 Sq km  L=   20 m  W=    10 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     100.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7917
*
ROUTE SPECIAL POND  ID=5 HYD NO=6917 INFLOW=3 PCODE=0 OPTION= 5
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 100.600
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  3
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0017
                     101.000     0.000  0.0000  0.0000   0.000  0.0017  0.0017
                     101.100     0.000  0.0000  0.0000   1.000  0.0018  0.0017
* MTE Development
* Compute runoff hydrograph from area 78917 - Road, Front Yard & Roof to PPav
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=78917 AREA=   0.00745 Sq km  L=   20 m  W=    10 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     66.2   3.4  0.0  25.3  0.0  5.1  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6917 & 78917 call result 17
*
ADD HYD             ID=6 HYD NO=3917 IDA=1 IDB=5 ICODE=0                  AREA=     0.0091
*
*
* LID Permeable Paver Infiltration for 7917 and 78917
*
ROUTE SPECIAL POND  ID=3 HYD NO=1917 INFLOW=6 PCODE=0 OPTION= 5
```

```
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 100.900
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  3
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     100.000     0.000  0.0000  0.0000   0.000  0.0000  0.2050
                     100.640     0.000  0.0000  0.0000   0.000  0.0671  0.2050
                     100.700     0.000  0.0000  0.0000   1.000  0.0740  0.2050
*
*
* Compute runoff hydrograph from area 8917 - Interior Space to Bioswale
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=1 NHD=8917 AREA=   0.00224 Sq km  L=   20 m  W=    10 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       0.0  10.1  0.0  74.8  0.0  15.1  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* LID BioSwale Infiltration for 8917
*
ROUTE SPECIAL POND  ID=6 HYD NO=917 INFLOW=1 PCODE=0 OPTION= 5
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 101.750
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  3
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0320
                     101.575     0.000  0.0000  0.0000   0.000  0.0202  0.0320
                     101.750     0.000  0.0000  0.0000   1.000  0.0222  0.0320
*
*
*
* Sum hydr. 917 & 1917 call result 3917
*
ADD HYD             ID=5 HYD NO=3917 IDA=6 IDB=3 ICODE=0                AREA=     0.0114
*
*
*
```

```
* Go to event file: 3917 LID - Permeable Pavement & Bioretention
*
*CHANGE INPUT FILE
*
*KEEP HYD            ID=5 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=5 IMET=0
*PRINT HYD           ID=5 PCODE=1 MODE=10
*
*
* Compute runoff hydrograph from area 4917 (remaining area to Beaver Creek)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=6 NHD=4917 AREA=   0.01436 Sq km  L=   150 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       22.0  7.9  0.0  58.3  0.0   11.8  0.0   0.0  0.0
                     RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                     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
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 4917 & 3917 call result 2917
*
ADD HYD             ID=3 HYD NO=2917 IDA=6 IDB=5 ICODE=0                  AREA=     0.02573
*
* Total water balance leaving X917 area:
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
*
* Sum hydr. 2006 & 2917 call result 2007
*
ADD HYD             ID=1 HYD NO=2007 IDA=4 IDB=3 ICODE=0                  AREA=     0.40133
*
*  Main channel Parabolic Swale - Flat                                    7
*
COMPUTE RATING CURVE ID=1  VS=     7.000   NSEGS=3
                      MIN EL=  100.70   MAX EL=  103.00
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      N= 0.070  DIST=   20.00
                      N=-0.050  DIST=   30.00
                      N= 0.070  DIST=   50.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  103.00    20.00  101.00    23.00  100.80
                       25.00  100.70    27.00  100.80    30.00  101.00
                       50.00  103.00
                     RFN=0.0000 PCODE=1
*
* Compute runoff hydrograph from area 3918 (undeveloped)
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=3918 AREA=   0.0060 Sq km  L=    50 m  W=   100 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0 20.0   0.0 79.0   0.0  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 WQPCODE=1
                     RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
                     GWFACT=0.00 GWON=0
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
```

```
*
* Sum hydr. 2007 & 3918 call result 2008
*
ADD HYD            ID=4 HYD NO=2008 IDA=1 IDB=3 ICODE=0                  AREA=     0.40733
*
* Beaver Creek at south end of Site
*
ADD HYD            ID=1 HYD NO=2009 IDA=2 IDB=4 ICODE=0                  AREA=     6.98333
*
* Go to event file: Beaver Creek at south end of Site
*
*CHANGE INPUT FILE
*
KEEP HYD           ID=1 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=1 IMET=0
PRINT HYD          ID=1 PCODE=1 MODE=10
*
* To Laurel Creek
* Compute runoff hydrograph from area 3092
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=3092 AREA=   0.04036 Sq km  L=   300 m  W=   100 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0  28.0  7.0  34.0  0.0  30.0  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 WQPCODE=1
                     RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
                     GWFACT=0.00 GWON=0
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD           ID=2 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=0
PRINT HYD          ID=2 PCODE=1 MODE=10
*
* Compute runoff hydrograph from area 3093
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=3093 AREA=   0.0070 Sq km  L=   150 m  W=   100 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0 40.0  18.0 41.0   0.0  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 WQPCODE=1
                     RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
                     GWFACT=0.00 GWON=0
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD           ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD          ID=3 PCODE=1 MODE=10
*
* Total outflow from 309
*
ADD HYD            ID=5 HYD NO=2010 IDA=2 IDB=3 ICODE=0                  AREA=     0.04736
*
* Compute runoff hydrograph from area 9914 (uncontrolled flow from X914 to Laurel Creek)
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=6 NHD=9914 AREA=   0.02176 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                      34.3   0.0  0.0  29.9  0.0  34.6  1.2  0.0  0.0
                     RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                     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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Total outflow to Laurel Creek
*
ADD HYD             ID=4 HYD NO=2011 IDA=5 IDB=6 ICODE=0                  AREA=     0.06912
*
KEEP HYD            ID=4 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=4 IMET=0
PRINT HYD           ID=4 PCODE=1 MODE=10
*
*   Typical Urban Cross-Section                                            6
*
COMPUTE RATING CURVE ID=1  VS=     8.000   NSEGS=3
                     MIN EL=  295.00   MAX EL=  295.70
                     CHNSLP= 0.00500   FLNSLP= 0.00500
                     N= 0.015  DIST=  200.00
                     N=-0.015  DIST=  300.00
                     N= 0.015  DIST=  500.00
                       DIST    ELEV     DIST    ELEV     DIST    ELEV
                       0.00  295.70   200.00  295.50   200.10  295.00
                     299.90  295.00   300.00  295.50   500.00  295.70
                    RFN=0.0000 PCODE=1
*
*   Typical Urban Cross-Section                                            6
*
COMPUTE RATING CURVE ID=6  VS=     8.000   NSEGS=3
                     MIN EL=  295.00   MAX EL=  295.70
                     CHNSLP= 0.00500   FLNSLP= 0.00500
                     N= 0.015  DIST=  200.00
                     N=-0.015  DIST=  300.00
                     N= 0.015  DIST=  500.00
                       DIST    ELEV     DIST    ELEV     DIST    ELEV
                       0.00  295.70   200.00  295.50   200.10  295.00
                     299.90  295.00   300.00  295.50   500.00  295.70
                    RFN=0.0000 PCODE=1
*
* Flows to Laurel Creek Reservoir (non-MTE Developments)
* Compute runoff hydrograph from area 7101
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=7101 AREA=   0.0165 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0   0.0  0.0   0.0  0.0  99.0  0.0
                    RATING CURVES: IDMC=1 IDOC=6 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7101
*
ROUTE SPECIAL POND  ID=3 HYD NO=6101 INFLOW=2 PCODE=0 OPTION= 5
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 101.300
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
```

```
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  5
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0372
                     100.999     0.000  0.0000  0.0000   0.000  0.0371  0.0372
                     101.000     0.000  0.0000  0.0000   0.001  0.0372  0.0372
                     101.200     0.000  0.0000  0.0000   0.200  0.0450  0.0372
                     101.300     0.000  0.0000  0.0000   0.250  0.0500  0.0372
*
* Compute runoff hydrograph from area 8101
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=8101 AREA=   0.0855 Sq km  L=   450 m  W=    50 m
               SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                     46.4   0.0  0.0  51.5  0.0   2.1  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6101 & 8101 call result 3101
*
ADD HYD             ID=5 HYD NO=3101 IDA=3 IDB=2 ICODE=0                  AREA=     0.102
*
KEEP HYD            ID=5 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=5 IMET=0
PRINT HYD           ID=5 PCODE=1 MODE=10
*
* 5101 Interim SWM Basin (surge protection only)
*
ROUTE SPECIAL POND  ID=2 HYD NO=5101 INFLOW=5 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 203.500
                    Recharge characteristics for Compartment A
                      LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 200.000 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                      CDB=   0.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  9
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.990     0.000  0.0000  0.0000   0.000  0.0000  0.4400
                     201.500     0.000  0.0000  0.0000   0.014  0.0050  0.4600
                     201.520     0.000  0.0000  0.0000   0.252  0.0055  0.5100
                     201.600     0.000  0.0000  0.0000   0.470  0.0070  0.5450
                     202.000     0.000  0.0000  0.0000   0.470  0.1420  0.5910
                     202.100     0.000  0.0000  0.0000   1.000  0.1590  0.5950
                     202.600     0.000  0.0000  0.0000   2.500  0.8700  0.6058
                     202.700     0.000  0.0000  0.0000   3.500  0.8900  0.6354
                     203.500     0.000  0.0000  0.0000   4.500  0.9100  0.6650
*
KEEP HYD            ID=2 CUTOFF=24 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=1
PRINT HYD           ID=2 PCODE=1 MODE=10
*
* Compute runoff hydrograph from area 7107
```

```
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=7107 AREA=   0.0210 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0   0.0  0.0   0.0  0.0  99.0  0.0
                     RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                     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
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7107
*
ROUTE SPECIAL POND  ID=5 HYD NO=6107 INFLOW=3 PCODE=0 OPTION= 5
                     Inflow controls:
                         USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                         GWPCT=  0% GWDIV=0
                     Maximum level for Routing Tables:  ZMAX= 101.300
                     Recharge characteristics for Compartment A
                       LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
                       CDA=   0.000 mm/h  DZA= 10.00 m
                     Recharge characteristics for Compartment B
                       LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                       CDB=  15.000 mm/h  DZB= 10.00 m
                     Irrigation Pond Controls: IPOND=0
                     Number of points=  5
                                    Compartment  A          Compartment B
                     Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                        (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                      100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0520
                      100.999     0.000  0.0000  0.0000   0.000  0.0519  0.0520
                      101.000     0.000  0.0000  0.0000   0.001  0.0520  0.0520
                      101.200     0.000  0.0000  0.0000   0.380  0.0600  0.0520
                      101.300     0.000  0.0000  0.0000   0.460  0.0700  0.0520
*
* Compute runoff hydrograph from area 8107
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=8107 AREA=   0.1090 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                      46.4   0.0  0.0  42.6  0.0  10.9  0.0   0.0  0.0
                     RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                     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
                     SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6107 & 8107 call result 3107
*
ADD HYD             ID=6 HYD NO=3107 IDA=5 IDB=3 ICODE=0                  AREA=     0.130
*
KEEP HYD            ID=6 CUTOFF=24 ICODE=5 ISTEP=1 IFORM=0 IDB=6 IMET=1
PRINT HYD           ID=6 PCODE=1 MODE=10
*
* Sum hydr. 5101 & 3107 call result 2012
*
ADD HYD             ID=3 HYD NO=2012 IDA=2 IDB=6 ICODE=0                  AREA=     0.232
*
*  Main channel Parabolic Swale - Flat                                    7
*
COMPUTE RATING CURVE ID=1  VS=     7.000   NSEGS=3
```

```
                      MIN EL=  100.70   MAX EL=  103.00
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      N= 0.070  DIST=   20.00
                      N=-0.050  DIST=   30.00
                      N= 0.070  DIST=   50.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  103.00    20.00  101.00    23.00  100.80
                       25.00  100.70    27.00  100.80    30.00  101.00
                       50.00  103.00
                     RFN=0.0000 PCODE=1
*
* Typical off-channel (Flat slopes)                                    6
*
COMPUTE RATING CURVE ID=6  VS=     1.100   NSEGS=3
                      MIN EL=  100.00   MAX EL=  100.60
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      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
*
* Compute runoff hydrograph from area 3105
* VS=   7.000 is main channel & VS=   1.100 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=3105 AREA=   0.0350 Sq km  L=   200 m  W=   180 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                        1.0   0.0  0.0  74.0  0.0  25.0  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=6 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=2 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=0
PRINT HYD           ID=2 PCODE=1 MODE=10
*
* Sum hydr. 2012 & 3105 call result 2013
*
ADD HYD             ID=5 HYD NO=2013 IDA=3 IDB=2 ICODE=0                 AREA=     0.267
*
*   Typical Urban Cross-Section                                         6
*
COMPUTE RATING CURVE ID=1  VS=     8.000   NSEGS=3
                      MIN EL=  295.00   MAX EL=  295.70
                      CHNSLP= 0.00500   FLNSLP= 0.00500
                      N= 0.015  DIST=  200.00
                      N=-0.015  DIST=  300.00
                      N= 0.015  DIST=  500.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  295.70   200.00  295.50   200.10  295.00
                      299.90  295.00   300.00  295.50   500.00  295.70
                     RFN=0.0000 PCODE=1
*
*   Typical Urban Cross-Section                                         6
*
COMPUTE RATING CURVE ID=6  VS=     8.000   NSEGS=3
                      MIN EL=  295.00   MAX EL=  295.70
                      CHNSLP= 0.00500   FLNSLP= 0.00500
                      N= 0.015  DIST=  200.00
```

```
                     N=-0.015  DIST=  300.00
                     N= 0.015  DIST=  500.00
                       DIST    ELEV     DIST    ELEV     DIST    ELEV
                       0.00  295.70   200.00  295.50   200.10  295.00
                     299.90  295.00   300.00  295.50   500.00  295.70
                    RFN=0.0000 PCODE=1
*
* Compute runoff hydrograph from area 7102
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=7102 AREA=   0.0150 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0   0.0  0.0   0.0  0.0  99.0  0.0
                    RATING CURVES: IDMC=1 IDOC=6 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7102
*
ROUTE SPECIAL POND  ID=3 HYD NO=6102 INFLOW=2 PCODE=0 OPTION= 5
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 101.300
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000                EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  5
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     100.000     0.000  0.0000  0.0000   0.000  0.0000  0.0364
                     100.999     0.000  0.0000  0.0000   0.000  0.0363  0.0364
                     101.000     0.000  0.0000  0.0000   0.001  0.0364  0.0364
                     101.200     0.000  0.0000  0.0000   0.120  0.0390  0.0364
                     101.300     0.000  0.0000  0.0000   0.200  0.0440  0.0364
*
* Compute runoff hydrograph from area 8102
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=8102 AREA=   0.06934 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                      46.4   0.0  0.0   0.0  0.0  53.6  0.0   0.0  0.0
                    RATING CURVES: IDMC=1 IDOC=1 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6102 & 8102 call result 3102
*
ADD HYD             ID=6 HYD NO=3102 IDA=3 IDB=2 ICODE=0                  AREA=     0.08434
*
KEEP HYD            ID=6 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=6 IMET=0
PRINT HYD           ID=6 PCODE=1 MODE=10
```

```
*
* Sum hydr. 2013 & 3102 call result 2014
*
ADD HYD             ID=2 HYD NO=2014 IDA=5 IDB=6 ICODE=0                  AREA=     0.35134
*
* 1102 End-of-Pipe Infiltration
*
ROUTE SPECIAL POND  ID=3 HYD NO=1102 INFLOW=2 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 200.500
                    Recharge characteristics for Compartment A
                      LEVELA= 198.340               EVAPA= 0.0 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 198.340 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                      CDB=  15.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points=  7
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.800     0.000  0.0000  0.0000   0.000  0.0000  0.1611
                     199.990     0.000  0.0000  0.0000   0.000  0.2684  0.1611
                     200.010     0.000  0.0000  0.0000   0.001  0.2685  0.1611
                     200.100     0.000  0.0000  0.0000   0.400  0.3000  0.1611
                     200.300     0.000  0.0000  0.0000   1.600  0.3500  0.1611
                     200.400     0.000  0.0000  0.0000   3.000  0.4000  0.1611
                     200.500     0.000  0.0000  0.0000   5.500  0.4300  0.1611
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
*
* 5102 Quantity SWM Basin
*
ROUTE SPECIAL POND  ID=2 HYD NO=5102 INFLOW=3 PCODE=0 OPTION=15
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 203.500
                    Recharge characteristics for Compartment A
                      LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                      CDA=   0.000 mm/h  DZA= 10.00 m
                    Recharge characteristics for Compartment B
                      LEVELB= 200.000 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                      CDB=   0.000 mm/h  DZB= 10.00 m
                    Irrigation Pond Controls: IPOND=0
                    Number of points= 10
                                   Compartment  A          Compartment B
                    Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                       (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                     199.990     0.000  0.0000  0.0000   0.000  0.0000  0.4400
                     200.000     0.000  0.0000  0.0000   0.000  0.0062  0.4400
                     201.500     0.000  0.0000  0.0000   0.014  0.0600  0.4600
                     201.520     0.000  0.0000  0.0000   0.039  0.1156  0.5100
                     201.600     0.000  0.0000  0.0000   0.500  0.3500  0.5450
                     202.000     0.000  0.0000  0.0000   1.500  0.4500  0.5910
                     202.100     0.000  0.0000  0.0000   2.500  0.5000  0.5950
                     202.600     0.000  0.0000  0.0000   3.500  0.5547  0.6058
                     202.700     0.000  0.0000  0.0000   4.500  0.6788  0.6354
                     203.500     0.000  0.0000  0.0000   5.500  0.7431  0.6650
*
```

```
* Go to event file: 5102 Quantity SWM Basin
*
*CHANGE INPUT FILE
*
KEEP HYD            ID=2 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=0
PRINT HYD           ID=2 PCODE=1 MODE=10
*
*  Main channel Parabolic Swale - Flat                                    7
*
COMPUTE RATING CURVE ID=1  VS=     7.000   NSEGS=3
                      MIN EL=  100.70   MAX EL=  103.00
                      CHNSLP= 0.01000   FLNSLP= 0.01000
                      N= 0.070  DIST=   20.00
                      N=-0.050  DIST=   30.00
                      N= 0.070  DIST=   50.00
                        DIST    ELEV     DIST    ELEV     DIST    ELEV
                        0.00  103.00    20.00  101.00    23.00  100.80
                       25.00  100.70    27.00  100.80    30.00  101.00
                       50.00  103.00
                     RFN=0.0000 PCODE=1
*
* Compute runoff hydrograph from area 3103
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=3 NHD=3103 AREA=   0.0020 Sq km  L=    50 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0 25.0   0.0  0.0  74.0  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 WQPCODE=1
                    RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
                    GWFACT=0.00 GWON=0
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
*
* Outflow from 310 WEST of Beaver Creek Road
*
ADD HYD             ID=5 HYD NO=2015 IDA=2 IDB=3 ICODE=0                  AREA=     0.35344
*
* Compute runoff hydrograph from area 7106
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=7106 AREA=   0.0520 Sq km  L=   450 m  W=    50 m
              SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                       1.0   0.0  0.0   0.0  0.0   0.0  0.0  99.0  0.0
                    RATING CURVES: IDMC=6 IDOC=6 QRMC=  0.50 QROC=  0.05
                    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
                    SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Rooftop Infiltration for 7106
*
ROUTE SPECIAL POND  ID=3 HYD NO=6106 INFLOW=2 PCODE=0 OPTION= 5
                    Inflow controls:
                        USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                        GWPCT=  0% GWDIV=0
                    Maximum level for Routing Tables:  ZMAX= 101.300
                    Recharge characteristics for Compartment A
                      LEVELA= 100.000               EVAPA= 0.0 mm/d ACODE=0
```

```
                    CDA=   0.000 mm/h  DZA= 10.00 m
                  Recharge characteristics for Compartment B
                    LEVELB= 100.000 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                    CDB=  15.000 mm/h  DZB= 10.00 m
                  Irrigation Pond Controls: IPOND=0
                  Number of points=  5
                                Compartment  A          Compartment B
                  Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                     (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                   100.000     0.000  0.0000  0.0000   0.000  0.0000  0.1304
                   100.999     0.000  0.0000  0.0000   0.000  0.1303  0.1304
                   101.000     0.000  0.0000  0.0000   0.001  0.1304  0.1304
                   101.200     0.000  0.0000  0.0000   0.950  0.1510  0.1304
                   101.300     0.000  0.0000  0.0000   1.050  0.1520  0.1304
*
* Compute runoff hydrograph from area 8106
* VS=   8.000 is main channel & VS=   8.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=8106 AREA=   0.2740 Sq km  L=   450 m  W=    50 m
             SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                    46.4   0.0  0.0  48.3  2.1   2.0  1.1   0.0  0.0
                  RATING CURVES: IDMC=6 IDOC=6 QRMC=  0.50 QROC=  0.05
                  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
                  SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
* Sum hydr. 6106 & 8106 call result 3106
*
ADD HYD             ID=6 HYD NO=3106 IDA=3 IDB=2 ICODE=0                  AREA=     0.326
*
KEEP HYD            ID=6 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=6 IMET=0
PRINT HYD           ID=6 PCODE=1 MODE=10
*
* Compute runoff hydrograph from area 3104
* VS=   7.000 is main channel & VS=   1.000 is off-channel
*
COMPUTE FLOWRATE    ID=2 NHD=3104 AREA=   0.0540 Sq km  L=   200 m  W=   150 m
             SOIL ZONE I    II  III    IV    V    VI  VII  VIII   IX
                    10.0   0.0  0.0  23.0 67.0   0.0  0.0   0.0  0.0
                  RATING CURVES: IDMC=1 IDOC=5 QRMC=  0.50 QROC=  0.05
                  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
                  SWQTH=   0.0 L/s SWPUMP=   0.0 L/s SWCODE=0
*
KEEP HYD            ID=2 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=0
PRINT HYD           ID=2 PCODE=1 MODE=10
*
* Sum hydr. 3106 & 3104 call result 2016
*
ADD HYD             ID=3 HYD NO=2016 IDA=6 IDB=2 ICODE=0                  AREA=     0.380
*
* 1106 End-of-Pipe Infiltration
*
ROUTE SPECIAL POND  ID=2 HYD NO=1106 INFLOW=3 PCODE=0 OPTION=15
                  Inflow controls:
                      USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                      GWPCT=  0% GWDIV=0
                  Maximum level for Routing Tables:  ZMAX= 200.300
                  Recharge characteristics for Compartment A
```

```
                    LEVELA= 198.340               EVAPA= 0.0 mm/d ACODE=0
                    CDA=   0.000 mm/h  DZA= 10.00 m
                  Recharge characteristics for Compartment B
                    LEVELB= 198.340 CCBA= 0.00000  EVAPB= 0.0 mm/d BCODE=1
                    CDB=  15.000 mm/h  DZB= 10.00 m
                  Irrigation Pond Controls: IPOND=0
                  Number of points=  6
                                Compartment  A          Compartment B
                  Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                     (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                   199.800     0.000  0.0000  0.0000   0.000  0.0000  0.0978
                   199.990     0.000  0.0000  0.0000   0.000  0.1629  0.0978
                   200.010     0.000  0.0000  0.0000   0.001  0.1630  0.0978
                   200.100     0.000  0.0000  0.0000   0.400  0.1750  0.0978
                   200.200     0.000  0.0000  0.0000   1.000  0.1800  0.0978
                   200.300     0.000  0.0000  0.0000   2.000  0.1830  0.0978
*
KEEP HYD            ID=2 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=0
PRINT HYD           ID=2 PCODE=1 MODE=10
*
* 5106 Quantity SWM Basin
*
ROUTE SPECIAL POND  ID=3 HYD NO=5106 INFLOW=2 PCODE=0 OPTION=15
                  Inflow controls:
                      USPCT=100% USDIV=0     PCTA=  0% ADIV=0
                      GWPCT=  0% GWDIV=0
                  Maximum level for Routing Tables:  ZMAX= 202.900
                  Recharge characteristics for Compartment A
                    LEVELA= 200.000               EVAPA= 1.4 mm/d ACODE=0
                    CDA=   0.000 mm/h  DZA= 10.00 m
                  Recharge characteristics for Compartment B
                    LEVELB= 200.000 CCBA= 0.00000  EVAPB= 1.4 mm/d BCODE=0
                    CDB=   0.000 mm/h  DZB= 10.00 m
                  Irrigation Pond Controls: IPOND=0
                  Number of points=  9
                                Compartment  A          Compartment B
                  Elevation  Outflow Storage  SFArea Outflow Storage SFArea
                     (m)       (cms)  (ha*m)    (ha)   (cms)  (ha*m)    (ha)
                   199.990     0.000  0.0000  0.0000   0.000  0.0000  0.6520
                   200.000     0.000  0.0000  0.0000   0.000  0.0065  0.6520
                   201.500     0.000  0.0000  0.0000   0.019  0.0900  0.6570
                   201.600     0.000  0.0000  0.0000   0.021  0.1304  0.6620
                   202.000     0.000  0.0000  0.0000   0.500  0.1800  0.6670
                   202.100     0.000  0.0000  0.0000   1.000  0.2300  0.6720
                   202.400     0.000  0.0000  0.0000   1.500  0.2800  0.6770
                   202.600     0.000  0.0000  0.0000   2.000  0.3300  0.6820
                   202.900     0.000  0.0000  0.0000   3.000  0.3800  0.6870
*
* Go to event file: 5106 Quantity SWM Basin
*
*CHANGE INPUT FILE
*
KEEP HYD            ID=3 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=3 IMET=0
PRINT HYD           ID=3 PCODE=1 MODE=10
*
* This is the total outflow from 310 in the Primary Study Area
*
ADD HYD             ID=2 HYD NO=2017 IDA=5 IDB=3 ICODE=0                  AREA=     0.73344
*
KEEP HYD            ID=2 CUTOFF=0 ICODE=5 ISTEP=1 IFORM=0 IDB=2 IMET=0
PRINT HYD           ID=2 PCODE=1 MODE=10
*
* Go to event file: This is the total outflow from 310 in the Primary Study Area
```

```
*
CHANGE INPUT FILE
*
FINISH
```

1	301	2.6500	1.13	0.0083	0.	RCFLAGS	0	0 25mm.dat
1	111	2.6500	1.12	0.0082	0.	RCFLAGS	0	0
1	381	3.3100	1.18	0.0115	0.	RCFLAGS	0	0
1	281	5.9600	1.15	0.0190	0.	RCFLAGS	0	0
1	581	5.9600	1.10	0.0190	398.	RCFLAGS	0	0
1	121	5.9600	1.10	0.0190	0.	RCFLAGS	0	0
1	3916	0.0260	2.27	0.0006	0.	RCFLAGS	0	0
1	3919	0.1360	2.27	0.0026	0.	RCFLAGS	0	0
1	2000	0.1620	2.27	0.0032	0.	RCFLAGS	0	0
1	3910	0.1760	1.90	0.0027	0.	RCFLAGS	0	0
1	2001	0.3380	2.07	0.0060	0.	RCFLAGS	0	0
1	7912	0.0270	2.18	0.0006	0.	RCFLAGS	0	0
1	6912	0.0270	0.00	0.0000	30.	RCFLAGS	0	0
1	8912	0.1410	6.48	0.1395	0.	RCFLAGS	0	0
1	3912	0.1680	5.44	0.1395	0.	RCFLAGS	0	0
1	1912	0.1680	0.00	0.0000	677.	RCFLAGS	0	0
1	5912	0.1680	0.00	0.0000	34.	RCFLAGS	0	0
1	2002	0.5060	1.39	0.0060	0.	RCFLAGS	0	0
1	7913	0.0180	2.17	0.0004	0.	RCFLAGS	0	0
1	6913	0.0180	0.00	0.0000	20.	RCFLAGS	0	0
1	8913	0.0920	6.45	0.0910	0.	RCFLAGS	0	0
1	3913	0.1100	5.39	0.0910	0.	RCFLAGS	0	0
1	1913	0.1100	0.00	0.0000	442.	RCFLAGS	0	0
1	5913	0.1100	0.00	0.0000	22.	RCFLAGS	0	0
1	2003	0.6160	1.14	0.0060	0.	RCFLAGS	0	0
1	2004	6.5760	1.10	0.0210	0.	RCFLAGS	0	0
1	131	6.5760	1.10	0.0210	0.	RCFLAGS	0	0
1	7914	0.0028	11.34	0.0148	0.	RCFLAGS	0	0
1	6914	0.0028	0.00	0.0000	24.	RCFLAGS	0	0
177914		0.0215	11.34	0.1160	0.	RCFLAGS	0	0
178914		0.0247	4.90	0.0393	0.	RCFLAGS	0	0
173914		0.0462	7.89	0.1553	0.	RCFLAGS	0	0
1	914	0.0462	0.00	0.0000	202.	RCFLAGS	0	0
1	1914	0.0490	0.00	0.0000	0.	RCFLAGS	0	0
188914		0.0258	7.03	0.0735	0.	RCFLAGS	0	0
1	814	0.0258	0.00	0.0000	113.	RCFLAGS	0	0
1	14	0.0748	0.00	0.0000	0.	RCFLAGS	0	0
1	8914	0.0465	7.95	0.0623	0.	RCFLAGS	0	0
1	3914	0.1213	3.05	0.0623	0.	RCFLAGS	0	0
1	5914	0.1213	2.93	0.0029	240.	RCFLAGS	0	0
1	4914	0.0252	5.38	0.0187	0.	RCFLAGS	0	0
1	2914	0.1465	3.35	0.0194	0.	RCFLAGS	0	0
1	7915	0.0039	11.34	0.0210	0.	RCFLAGS	0	0
1	8915	0.0151	8.15	0.0528	0.	RCFLAGS	0	0
1	3915	0.0190	8.80	0.0738	0.	RCFLAGS	0	0
1	5915	0.0190	0.00	0.0000	92.	RCFLAGS	0	0
1	4915	0.0076	2.50	0.0020	0.	RCFLAGS	0	0 25mm.dat
1	2915	0.0265	0.71	0.0020	0.	RCFLAGS	0	0
1	2005	0.1730	2.95	0.0200	0.	RCFLAGS	0	0
1	3911	0.2030	2.03	0.0025	0.	RCFLAGS	0	0
1	2006	0.3760	2.45	0.0225	0.	RCFLAGS	0	0
1	7917	0.0017	10.90	0.0091	0.	RCFLAGS	0	0
1	6917	0.0017	0.00	0.0000	16.	RCFLAGS	0	0
178917		0.0075	8.50	0.0266	0.	RCFLAGS	0	0
1	3917	0.0091	6.94	0.0266	0.	RCFLAGS	0	0
1	1917	0.0091	0.00	0.0000	40.	RCFLAGS	0	0
1	8917	0.0022	2.95	0.0000	0.	RCFLAGS	0	0
1	917	0.0022	0.00	0.0000	2.	RCFLAGS	0	0
1	3917	0.0114	0.00	0.0000	0.	RCFLAGS	0	0
1	4917	0.0144	4.80	0.0170	0.	RCFLAGS	0	0
1	2917	0.0257	2.68	0.0170	0.	RCFLAGS	0	0
1	2007	0.4017	2.47	0.0322	0.	RCFLAGS	0	0
1	3918	0.0060	1.64	0.0003	0.	RCFLAGS	0	0

1	2008	0.4077	2.45	0.0326	0.	RCFLAGS	0	0
1	2009	6.9837	1.18	0.0326	0.	RCFLAGS	0	0
1	3092	0.0404	4.19	0.0008	0.	RCFLAGS	0	0
1	3093	0.0070	1.75	0.0002	0.	RCFLAGS	0	0
1	2010	0.0474	3.83	0.0010	0.	RCFLAGS	0	0
1	9914	0.0218	5.34	0.0188	0.	RCFLAGS	0	0
1	2011	0.0691	4.30	0.0198	0.	RCFLAGS	0	0
1	7101	0.0165	2.17	0.0004	0.	RCFLAGS	0	0
1	6101	0.0165	0.00	0.0000	18.	RCFLAGS	0	0
1	8101	0.0855	6.47	0.0846	0.	RCFLAGS	0	0
1	3101	0.1020	5.43	0.0846	0.	RCFLAGS	0	0
1	5101	0.1020	5.41	0.0827	51.	RCFLAGS	0	0
1	7107	0.0210	2.18	0.0005	0.	RCFLAGS	0	0
1	6107	0.0210	0.00	0.0000	23.	RCFLAGS	0	0
1	8107	0.1090	6.47	0.1080	0.	RCFLAGS	0	0
1	3107	0.1300	5.43	0.1080	0.	RCFLAGS	0	0
1	2012	0.2320	5.42	0.1748	0.	RCFLAGS	0	0
1	3105	0.0350	2.31	0.0007	0.	RCFLAGS	0	0
1	2013	0.2670	5.01	0.1756	0.	RCFLAGS	0	0
1	7102	0.0150	2.17	0.0003	0.	RCFLAGS	0	0
1	6102	0.0150	0.00	0.0000	17.	RCFLAGS	0	0
1	8102	0.0693	6.43	0.0686	0.	RCFLAGS	0	0
1	3102	0.0843	5.29	0.0686	0.	RCFLAGS	0	0
1	2014	0.3513	5.08	0.2442	0.	RCFLAGS	0	0
1	1102	0.3513	0.00	0.0000	1267.	RCFLAGS	0	0
1	5102	0.3513	0.00	0.0000	62.	RCFLAGS	0	0
1	3103	0.0020	2.06	0.0001	0.	RCFLAGS	0	0
1	2015	0.3533	0.01	0.0001	0.	RCFLAGS	0	0
1	7106	0.0520	2.19	0.0011	0.	RCFLAGS	0	0
1	6106	0.0520	0.00	0.0000	58.	RCFLAGS	0	0 25mm.dat
1	8106	0.2740	6.46	0.2714	0.	RCFLAGS	0	0
1	3106	0.3260	5.43	0.2714	0.	RCFLAGS	0	0
1	3104	0.0540	2.73	0.0139	0.	RCFLAGS	0	0
1	2016	0.3800	5.05	0.2853	0.	RCFLAGS	0	0
1	1106	0.3800	0.00	0.0000	1374.	RCFLAGS	0	0
1	5106	0.3800	0.00	0.0000	65.	RCFLAGS	0	0
1	2017	0.7333	0.01	0.0001	0.	RCFLAGS	0	0
2	301	2.6500	4.01	0.0338	0.	RCFLAGS	0	0 2.dat
2	111	2.6500	3.96	0.0326	0.	RCFLAGS	0	0
2	381	3.3100	4.03	0.0462	0.	RCFLAGS	0	0
2	281	5.9600	4.00	0.0758	0.	RCFLAGS	0	0
2	581	5.9600	3.81	0.0714	1221.	RCFLAGS	0	0
2	121	5.9600	3.80	0.0714	0.	RCFLAGS	0	0
2	3916	0.0260	7.95	0.0019	0.	RCFLAGS	0	0
2	3919	0.1360	8.06	0.0079	0.	RCFLAGS	0	0
2	2000	0.1620	8.04	0.0097	0.	RCFLAGS	0	0
2	3910	0.1760	8.08	0.0093	0.	RCFLAGS	0	0
2	2001	0.3380	8.06	0.0184	0.	RCFLAGS	0	0
2	7912	0.0270	7.63	0.0017	0.	RCFLAGS	0	0
2	6912	0.0270	0.00	0.0000	110.	RCFLAGS	0	0
2	8912	0.1410	25.76	0.4049	0.	RCFLAGS	0	0
2	3912	0.1680	21.62	0.4049	0.	RCFLAGS	0	0
2	1912	0.1680	12.34	0.3491	1067.	RCFLAGS	0	0
2	5912	0.1680	12.29	0.0149	1548.	RCFLAGS	0	0
2	2002	0.5060	9.47	0.0301	0.	RCFLAGS	0	0
2	7913	0.0180	7.59	0.0011	0.	RCFLAGS	0	0
2	6913	0.0180	0.00	0.0000	73.	RCFLAGS	0	0
2	8913	0.0920	25.68	0.2642	0.	RCFLAGS	0	0
2	3913	0.1100	21.48	0.2642	0.	RCFLAGS	0	0
2	1913	0.1100	12.28	0.2310	694.	RCFLAGS	0	0
2	5913	0.1100	12.20	0.0117	974.	RCFLAGS	0	0
2	2003	0.6160	9.95	0.0401	0.	RCFLAGS	0	0
2	2004	6.5760	4.38	0.0827	0.	RCFLAGS	0	0

2	131	6.5760	4.37	0.0827	0.	RCFLAGS	0	0
2	7914	0.0028	46.41	0.0279	0.	RCFLAGS	0	0
2	6914	0.0028	9.55	0.0143	68.	RCFLAGS	0	0
27	7914	0.0215	46.44	0.2179	0.	RCFLAGS	0	0
27	8914	0.0247	19.13	0.0738	0.	RCFLAGS	0	0
27	3914	0.0462	31.83	0.2918	0.	RCFLAGS	0	0
2	914	0.0462	1.05	0.0514	771.	RCFLAGS	0	0
2	1914	0.0490	1.52	0.0657	0.	RCFLAGS	0	0
28	8914	0.0258	28.17	0.1381	0.	RCFLAGS	0	0
2	814	0.0258	16.91	0.1364	120.	RCFLAGS	0	0
2	14	0.0748	6.83	0.1364	0.	RCFLAGS	0	0
2	8914	0.0465	32.08	0.1809	0.	RCFLAGS	0	0
2	3914	0.1213	16.51	0.3173	0.	RCFLAGS	0	0
2	5914	0.1213	15.80	0.0093	1475.	RCFLAGS	0	0
2	4914	0.0252	21.16	0.0541	0.	RCFLAGS	0	0
2	2914	0.1465	16.72	0.0597	0.	RCFLAGS	0	0
2	7915	0.0039	46.44	0.0395	0.	RCFLAGS	0	0
2	8915	0.0151	32.88	0.0992	0.	RCFLAGS	0	0
2	3915	0.0190	35.67	0.1387	0.	RCFLAGS	0	0
2	5915	0.0190	0.54	0.0003	431.	RCFLAGS	0	0
2	4915	0.0076	9.28	0.0038	0.	RCFLAGS	0	0 2.dat
2	2915	0.0265	3.03	0.0038	0.	RCFLAGS	0	0
2	2005	0.1730	14.62	0.0635	0.	RCFLAGS	0	0
2	3911	0.2030	8.95	0.0336	0.	RCFLAGS	0	0
2	2006	0.3760	11.56	0.0813	0.	RCFLAGS	0	0
2	7917	0.0017	46.41	0.0170	0.	RCFLAGS	0	0
2	6917	0.0017	33.31	0.0170	17.	RCFLAGS	0	0
27	8917	0.0075	34.31	0.0524	0.	RCFLAGS	0	0
2	3917	0.0091	34.13	0.0694	0.	RCFLAGS	0	0
2	1917	0.0091	0.00	0.0000	205.	RCFLAGS	0	0
2	8917	0.0022	10.32	0.0022	0.	RCFLAGS	0	0
2	917	0.0022	0.00	0.0000	8.	RCFLAGS	0	0
2	3917	0.0114	0.00	0.0000	0.	RCFLAGS	0	0
2	4917	0.0144	18.47	0.0429	0.	RCFLAGS	0	0
2	2917	0.0257	10.31	0.0429	0.	RCFLAGS	0	0
2	2007	0.4017	11.48	0.1214	0.	RCFLAGS	0	0
2	3918	0.0060	7.77	0.0016	0.	RCFLAGS	0	0
2	2008	0.4077	11.43	0.1220	0.	RCFLAGS	0	0
2	2009	6.9837	4.78	0.1434	0.	RCFLAGS	0	0
2	3092	0.0404	15.72	0.0415	0.	RCFLAGS	0	0
2	3093	0.0070	7.86	0.0018	0.	RCFLAGS	0	0
2	2010	0.0474	14.56	0.0419	0.	RCFLAGS	0	0
2	9914	0.0218	21.00	0.0552	0.	RCFLAGS	0	0
2	2011	0.0691	16.59	0.0892	0.	RCFLAGS	0	0
2	7101	0.0165	7.58	0.0010	0.	RCFLAGS	0	0
2	6101	0.0165	0.00	0.0000	67.	RCFLAGS	0	0
2	8101	0.0855	25.75	0.2455	0.	RCFLAGS	0	0
2	3101	0.1020	21.58	0.2455	0.	RCFLAGS	0	0
2	5101	0.1020	21.52	0.2442	55.	RCFLAGS	0	0
2	7107	0.0210	7.61	0.0013	0.	RCFLAGS	0	0
2	6107	0.0210	0.00	0.0000	86.	RCFLAGS	0	0
2	8107	0.1090	25.75	0.3133	0.	RCFLAGS	0	0
2	3107	0.1300	21.59	0.3133	0.	RCFLAGS	0	0
2	2012	0.2320	21.56	0.5575	0.	RCFLAGS	0	0
2	3105	0.0350	8.06	0.0022	0.	RCFLAGS	0	0
2	2013	0.2670	19.79	0.5597	0.	RCFLAGS	0	0
2	7102	0.0150	7.58	0.0009	0.	RCFLAGS	0	0
2	6102	0.0150	0.00	0.0000	61.	RCFLAGS	0	0
2	8102	0.0693	25.64	0.1991	0.	RCFLAGS	0	0
2	3102	0.0843	21.08	0.1991	0.	RCFLAGS	0	0
2	2014	0.3513	20.10	0.7589	0.	RCFLAGS	0	0
2	1102	0.3513	7.53	0.3987	2999.	RCFLAGS	0	0
2	5102	0.3513	7.48	0.0828	1379.	RCFLAGS	0	0

2	3103	0.0020	7.74	0.0007	0.	RCFLAGS	0	0
2	2015	0.3533	7.48	0.0828	0.	RCFLAGS	0	0
2	7106	0.0520	7.71	0.0033	0.	RCFLAGS	0	0
2	6106	0.0520	0.00	0.0000	213.	RCFLAGS	0	0 2.dat
2	8106	0.2740	25.76	0.7877	0.	RCFLAGS	0	0
2	3106	0.3260	21.65	0.7877	0.	RCFLAGS	0	0
2	3104	0.0540	11.50	0.0411	0.	RCFLAGS	0	0
2	2016	0.3800	20.21	0.8287	0.	RCFLAGS	0	0
2	1106	0.3800	11.64	0.7736	1796.	RCFLAGS	0	0
2	5106	0.3800	11.44	0.4066	1703.	RCFLAGS	0	0
2	2017	0.7333	9.53	0.4303	0.	RCFLAGS	0	0
3	301	2.6500	8.46	0.4342	0.	RCFLAGS	0	0 5.dat
3	111	2.6500	8.43	0.4128	0.	RCFLAGS	0	0
3	381	3.3100	9.95	0.8554	0.	RCFLAGS	0	0
3	281	5.9600	9.27	1.2095	0.	RCFLAGS	0	0
3	581	5.9600	9.04	0.6644	8985.	RCFLAGS	0	0
3	121	5.9600	9.04	0.6641	0.	RCFLAGS	0	0
3	3916	0.0260	12.34	0.0274	0.	RCFLAGS	0	0
3	3919	0.1360	11.68	0.0768	0.	RCFLAGS	0	0
3	2000	0.1620	11.79	0.1043	0.	RCFLAGS	0	0
3	3910	0.1760	12.20	0.0860	0.	RCFLAGS	0	0
3	2001	0.3380	12.00	0.1903	0.	RCFLAGS	0	0
3	7912	0.0270	9.98	0.0023	0.	RCFLAGS	0	0
3	6912	0.0270	0.00	0.0000	146.	RCFLAGS	0	0
3	8912	0.1410	38.30	0.7218	0.	RCFLAGS	0	0
3	3912	0.1680	32.14	0.7218	0.	RCFLAGS	0	0
3	1912	0.1680	22.34	0.6827	1248.	RCFLAGS	0	0
3	5912	0.1680	22.27	0.0424	2845.	RCFLAGS	0	0
3	2002	0.5060	15.41	0.2046	0.	RCFLAGS	0	0
3	7913	0.0180	9.93	0.0015	0.	RCFLAGS	0	0
3	6913	0.0180	0.00	0.0000	97.	RCFLAGS	0	0
3	8913	0.0920	36.06	0.3928	0.	RCFLAGS	0	0
3	3913	0.1100	30.16	0.3928	0.	RCFLAGS	0	0
3	1913	0.1100	20.25	0.3691	781.	RCFLAGS	0	0
3	5913	0.1100	20.11	0.0172	1713.	RCFLAGS	0	0
3	2003	0.6160	16.25	0.2151	0.	RCFLAGS	0	0
3	2004	6.5760	9.71	0.7201	0.	RCFLAGS	0	0
3	131	6.5760	9.71	0.7199	0.	RCFLAGS	0	0
3	7914	0.0028	63.96	0.0383	0.	RCFLAGS	0	0
3	6914	0.0028	29.48	0.0276	68.	RCFLAGS	0	0
377	914	0.0215	63.96	0.2996	0.	RCFLAGS	0	0
378	914	0.0247	27.74	0.1611	0.	RCFLAGS	0	0
373	914	0.0462	44.59	0.4607	0.	RCFLAGS	0	0
3	914	0.0462	9.96	0.2521	786.	RCFLAGS	0	0
3	1914	0.0490	11.06	0.2797	0.	RCFLAGS	0	0
388	914	0.0258	39.74	0.2314	0.	RCFLAGS	0	0
3	814	0.0258	27.55	0.2086	121.	RCFLAGS	0	0
3	14	0.0748	16.75	0.4883	0.	RCFLAGS	0	0
3	8914	0.0465	44.92	0.2624	0.	RCFLAGS	0	0
3	3914	0.1213	27.54	0.7507	0.	RCFLAGS	0	0
3	5914	0.1213	26.24	0.0509	2372.	RCFLAGS	0	0
3	4914	0.0252	30.44	0.0900	0.	RCFLAGS	0	0
3	2914	0.1465	26.96	0.0997	0.	RCFLAGS	0	0
3	7915	0.0039	63.96	0.0543	0.	RCFLAGS	0	0
3	8915	0.0151	45.77	0.1503	0.	RCFLAGS	0	0
3	3915	0.0190	49.52	0.2047	0.	RCFLAGS	0	0
3	5915	0.0190	8.02	0.0073	579.	RCFLAGS	0	0
3	4915	0.0076	14.37	0.0243	0.	RCFLAGS	0	0 5.dat
3	2915	0.0265	9.83	0.0246	0.	RCFLAGS	0	0
3	2005	0.1730	24.34	0.1197	0.	RCFLAGS	0	0
3	3911	0.2030	15.26	0.1593	0.	RCFLAGS	0	0
3	2006	0.3760	19.44	0.2627	0.	RCFLAGS	0	0
3	7917	0.0017	63.96	0.0234	0.	RCFLAGS	0	0

3	6917	0.0017	50.98	0.0233	17.	RCFLAGS	0	0
3	78917	0.0075	48.63	0.0863	0.	RCFLAGS	0	0
3	3917	0.0091	49.06	0.1097	0.	RCFLAGS	0	0
3	1917	0.0091	0.00	0.0000	303.	RCFLAGS	0	0
3	8917	0.0022	18.34	0.0157	0.	RCFLAGS	0	0
3	917	0.0022	0.00	0.0000	17.	RCFLAGS	0	0
3	3917	0.0114	0.00	0.0000	0.	RCFLAGS	0	0
3	4917	0.0144	28.60	0.1224	0.	RCFLAGS	0	0
3	2917	0.0257	15.96	0.1224	0.	RCFLAGS	0	0
3	2007	0.4017	19.21	0.3357	0.	RCFLAGS	0	0
3	3918	0.0060	12.60	0.0123	0.	RCFLAGS	0	0
3	2008	0.4077	19.12	0.3480	0.	RCFLAGS	0	0
3	2009	6.9837	10.25	0.7580	0.	RCFLAGS	0	0
3	3092	0.0404	24.64	0.1172	0.	RCFLAGS	0	0
3	3093	0.0070	15.98	0.0156	0.	RCFLAGS	0	0
3	2010	0.0474	23.36	0.1329	0.	RCFLAGS	0	0
3	9914	0.0218	30.24	0.0912	0.	RCFLAGS	0	0
3	2011	0.0691	25.53	0.2164	0.	RCFLAGS	0	0
3	7101	0.0165	9.92	0.0014	0.	RCFLAGS	0	0
3	6101	0.0165	0.00	0.0000	89.	RCFLAGS	0	0
3	8101	0.0855	38.16	0.4333	0.	RCFLAGS	0	0
3	3101	0.1020	31.99	0.4333	0.	RCFLAGS	0	0
3	5101	0.1020	31.91	0.4201	68.	RCFLAGS	0	0
3	7107	0.0210	9.95	0.0018	0.	RCFLAGS	0	0
3	6107	0.0210	0.00	0.0000	113.	RCFLAGS	0	0
3	8107	0.1090	37.63	0.5290	0.	RCFLAGS	0	0
3	3107	0.1300	31.55	0.5290	0.	RCFLAGS	0	0
3	2012	0.2320	31.71	0.9491	0.	RCFLAGS	0	0
3	3105	0.0350	14.84	0.0662	0.	RCFLAGS	0	0
3	2013	0.2670	29.50	1.0153	0.	RCFLAGS	0	0
3	7102	0.0150	9.90	0.0013	0.	RCFLAGS	0	0
3	6102	0.0150	0.00	0.0000	81.	RCFLAGS	0	0
3	8102	0.0693	34.90	0.2736	0.	RCFLAGS	0	0
3	3102	0.0843	28.69	0.2736	0.	RCFLAGS	0	0
3	2014	0.3513	29.30	1.2787	0.	RCFLAGS	0	0
3	1102	0.3513	15.98	1.1226	3301.	RCFLAGS	0	0
3	5102	0.3513	15.93	0.3233	2602.	RCFLAGS	0	0
3	3103	0.0020	12.64	0.0051	0.	RCFLAGS	0	0
3	2015	0.3533	15.91	0.3236	0.	RCFLAGS	0	0
3	7106	0.0520	10.09	0.0045	0.	RCFLAGS	0	0
3	6106	0.0520	0.00	0.0000	282.	RCFLAGS	0	0 5.dat
3	8106	0.2740	38.00	1.3683	0.	RCFLAGS	0	0
3	3106	0.3260	31.94	1.3683	0.	RCFLAGS	0	0
3	3104	0.0540	16.76	0.0870	0.	RCFLAGS	0	0
3	2016	0.3800	29.78	1.4515	0.	RCFLAGS	0	0
3	1106	0.3800	21.13	1.4351	1813.	RCFLAGS	0	0
3	5106	0.3800	20.80	1.0724	2372.	RCFLAGS	0	0
3	2017	0.7333	18.44	1.1527	0.	RCFLAGS	0	0
4	301	2.6500	28.23	2.3115	0.	RCFLAGS	0	0 100.dat
4	111	2.6500	28.21	2.2647	0.	RCFLAGS	0	0
4	381	3.3100	31.66	3.7703	0.	RCFLAGS	0	0
4	281	5.9600	30.13	5.9551	0.	RCFLAGS	0	0
4	581	5.9600	29.80	3.5819	35854.	RCFLAGS	0	0
4	121	5.9600	29.80	3.5818	0.	RCFLAGS	0	0
4	3916	0.0260	37.63	0.2053	0.	RCFLAGS	0	0
4	3919	0.1360	36.38	0.8434	0.	RCFLAGS	0	0
4	2000	0.1620	36.58	1.0486	0.	RCFLAGS	0	0
4	3910	0.1760	31.30	0.6186	0.	RCFLAGS	0	0
4	2001	0.3380	33.83	1.6673	0.	RCFLAGS	0	0
4	7912	0.0270	18.15	0.0138	0.	RCFLAGS	0	0
4	6912	0.0270	0.00	0.0000	252.	RCFLAGS	0	0
4	8912	0.1410	73.56	1.5761	0.	RCFLAGS	0	0
4	3912	0.1680	61.74	1.5761	0.	RCFLAGS	0	0

4	1912	0.1680	51.58	1.5071	1680.	RCFLAGS	0	0
4	5912	0.1680	51.25	0.5405	4745.	RCFLAGS	0	0
4	2002	0.5060	39.62	1.6831	0.	RCFLAGS	0	0
4	7913	0.0180	18.03	0.0092	0.	RCFLAGS	0	0
4	6913	0.0180	0.00	0.0000	167.	RCFLAGS	0	0
4	8913	0.0920	70.23	0.9351	0.	RCFLAGS	0	0
4	3913	0.1100	58.73	0.9351	0.	RCFLAGS	0	0
4	1913	0.1100	48.54	0.8425	1112.	RCFLAGS	0	0
4	5913	0.1100	48.12	0.4269	2617.	RCFLAGS	0	0
4	2003	0.6160	41.13	1.6957	0.	RCFLAGS	0	0
4	2004	6.5760	30.86	3.7747	0.	RCFLAGS	0	0
4	131	6.5760	30.85	3.7734	0.	RCFLAGS	0	0
4	7914	0.0028	108.65	0.0641	0.	RCFLAGS	0	0
4	6914	0.0028	72.63	0.0636	68.	RCFLAGS	0	0
477914		0.0215	108.65	0.5010	0.	RCFLAGS	0	0
478914		0.0247	58.62	0.4795	0.	RCFLAGS	0	0
473914		0.0462	81.88	0.9804	0.	RCFLAGS	0	0
4	914	0.0462	38.66	0.7862	861.	RCFLAGS	0	0
4	1914	0.0490	40.57	0.8498	0.	RCFLAGS	0	0
488914		0.0258	75.18	0.5332	0.	RCFLAGS	0	0
4	814	0.0258	60.76	0.4624	124.	RCFLAGS	0	0
4	14	0.0748	47.53	1.3122	0.	RCFLAGS	0	0
4	8914	0.0465	82.34	0.5263	0.	RCFLAGS	0	0
4	3914	0.1213	60.87	1.8372	0.	RCFLAGS	0	0
4	5914	0.1213	59.31	0.1591	5052.	RCFLAGS	0	0
4	4914	0.0252	62.34	0.2402	0.	RCFLAGS	0	0
4	2914	0.1465	59.83	0.3801	0.	RCFLAGS	0	0
4	7915	0.0039	108.65	0.0909	0.	RCFLAGS	0	0
4	8915	0.0151	83.60	0.3206	0.	RCFLAGS	0	0
4	3915	0.0190	88.75	0.4115	0.	RCFLAGS	0	0
4	5915	0.0190	41.97	0.0693	934.	RCFLAGS	0	0
4	4915	0.0076	40.64	0.1351	0.	RCFLAGS	0	0 100.dat
4	2915	0.0265	41.59	0.1829	0.	RCFLAGS	0	0
4	2005	0.1730	57.04	0.4570	0.	RCFLAGS	0	0
4	3911	0.2030	38.07	0.6459	0.	RCFLAGS	0	0
4	2006	0.3760	46.79	1.1029	0.	RCFLAGS	0	0
4	7917	0.0017	108.65	0.0391	0.	RCFLAGS	0	0
4	6917	0.0017	95.04	0.0391	17.	RCFLAGS	0	0
478917		0.0075	87.79	0.1655	0.	RCFLAGS	0	0
4	3917	0.0091	89.12	0.2045	0.	RCFLAGS	0	0
4	1917	0.0091	0.00	0.0000	564.	RCFLAGS	0	0
4	8917	0.0022	46.27	0.0450	0.	RCFLAGS	0	0
4	917	0.0022	0.00	0.0000	70.	RCFLAGS	0	0
4	3917	0.0114	0.00	0.0000	0.	RCFLAGS	0	0
4	4917	0.0144	60.54	0.2984	0.	RCFLAGS	0	0
4	2917	0.0257	33.79	0.2984	0.	RCFLAGS	0	0
4	2007	0.4017	45.96	1.2204	0.	RCFLAGS	0	0
4	3918	0.0060	36.32	0.0972	0.	RCFLAGS	0	0
4	2008	0.4077	45.82	1.3176	0.	RCFLAGS	0	0
4	2009	6.9837	31.73	3.9985	0.	RCFLAGS	0	0
4	3092	0.0404	56.90	0.3737	0.	RCFLAGS	0	0
4	3093	0.0070	46.50	0.0626	0.	RCFLAGS	0	0
4	2010	0.0474	55.36	0.4363	0.	RCFLAGS	0	0
4	9914	0.0218	62.06	0.2426	0.	RCFLAGS	0	0
4	2011	0.0691	57.47	0.6623	0.	RCFLAGS	0	0
4	7101	0.0165	18.02	0.0084	0.	RCFLAGS	0	0
4	6101	0.0165	0.00	0.0000	153.	RCFLAGS	0	0
4	8101	0.0855	73.36	0.9505	0.	RCFLAGS	0	0
4	3101	0.1020	61.50	0.9505	0.	RCFLAGS	0	0
4	5101	0.1020	61.40	0.4700	1077.	RCFLAGS	0	0
4	7107	0.0210	18.08	0.0107	0.	RCFLAGS	0	0
4	6107	0.0210	0.00	0.0000	195.	RCFLAGS	0	0
4	8107	0.1090	72.56	1.1844	0.	RCFLAGS	0	0

4	3107	0.1300	60.84	1.1844	0.	RCFLAGS	0	0
4	2012	0.2320	61.08	1.6544	0.	RCFLAGS	0	0
4	3105	0.0350	41.38	0.2896	0.	RCFLAGS	0	0
4	2013	0.2670	58.50	1.9440	0.	RCFLAGS	0	0
4	7102	0.0150	17.99	0.0077	0.	RCFLAGS	0	0
4	6102	0.0150	0.00	0.0000	139.	RCFLAGS	0	0
4	8102	0.0693	68.48	0.6680	0.	RCFLAGS	0	0
4	3102	0.0843	56.30	0.6680	0.	RCFLAGS	0	0
4	2014	0.3513	57.97	2.6120	0.	RCFLAGS	0	0
4	1102	0.3513	44.14	2.2781	3869.	RCFLAGS	0	0
4	5102	0.3513	42.81	1.6933	4597.	RCFLAGS	0	0
4	3103	0.0020	42.21	0.0355	0.	RCFLAGS	0	0
4	2015	0.3533	42.81	1.6942	0.	RCFLAGS	0	0
4	7106	0.0520	18.27	0.0266	0.	RCFLAGS	0	0
4	6106	0.0520	0.00	0.0000	486.	RCFLAGS	0	0 100.dat
4	8106	0.2740	72.82	2.9959	0.	RCFLAGS	0	0
4	3106	0.3260	61.20	2.9959	0.	RCFLAGS	0	0
4	3104	0.0540	39.67	0.4078	0.	RCFLAGS	0	0
4	2016	0.3800	58.14	3.4037	0.	RCFLAGS	0	0
4	1106	0.3800	49.36	3.3693	1871.	RCFLAGS	0	0
4	5106	0.3800	48.73	3.0140	3807.	RCFLAGS	0	0
4	2017	0.7333	45.88	3.8103	0.	RCFLAGS	0	0
5	301	2.6500	184.52	16.7127	0.	RCFLAGS	0	0 REG1.dat
5	111	2.6500	184.51	16.6346	0.	RCFLAGS	0	0
5	381	3.3100	195.64	22.8378	0.	RCFLAGS	0	0
5	281	5.9600	190.69	39.1026	0.	RCFLAGS	0	0
5	581	5.9600	190.54	24.5241	328016.	RCFLAGS	0	0
5	121	5.9600	190.54	24.5181	0.	RCFLAGS	0	0
5	3916	0.0260	183.40	0.3679	0.	RCFLAGS	0	0
5	3919	0.1360	179.18	1.8321	0.	RCFLAGS	0	0
5	2000	0.1620	179.86	2.2001	0.	RCFLAGS	0	0
5	3910	0.1760	152.23	2.0472	0.	RCFLAGS	0	0
5	2001	0.3380	165.47	4.2473	0.	RCFLAGS	0	0
5	7912	0.0270	104.11	0.3279	0.	RCFLAGS	0	0
5	6912	0.0270	73.19	0.3140	821.	RCFLAGS	0	0
5	8912	0.1410	240.10	1.9623	0.	RCFLAGS	0	0
5	3912	0.1680	213.28	2.2746	0.	RCFLAGS	0	0
5	1912	0.1680	205.04	2.2072	2047.	RCFLAGS	0	0
5	5912	0.1680	205.83	2.1081	6500.	RCFLAGS	0	0
5	2002	0.5060	178.87	6.1079	0.	RCFLAGS	0	0
5	7913	0.0180	104.10	0.2186	0.	RCFLAGS	0	0
5	6913	0.0180	73.68	0.2153	472.	RCFLAGS	0	0
5	8913	0.0920	227.09	1.2788	0.	RCFLAGS	0	0
5	3913	0.1100	201.98	1.4847	0.	RCFLAGS	0	0
5	1913	0.1100	193.57	1.4252	1524.	RCFLAGS	0	0
5	5913	0.1100	192.59	1.2430	4085.	RCFLAGS	0	0
5	2003	0.6160	181.32	7.1548	0.	RCFLAGS	0	0
5	2004	6.5760	189.68	24.9216	0.	RCFLAGS	0	0
5	131	6.5760	189.76	24.9177	0.	RCFLAGS	10	0
5	7914	0.0028	278.31	0.0398	0.	RCFLAGS	0	0
5	6914	0.0028	226.33	0.0393	68.	RCFLAGS	0	0
577914		0.0215	278.31	0.3109	0.	RCFLAGS	0	0
578914		0.0247	212.53	0.3548	0.	RCFLAGS	0	0
573914		0.0462	243.11	0.6656	0.	RCFLAGS	0	0
5	914	0.0462	171.05	0.6538	821.	RCFLAGS	0	0
5	1914	0.0490	174.16	0.6931	0.	RCFLAGS	0	0
588914		0.0258	234.29	0.3708	0.	RCFLAGS	0	0
5	814	0.0258	219.93	0.3698	123.	RCFLAGS	0	0
5	14	0.0748	189.94	1.0629	0.	RCFLAGS	0	0
5	8914	0.0465	243.71	0.6460	0.	RCFLAGS	0	0
5	3914	0.1213	210.55	1.6934	0.	RCFLAGS	0	0
5	5914	0.1213	202.82	1.6879	6166.	RCFLAGS	0	0
5	4914	0.0252	217.43	0.3491	0.	RCFLAGS	0	0

5	2914	0.1465	205.34	2.0370	0.	RCFLAGS	0	0
5	7915	0.0039	278.31	0.0564	0.	RCFLAGS	0	0
5	8915	0.0151	245.01	0.2170	0.	RCFLAGS	0	0
5	3915	0.0190	251.86	0.2734	0.	RCFLAGS	0	0
5	5915	0.0190	182.32	0.2703	1172.	RCFLAGS	0	0
5	4915	0.0076	187.89	0.1084	0.	RCFLAGS	0	0 REG1.dat
5	2915	0.0265	183.90	0.3787	0.	RCFLAGS	0	0
5	2005	0.1730	202.05	2.4121	0.	RCFLAGS	0	0
5	3911	0.2030	149.15	2.0825	0.	RCFLAGS	0	0
5	2006	0.3760	173.49	4.4506	0.	RCFLAGS	0	0
5	7917	0.0017	278.31	0.0243	0.	RCFLAGS	0	0
5	6917	0.0017	260.60	0.0242	17.	RCFLAGS	0	0
578	917	0.0075	253.80	0.1075	0.	RCFLAGS	0	0
5	3917	0.0091	255.05	0.1317	0.	RCFLAGS	0	0
5	1917	0.0091	122.45	0.1314	680.	RCFLAGS	0	0
5	8917	0.0022	205.79	0.0322	0.	RCFLAGS	0	0
5	917	0.0022	94.56	0.0308	203.	RCFLAGS	0	0
5	3917	0.0114	116.95	0.1622	0.	RCFLAGS	0	0
5	4917	0.0144	221.75	0.2065	0.	RCFLAGS	0	0
5	2917	0.0257	175.44	0.3688	0.	RCFLAGS	0	0
5	2007	0.4017	173.62	4.8118	0.	RCFLAGS	0	0
5	3918	0.0060	180.93	0.0861	0.	RCFLAGS	0	0
5	2008	0.4077	173.72	4.8978	0.	RCFLAGS	0	0
5	2009	6.9837	188.82	28.0209	0.	RCFLAGS	0	0
5	3092	0.0404	210.27	0.5543	0.	RCFLAGS	0	0
5	3093	0.0070	201.00	0.0993	0.	RCFLAGS	0	0
5	2010	0.0474	208.90	0.6536	0.	RCFLAGS	0	0
5	9914	0.0218	217.07	0.3094	0.	RCFLAGS	0	0
5	2011	0.0691	211.47	0.9630	0.	RCFLAGS	0	0
5	7101	0.0165	104.10	0.2004	0.	RCFLAGS	0	0
5	6101	0.0165	75.68	0.1939	448.	RCFLAGS	0	0
5	8101	0.0855	239.33	1.1898	0.	RCFLAGS	0	0
5	3101	0.1020	212.86	1.3837	0.	RCFLAGS	0	0
5	5101	0.1020	212.82	1.1041	2084.	RCFLAGS	0	0
5	7107	0.0210	104.11	0.2550	0.	RCFLAGS	0	0
5	6107	0.0210	73.34	0.2509	573.	RCFLAGS	0	0
5	8107	0.1090	236.10	1.5164	0.	RCFLAGS	0	0
5	3107	0.1300	209.81	1.7673	0.	RCFLAGS	0	0
5	2012	0.2320	211.13	2.8046	0.	RCFLAGS	0	0
5	3105	0.0350	197.83	0.4844	0.	RCFLAGS	0	0
5	2013	0.2670	209.39	3.2889	0.	RCFLAGS	0	0
5	7102	0.0150	104.10	0.1821	0.	RCFLAGS	0	0
5	6102	0.0150	73.86	0.1740	424.	RCFLAGS	0	0
5	8102	0.0693	220.28	0.9632	0.	RCFLAGS	0	0
5	3102	0.0843	194.24	1.1357	0.	RCFLAGS	0	0
5	2014	0.3513	205.75	4.4247	0.	RCFLAGS	0	0
5	1102	0.3513	193.77	4.4158	4170.	RCFLAGS	0	0
5	5102	0.3513	193.70	4.0407	6218.	RCFLAGS	0	0
5	3103	0.0020	186.21	0.0287	0.	RCFLAGS	0	0
5	2015	0.3533	193.65	4.0612	0.	RCFLAGS	0	0
5	7106	0.0520	104.81	0.6314	0.	RCFLAGS	0	0
5	6106	0.0520	73.44	0.6205	1438.	RCFLAGS	0	0 REG1.dat
5	8106	0.2740	237.08	3.8033	0.	RCFLAGS	0	0
5	3106	0.3260	210.98	4.4239	0.	RCFLAGS	0	0
5	3104	0.0540	187.52	0.7694	0.	RCFLAGS	0	0
5	2016	0.3800	207.65	5.1933	0.	RCFLAGS	0	0
5	1106	0.3800	200.15	5.1534	1925.	RCFLAGS	0	0
5	5106	0.3800	200.03	5.0430	4822.	RCFLAGS	0	0
5	2017	0.7333	196.96	8.9846	0.	RCFLAGS	0	0

APPENDIX C

PROPOSED GAWSER CONTINUOUS SIMULATION MODEL OUTPUT

WATER BALANCE SUMMARY FOR HYDROGRAPH 2914

Location: Hydrograph 2914
Scenario File: wb_D01.dat
Period: 1951/01/01 to 2005/12/30 Area: 0.1468 km^2

Water Balance Quantities (in mm)

Month	Precip	ET	Runoff	Infiltration (Baseflow)	Infiltration (Losses)	Total Flow
JAN	48.0	7.9	8.8	5.8	25.5	14.6
FEB	42.6	7.1	12.0	4.7	18.8	16.7
MAR	60.4	9.1	31.3	5.7	14.3	37.0
APR	76.7	33.3	24.5	7.6	11.3	32.1
MAY	77.8	55.3	17.6	7.6	-2.7	25.3
JUN	76.7	54.5	17.6	4.9	-0.4	22.6
JUL	85.1	49.8	23.4	2.5	9.4	26.0
AUG	86.0	43.4	22.7	1.7	18.3	24.3
SEP	79.4	32.1	18.9	1.4	27.0	20.3
OCT	66.5	24.8	15.9	2.0	23.7	17.9
NOV	82.3	13.7	20.4	3.4	44.8	23.8
DEC	63.2	7.2	13.0	5.5	37.5	18.5
Total	844.8	338.4	226.1	52.8	227.5	279.0

Extreme Flows Summary

Return Period (Years)	High Flows (m^3/s)	Low Flows (m^3/s)
1.25	0.048	0.0001
2.00	0.097	0.0000
5.00	0.180	0.0000
10.00	0.240	0.0000
20.00	0.300	0.0000
25.00	0.320	0.0000
50.00	0.390	0.0000
100.00	0.470	0.0000
200.00	0.550	0.0000
500.00	0.660	0.0000

Flow-Duration Summary

PCT% Time	Flow (m^3/s)	PCT% Time	Flow (m^3/s)
98.0	0.00000	50.0	0.00045
90.0	0.00006	40.0	0.00060
80.0	0.00016	30.0	0.00097
70.0	0.00027	20.0	0.00200
60.0	0.00037	10.0	0.00400

WATER BALANCE SUMMARY FOR HYDROGRAPH 2915
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Location: Hydrograph 2915
Scenario File: wb_D01.dat
Period: 1951/01/01 to 2005/12/30 Area: 0.0265 km^2

Water Balance Quantities (in mm)

Month	Precip	ET	Runoff	Infiltration (Baseflow)	Infiltration (Losses)	Total Flow
JAN	48.0	7.9	9.8	8.7	21.5	18.6
FEB	42.6	7.1	14.7	7.3	13.5	22.0
MAR	60.4	9.7	41.0	9.0	0.7	50.0
APR	76.7	36.9	16.6	9.6	13.5	26.2
MAY	77.8	59.0	2.1	9.1	7.7	11.2
JUN	76.7	57.8	1.4	5.4	12.1	6.8
JUL	85.1	52.4	5.3	2.9	24.5	8.2
AUG	86.0	45.6	2.7	1.6	36.2	4.2
SEP	79.4	33.6	1.6	1.4	42.8	3.0
OCT	66.5	26.1	2.5	2.2	35.8	4.7
NOV	82.3	14.5	6.3	4.1	57.4	10.4
DEC	63.2	7.4	11.5	7.9	36.4	19.4
Total	844.8	357.9	115.4	69.2	302.2	184.6

Extreme Flows Summary
==========

Return Period (Years)	High Flows (m^3/s)	Low Flows (m^3/s)
1.25	0.012	0.0000
2.00	0.024	0.0000
5.00	0.046	0.0000
10.00	0.063	0.0000
20.00	0.082	0.0000
25.00	0.088	0.0000
50.00	0.110	0.0000
100.00	0.130	0.0000
200.00	0.160	0.0000
500.00	0.190	0.0000

Flow-Duration Summary
==========

PCT% Time	Flow (m^3/s)	PCT% Time	Flow (m^3/s)
98.0	0.00000	50.0	0.00006
90.0	0.00000	40.0	0.00008
80.0	0.00001	30.0	0.00009
70.0	0.00003	20.0	0.00011
60.0	0.00004	10.0	0.00023

WATER BALANCE SUMMARY FOR HYDROGRAPH 2917

Location: Hydrograph 2917
Scenario File: wb_D01.dat
Period: 1951/01/01 to 2005/12/30 Area: 0.0257 km^2

Water Balance Quantities (in mm)

Month	Precip	ET	Runoff	Infiltration (Baseflow)	Infiltration (Losses)	Total Flow
JAN	48.0	7.9	5.9	8.9	25.2	14.9
FEB	42.6	7.1	8.9	7.6	19.1	16.5
MAR	60.4	9.3	27.0	8.0	16.2	34.9
APR	76.7	39.7	17.6	10.6	8.7	28.2
MAY	77.8	69.5	8.7	10.9	-11.2	19.6
JUN	76.7	69.2	7.6	6.3	-6.5	14.0
JUL	85.1	62.8	10.5	3.3	8.5	13.8
AUG	86.0	53.7	9.0	1.8	21.5	10.9
SEP	79.4	38.2	8.2	1.7	31.3	9.9
OCT	66.5	28.8	7.6	2.9	27.3	10.4
NOV	82.3	14.7	11.4	5.0	51.2	16.4
DEC	63.2	7.2	8.7	8.2	39.0	16.9
Total	844.8	408.1	131.1	75.3	230.3	206.4

Extreme Flows Summary

Return Period (Years)	High Flows (m^3/s)	Low Flows (m^3/s)
1.25	0.020	0.0000
2.00	0.037	0.0000
5.00	0.065	0.0000
10.00	0.085	0.0000
20.00	0.110	0.0000
25.00	0.110	0.0000
50.00	0.140	0.0000
100.00	0.160	0.0000
200.00	0.190	0.0000
500.00	0.230	0.0000

Flow-Duration Summary

PCT% Time	Flow (m^3/s)	PCT% Time	Flow (m^3/s)
98.0	0.00000	50.0	0.00008
90.0	0.00001	40.0	0.00010
80.0	0.00002	30.0	0.00012
70.0	0.00004	20.0	0.00014
60.0	0.00006	10.0	0.00034

GAWSER V6.9.18 - Released - Sep. 21, 2016

Upper Speed River Watershed
Threshold Flow Exceedance Summaries
For Existing Conditions

```
   Input file 1=EXCEED1.dat
   Input file 2=
   Output file =EXCEED1.txt
* ========================================================================
* File created by Dr. H.O. Schroeter, P.Eng., November 10, 2011
* ========================================================================
START               KUNITS=2  TOTAL AREA=174 SQ KM
                    BASEFLOW AT OUTLET: QBSS=0.0    QBGW=0.60  CMS
                    PRINT OPTIONS:ECHO=3 OUTPUT=0 PLOTS=1 RCS=1 SUBW=1
                        PLOT CUTOFF TIME=576 SUM=4 FREE=0
                    PARAMETER ADJUSTMENT FACTORS: FDS=1  FKEFF=0.05
                       FCS=1.0 FD=1.0 FSAV=1.0 FKO=1.0 FKSS=1 FKMF=1
                    INITIAL SOIL/SNOW WATER FACTORS:
                       FIMCI=0.75  FIMCII=1.00 FIWE=0.0
                    GLOBAL RAINFALL SCALING FACTOR: GFRF=1.0
                    SIMULATION CONTROLS: TTI=1 HR IDEL=4 HOURS=576
                    SUBWATERSHED INITIAL BASEFLOWS IN CMS=-999
```

STREAM DISCHARGE EXCEEDANCE SUMMARY FOR 2004

Location: Hydrograph 2004
Period: 1951/ 1/ 1 to 2005/12/30

	Total	Threshold 1			Threshold 2		
Month	Hours	Flow	Hours	PCT	Flow	Hours	PCT
JAN	40920.	0.36000	511.	1.2	0.27000	699.	1.7
FEB	37296.	0.36000	789.	2.1	0.27000	1027.	2.8
MAR	40920.	0.36000	3399.	8.3	0.27000	4307.	10.5
APR	39600.	0.36000	2031.	5.1	0.27000	2547.	6.4
MAY	40920.	0.36000	321.	0.8	0.27000	413.	1.0
JUN	39600.	0.36000	56.	0.1	0.27000	84.	0.2
JUL	40920.	0.36000	228.	0.6	0.27000	269.	0.7
AUG	40920.	0.36000	97.	0.2	0.27000	128.	0.3
SEP	39600.	0.36000	31.	0.1	0.27000	38.	0.1
OCT	40920.	0.36000	112.	0.3	0.27000	136.	0.3
NOV	39600.	0.36000	430.	1.1	0.27000	599.	1.5
DEC	40896.	0.36000	640.	1.6	0.27000	879.	2.1
Total	482112.	0.36000	8645.	1.8	0.27000	11126.	2.3

STREAM DISCHARGE EXCEEDANCE SUMMARY FOR 2009

Location: Hydrograph 2009
Period: 1951/ 1/ 1 to 2005/12/30

	Total	Threshold 1			Threshold 2		
Month	Hours	Flow	Hours	PCT	Flow	Hours	PCT
JAN	40920.	0.66000	256.	0.6	0.31000	636.	1.6
FEB	37296.	0.66000	411.	1.1	0.31000	971.	2.6
MAR	40920.	0.66000	1663.	4.1	0.31000	4040.	9.9
APR	39600.	0.66000	1071.	2.7	0.31000	2383.	6.0
MAY	40920.	0.66000	170.	0.4	0.31000	393.	1.0
JUN	39600.	0.66000	39.	0.1	0.31000	75.	0.2
JUL	40920.	0.66000	155.	0.4	0.31000	261.	0.6
AUG	40920.	0.66000	35.	0.1	0.31000	123.	0.3
SEP	39600.	0.66000	28.	0.1	0.31000	40.	0.1
OCT	40920.	0.66000	63.	0.2	0.31000	126.	0.3
NOV	39600.	0.66000	225.	0.6	0.31000	541.	1.4
DEC	40896.	0.66000	311.	0.8	0.31000	810.	2.0
Total	482112.	0.66000	4427.	0.9	0.31000	10399.	2.2

APPENDIX D

WATER BALANCE CALCULATIONS (SURFACE)

Drawing on experience...Building on strength.

Water Balance (Surface Runoff) Analysis
For areas draining directly to Western Wetland node

Northgate Subdivision
City of Waterloo

Project: 39502-104
Date: July 5, 2017
Note: Based on Draft Plan July 4, 2017
By: MSB/GMK

Hydrologic Cycle Component Values

Annual Precipitation (mm) 844.8

			ET	Infiltration	Runoff
			(mm/yr)		
NWSSS Catchments	Existing	3911 (Wetland)	563.7	197.3	83.8
Page 242	Existing	3914 (Cropland)	553.0	211.9	79.9
	Existing	3917 (Cropland)	551.0	177.0	116.7
	Existing	3918 (Woodlot)	575.5	192.7	76.6
	Proposed	3914 (Rear yards)	530.0	212.8	102.0
	Proposed	3917 (Rear yards)	536.0	173.8	135.0

IMPERVIOUS LANDUSE

	Precip	ET	Infiltration	Runoff
			mm/yr	
Typical roof	844.8	118.3	706.0	20.5

* Note: Based on 15mm/hr soil, and 30mm storage volume

Location	Pre-Development						Location	Post-Development						Comments
	Pervious			Impervious				Pervious			Impervious			
	Area Draining to Location from Site (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)	Road Area Directed to Wetland (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)		Area Draining to Location from Site (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)	Road/Roof Area Directed to Pipe (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)	
A - Wetland	7.22	84	**6,050**				1 - Wetland	7.31	84	**6,126**				
B1 - Cropland	10.65	80	**8,509**				2.1 - Rear Yards	1.44	102	**1,469**				
B2 - Cropland	1.21	117	**1,412**				2.2 - Rear Yards	0.49	135	**662**				
C1 - Woodlot	0.62	84	**520**				Roofs [1 2]				0.87	706	**6,128**	
C2 - Woodlot	0.57	77	**437**				3.1 - Woodlot	1.39	84	**1,165**				
							3.2 - Woodlot	0.57	77	**437**				
	20.27		**15,972**	0.00		**0**		11.20		**9,858**	0.87		**6,128**	
					Total Pre-Development	**15,972**						**Total Post-Development**		**15,986**

NOTES:

1. Roof areas assumed:	**200** m2	**240** m2
2a) 14m+/- wide lots:	**17** lots	
2b) 15.2m to 20m wide lots:		**22** lots
3. Refer to Figures 6.1 and 6.2		

14	Net **gain** m3/year
0.1%	decrease

Water Balance (Surface Runoff) Analysis
For areas draining directly to Eastern Wetland node

Northgate Subdivision
City of Waterloo

Project: 39502-104
Date: July 5, 2017
Note: Based on Draft Plan July 4, 2017
By: MSB/GMK

Hydrologic Cycle Component Values

Annual Precipitation (mm) 844.8

			ET	Infiltration	Runoff
			(mm/yr)		
NWSSS Catchments	Existing	3911 (Wetland)	563.7	197.3	83.8
Page 242	Existing	3915 (Cropland)	551.9	222.9	69.9
	Existing	3917 (Cropland)	551.0	177.0	116.7
	Proposed	3102 (Rear yards)	528.0	202.8	114.0
	Proposed	3917 (Rear yards)	536.0	173.8	135.0

IMPERVIOUS LANDUSE

	Precip	ET	Infiltration	Runoff
		mm/yr		
Typical roof	844.8	118.3	706.0	20.5

* Note: Based on 15mm/hr soil, and 30mm storage volume

Location	Pre-Development						Location	Post-Development						Comments
	Pervious			Impervious				Pervious			Impervious			
	Area Draining to Location from Site (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)	Road Area Directed to Wetland (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)		Area Draining to Location from Site (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)	Road/Roof Area Directed to Pipe (ha)	Runoff Rate (mm/yr)	Runoff Volume (m^3/year)	
D - Wetland	9.86	84	**8,263**				4 - Wetland	9.93	84	**8,321**				
E1 - Cropland	1.68	70	**1,174**				5 - Rear Yards	0.68	114	**775**				
E2 - Cropland	1.13	117	**1,319**				6 - Rear Yards	0.42	135	**567**				
							Roofs [1 2]				0.18	706	**1,243**	
	12.67		**10,756**	0.00		**0**		11.03		**9,664**	0.18		**1,243**	
					Total Pre-Development	**10,756**						**Total Post-Development**		**10,906**

NOTES:

1. Roof areas assumed:	**200** m2	**240** m2
2a) 14m+/- wide lots:	**4** lots	
2b) 20m wide lots:		**4** lots

3. Refer to Figures 6.1 and 6.2

150	Net **gain** m3/year
1.4%	Increase

APPENDIX E

INFILTRATION GALLERY SIZING

Drawing on experience...Building on strength.

StormTech
A division of ADS

User Inputs

Chamber Model	SC-310
Outlet Control Structure	No Outlet
Project Name	Northgate (Park Block infiltration)
Engineer	MSB
Project Location	Waterloo, Ontario
Project Date	05/19/2017
Measurement Type	Metric
Required Storage Volume	118 cubic meters
Stone Porosity	40%
Stone Foundation Depth	152 mm.
Stone Above Chambers	152 mm.
Average Cover Over Chambers	1750 mm.
Design Constraint	Width
Design Constraint Dimension	7 meters

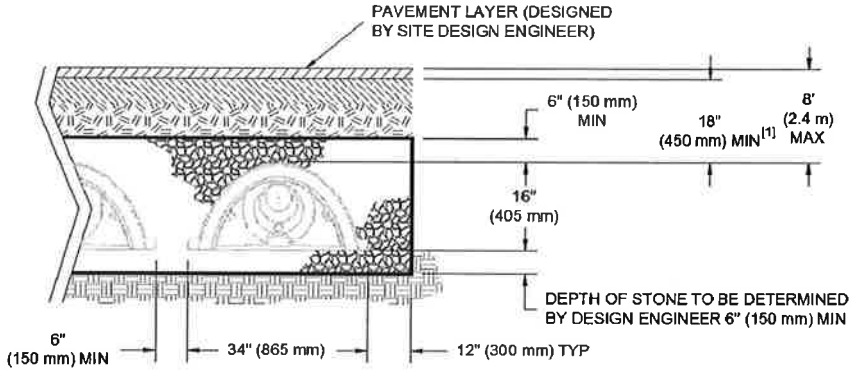
Results

System Volume and Bed Size

Installed Storage Volume	118 cubic meters
Storage Volume Per Chamber	0.88 cubic meters
Number Of Chambers Required	124 each
Number Of End Caps Required	12 each
Rows/Chambers	4 row(s) of 21 chamber(s)
Leftover Rows/Chambers	2 row(s) of 20 chamber(s)
Maximum Length	47.59 meters
Maximum Width	6.55 meters
Approx. Bed Size Required	307 square meters

System Components

Amount Of Stone Required	166 cubic meters
Volume Of Excavation (Not Including Fill)	218 cubic meters
Non-woven Filter Fabric Required	690 square meters
Length Of Isolator Row	45.92 meters
Non-Woven Isolator Row Fabric	68 square meters
Woven Isolator Row Fabric	55 square meters



[1] - TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

© ADS Stormtech 2016

Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	6/15/2017
Project Name	Northgate
Project Number	39502-104
Location	Conservation Drive

Designer Information

Company	MTE
Contact	Mark Brown

Notes

Park Block 20 - Conveyance Facility

Drainage Area

Total Area (ha)	2.579
Imperviousness (%)	52.8

The Stormceptor System model STC 6000 achieves the water quality objective removing 81% TSS for a City of Toronto (clay, silt and sand) particle size distribution.

Rainfall

Name	WATERLOO WELLINGTON A
State	ON
ID	9387
Years of Records	1970 to 2003
Latitude	43°27'N
Longitude	80°23'W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 300	53
STC 750	64
STC 1000	65
STC 1500	66
STC 2000	72
STC 3000	73
STC 4000	77
STC 5000	78
STC 6000	**81**
STC 9000	85
STC 10000	85
STC 14000	88

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

City of Toronto (clay, silt and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
10	20	2.65	0.0004					
30	10	2.65	0.0008					
50	10	2.65	0.0022					
95	20	2.65	0.0063					
265	20	2.65	0.0366					
1000	20	2.65	0.1691					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

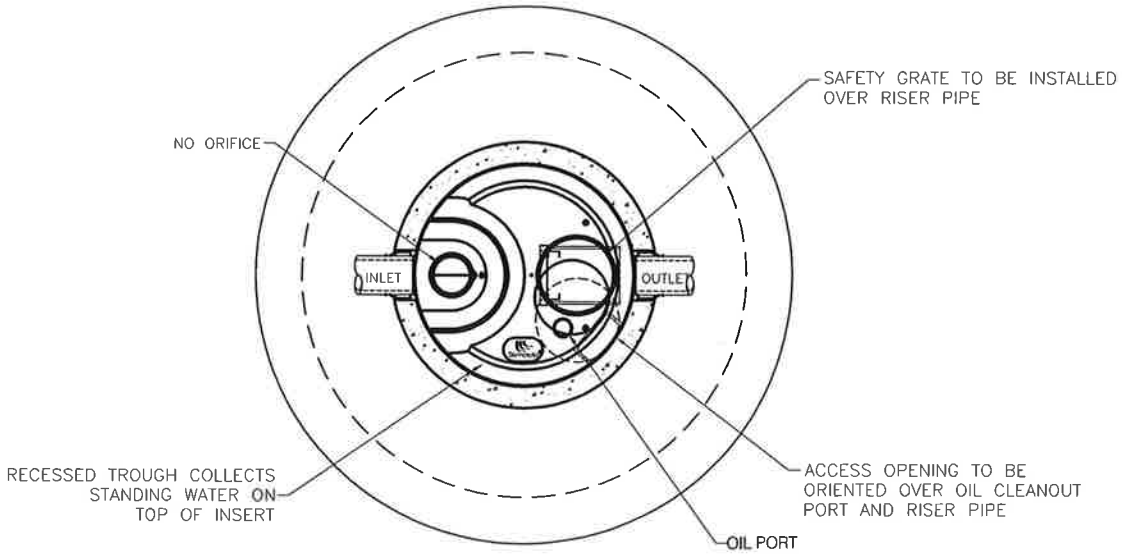
Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

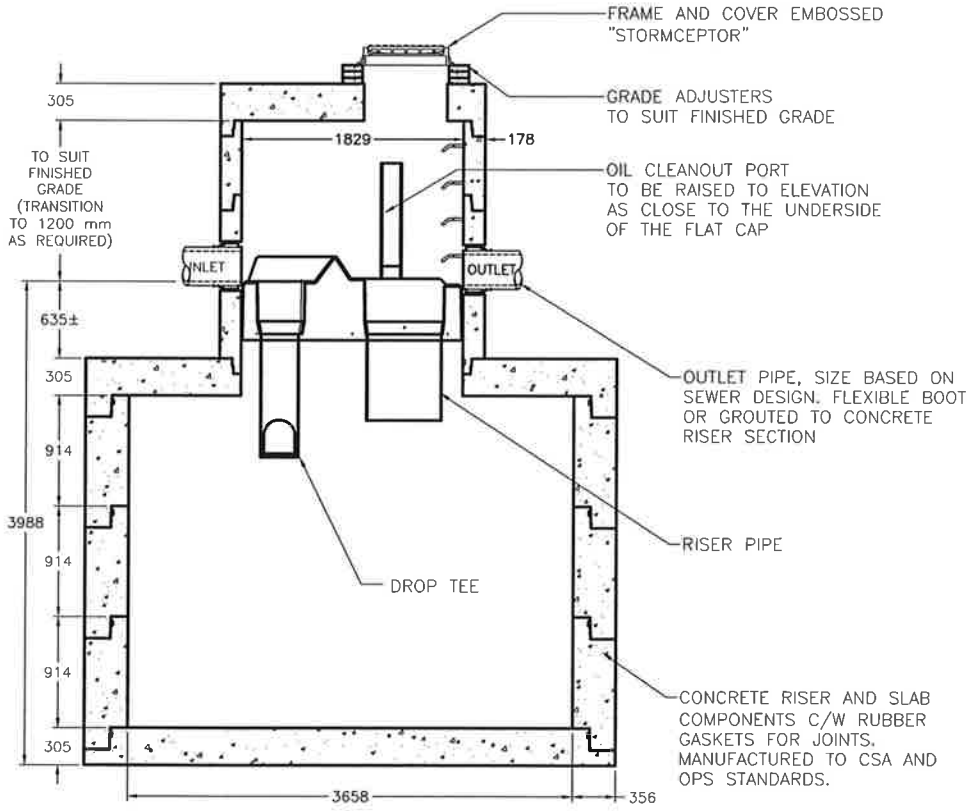
- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

DRAWING NOT TO BE USED FOR CONSTRUCTION

THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OF THE FOLLOWING PATENTS:
United States Patent No. 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690 • 7,582,216 • 7,666,303 | Australia Patent No. 729,096 • 779,401 • 2008,279,378 • 2008,288,900 |
Canadian Patent No. 2,206,338 • 2,327,768 • 2,694,159 • 2,697,287 | Indonesian Patent No. 007058 | Japan Patent No. 9-11476 • 3,581,233 • 5,555,160 |
Korea Patent No. 10-1451593 • 0519212 | Malaysia Patent No. 118987 | New Zealand Patent No. 314,646 • 583,583 • 583,008 | South African Patent No. 2010,00683 • 2010,01796 |



PLAN VIEW



SECTION VIEW

Stormceptor®

THE DESIGN AND INFORMATION SHOWN ON THIS DRAWING IS PROVIDED AS A SERVICE TO THE PROJECT OWNER, ENGINEER AND CONTRACTOR BY IMBRIUM SYSTEMS (IMBRIUM). NEITHER THIS DRAWING, NOR ANY PART THEREOF, MAY BE USED, REPRODUCED OR MODIFIED IN ANY MANNER WITHOUT THE PRIOR WRITTEN CONSENT OF IMBRIUM. FAILURE TO COMPLY IS DONE AT THE USER'S OWN RISK AND IMBRIUM EXPRESSLY DISCLAIMS ANY LIABILITY OR RESPONSIBILITY FOR SUCH USE. IF DISCREPANCIES BETWEEN THE SUPPLIED INFORMATION UPON WHICH THE DRAWING IS BASED AND ACTUAL FIELD CONDITIONS ARE ENCOUNTERED AS SITE WORK PROGRESSES, THESE DISCREPANCIES MUST BE REPORTED TO IMBRIUM IMMEDIATELY FOR RE-EVALUATION OF THE DESIGN. IMBRIUM ACCEPTS NO LIABILITY FOR DESIGNS BASED ON MISSING, INCOMPLETE OR INACCURATE INFORMATION SUPPLIED BY OTHERS.

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866-740-3318 410-796-5505 866-376-8511 FAX

STC 6000
STANDARD MODEL

####

REV #	DATE	REVISION DESCRIPTION	BY

SHEET NUMBER 1 OF 1

DATE:######## | SCALE: 60 | PROJECT No.: ##### | DRAWN: ### | CHECKED: ###

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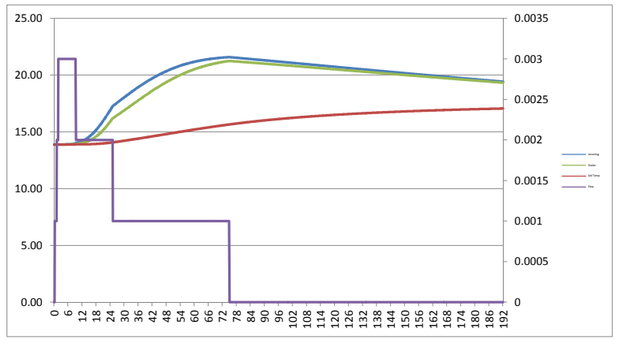
APPENDIX F

COOLING TRENCH MODELING

Conduction/Mixing Temperature Model for Cooling Trench

Trench Dimensions		***Trench Characteristics***	
Width/Diameter	5.1 m	Void Ratio	0.4
Height	1.1 m	Segment Length	5 m
Perimeter	12.40 m	Segment #	10
Area	5.61 m^2	Total length	50 m
		Volume (V_T)	11.22 m^3
# of Trenchs	1	GW contact	5.5 m^2
Time increment	10 min	Hydraulic gradient	0.003 m/m
Time increment	0.1667 hr	Hydraulic conductivity	1.6E-05 m/s
Initial Stormwater Temp	24 C	GW velocity	4.86E-08 m/s
Initial Trench Temp	13.9 C	Groundwater Inflow/Outflow	2.673E-07 m^3/s
Water Density	999 kg/m^3	Incoming Groundwater temp	13.9 C
Sat. Soil. Thermal Cond. (k)	2 J/m.s.K		
Saturated Soil Heat Cap (Ch)	2.80E+06 $J/m^3.K$		
Cooling Trench Rock Thermal Cond. (k)	2.15 J/m.s.K		
Cooling Trench Rock Heat Cap (Ch)	1.91E+06 $J/m^3.K$		
Soil temperature evaluation depth	0.1 m		

Length	50 m
Total trench length	50 m
Maximum outlet temp	21.25 C
Flow weighted temp	16.66 C
Treated Volume per trench	382.20 m^3
Total treated volume	382.2 m^3



Sources:

1. Ghildyal e
2. Koorevaa
3. Incropera

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Q	Q_T	T_I	T_I	T_M	T_M	T_S	T_S	c	k	$T_{INT-INS}$	$T_{INT-AVG}$	q	ΔT	T_{FINAL}
		Total Cooling Trench	Individual Trench	Incoming Water		Mixed Water/Stone		Soil	Soil	Water	Water	Instant	Average	Heat		Water
	Time	Flow	Flow	Temperature	Temperature	Temperature	Temperature	Temperature	Temperature	Specific Heat	Therm. Cond.	Interface Temp	Interface Temp.	Transfer	Temp Change	End Temp.
	(hr)	(m^3/s)	(m^3/s)	C	K	C	K	K	C	J/kg.K	J/m.s.K	K	K	J/s	C or K	C
1	0.00	0	0	13.90	287.05	13.9	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00		13.90
2	0.17	0	0	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
3	0.33	0.001	0.001	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
4	0.50	0.001	0.001	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
5	0.67	0.001	0.001	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
6	0.83	0.001	0.001	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
7	1.00	0.001	0.001	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
8	1.17	0.002	0.002	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
9	1.33	0.002	0.002	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
10	1.50	0.002	0.002	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
11	1.67	0.002	0.002	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
12	1.83	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
13	2.00	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
14	2.17	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
15	2.33	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
16	2.50	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
17	2.67	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
18	2.83	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
19	3.00	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
20	3.17	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
21	3.33	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
22	3.50	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
23	3.67	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
24	3.83	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
25	4.00	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
26	4.17	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
27	4.33	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
28	4.50	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
29	4.67	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.00	0.00000	13.90
30	4.83	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.01	0.00000	13.90
31	5.00	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.01	0.00000	13.90
32	5.17	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.01	0.00000	13.90
33	5.33	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.01	0.00000	13.90
34	5.50	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.02	0.00000	13.90
35	5.67	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.02	0.00000	13.90
36	5.83	0.003	0.003	13.90	287.05	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.03	0.00000	13.90
37	6.00	0.003	0.003	13.91	287.06	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.04	0.00000	13.90
38	6.17	0.003	0.003	13.91	287.06	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.05	0.00000	13.90
39	6.33	0.003	0.003	13.91	287.06	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.06	0.00000	13.90
40	6.50	0.003	0.003	13.91	287.06	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.07	0.00000	13.90
41	6.67	0.003	0.003	13.91	287.06	13.90	287.05	287.05	13.90	4186.83	0.59	287.05	287.05	0.09	0.00000	13.90
42	6.83	0.003	0.003	13.91	287.06	13.90	287.05	287.05	13.90	4186.82	0.59	287.05	287.05	0.11	0.00000	13.90
43	7.00	0.003	0.003	13.92	287.07	13.90	287.05	287.05	13.90	4186.82	0.59	287.05	287.05	0.13	0.00000	13.90
44	7.17	0.003	0.003	13.92	287.07	13.91	287.06	287.05	13.90	4186.82	0.59	287.05	287.05	0.16	0.00000	13.91
45	7.33	0.003	0.003	13.92	287.07	13.91	287.06	287.05	13.90	4186.82	0.59	287.05	287.05	0.18	0.00000	13.91
46	7.50	0.003	0.003	13.93	287.08	13.91	287.06	287.05	13.90	4186.82	0.59	287.05	287.05	0.22	0.00000	13.91
47	7.67	0.003	0.003	13.93	287.08	13.91	287.06	287.05	13.90	4186.82	0.59	287.05	287.05	0.26	0.00000	13.91
48	7.83	0.003	0.003	13.94	287.09	13.91	287.06	287.05	13.90	4186.82	0.59	287.06	287.05	0.30	0.00000	13.91
49	8.00	0.003	0.003	13.94	287.09	13.91	287.06	287.05	13.90	4186.81	0.59	287.06	287.05	0.35	0.00000	13.91
50	8.17	0.003	0.003	13.95	287.10	13.92	287.07	287.05	13.90	4186.81	0.59	287.06	287.05	0.41	0.00000	13.92

APPENDIX G

BOREHOLE LOGS

Drawing on experience...Building on strength.

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

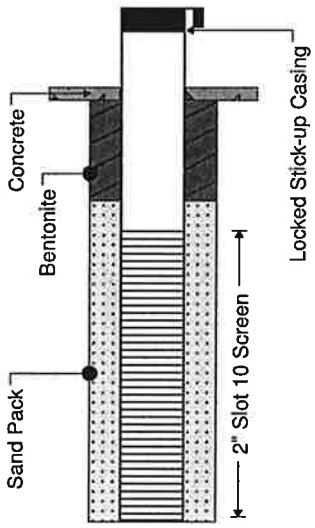
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW100-14

Job Number: 39502-104

Drill Date: 12/12/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
0.00	344.68	Ground Elevation							
0.00	343.92	**TOPSOIL** borwn, sandy silt, trace organics, damp							
0.76	343.16	**SILT** stiff, brown, clayey silt, little sand, trace gravel, moist		1	SS	3			
1.52	342.39	**SAND** compact, borwnish grey, medium sand, some gravel, little silt, saturated		2	SS	14			
2.29	341.58	compact, brown, fine sand		3	SS	13			
3.10	340.87	**CLAY** stiff, grey, silty clay, wet		4	SS	26			
3.81	340.11	**SAND** compact, brown, fine sand, brown, saturated		5	SS	22			
4.57	339.50	**CLAY TILL** very stiff, grey, clay till , some silt, wet		6	SS	21			
5.18		no clasts observed, some silt							
		Borehole Terminated at 5.18m							



January 9, 2015
Water Level 1.8 mbTOC (343.77 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Logged By: TFC

Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW101-14

Job Number: 39502-104

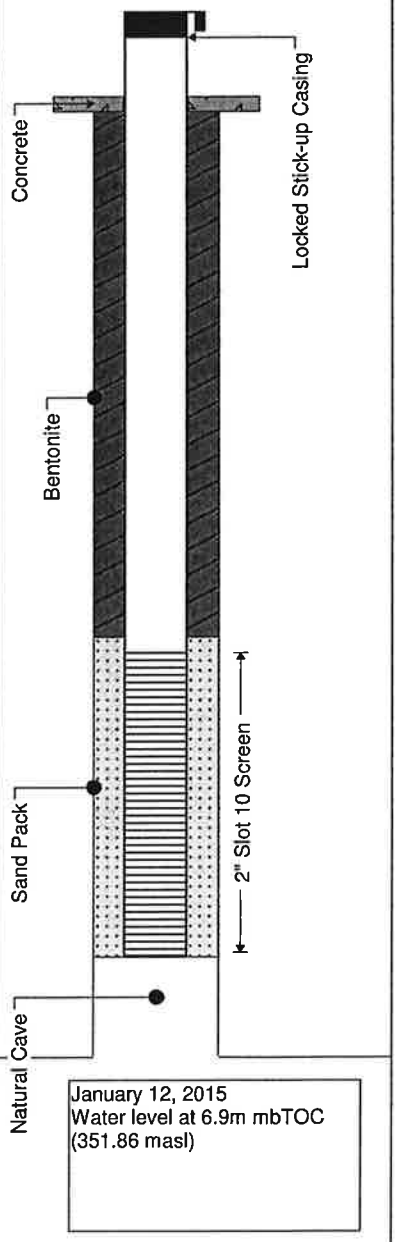
Drill Date: 12/12/14

Depth (m)	Elevation (m)	Soil Description	Number	Type	N-Value
	357.85	Ground Elevation			
0.0	0.00	**TOPSOIL** light brown, silty sand, little organics, damp			
	357.09				
	0.76	**SAND** loose, brown, medium to coarse sand, trace gravel, moist	1	SS	6
	356.33				
2.0	1.52	compact, grey brown, medium to coarse sand, little gravel, moist	2	SS	11
			3	SS	8
	354.80				
	3.05	compact, grey brown, fine to medium sand, trace gravel, moist	4	SS	13
	354.04				
4.0	3.81	compact, grey borwn, fine to medium sand, moist	5	SS	22
	353.58				
	4.27	wet	6	SS	30
	352.52				
	5.33	compact, grey brown, fine to medium sand, trace gravel, wet	7	SS	21
	352.06				
6.0	5.79	saturated			
		compact, grey brown, fine sand	8	SS	18
	350.23				
	7.62	compact, brown, fine sand	9	SS	25
8.0					
	348.71				
	9.14	compact, grey brown, medium to coarse sand	10	SS	30
	348.10				
10.0	9.75	Borehole Terminated at 9.75			

Standard Penetration Graph: 25 50 75

Headspace (ppm)

Groundwater Observations and Well Details



Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

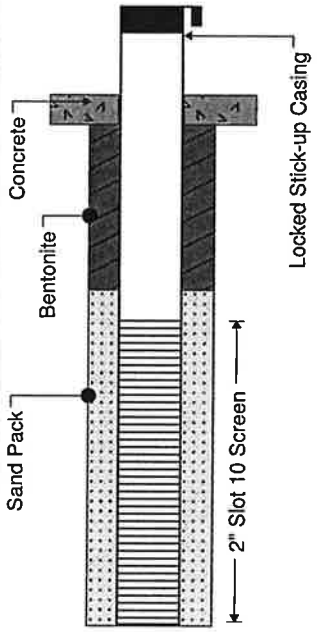
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW102-14

Job Number: 39502-104

Drill Date: 12/12/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
0.0	350.95	Ground Elevation							
0.0	350.95	**TOPSOIL** dark brown, silty sand, little organics, damp							
0.76	350.19	**SILT TILL** firm, brown, clayey silt till, some sand, trace gravel, moist		1	SS	6			
1.52	349.43	stiff, brown, oxidation staining, mottled tan brown, some fine sand moist		2	SS	17			
1.98	348.97	stiff, grey, clayey silt till, trace sand, grey, wet		3	SS	11			
3.05	347.90	**SILT** stiff, grey, clayey silt, saturated		4	SS	9			
				5	SS	13			
				6	SS	11			
5.94	345.01	Borehole Terminated at 5.94		7	SS	16			



January 12, 2015
Water level 1.8 mbTOC (349.9 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW103-14

Job Number: 39502-104

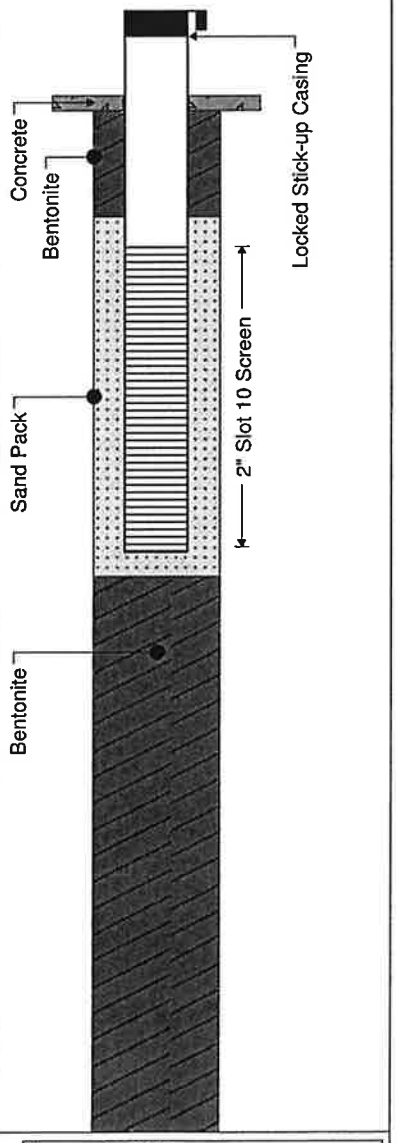
Drill Date: 12/11/14

Depth (m)	Elevation (m)	Soil Description	Number	Type	N-Value
	345.78	Ground Elevation			
	0.00	**TOPSOIL** dark brown, silty sand, little organics, moist			
	345.02 0.76	**SAND** loose, brown, medium to course sand, few gravel, trace organics, wet	1	SS	8
	344.26 1.52		2	SS	26
2.0	343.80 1.98	compact, brown, medium sand, trace gravel, saturated			
		compact, greyish brown, medium to course sand, trace gravel	3	SS	16
	342.88 2.90	**CLAY TILL** very stiff, grey, clay till, some silt, trace fine sand, wet	4	SS	17
4.0		**SAND** compact, grey, medium sand, grey, saturated	5	SS	12
	341.21 4.57	**CLAY** very stiff, grey, clay till, some silt, trace fine sand, wet	6	SS	17
	340.45 5.33	**SILT** compact, grey, sandy silt, saturated	7	SS	10
6.0	339.68 6.10	**SILT** compact, brownish grey, clayey silt, some fine sand, saturated	8	SS	2
	338.16 7.62	**SAND** very loose, brownish grey, silty fine sand	9	SS	17
8.0		compact brownish grey, fine sand, some silt			
			10	SS	36
	335.87 9.91	**SAND** dense, brownish grey, silty fine sand	11	SS	33
10.0	335.26 10.52	Borehole Terminated at 10.52m			

Standard Penetration Graph: 25 50 75

Headspace (ppm)

Groundwater Observations and Well Details



January 8, 2015
Water level 1.3 mbTOC (345.3 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

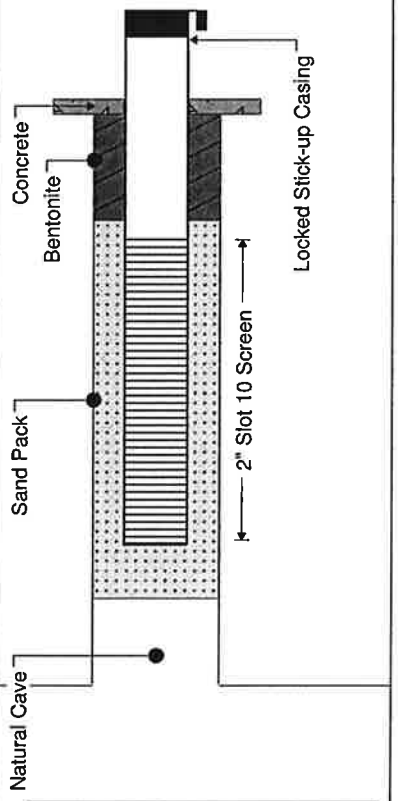
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW104-14

Job Number: 39502-104

Drill Date: 12/11/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
	346.17	Ground Elevation							
0.00		**TOPSOIL** dark brown, silty sand, little organics, damp							
	345.41								
0.76		**SAND** loose, orange brown, fine sand, moist		1	SS	7			
	344.65								
1.52		compact, saturated		2	SS	14			
2.0				3	SS	10			
				4	SS	15			
	342.64								
3.53		compact, greyish brown, fine sand		5	SS	26			
4.0				6	SS	11			
				7	SS	4			
	340.23								
5.94		Borehole Terminated at 5.94							
6.0									
8.0									
10.0									



January 8, 2015
Water level 1.9 mbTOC (345.19 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW105A-14

Job Number: 39502-104

Drill Date: 12/15/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
0.0	349.58	Ground Elevation							
0.0	0.00	**TOPSOIL** brown, silty sand, little organics, damp							
	348.82								
	0.76	**SILT** firm, brown, clayey silt, little sand, laminated grey silt layers, moist		1	SS	8			
2.0	348.28			2	SS	6			
	1.30								
	347.29	**SAND** loose, brown, silty fine sand,wet saturated		3	SS	7			
	2.29								
4.0	345.77			4	SS	20			
	3.81	**SAND** compact, dark brown, fine sand		5	SS	13			
				6	SS	23			
6.0				7	SS	19			
				8	SS	23			
	341.96								
	7.62	**SILT** dense, grey, clayey silt till		9	SS	18			
8.0				10	SS	26			
10.0				11	SS	20			

Concrete

Locked Stick-up Casing

Bentonite

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes: * Sampler advanced under static pressure

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Sheet: 1 of 2

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

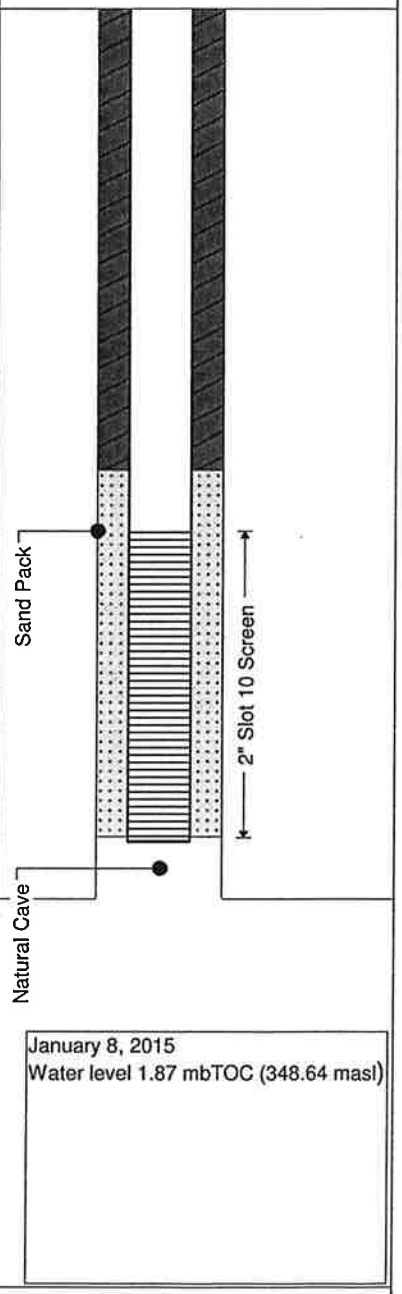
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW105A-14

Job Number: 39502-104

Drill Date: 12/15/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
40.0	337.39								
	12.19	**SILT** compact, grey		12	SS	15			
42.0									
13.0									
44.0									
46.0				13	SS	14			
48.0									
15.0									
50.0				14	SS	14			
52.0									
54.0									
17.0									
56.0									
58.0									
60.0	331.29								
	18.29	**SAND** very loose, greyish brown, fine sand		15	SS	0*			
62.0									
19.0									
64.0									
66.0	329.16			16	SS	15			
	20.42	Borehole Terminate at 20.42m							
68.0									
21.0									
70.0									
72.0									
74.0									
23.0									
76.0									
78.0									



Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes: * Sampler advanced under static pressure

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Sheet: 2 of 2

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW105B-14

Job Number: 39502-104

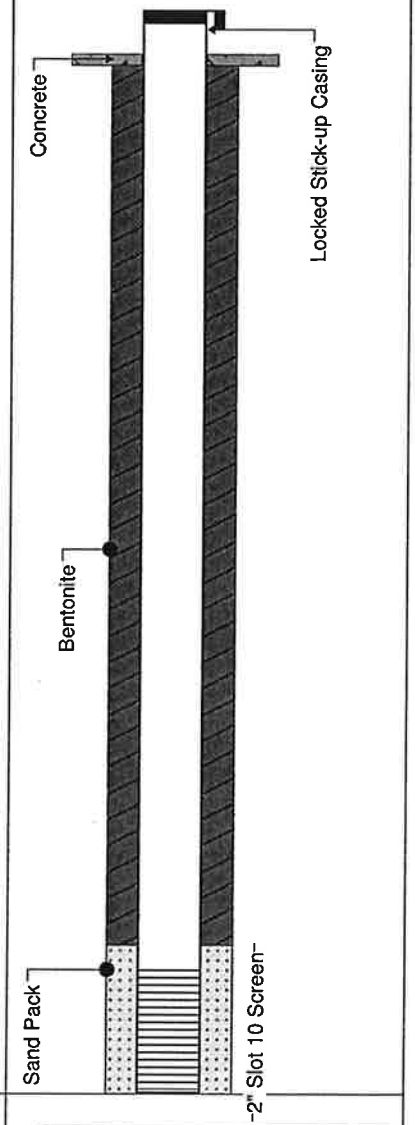
Drill Date: 12/15/14

Depth (m)	Elevation (m)	Soil Description	Number	Type	N-Value
	349.66	Ground Elevation			
	0.00	**TOPSOIL** brown, silty sand, little organics, moist			
	348.90		1	SS	8
	0.76				
	348.36	**SILT** firm, brown, clayey silt, little sand, laminated grey silt layers, moist	2	SS	6
	1.30				
2.0	347.37		3	SS	7
	2.29	**SAND** loose, brown, silty fine sand, wet saturated	4	SS	20
	345.85				
4.0	3.81	**SAND** compact, dark brown, fine sand	5	SS	13
			6	SS	23
			7	SS	19
6.0			8	SS	23
	342.04				
8.0	7.62	**SILT TILL** dense, grey, clayey silt till	9	SS	18
			10	SS	26
10.0			11	SS	20
12.0	337.47				
	12.19	**SILT** compact, grey	12	SS	15
	336.86	Borehole Terminate at 12.8m			
	12.80				
14.0					

Standard Penetration Graph: 25 50 75

Headspace (ppm)

Groundwater Observations and Well Details



January 8, 2015
Water level 1.87 mbTOC (348.33 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes: * Sampler advanced under static pressure

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW106-14

Job Number: 39502-104

Drill Date: 12/10/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
	350.79	Ground Elevation							
0.0	0.00	**TOPSOIL** light brown, silty sand, little organics, damp							
	350.03								
	0.76	**SILT** compact, tan, sandy silt, little fine sand, little clay, trace organic, moist		1	SS	10			
	349.27								
2.0	1.52			2	SS	9			
		wet		3	SS	27			
	347.74								
	3.05	**SILT TILL** dense, light brown, silt till, moist		4	SS	33			
	346.98								
4.0	3.81	**SILT** compact, grey, clayey silt till, moist		5	SS	22			
				6	SS	34			
	345.46								
	5.33	compact, grey, clayey silt		7	SS	40			
6.0	344.69								
	6.10	**SILT** compact, grey, silt		8	SS	28			
		saturated							
	343.17								
	7.62	compact, grey, some fine sand layers		9	SS	14			
8.0									
				10	SS	21			
10.0									
				11	SS	16			
12.0									
	337.99			12	SS	12			
	12.80								January 8, 2015 Water level 3.08 mbTOC (348.55 masl)
14.0									

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

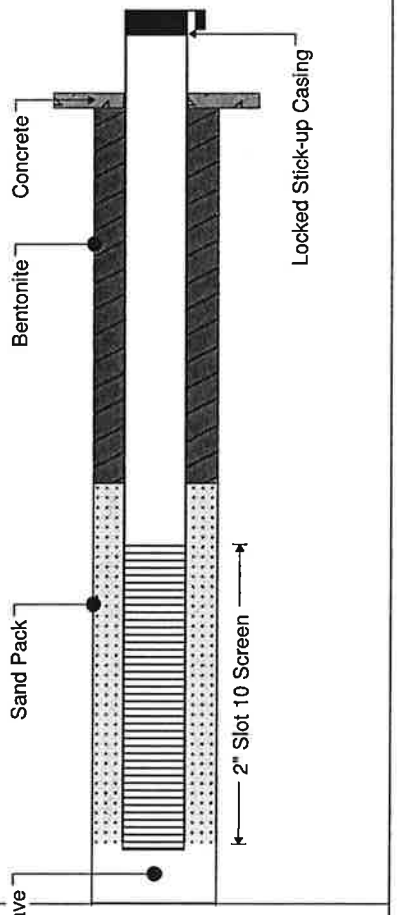
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW107-14

Job Number: 39502-104

Drill Date: 12/17/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
ft / m	350.58	Ground Elevation							
	0.00	**TOPSOIL** grey brown to dark brown, sandy silt, trace organics, damp							
	349.74								
	0.84	**SAND** loose, brown, silty fine sand, damp		1	SS	4			
2.0		**SAND** compact, tan, fine sand, damp		2	SS	12			
				3	SS	16			
	347.53								
	3.05	moist		4	SS	15			
	346.62								
4.0	3.96	compact, dark brown, fine sand, wet		5	SS	25			
	346.01								
	4.57	saturated		6	SS	27			
				7	SS	20			
6.0				8	SS	5			
	342.90								
	7.68	dense, brownish grey, fine sand		9	SS	48			
8.0	342.35								
	8.23	Borehole Terminated at 8.23m							
10.0									



January 7, 2015
Water level 5.18 mbTOC (346.26 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes: Aardvark

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Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW108-14

Job Number: 39502-104

Drill Date: 12/16/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
	346.21	Ground Elevation							
0.00		**TOPSOIL** brown to dark brown, some clay, organics, damp							
0.76	345.45	**SILT** stiff, tan, clayey silt, trace course sand, trace organics, damp		1	SS	11			
1.52	344.69	compact, tan, clayey silt, some fine sand, trace course sand, moist		2	SS	14			
2.29	343.92	**SAND** compact, tan, fine sand, saturated		3	SS	17			
				4	SS	20			
3.81	342.40	dense, mottled tan brown with oxidation staining, fine sand		5	SS	40			
4.57	341.64	dense, brown, fine sand							
		compact, grey brown, fine sand		6	SS	14			
				7	SS	20			
6.10	340.11	compact, grey, fine sand		8	SS	15			
6.71	339.50	Borehole Terminated at 6.71m							

Concrete
Bentonite
Sand Pack
Natural Cave
Locked Stick-up Casing
2" Slot 10 Screen

January 8, 2015
Water level 1.85 mbTOC (345.08 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW109A-14

Job Number: 39502-104

Drill Date: 12/18/14

Depth (m)	Elevation (m)	Soil Description	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
	349.77	Ground Elevation						
0.00		**TOPSOIL** loose, dark brown, fill, silty sand, little organics, damp	1	SS	8			
1.0			2	SS	15			
3.0		**SILT TILL** stiff, brown, clayey silt till, moist	3	SS	15			
5.0								
2.0		mottled brown, no clasts observed, moist	4	SS	9			
7.0								
9.0	346.72							
3.05		**CLAY** stiff, grey, little silt, moist	5	SS	10			
11.0								
4.0			6	SS	7			
13.0								
15.0			7	SS	9			
17.0	344.41							
5.36		**SAND** loose, brown, silty fine sand, wet	8	SS	8			
6.0	343.67							
6.10		**SAND** loose, brownish grey, fine to medium sand, saturated	9	SS	18			
21.0		compact, brown, fine sand						
23.0								
25.0			10	SS	16			
8.0								
27.0								
29.0			11	SS	5			
31.0								
10.0								
33.0								
35.0			12	SS	11			
37.0								
39.0								
12.0	337.58							
12.19		compact, brown, fine sand, little silt	13	SS	14			
41.0								
43.0								
45.0	336.05							
13.72		compact brownish grey, fine sand, little silt	14	SS	23			
14.0								
47.0								

Concrete

Locked Stick-up Casing

Bentonite

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

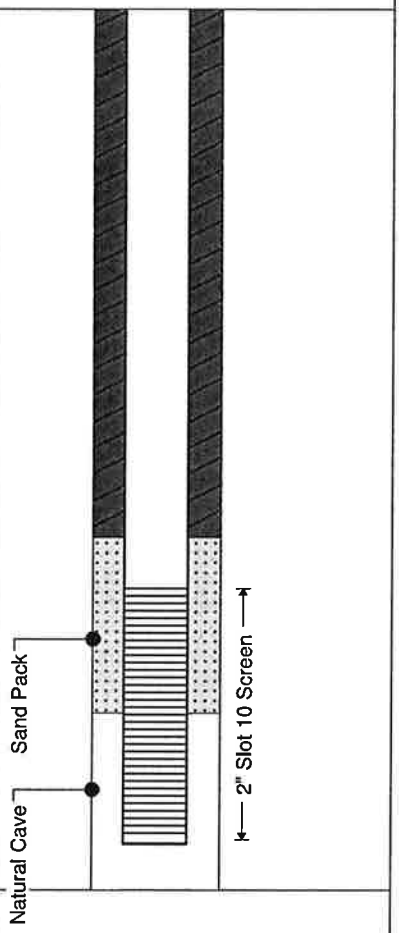
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW109A-14

Job Number: 39502-104

Drill Date: 12/18/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
49.0									
51.0				15	SS	30			
53.0	16.0								
55.0	333.01								
	16.76	**CLAY** hard, brownish grey, silty clay, some fine sand,wet		16	SS	40			
57.0									
59.0	18.0								
	331.48								
	18.29	**SAND** dense, brown, fine sand, saturated		17	SS	37			
61.0									
63.0		**CLAY** hard, brownish grey, clay, wet							
65.0	20.0			18	SS	22			
67.0									
69.0									
	328.43								
	21.34	**SAND** dense, brownish grey, silty fine sand, saturated		19	SS	36			
71.0									
73.0	22.0								
75.0				20	SS	37			
77.0									
79.0	24.0								
81.0				21	SS	19			
	324.78								
	24.99	Borehole Terminated at 24.99m							
83.0									
85.0	26.0								
87.0									
89.0									
91.0	28.0								
93.0									
95.0									
97.0									



January 7, 2015
Water level 3.87 mbTOC (346.62 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

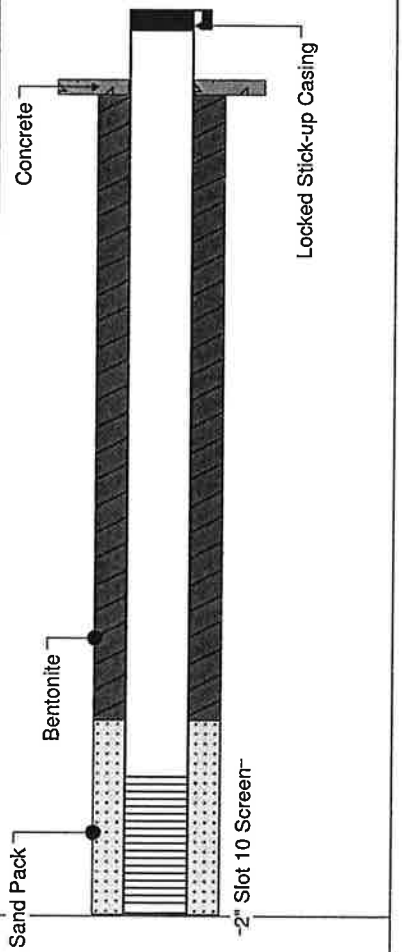
Location: Conservation Dr. Waterloo, Ontario

Borehole Number: MW109B-14

Job Number: 39502-104

Drill Date: 12/18/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
	349.77	Ground Elevation							
0.00		**TOPSOIL** loose, dark brown, fill, silty sand, little organics, damp		1	SS	8			
2.0		**SILT TILL** stiff, brown, clayey silt till, moist; mottled brown, no clasts observed, moist		2	SS	15			
				3	SS	15			
				4	SS	9			
	346.72								
3.05		**CLAY** stiff, grey, little silt, moist		5	SS	10			
4.0				6	SS	7			
				7	SS	9			
	344.41								
5.36		**SAND** loose, brown, silty fine sand, wet		8	SS	8			
6.0	343.67								
6.10		**SAND** loose, brownish grey, fine to medium sand, saturated; compact, brown, fine sand		9	SS	18			
8.0				10	SS	16			
	340.63								
9.14		Borehole Terminated at 9.14m							
10.0									
12.0									



January 5, 2015
Water level 4.76 mbTOC (345.76 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

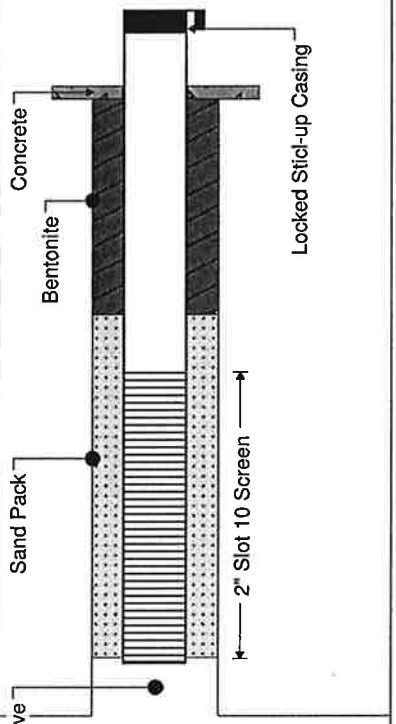
Location: 675 Conservation Dr. Waterloo, Ontario

Borehole Number: MW110-14

Job Number: 39502-104

Drill Date: 12/17/14

Depth (m)	Elevation (m)	Soil Description	Symbol	Number	Type	N-Value	Standard Penetration Graph (25 50 75)	Headspace (ppm)	Groundwater Observations and Well Details
0.0	349.37	Ground Elevation							
0.0 – 0.76	349.37 – 348.61	**TOPSOIL** dark brown, silty sand, trace organics, moist							
0.76 – 1.52	348.61 – 347.85	**SAND** compact, grey, fine to medium sand,some silt, some gravel, wet		1	SS	19			
1.52 – 2.44	347.85 – 346.93	compact, brownish grey, fine sand, some silt, wet		2	SS	16			
2.44 – 6.71	346.93 – 342.66	saturated		3	SS	13			
				4	SS	8			
				5	SS	9			
				6	SS	14			
				7	SS	0*			
				8	SS	1			
6.71	342.66	Borehole Terminated at 6.71m							



January 7, 2015
Water level 2.10 mbTOC (348.08 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes: * Sampler advanced under static pressure

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Sheet: 1 of 1

Client: Northgate Lands Corp.

Project: Northgate Lands Subdivision

Location: 675 Conservation Dr. Waterloo, Ontario

Borehole Number: MW111-14

Job Number: 39502-104

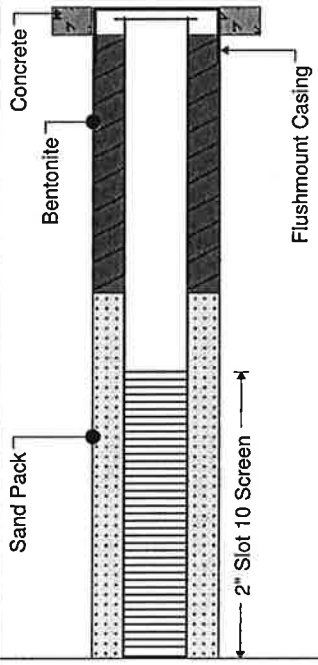
Drill Date: 12/17/14

Depth (m)	Elevation (m)	Soil Description	Number	Type	N-Value
	349.43	Ground Elevation			
0.0	0.00	**TOPSOIL** tan brown, silty sand, trace organics, moist			
	348.67				
0.76	0.76	**SILT** firm, mottled borwn, clayey silt till, moist	1	SS	6
1.5			2	SS	9
2.0	347.14				
	2.29	**SAND** compact, brown, silty fine sand, saturated	3	SS	21
3.0		**CLAY** very stiff, brown, clay, little silt, little sand, wet	4	SS	19
4.0		**SAND** compact, grey, fine sand, saturated	5	SS	26
	344.86				
	4.57	**CLAY** very stiff, brown, clay, little silt, little sand, wet	6	SS	43
6.0	343.33	**SILT** hard, grey, clayey silt, little sand, wet	7	SS	34
	6.10		8	SS	17
	342.50				
	6.93	**CLAY** very stiff, grey, clay, some silt, wet			
8.0		Borehole Terminated at 6.93m			
10.0					
12.0					

Standard Penetration Graph: 25 50 75

Headspace (ppm)

Groundwater Observations and Well Details



January 7, 2015
Water level 0.75 mbTOC (348.56 masl)

Reviewed By: ALB

Method: CME75 Hollow Stem Auger

Notes:

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Sheet: 1 of 1

Monitoring Well: MW8-10

Project:	North Waterloo Subwatershed Study	**Field investigator:**	R.Dong/L.Veale
Client:		**Contractor:**	Pro Core Drilling
Location:	North Waterloo, ON; 08	**Drilling method:**	Track Mount, CME55, Hollow Stem Auger
Number:	160340875	**Date started/completed:**	05-Mar-2010 / 08-Mar-2010

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS					WELL DETAILS
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) / Depth (m BGS)	Hydro-Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	GS Elev: 350.44 m AMSL TOC Elev: 351.28 m AMSL Easting: 532289 Northing: 4814537 Stick-up: 0.82 m GS Elev: 350.38 m AMSL TOC Elev: 351.28 m AMSL Easting: 532271 Northing: 4814538 Stick-up: 0.90 m
			Ground Surface	350.44							
0	0		TOPSOIL some organic material, dark brown, stiff, dry	0.00 349.60			1	SS	2-2-2-3 (4)	12" 50%	Cement
			SILT little fine sand, trace clay, light brown	0.84 348.91			2	SS	5-7-9-2 (16)	9" 38%	Holeplug
5			becoming wet at 1.37 m BGS	1.52							
	2		SILT light brown, homogeneous, stiff, wet				3	SS	3-5-7-12 (12)	24" 100%	52 mm Schedule 40 PVC casing
							4	SS	9-13-14-14 (27)	24" 100%	
10							5	PQ	n/a	29" 161%	Top of sand (2.74 m BGS)
	4		some clay beginning at 3.6 m BGS, becoming brownish grey, firm		ATB1	Upper Maryhill Till and Equivalents	6	PQ	n/a	54" 90%	Top of screen (3.05 m BGS) No.2 Silica Sand No.10 Slot PVC screen 50 mm diameter
15											
20	6						7	PQ	n/a	54" 90%	Bottom of screen (4.57 m BGS)
							8	PQ	n/a	54" 90%	
25	8			341.93							
			SAND fine grained, some silt, brown, homogeneous, wet	8.51			9	PQ	n/a	49" 82%	
30	10		trace silt beginning at 9.8 m BGS				10	PQ	n/a	55" 92%	
35											
40	12		little silt beginning at 12.5 m BGS, becoming greyish brown, soft				11	PQ	n/a	51" 85%	52 mm Schedule 80 PVC casing
							12	PQ	n/a	55" 92%	
45	14						13	PQ	n/a	55" 92%	
50											
55	16		layer of fine sand, trace silt, stiff at 16.2 to 17.1 m BGS				14	PQ	n/a	28" 47%	
60	18						15	PQ	n/a	55" 92%	Bentonite Grout
			some silt beginning at 18.9 m BGS				16	PQ	n/a	58" 97%	
65	20										
70							17	PQ	n/a	56" 93%	
	22		trace silt beginning at 21.6 m BGS				18	PQ	n/a	37" 62%	
75				328.03 22.40							
			fine grained, little medium grained sand, grey brown, wet		AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents	19	PQ	n/a	38" 63%	
80	24		seam of grey brown, fine sand with little silt 0.2 m thick at 24.5 m BGS								
			medium sand content between 24.7 to 26.2 m BGS				20	PQ	n/a	44" 73%	
85	26										
							21	PQ	n/a	60" 100%	
90			seam of medium sand 0.2 m thick at 27.7 m BGS								

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
PQ - wireline continuous core sample
n/a - not available

mAMSL - metres above mean sea level
mBGS - metres below ground surface

PQ - continuous core sampling
SS - split spoon sampling

Drawn By/Checked By: OR/LV

Stantec

STANTEC BOREHOLE AND WELL - CLUST 11X17 160340875 - DPS.GPJ EDGE DATA TEMPLATE.GDT 2/4/11 MJFRASER

Monitoring Well: MW8-10

Project:	North Waterloo Subwatershed Study	**Field Investigator:**	R.Dong/L.Veale
Client:		**Contractor:**	Pro Core Drilling
Location:	North Waterloo, ON; 08	**Drilling method:**	Track Mount, CME55, Hollow Stem Auger
Number:	160340875	**Date started/completed:**	05-Mar-2010 / 08-Mar-2010

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS				WELL DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	GS Elev: 350.44 m AMSL TOC Elev: 351.26 m AMSL Easting: 532269 Northing: 4814537 Stick-up: 0.82 m
95			little silt from 28.0 to 28.7 m BGS fine grained, little medium grained sand, grey brown, wet				22	PQ	n/a	60" 100%	
100	30						23	PQ	n/a	14" 23%	
105	32						24	PQ	n/a	50" 83%	Bentonite Grout
110	34		seam of fine sand 5 cm thick at 33.8 m BGS				25	PQ	n/a	25" 42%	
115	36						26	PQ	n/a	3" 5%	Holeplug
120			seam of homogeneous fine sand between 36.9 and 37.4 m BGS, and				27	PQ	n/a	3" 5%	Top of sand (35.97 m BGS) Top of screen (36.58 m BGS)
125	38		37.8 and 38.1 m BGS, and				28	PQ	n/a	60" 100%	No.2 Silica Sand
			38.8 and 38.8 m BGS	311.42							No.10 Slot PVC screen 50 mm diameter
			trace gravel beginning at 39.0 m BGS	39.01			29	PQ	n/a	41" 82%	
130	40		SAND AND COBBLE large cobble at 39 m BGS, at 39.5 m and 39.7 m BGS	310.76	AFB3	Lower Moraine Stratified Sediments					Bottom of screen (39.68)
			End of Borehole	39.68							
135	42										
140											
145	44										
150	46										
155											
160	48										
165	50										
170	52										
175											
180	54										
185	56										

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
PQ - wireline continuous core sample
n/a - not available

mAMSL - metres above mean sea level
mBGS - metres below ground surface

PQ - continuous core sampling
SS - split spoon sampling

Drawn By/Checked By: OR/LV

Stantec

STANTEC BOREHOLE AND WELL - CLIENT 11X17 - MOD0875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 2/1/11 MAFRASER

Monitoring Well: MW9-10

Project:	North Waterloo Subwatershed Study	**Field Investigator:**	J.Koch
Client:		**Contractor:**	Pro Core Drilling
Location:	North Waterloo, ON; 09	**Drilling method:**	Track Mount, CME75, Hollow Stem Auger
Number:	160340875	**Date started/completed:**	02-Mar-2010 / 04-Mar-2010

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS				WELL DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) / Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	GS Elev: 345.71 m AMSL TOC Elev: 346.50 m AMSL Easting: 532634 Northing: 4814717 Stick-up: 0.79 m
			Ground Surface	345.71							
0	0		TOPSOIL some clay and silt, dark brown	0.00 344.95			1	SS	n/a	6" 25%	Cement
			CLAY some silt, trace gravel, brown, firm	0.76 344.19			2	SS	2-5-7-9 (12)	14" 58%	Holeplug
5	2		brownish grey, homogeneous, firm, wet	1.52	ATB1	Upper Maryhill Port Stanley Till and Equivalents	3	SS	4-5-7-9 (12)	15" 63%	52 mm Schedule 40 PVC casing
							4	SS	2-3-4-6 (7)	15" 63%	Top of sand (2.61 m BGS)
10							5	PQ	n/a	25" 96%	Top of screen (3.05 m BGS)
	4			341.90							No.2 Silica Sand
			SANDY SILT some clay, brownish grey, firm, wet	3.81 340.93			6	PQ	n/a	52.5" 88%	No.10 Slot PVC screen 50 mm diameter
15			SAND medium grained, silty to some silt, brownish grey, soft, wet	4.76 340.02							Bottom of screen (4.57 m BGS)
20	6		SILT sandy to some sand, greyish brown, very stiff, wet	5.69			7	PQ	n/a	44" 73%	
			seam of fine sand, little silt between 6.6 and 9.5 m BGS				8	PQ	n/a	59" 98%	
25	8		little clay between 8.1 and 9.5 m BGS				9	PQ	n/a	58" 96%	
30			stratified layers of clayey silt, little to some sand, firm to soft and silt, little clay, very hard between 9.5 and 11.3 m BGS								52 mm Schedule 80 PVC casing
	10		becoming soft at 11.3 m BGS				10	PQ	n/a	58" 95%	
35											
40	12				AFB1 / AFB2	Upper / Mide Moraine Stratified Sediments and Equivalents	11	PQ	n/a	59" 100%	
			laminated sediments at 13.4 m BGS				12	PQ	n/a	57" 95%	Bentonite Grout
45	14		little fine sand beginning at 14.2 m BGS, soft to firm								
50							13	PQ	n/a	51" 85%	
	16						14	PQ	n/a	58" 97%	
55			laminated sediments at 17.1 m BGS								
60	18		trace fine sand beginning at 18.8 m BGS				15	PQ	n/a	54" 88%	
65	20		cobble, 11 cm diameter, at 19.8 m BGS	325.82 19.89			16	PQ	n/a	43" 73%	
			SAND AND GRAVEL coarse grained gravel, some fine gravel, some cobbles, rounded particles		AFB3	Lower Moraine Stratified Sediments	17	PQ	n/a	n/a	
70				324.09							
	22		SILT TILL some fine sand, some coarse gravel, trace fine gravel, grey, very hard, moist	21.82			18	PQ	n/a	60" 101%	
75											Holeplug
	24				ATC1	Upper/ Main Catfish Creek Till	19	PQ	n/a	45" 61%	Top of sand (23.98 m BGS)
80											Top of screen (24.48 m BGS)
85	26						20	PQ	n/a	54" 90%	No.2 Silica Sand
											No.10 Slot PVC screen 50 mm diameter
90	28		End of Borehole	318.20 27.51							Bottom of screen (27.51)

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
PQ - wireline continuous core sample
n/a - not available

mAMSL - metres above mean sea level
mBGS - metres below ground surface

PQ - continuous core sampling
SS - split spoon sampling

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STANTEC BOREHOLE AND WELL - CLIENT 11X17 - 160340875 - DPS.GPJ EGAS DATA TEMPLATE.GDT 3/1/11 MJFRASER

Monitoring Well: MW10-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Track Mount, CME55, Hollow Stem Auger
Client:		**Date started/completed:**	19-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	346.25 m AMSL
Number:	160340875	**Top of casing elevation:**	347.05 m AMSL
Field investigator:	A.Vandenhoff	**Easting:**	532654
Contractor:	Pro Core Drilling	**Northing:**	4814388

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS				WELL DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	Diagram	Description
												Stick-up = 0.80 m
0	0		Ground Surface	346.25								
			TOPSOIL some clay, organics, dark brown	0.00 345.94								Concrete
			SAND fine to medium grained, light brown with oxidation staining throughout	0.30			1	SS	2-4-5-8 (9)	16" 67%		Holeplug
							2	SS	10-8-6-6 (14)	0" 0%		52 mm Schedule 40 PVC casing
5				344.57								Top of sand (0.9 m BGS)
			SILTY CLAY light brown	1.68 344.42	AFB1 / AFB2	Upper / Midle Moraine Stratified Sediments and Equivalents	3	SS	3-5-5-5 (10)	18" 75%		Top of screen (1.5 m BGS)
	2		SAND fine grained, some medium sand and silt, light brown, loose to compact, wet	1.83								No.2 Silica Sand
			becoming finer with depth				4	SS	2-3-4-5 (7)	8" 33%		No.10 Slot PVC screen 50 mm diameter
10							5	SS	6-8-10-8 (18)	16" 67%		Bottom of screen (3.1 m BGS)
				342.59								
			End of Borehole	3.66								
	4											
15												
20	6											
25												
	8											

Screen Interval: 1.52 - 3.05 m BGS
Sand Pack Interval: 0.91 - 3.05 m BGS
Well Seal Interval: 0.30 - 0.91 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 2/1/11 MJFRASER

Monitoring Well: MW11-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Track Mount, CME55, Hollow Stem Auger
Client:		**Date started/completed:**	05-Mar-2010 / 08-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	355.07 m AMSL
Number:	160340875	**Top of casing elevation:**	355.96 m AMSL
Field investigator:	A.Vandenhoff	**Easting:**	533047
Contractor:	Pro Core Drilling	**Northing:**	4814655

SUBSURFACE PROFILE					HYDROGEOLOGY		SAMPLE DETAILS				WELL DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	Diagram	Description
												Stick-up = 0.69 m
0	0		Ground Surface	355.07								
			SAND fine to medium grained, trace silt and organics, light brown	0.00 354.76								Concrete
			SAND fine to medium grained, light brown, some oxidation staining, loose	0.30			1	SS	1-3-3-5 (6)	11" 46%		
			some coarse sand and gravel at 0.8 to 1.4 m BGS				2	SS	4-6-7-6 (13)	6" 25%		52 mm Schedule 40 PVC casing
5							3	SS	4-7-12-14 (19)	14" 58%		
	2		SILTY SAND fine grained sand, light brown, compact, moist	353.09 1.98 352.93								Holeplug
			SAND fine grained, some medium sand, light brown, loose to compact, moist	2.13			4	SS	5-10-12-12 (22)	15" 63%		
10					AFB1 / AFB2	Upper / Midle Moraine Stratified Sediments and Equivalents	5	SS	2-10-16-18 (26)	15" 63%		
			fine to coarse grained sand, trace gravel, light brown, loose, wet	351.41 3.66								Top of sand (3.7 m BGS)
	4											Top of screen (4.3 m BGS)
15							6	SS	7-11-12-12 (23)	20" 83%		No.2 Silica Sand
												No.10 Slot PVC screen 50 mm diameter
	6			348.97								Bottom of screen (5.8 m BGS)
20			SILTY CLAY grey	6.10			7	SS	2-4-5-5 (9)	24" 100%		Natural Cave
				348.36								
			End of Borehole	6.71								
25												
	8											

Screen Interval: 4.27 - 5.79 m BGS
Sand Pack Interval: 3.66 - 5.79 m BGS
Well Seal Interval: 0.30 - 3.66 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 2/1/11 MJFRASER

Monitoring Well: MW12-10

Project:	North Waterloo Subwatershed Study	**Field Investigator:**	R Dong
Client:		**Contractor:**	Pro Core Drilling
Location:	North Waterloo, ON; 12	**Drilling method:**	Track Mount, CME55, Hollow Stem Auger
Number:	160340875	**Date started/completed:**	09-Mar-2010 / 11-Mar-2010

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS				WELL DETAILS
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) / Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	GS Elev: 348.63 m AMSL TOC Elev: 349.52 m AMSL Easting: 532584 Northing: 4814125 Stick-up: 0.89 m
			Ground Surface	348.63							
0	0		TOPSOIL brown, decaying wood, moist	0.00			1	SS	2-3-4-4 (7)	12" 50%	Cement
				347.26			2	SS	3-4-4-4 (8)	10" 42%	Holeplug
5	2		CLAYEY SILT trace fine sand, light and dark brown mottled, soft, moist	1.37			3	SS	6-1-7-4 (8)	8" 33%	
			SILTY CLAY light brown and brown mottled, very stiff, moist	340.34 2.29			4	SS	6-6-8-14 (14)	17" 71%	52 mm Schedule 40 PVC casing
10			SILT little clay, trace coarse and fine gravel, trace well graded sand, brown, very soft, moist to wet	346.17 2.46			5	SS	n/a	14" 74%	Holeplug
				345.25							
15	4		SILTY CLAY little fine sand, trace cobbles, light brown, firm, moist to wet	3.38			6	PQ	n/a	24" 40%	Top of sand (4.57 m BGS)
			becoming stiff, brown at 4.9m BGS								Top of screen (5.18 m BGS)
			seam of wet, brown, fine sand, 0.23 m thick at 5.3 m BGS								No.2 Silica Sand
20	6		becoming brown grey at 5.9 m BGS		ATB1	Upper Maryhill Port Stanley Till and Equivalents	7	PQ	n/a	48" 79%	No.10 Slot PVC screen 50 mm diameter
			trace gravel beginning at 7.0 m BGS								Bottom of screen (6.71m BGS)
			trace coarse and medium sand beginning at 7.5 m BGS lensed trace soft clay pockets (1-2 mm in diameter), red and grey starting at 7.5 m BGS				8	PQ	n/a	50" 83%	
25	8		lensed trace to little silt pockets								52 mm Schedule 80 PVC casing
			laminated 2 mm thick of soft grey clay at 9.4 m BGS				9	PQ	n/a	61" 100%	
30	10										
			seam of wet silt and very fine sand, 0.05 m thick at 10.4 m BGS seam of little fine and coarse gravel, little well graded sand, 0.2 m thick at 10.5 m BGS seam of silt and very fine sand 0.05 thick between 10.7 and 11.0 m BGS				10	PQ	n/a	49" 83%	
35			seam of fine sand 2 mm thick at 11.4 m BGS	337.10							
			SILT AND SAND fine grained, brown grey, homogeneous, wet	11.53 336.64			11	PQ	n/a	52" 93%	
40	12		SAND fine grained, brown grey, homogeneous, wet	11.99							Bentonite Grout
			seam of silt, 0.01 m thick at 12.9 m BGS				12	PQ	n/a	46" 102%	
45			seam of silt, 0.01 m thick at 13.3 m BGS								
	14		seam of silt, 0.01 m thick at 14.4 m BGS				13	PQ	n/a	42" 70%	
50											
	16		seam of browny grey silty clay with lensed grey clay 0.05 m thick at 15.8 m BGS some medium sand between 16.1 and 16.5 m BGS		AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents	14	PQ	n/a	43" 63%	
55							15	PQ	n/a	42" 89%	
60	18		pocket of very fine sand, 0.03 m diameter at 18.5 m BGS some medium sand between 18.3 and 18.7 m BGS seam of firm silty clay 0.03 m thick at 18.7 m BGS								
			seam of coarse gravel 0.05 m thick at 19.3 m BGS				16	PQ	n/a	34" 59%	
65	20		seam of sand, stiff, 0.1 m thick at 20.0 m BGS								
			seam of some silt 0.04 m thick at 20.8 m BGS seam of some silt 0.13 m thick at 20.9 m BGS stratified clayey silt 0.03 m thick at 21.1 m BGS	327.50 21.13 327.09			17	PQ	n/a	48" 89%	
70			SAND AND SILT stratified fine sand with little silt, 2 cm thick and coarse sand with fine gravel 0.2 cm thick browny grey, wet	21.54							Holeplug
	22		SAND AND GRAVEL well graded, brown and grey, wet				18	PQ	n/a	36" 74%	Top of sand (21.95 m BGS)
75											Top of screen (22.56 m BGS)
					AFB3	Lower Moraine Stratified Sediments					
80	24										No.2 Silica Sand
				323.48							No.10 Slot PVC screen 50 mm diameter
			SANDY SILT TILL little medium sand coarse sand, trace to little fine and coarse gravel, grey brown, brown very hard, moist	25.15	ATC1	Upper/Main Catfish Creek Till	19	PQ	n/a	44" 69%	
85	26			322.37							Bottom of screen (25.60 m BGS)
			End of Borehole	26.26							
90	28										

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
PQ - wireline continuous core sample
n/a - not available

mAMSL - metres above mean sea level
mBGS - metres below ground surface

PQ - continuous core sampling
SS - split spoon sampling

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL - CLUST 1 (V3) - MOSSKRR - DPS.GPJ - EQUIS DATA TEMPLATE.GDT - 2/3/11 - MURHAISER

Monitoring Well: MW13-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Track Mount, CME55, Hollow Stem Auger
Client:		**Date started/completed:**	19-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	345.34 m AMSL
Number:	160340875	**Top of casing elevation:**	346.15 m AMSL
Field investigator:	A.Vandenhoff	**Easting:**	533060
Contractor:	Pro Core Drilling	**Northing:**	4814339

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS				WELL DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	N Value	Recovery	Diagram	Description
												Stick-up = 0.81 m
0	0		Ground Surface	345.34								
			TOPSOIL clay, organic material, dark brown	0.00			1	SS	1-2-4-6 (6)	7" 29%		Concrete
				344.42								Holeplug
			SILTY CLAY light brown	0.91			2	SS	1-2-4-4 (6)	24" 100%		
5			becoming coarser with depth		ATB1	Upper Maryhill Port Stanley Till and Equivalents						52 mm Schedule 40 PVC casing
	2		becoming clayey silt, some sandy silt				3	SS	2-3-6-8 (9)	14" 58%		
				343.05								
			SANDY SILT fine grained sand, light brown, moist	2.29			4	SS	6-6-6-7 (12)	2" 8%		Top of sand (2.4 m BGS)
10				342.14								Top of screen (3.1 m BGS)
			SILTY SAND fine grained, light brown, wet	3.20			5	SS	0-3-3-7 (6)	16" 67%		No.2 Silica Sand
	4				AFB1 / AFB2	Upper / Midle Moraine Stratified Sediments and Equivalents						No.10 Slot PVC screen 50 mm diameter
15			some medium sand, trace silt beginning at 4.6 m BGS				6	SS	1-2-2-3 (4)	24" 100%		Bottom of screen (4.6 m BGS)
				340.16								
			End of Borehole	5.18								
20	6											
25	8											

Screen Interval: 3.05 - 4.57 m BGS
Sand Pack Interval: 2.44 - 4.57 m BGS
Well Seal Interval: 0.30 - 2.44 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 2/1/11 MJFRASER

Test Pit: TP3-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	10-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	350.20 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	532454
Contractor:	Pro Core Drilling	**Northing:**	4814491

SUBSURFACE PROFILE					HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	350.20					
			TOPSOIL silt, organics, dark brown, moist	0.00					
				349.90					
			SANDY SILT fine grained, light brown, loose, moist	0.30	ATB1	Upper Maryhill Port Stanley Till and Equivalents			
2	1								
4									
6	2								
8									
10	3								
12			End of Test Pit	346.54 3.66					
	4								
14									

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

No standing water encountered within excavation

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

Test Pit: TP4-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	10-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	346.80 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	532628
Contractor:	Pro Core Drilling	**Northing:**	4814574

SUBSURFACE PROFILE					HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	346.80					
			TOPSOIL clayey silt with organics, dark brown, moist	0.00					
				346.40					
			SAND medium grained, some fine and coarse sand, light brown, loose, moist	0.40					
2					AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents			
	1		becoming wet at 1.0 m BGS	345.79					
			SAND some fine gravel, light brown, loose, well graded, wet	1.01					
4									
			standing water encountered at 1.8 m BGS	345.03					
6			End of Test Pit	1.77					
	2								
8									
10	3								
12									
	4								
14									

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

Test Pit: TP6-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	11-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	350.60 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	532803
Contractor:	Pro Core Drilling	**Northing:**	4814702

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	350.60					
			TOPSOIL organics, dark brown, moist	0.00					
				350.20					
			CLAYEY SILT light brown, soft, moist	0.40					
2	1		wet layer at 1.1 m BGS		ATB1	Upper Maryhill Port Stanley Till and Equivalents			
4									
6	2								
				348.31					
8			SILT some clay, grey, soft, moist to wet	2.29					
				347.70					
10	3		CLAY grey, soft to firm, moist to wet	2.90					
				347.49					
			End of Test Pit	3.11					
12	4								
14									

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

No standing water encountered within excavation

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

Test Pit: TP7-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	10-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	352.80 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	532458
Contractor:	Pro Core Drilling	**Northing:**	4814292

SUBSURFACE PROFILE					HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	352.80					
			TOPSOIL clayey sand, organics, brown	0.00 352.50					
			SAND fine grained, brown, loose, moist	0.30	AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents			
2									
	1								
4									
6									
	2								
8									
10									
	3								
12									
	4		End of Test Pit	348.84 3.96					
14									

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

No standing water encountered within excavation

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

Test Pit: TP8-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	10-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	346.30 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	532890
Contractor:	Pro Core Drilling	**Northing:**	4814475

SUBSURFACE PROFILE					HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	346.30					
			CLAYEY SILT some organics, brown, moist	0.00	ATB1	Upper Maryhill Port Stanley Till and Equivalents			
				345.08					
			SILT some clay, light brown, soft to firm, moist	1.22					
				344.47					
			SAND fine grained, little silt, light brown, loose	1.83	AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents			
			becoming wet at 2.3 m BGS						
			standing water encountered at 3.35 m BGS	342.95					
			End of Test Pit	3.35					

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

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STANTEC BOREHOLE AND WELL 160330975 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

Test Pit: TP9-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	11-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	356.60 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	533098
Contractor:	Pro Core Drilling	**Northing:**	4814768

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	356.60					
			TOPSOIL FROST fine grained with organics, dark brown, moist	0.00 356.30					
			SAND fine to medium grained, medium to light brown, loose, moist	0.30	AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents			
2	1								
4									
6	2								
8									
10	3								
12									
	4		End of Test Pit	352.66 3.94					
14									

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

No standing water encountered within excavation

Drawn By/Checked By: OR/LV

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STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

Test Pit: TP10-10

Project:	North Waterloo Subwatershed Study	**Drilling method:**	Rubber Tire Backhoe
Client:		**Date started/completed:**	10-Mar-2010
Location:	North Waterloo, ON	**Ground surface elevation:**	355.20 m AMSL
Number:	160340875	**Top of casing elevation:**	n/a
Field investigator:	L.Jo	**Easting:**	533243
Contractor:	Pro Core Drilling	**Northing:**	4814589

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			Ground Surface	355.20					
			TOPSOIL fine to medium grained sand with organics, dark brown, moist	0.00 354.90					
			SAND fine to medium grained, some coarse sand, trace gravel, trace cobbles (rounded), trace boulders, light brown, loose, moist	0.30					
2	1		gravel seam approx 0.15 m thick at 0.9 m BGS						
4									
6	2				AFB1 / AFB2	Upper / Middle Moraine Stratified Sediments and Equivalents			
8									
10	3			351.33					
12	4		End of Test Pit	3.87					
14									

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available

No standing water encountered within excavation

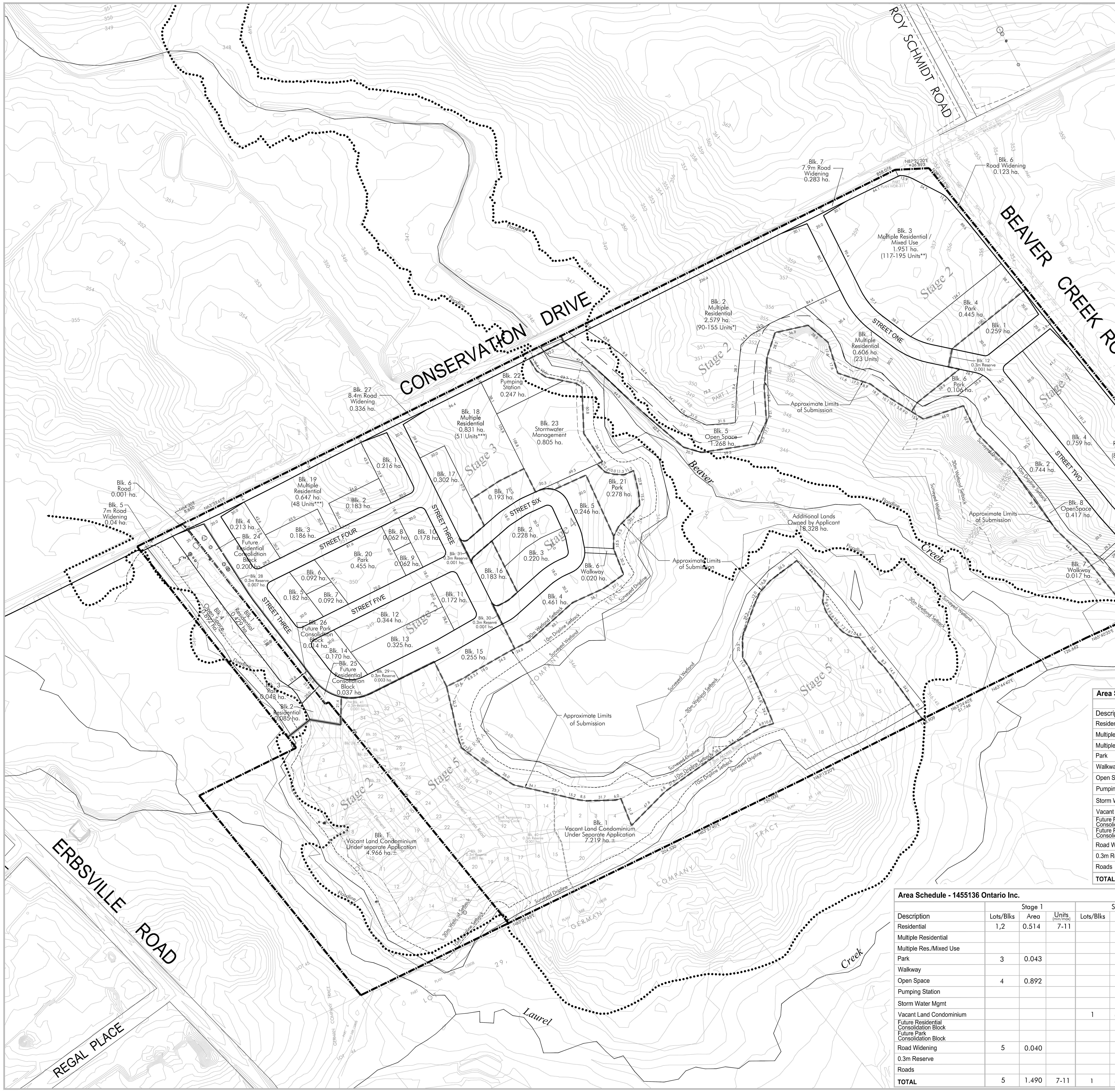
Drawn By/Checked By: OR/LV

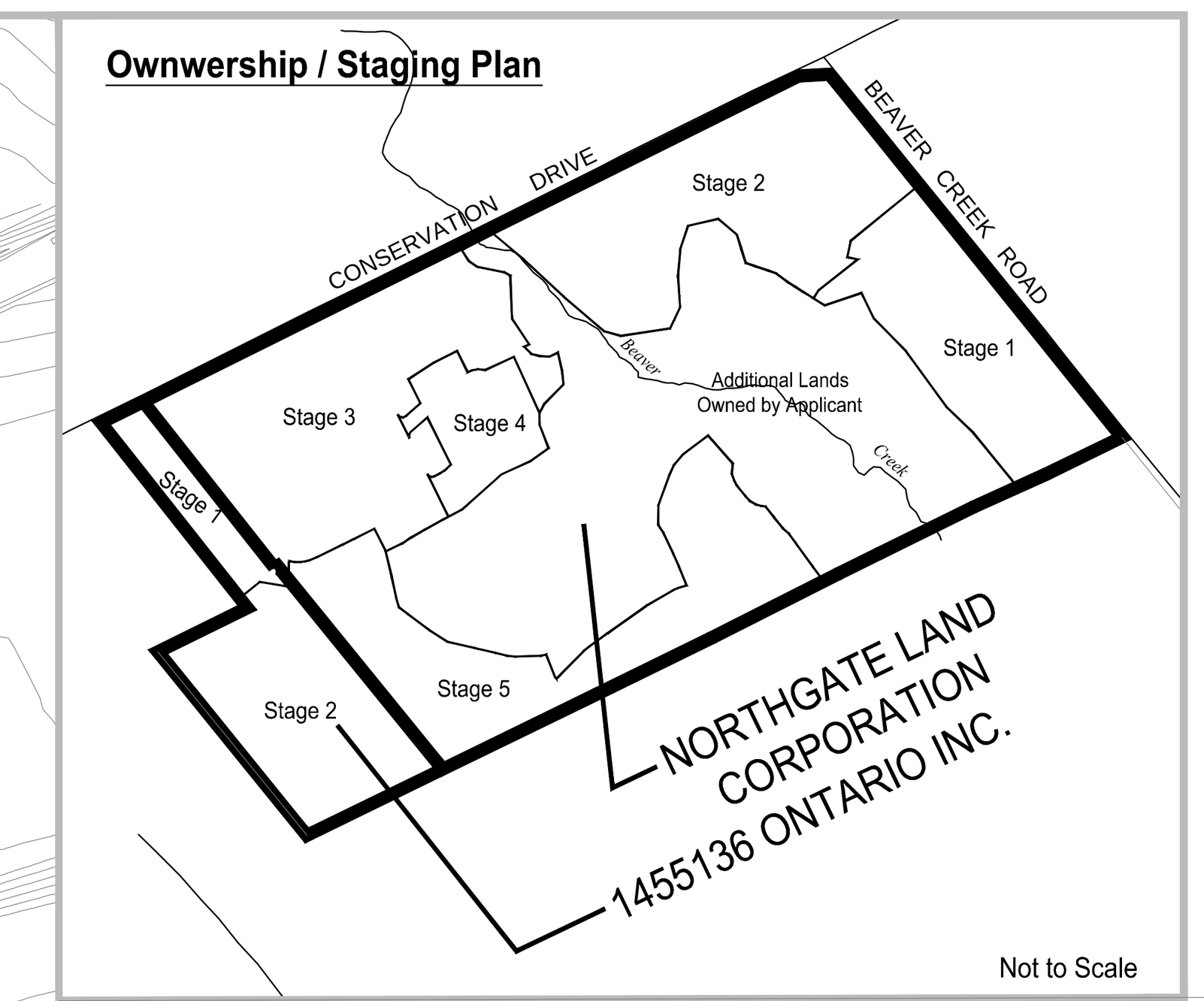
Stantec

Sheet 1 of 1

STANTEC BOREHOLE AND WELL 160330875 - DPS.GPJ EQUIS DATA TEMPLATE.GDT 1/18/11 MJFRASER

FULL SIZE DRAWINGS

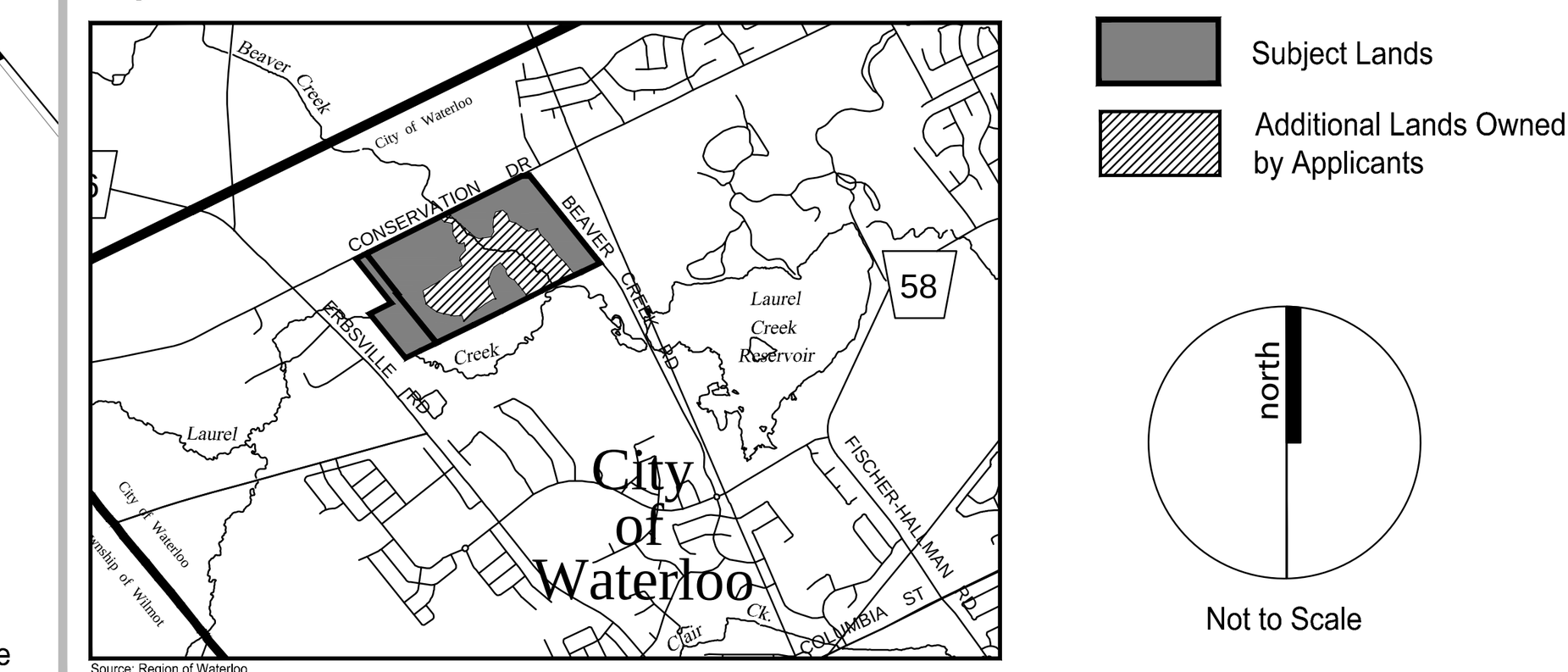




Legal Description

PART OF LOT 28, GERMAN COMPANY TRACT,
(GEOGRAPHIC TOWNSHIP OF WATERLOO),
CITY OF WATERLOO,
REGIONAL MUNICIPALITY OF WATERLOO

Key Plan



Additional Information Required Under Section 51(17) of the Planning Act R.S.O. 1990, c.P.13 as Amended

A. As Shown — B. As Shown — C. As Shown
D. Residential, Park, Open Space, Stormwater Management
E. As Shown — F. As Shown
G. As Shown — H. Municipal Water Supply — I. Sandy Loam
J. As Shown — K. All Services As Required — L. As Shown

Area Schedule - Northgate Land Corporation — 30T - ______

Description	STAGE 1 Lots/Blks	Area	Units (min/max)	STAGE 2 Lots/Blks	Area	Units (min/max)
Residential	1-4	2.056	45-67			
Multiple Residential	5	1.055	88	1,2	3.185	113-178
Multiple Res./Mixec Use				3	1.951	117-195
Park	6	0.106		4	0.445	
Walkway	7	0.017				
Open Space	8, 9	0.583		5	1.268	
Pumping Station	10	0.207				
Storm Water Mgmt						
Road Widening	11	0.150		6, 7	0.406	
0.3m Reserve	12	0.001				
Roads		0.878			0.461	
TOTAL	12	5.053	133-155	7	7.716	230-373

Description	STAGE 3 Lots/Blks	Area	Units (min/max)	STAGE 4 Lots/Blks	Area	Units (min/max)
Residential	1-17	3.217	64-100	1-5	1.348	27-43
Multiple Residential	18,19	1.478	99			
Park	20,21	0.733				
Walkway				6	0.020	
Open Space						
Pumping Station	22	0.247				
Storm Water Mgmt	23	0.805				
Future Residential Consolidation Block	24,25	0.237	7-11			
Future Park Consolidation Block	26	0.014				
Road Widening	27	0.336				
0.3m Reserve	28-31	0.012				
Roads		1.992			0.532	
TOTAL	31	9.071	170-210	6	1.900	27-43

Area Schedule - Northgate Land Corporation

Description	STAGE 5 Lots/Blks	Area	Units (min/max)	TOTAL Lots/Blks	Area	Units (min/max)
Residential				26	6.621	136-210
Multiple Residential				6	7.669	300-365
Multiple Res./Mixed Use				1	1.951	117-195
Park				4	1.284	
Walkway				2	0.037	
Open Space				3	1.851	
Pumping Station				2	0.454	
Storm Water Mgmt				1	0.805	
Vacant Land Condominium	1	7.219	56	1	7.219	56
Future Residential Consolidation Block				2	0.237	7-11
Future Park Consolidation Block				1	0.014	
Road Widening				4	0.892	
0.3m Reserve				5	0.013	
Roads					3.863	
TOTAL	1	7.219	56	55	30.959	616-837

Area Schedule - 1455136 Ontario Inc.

Description	Stage 1 Lots/Blks	Area	Units (min/max)	Stage 2 Lots/Blks	Area	Units (min/max)	TOTAL Lots/Blks	Area	Units (min/max)	Northgate Land Corporation & 1455136 Ontario Inc. Lots/Blks	Area	Units (min/max)
Residential	1,2	0.514	7-11				2	0.514	7-11	28	6.621	143-221
Multiple Residential										6	7.669	300-365
Multiple Res./Mixed Use										1	1.951	117-195
Park	3	0.043					1	0.043		5	1.284	
Walkway										2	0.037	
Open Space	4	0.892					1	0.892		4	1.851	
Pumping Station										2	0.454	
Storm Water Mgmt										1	0.805	
Vacant Land Condominium				1	4.966	24	1	4.966	24	2	12.185	80
Future Residential Consolidation Block										2	0.237	7-11
Future Park Consolidation Block										1	0.014	
Road Widening	5	0.040					1	0.040		5	0.892	
0.3m Reserve										5	0.013	
Roads								0.001			3.863	
TOTAL	5	1.490	7-11	1	4.966	24	6	6.456	31-35	61	37.415	647-872

Notes:

- Boundary information provided by MacDonald Tamblyn Surveying Ltd., February 5,2008, Plan 58R-16404.
- Topographic information provided by Stantec Consulting. Contour Interval - 0.5m.
*- BCM District Plan, Low Density Residential 2 calculated at 35-60 Units per Hectare
**- BCM District Plan, Mixed Use Medium Density Residential calculated at 60-100 Units per Hectare
***- Multiple Block Unit Yield based on Conceptual Site Plan prepared by MHBC Planning.
VLC - denotes Vacant Land Condominium.
- Floodline mapping obtained from North Waterloo Scoped Subwatershed Study, November 2012 and GRCA Developement Resource On-Line Mapping, January 23,2017.

MHBC PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE
200-540 BINGEMANS CENTRE DR. KITCHENER, ON, N2B 3X9 | P: 519.576.3650 F: 519.576.0121 | WWW.MHBCPLAN.COM

Approval Stamp

Date	July 4,2017
File No.	14148A
Plan Scale	1:1,250
Drawn By	L.H.B. / G.M.C.
Checked By	P.B. / D.A.

Northgate Land Corporation & 1455136 Ontario Inc.
Conservation Drive
Waterloo, Ontario

north

File Name
DRAFT PLAN CONSOLIDATION

K:\14148A-NORTHGATE-WATERLOO\DRAFT PLAN\DRAFT PLAN CONSILIDATION JULY 4 2017.DWG

39502-104-AG1.1
MTE FILE No:
FINISHED GRADE CONTOURS PLAN
P:_P\39502\104\39502-104-AG1.DWG

July 5, 2017 – 9:38 a.m. – Plotted By: klaylor

CREEKSIDE CHURCH

CONSERVATION DRIVE

BEAVER CREEK ROAD

LEGEND OF EXISTING FEATURES

- SITE BOUNDARY
- STAGE LIMIT
- EXISTING CONTOURS
- FINSIHED GRADE CONTOURS
- PROPOSED SPOT ELEVATIONS
- PROPOSED DIRECTION OF DRAINAGE

STREET ONE
STREET TWO
STREET THREE
STREET FOUR
STREET FIVE
STREET SIX
STREET SEVEN
STREET EIGHT

Stage 1
Stage 2
Stage 3
Stage 4

SITE BENCHMARK ELEV=351.265

3:1 EMBANKMENT INTO BUFFER

50m RETAINING WALL MAXIMUM HEIGHT 1.2m

PROP. 13m–375mmø STM @ 3.8%

PROP. 28x2.4x1.2m BOX CULVERT @ 0.5%

Laurel Creek
Floodline
Beaver Creek

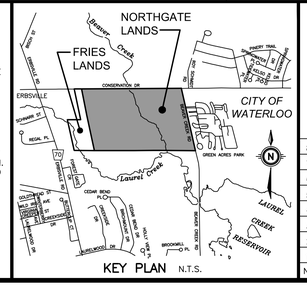
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ALL DRAWINGS REMAIN THE PROPERTY OF THE ENGINEER AND SHALL NOT BE REPRODUCED OR REUSED WITHOUT THE ENGINEER'S WRITTEN PERMISSION.

THE OWNER/ARCHITECT/CONTRACTOR IS ADVISED THAT M.T.E. CONSULTANTS INC. CANNOT CERTIFY ANY COMPONENT OF THE SITE WORKS NOT INSPECTED DURING CONSTRUCTION. IT IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR TO NOTIFY M.T.E. CONSULTANTS INC. PRIOR TO COMMENCEMENT OF CONSTRUCTION TO ARRANGE FOR INSPECTION.



KEY PLAN N.T.S.

No.	REVISION	BY	DATE
8.			
7.			
6.			
5.			
4.			
3.			
2.			
1.			

GEODETIC BM ELEV. = 349.950m
TABLET SET ON N.E. END OF E. CURB OF CONCRETE BOX CULVERT ON REGIONAL RD. 16 IN ERBSVILLE, 4.9m E. OF CONTRELINE OF REGIONAL RD. 16 32m N.E. OF THE N.E. CORNER OF WHITE FRAME HOUSE, 161m S. OF THE INTERSECTION OF REGIONAL RD. 14 AND 16.

SITE BENCHMARK ELEV. = 351.265m
TOP OF SIB (SEE PLAN FOR LOCATION)

OWNER
1017081 ONTARIO LIMITED & GABRIELLA ELIZABETH GROFF/1455136 ONTARIO INC
1455136 ONTARIO INC. KITCHENER

PROJECT
NORTHGATE AND ERBSVILLE KARTWAY SUBDIVISIONS
CONSERVATION DRIVE WATERLOO

DRAWING
FINISHED GRADE CONTOURS PLAN

MTE
Engineers | Scientists | Surveyors
(519)743-6500 www.mte85.com

Project Manager: V.LAZIC	Project No.: 39502-104
Design By:	Checked By:
Drawn By: KAT	Checked By: MSB
Surveyed By: MTE	Drawing No.: AG1.1
Date: May.02/17	
Scale: 1:1500	Sheet of

39502-104-EC1.1
MTE FILE No:
EXISTING CONDITIONS PLAN
P:_P\39502\104\39502-104-EC1.DWG

July 5, 2017 – 9:25 a.m. – Plotted By: kaylor

CONSERVATION DRIVE

BEAVER CREEK ROAD

LEGEND OF EXISTING FEATURES

- SITE BOUNDARY
- EXISTING SPOT ELEVATIONS/CONTOURS (326)
- EXISTING SANITARY SEWER (Ex. 300mmø SAN., Ex. MH)
- EXISTING WATERMAIN (Ex. 200mmø WTM., Ex. HYD. SET)
- EXISTING STORM SEWER (Ex. 375mmø STM., Ex. MH)
- EXISTING FENCE
- EXISTING EMBANKMENT (SLOPE AS NOTED) (TOP) (BOTTOM)
- TEST PITS (STANTEC, 2010)
- MONITORING WELL
  - -10 STANTEC S=SHALLOW D=DEEP
  - -14 MTE A=DEEP B=SHALLOW

SITE BENCHMARK ELEV=351.265

Laurel Creek Floodline

Beaver Creek Floodline

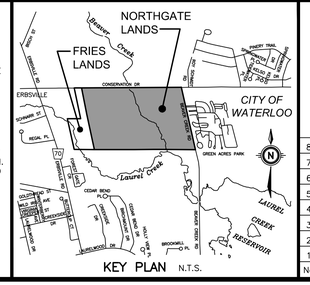
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8.			
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CONSERVATION DRIVE WATERLOO

DRAWING
EXISTING CONDITIONS PLAN

MTE
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Project Manager V.LAZIC	Project No. 39502-104
Design By	Checked By
Drawn By KAT	Checked By MSB
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Date Aug.14/14	
Scale 1:1500	Sheet of