



**Waterloo West Side Employment Lands,
Waterloo ON**

Preliminary Stormwater Management Report

August 2018

Prepared for:

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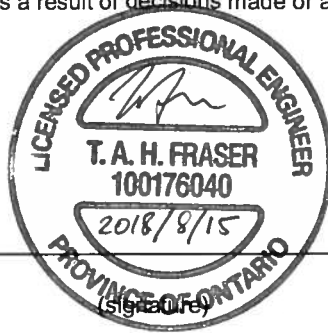
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Sign-off Sheet

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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has been retained by the City of Waterloo (City) to complete the stormwater management (SWM) design and analysis for the Waterloo West Side Employment Lands (WSEL). The WSEL consist of 43 ha of land bounded by Wilmot Line to the west, Columbia Street to the north, the Hydro One Networks Inc. (HONI) corridor to the east, and Erb Street and the Costco Lands to the south as shown on Figure 1.0. In addition, there is a private property located at 50 Wilmot Line and Regional Municipality of Waterloo (RMOW) lands at the corner of Wilmot Line and Erb Street. The employment lands are proposed to be developed into 24 blocks with 13 of those blocks planned for employment and/or commercial use. For the purposes of this assessment, the study area is the WSEL (43 ha), 50 Wilmot Line and the Region's lands at the corner of Erb Street and Wilmot Line (4 ha) for a total area of 47 ha. The proposed Draft Plan of Subdivision (Stantec, July 2018) is presented in Appendix A.

A previously approved stormwater management (SWM) plan for a 77 ha study area, including the subject lands as well as an additional 30 ha, was completed in 2014 as part of the commercial development of the West Waterloo Commercial Centre lands north of Erb Street. The plan included the design of an end-of-pipe wet pond SWM facility located within the Hydro One Networks Inc. (HONI) corridor providing water quality and water quantity treatment for the upstream 77 ha of future development lands. The SWM facility was also designed to meet the requirements of the Laurel Creek Watershed Study (LCWS) and the Subwatershed #314 Management Plan. Due to the timing of the individual development parcels (Costco, City lands, residential lands north of Columbia Street), a water balance, an infiltration analysis, and an erosion control strategy for the City lands was not considered at the time. Refer to Appendix B for the previously approved catchment delineation which is illustrated on Figure 3 in Appendix B of the *West Waterloo Commercial Centre Final SWM Report* (Stantec, 2014).

The objective of the following SWM strategy is to support the Zoning By-law Amendment (ZBA), Official Plan Amendment (OPA), and Plan of Subdivision for the subject lands and to ensure that the proposed future land development adheres to the assumptions made for the previously designed SWM plan for the larger, 77 ha study area. In addition, the SWM strategy outlines the infiltration targets for individual site plans and the corresponding water balance results for the subject lands.

The approach for the current study involved the following components:

- Completion of background review of relevant, existing documents (listed in the following section);
- Review of previously approved hydrologic models for the proposed development condition to determine potential impacts of development;
- Completion of water balance analysis for the subject lands and establishment of target infiltration volumes for individual parcels;
- Development of preliminary erosion control design; and
- Development of preliminary monitoring and maintenance program.





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CITY OF WATERLOO
WEST SIDE EMPLOYMENT LANDS

Figure No.

FIG. 1

Title

LOCATION PLAN

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ORIGINAL SHEET - ANSI A

1.1 BACKGROUND

Numerous guiding documents and site-specific background studies were used in the completion of the SWM strategy, including:

- *Hydrogeological Investigation, Waterloo West Side Employment Lands, Waterloo, Ontario*, Stantec Consulting Ltd., July 23, 2018.
- *Waterloo West Side Employment Lands Environmental Impact Study*, Stantec Consulting Ltd., August 1, 2017.
- *Geotechnical Investigation Waterloo West Side Employment Lands Erb Street W and Wilmot Line, Waterloo, Ontario*, Stantec Consulting Ltd., July 19, 2017.
- *West Waterloo Commercial Centre, Waterloo, Ontario, Final Stormwater Management Report*, Stantec Consulting Ltd., February 26, 2014.
- *City of Waterloo Development Engineering Manual*, City of Waterloo, 2013.
- *Geotechnical Investigation – 930 Erb Street Development*, Stantec Consulting Ltd., November 2013.
- *Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0*, Toronto and Region Conservation Authority and Credit Valley Conservation Authority, 2010.
- *Stormwater Management Planning and Design (SWMPD) Manual*, Ministry of the Environment, 2003.
- *Subwatershed 314 Management Plan*, Mark L. Dorfman, Planner Inc., October 1996.
- *City of Waterloo Design Principles for Stormwater Management*, City of Waterloo, 1996.
- *Laurel Creek Watershed Study*, Triton Engineering Services et al., January, 1993, prepared for the Grand River Conservation Authority.

1.2 STORMWATER MANAGEMENT DESIGN CRITERIA

The SWM criteria for the subject lands were established through the *Subwatershed 314 Management Plan* (Dorfman, 1996) and are predominantly based on the characteristics of the Clair Creek receiving system and the requirements of the LCWS. A portion of the subject lands along Wilmot Line currently drain west to Monastery Creek; however, no subwatershed study has been completed for this area so the LCWS criteria have been used for the purposes of this analysis.

Water Quality: Water quality storage requirements for the subject lands were established using the MOE Water Quality Sizing Criteria from the Stormwater Management Planning and Design Manual (MOE, 2003). A Normal (70% long term removal of TSS) level of water quality control was used, which is consistent with other developments within the downstream reach of Clair Creek.

It was desirable for the number of facilities implemented throughout the watershed be minimized to the extent feasible in recognition that the Municipality will ultimately own and maintain the system and fewer facilities generally corresponds with lower long-term operating costs.



Water Quantity Control: Water quantity controls required for new development within Subwatershed (SW) #314 include the following:

- Post-development peak flows exiting the site, as generated using GAWSER, are to be controlled to the target rates established by previous studies
- In addition to matching target flows under post-development conditions, the timing of the hydrograph peaks are to be within 75% of existing conditions
- Maintain pre-development Regional storm discharge rates from the SW while maintaining or exceeding existing storage levels onsite
- Runoff volume is to be matched to existing levels, exclusive of extended detention volumes (these targets apply to the 1:25-year to the 1:100-year and Regional storms)

Furthermore, and in accordance with other designs and analyses completed for adjacent developments (Clair Meadows Subdivision, Clair Hills Subdivision, Waterloo West Side Development Lands), it should also be shown that the target flow and hydrograph timing criteria established above can be achieved at the downstream limits of SW #314 (Columbia Street).

Infiltration: The 2014 SWM strategy developed for the West Waterloo Commercial Centre noted that site soils were not feasible for the implementation of infiltration practices according to the SWMPD Manual but recommended that infiltration and water balance analyses be addressed when the subject lands were ready for development. As such, according to the LCWS and the Subwatershed 314 Management Plan, infiltration is to be maintained on an average annual basis for the entire subwatershed under developed conditions.

In addition to the above infiltration requirement, revised stormwater management guidelines from the Ministry of the Environment, Conservation and Parks (MOECP) are forthcoming and may be implemented prior to obtaining approval for the development of the subject lands and the individual site plans are completed. These guidelines are expected to include a stormwater retention requirement of 25-30 mm of runoff from all new development, including roadways. As such, the City may be required to provide retention volume for the proposed road network while each individual site plan may be required to provide sufficient on-site retention to meet this criterion; however, for the purposes of this assessment, it is assumed an infiltration balance only is required at this time.



2.0 EXISTING CONDITIONS

2.1 TOPOGRAPHY AND SURFACE DRAINAGE

The subject lands contain approximately 43 ha of proposed employment lands. They are part of the larger Study Area considered in the following analysis which includes 50 Wilmot Line and Region lands located at the corner of Erb Street and Wilmot Line. The total area encompasses approximately 47 ha. The entire Study Area is located within the Laurel Creek Watershed. Approximately half of the land is currently used for agriculture, with corn, alfalfa and/or soybean production in recent years while the other half is a former golf course. Total topographic relief across the subject lands is approximately 30 m from a high point of 407 m AMSL at the western limits of the existing Subwatershed (SW) #314 boundary to a low point of 377 m AMSL at the eastern limits of the hydro corridor.

2.2 GEOTECHNICAL INVESTIGATION

Numerous geotechnical and hydrogeological investigations have been completed for the surrounding lands as part of the neighbouring developments. Two investigations were completed by CH2MHill in 2004 and 2010 with a third completed in 2013 by Stantec. Another investigation was completed in July 2017 as part of the proposed development and included 17 boreholes spaced across the site. For details of this report, please refer to *Geotechnical Investigation, Waterloo West Side Employment Lands, Erb St. W and Wilmot Line, Waterloo, Ontario* (Stantec, 2017).

Based on previous investigations and the most recent results from 2017, soils are generally composed of silty sand, sandy silt and/or clay fill which is underlain by native deposits of silt and/or silty clay. While no infiltration rates were determined as a part of the investigation, it is expected that rates will be low due to the silty clay soils in the area.

2.3 HYDROGEOLOGY

A *Hydrogeological Investigation* was completed by Stantec in July 2018 to summarize the results of a long-term investigation to determine the subsurface conditions and groundwater flow in the area. The area generally consists of topsoil over silty sand, sandy silt and/or clay fill which is then underlain by native deposits of silt and/or silty clay as mentioned in Section 2.2. This is underlain by an aquitard to a depth of approximately 13 m which creates a perched groundwater condition in the area. A Regional Aquifer (Aquifer 1) is located at a depth of 21 to 45 m below ground. The investigation determined that groundwater levels across the site vary considerably with the highest groundwater levels appearing near the ground surface at topographic lows and the deepest levels at topographic highs. Groundwater levels range from 0.4 to 8.1 m below ground surface (BGS). These high groundwater levels are located in the perched groundwater zones and may be removed due to grading and servicing (i.e., the perched condition drains to the underlying aquifer layer); however, this should be confirmed at the detailed engineering design stage.

Retention in the form of infiltration practices is anticipated for each property within the subject lands, and, as such, require 1 m separation from the bottom of the infiltration system to the high groundwater level. The high groundwater levels across the subject lands should be reviewed prior to implementing infiltration practices at the individual site plan design stage for each development block.



Existing Conditions

The sandy to silty clay till within the site is characterized by hydraulic conductivities ranging from 10^{-7} to 10^{-8} m/s corresponding to infiltration rates ranging from 12 to 30 mm/hour. The suitability of different infiltration augmentation options should be evaluated on a site-by-site basis at the detailed design stage.

An existing conditions water balance calculation was also completed as part of the *Hydrogeological Investigation*. The results of these calculations were used as the targets for the post-development retention/infiltration requirements and are presented in Section 3.3. For full details of the hydrogeology within the area, please refer to the *Hydrogeological Investigation* (Stantec, 2018).



3.0 STORMWATER MANAGEMENT DESIGN

The hydrologic model GAWSER was originally used to estimate the hydrologic regime in the Laurel Creek Watershed. The information and parameters were then used to complete a more detailed model for Subwatershed 314. The Subwatershed model was updated in 2010 as part of the Waterloo West Side Subdivision work and then again in 2014 as part of the Waterloo West Side Commercial Centre development to include the proposed centralized, ultimate SWM facility located in the HONI corridor.

The Subwatershed 314 model included a future SWM facility servicing the majority of the lands west of the HONI corridor, north of Erb Street and south of the future Columbia Street extension. The facility was not needed until the lands developed. As the West Waterloo Commercial Centre moved forward in 2013, the design and approval of the ultimate SWM facility was required. For full details of the design, modeling approach and revisions, please refer to the *West Waterloo Commercial Centre Final Stormwater Management Report* (Stantec, 2014). Given the WSEL were not yet ready to move forward with development in 2014, the West Waterloo Commercial Centre design required an interim SWM facility to be implemented as the details and approval of the ultimate facility on the HONI corridor were worked out between the contributing land owners, HONI, and the MOECC. As such, an interim facility was designed and constructed to provide water quantity and water quality control for the West Waterloo Commercial Centre lands, a portion of the undeveloped City of Waterloo lands, and roadways. The facility was designed as a permanent structure as the build out of the WSEL was unknown at the time. As the WSEL move forward for Draft Plan Approval, the construction of the ultimate facility is in the near future, the West Waterloo Commercial Centre can be connected to the facility and the interim facility decommissioned.

The ultimate facility replaces Basins 'A' and 'G' of the original GAWSER model. The facility services approximately 77 ha of developed land. It connects to the downstream Clair Hills District storm sewer system through a set of double catchbasins located east of the HONI corridor in the Clair Hills District subdivision. Overflows from the facility are directed to the existing wetland feature; however, the facility is designed to control the peak flow rate from the Regional rainfall event so overflows are only anticipated if the facility requires maintenance and is not performing as designed. Please refer to Figure 4 in Appendix B for details of the SWM facility design.

3.1 CURRENT SWM DESIGN AND DRAINAGE

Following development of the *West Waterloo Commercial Centre Final Stormwater Management Report* (Stantec, 2014), approximately 77 ha of drainage is proposed to be directed to the ultimate, centralized SWM facility in the HONI corridor. The assumption of contributing drainage area to the facility included the subject lands, the Waterloo West Side Greyerbiehl Subdivision to the north, the West Waterloo Commercial Centre to the south, and the lands located between Wilmot Line to the west and the HONI corridor to the east. Approximately half of this drainage area is represented by the WSEL and has an assumed impervious coverage of 80%, consistent with the proposed employment land use (Catchments 510, 511, and 512 on Figure 3.0 in Appendix B).



The SWM facility is designed as a wet pond facility with a sedimentation forebay and a main cell. The permanent pool and extended detention provide sufficient volume to achieve the MOECP water quality requirements. In addition, the outlet structure is designed to attenuate peak flow rates to target values from the Subwatershed 314 hydrologic model for all storm events up to and including the Regional rainfall event. The approved design of the SWM facility is presented in Appendix B.

No retention or infiltration on the upstream lands was assumed as part of the current drainage design.

3.2 PROPOSED SWM DESIGN

The design of the ultimate SWM facility on the HONI lands provides sufficient water quality and water quantity control for the WSEL provided impervious coverage is 80% or less. At the preliminary stage, it is expected that the assumption for impervious coverage is appropriate and will not be exceeded. As such, the approved SWM facility design is sufficient for water quality and water quantity control of the subject lands to meet the LCWS, Subwatershed 314, and MOECP design standards.

No infiltration or retention was included as part of the *West Waterloo Commercial Centre Final Stormwater Management Report* (Stantec, 2014) but it was recommended that a water balance and retention design be explored when the upstream City lands are ready for development to meet the Subwatershed 314 target of maintaining infiltration volumes on an annual basis. Individual site plans for each property have not been developed at this time; however, annual target infiltration volumes are provided for each property as a design requirement when development occurs. These infiltration/retention practices are anticipated to also provide at-source water quantity control to help reduce runoff volumes and rates for more frequent rainfall events. A summary of the infiltration and water balance details is provided in Section 3.3.

Subwatershed #314 states that runoff volume is to be matched to existing levels, exclusive of extended detention volumes. In addition, the proposed retention practices will provide additional at-source water quantity control. As such, the GAWSER model that was updated in 2014 has been revised to reflect the proposed infiltration practices on Catchments 510, 511, and 512 (Figure in Appendix B) to determine runoff volumes and peak flow rates following on-site retention. The results of this analysis have been compared to the original target values and the updated 2014 values and are presented in Table 1 and Table 2. The revised GAWSER hydrologic model input and output is provided in Appendix C.



Table 1: Summary of Proposed Flow Rates at Columbia Street Crossing

Return Period	Flow Comparison Location					
	Downstream Limits of SW #314 (just upstream of Erbsville Road)					
	Target Peak Flow Rate (m ³ /s) ¹	Target Time to Peak (hrs.)	2014 Peak Flow Rate (m ³ /s)	2014 Time to Peak (hrs.)	Proposed Peak Flow Rate (m ³ /s)	Proposed Time to Peak (hrs.)
1:2-year	0.83	12.25	0.81	13.50	0.78	12.25
1:5-year	1.59	12.25	1.59	12.75	1.59	12.50
1:25-year	3.66	12.25	3.30	12.75	3.25	12.75
1:100-year	5.56	12.25	4.66	13.00	4.46	13.25
Regional	16.20	47.25	15.70	48.00	15.55	47.75

¹ Target peak flow rate at downstream end of Subwatershed 314 taken from Subwatershed 314 Management Plan (Dorfman, 1996); 2-year target rate taken from Waterloo West Side Development Lands (October 2010)

Table 2: Summary of Proposed Runoff Volumes at Columbia Street Crossing

Return Period	Flow Comparison Location		
	Downstream Limits of SW #314 (just upstream of Erbsville Road)		
	SW #314 Target Volume (mm)	2014 Approved Runoff Volume (mm)	Proposed Runoff Volume (mm)
1:2-year ¹	13.6	27.3	26.3
1:5-year ²	21.9	40.0	39.1
1:25-year	36.4	58.3	57.3
1:100-year	48.7	74.0	73.1
Regional	161.0	206.0	204.8

In general, Table 1 and Table 2 show a decrease in peak flow rates and volumes from the 2014 approved values. This is expected as the recommended retention strategies for each site plan will reduce the total runoff to the future SWM facility on the HONI lands as well as the downstream end of SW #314. There are minor changes to the times to peak for each storm event; however, they still remain within the target of 75% of the existing values per the Subwatershed #314 requirements.

Based on the results of the revised hydrologic model, no further water quantity control is required for the WSEL to achieve the targets at the downstream end of SW #314. The retention strategies and targets are provided in the following section.



3.3 WATER BALANCE AND INFILTRATION ASSESSMENT

As mentioned in Section 2.3, an existing conditions water balance was completed as part of the *Hydrogeological Investigation* (Stantec, 2017). The analysis assumed the existing land use consisted of mainly crops, pasture, and lawn area. A temporary SWM facility is currently located on a part of the City lands adjacent to the HONI corridor but has not been included in the analysis as this facility will be decommissioned as part of this project. The existing annual groundwater recharge and surface runoff from the subject lands are 45,640 m³/year (104 mm/year) and 95,420 m³/year (218 mm/year), respectively. The analysis and accompanying Figure 10 are presented in Appendix D.

The revised GAWSER hydrologic model assumes retention of rooftop runoff (i.e., 'clean' stormwater) from the 10 mm rainfall event. The 10 mm rainfall event typically represents approximately 60% of the average annual rainfall volume (*Former Sun Valley Property Stormwater Management Report*, Paragon Engineering, July 1992) and has been used as a target for this analysis. To determine the retention volume requirements to maintain infiltration volumes of the LCWS and Subwatershed #314, a monthly water balance for the subject lands has been prepared for existing and proposed conditions. Development will always reduce the total volume of recharge (infiltration) and evapotranspiration and increase runoff volume due to changes to the surface cover. As such, site level infiltration/retention strategies are necessary for each site plan. This analysis provides retention volume requirements with the assumption that all areas part of the subject lands will have 80% impervious coverage, consistent with City of Waterloo design guidelines for employment lands. The analysis assumes 25% of each site within the subject lands is rooftop area with 'clean' runoff which can be directed to a retention system. Individual site plan applications will require a detailed analysis to ensure the above assumptions remain correct following site plan design.

Based on the above assumptions, under proposed conditions with infiltration/retention practices implemented by each site, there is an expected recharge surplus of 9,519 m³/year (22 mm/year) and a runoff surplus of 199,409 m³/year (464 mm/year). The site water balance calculations are provided in Appendix D.

The rooftop retention target on a block by block basis is 97 mm/year; as mentioned above, this target is based on a rooftop coverage of 25% of the total block area and retention of all rainfall events equal to or less than the 10 mm rainfall event. If a site is unable to achieve the target through rooftop retention then the difference is required to be met through retention of other impervious runoff. Retention targets can be met through practices such as infiltration trenches, green roofs, permeable pavers (or increased landscaped areas), grey water reuse, or other green infrastructure or Low Impact Development practices.

The above retention targets are recommended for the WSEL to maintain/enhance the recharge component of the water balance. It is anticipated that new MOECP guidelines will require higher retention volumes (25-30 mm of retention for all developed areas) and, as such, if these policies are implemented prior to a site being approved, these more stringent guidelines will replace the targets in this report.



4.0 EROSION AND SEDIMENT CONTROL STRATEGY

4.1 EVALUATION OF EROSION POTENTIAL

The Grand River Conservation Authority (GRCA) uses the *Greater Golden Horseshoe Conservation Authorities' Erosion and Sediment Control Guideline* (GGHCA ESC) for Urban Construction (2006) to determine the erosion potential of the site. The erosion potential is based on slope gradient, slope length and soil texture which is then used to determine appropriate erosion control measures.

Existing site slope gradients for the development are highly variable and can be summarized as generally moderate with a range of slopes in the order of 1 – 10%. Slope lengths are generally greater than 30 m and are considered 'long'. Given that the surficial soils are a mix of silty sand, sandy silt and/or clay fill underlain by native deposits of silt and/or silty clay, the site is considered to have a high erodibility potential. Thus, the overall erosion potential for the site is considered to be "high".

4.2 EROSION AND SEDIMENT CONTROL RECOMMENDATIONS

A more detailed Erosion and Sediment Control Plan complete with design drawings should be prepared for the overall site during detailed design as well as for each individual site plan; however, at this preliminary stage, the following standard erosion control measures are recommended at a minimum:

- Erect light duty silt fence in down-gradient areas around the perimeter of the property prior to commencing construction activity to protect adjacent lands, in particular along the length of the HONI corridor and adjacent to 50 Wilmot Line and Region lands along Wilmot Line;
- Erect heavy duty silt fence prior to grading or construction in areas adjacent to existing road rights-of-way that are down gradient along the perimeter of the property to protect adjacent and downstream areas from migration of sediment in any overland flow;
- Erect tree protection fencing prior to grading or construction where applicable in consultation with the environmental consultant;
- Provide construction entrance features ('mud mat') at all entrances to minimize the offsite transport of sediment from construction vehicles;
- Install erosion control mats on steep slopes and stabilize as soon as possible;
- Install temporary rock check dams in swales, where appropriate, to help attenuate flows and encourage sediment deposition;
- Install temporary sediment traps for drainage areas under 2 ha;
- Install temporary sedimentation basins;
- Stabilize all disturbed areas according to OPSS 804; and
- During construction, all catchbasins are to be sealed until roads are paved to prevent sediment deposition in the catchbasin sumps and conveyance of silt to the downstream storm sewer system.



To ensure the effectiveness of the various erosion and sediment control measures, an appropriate inspection and maintenance program is necessary. The inspection activities will include:

- Inspections of the erosion and sediment controls weekly or after each significant rainfall event (>13 mm), whichever is shorter, during periods of active construction. During periods of inactivity, inspections should continue on a monthly basis to ensure site remains stable until full buildout;
- Inspections should include all silt fence installation, construction entrance(s), storm sewer outlets and vegetation during periods of active construction; and
- Submission of weekly inspection reports to the City of Waterloo and GRCA during periods of active construction.

Again, the above erosion and sediment control plan should be revisited at detailed design to ensure all recommendations are still applicable. Further details should be provided once the site layout and construction phasing has been determined and should be illustrated with details on design drawings.



5.0 MONITORING AND MAINTENANCE PROGRAM

Monitoring and maintenance activities are an important part of a SWM Strategy to ensure the designed features continue to operate as intended. As such, inspections should take place at a regular frequency to observe any evidence of sediment deposition or malfunctioning of the proposed infiltration trenches and/or subsurface SWM facility. These inspections will occur following significant rainfall events (where possible) and will include inspection of the conditions of the ultimate SWMF and temporary SWM controls (such as temporary sedimentation basins and sediment traps).

The City of Waterloo and the requirements of the LCWS provide a general monitoring plan which should commence at the start of construction and should continue until the subject lands are 90% stable/built out. The City of Waterloo requires that pre-construction, during-construction, and post-construction monitoring programs for terrestrial, surface water, and groundwater features are adapted at the outset of a project to ensure no negative effects to these features occurs following development. At least two years of consecutive pre-construction monitoring is required to establish baseline conditions for the development. Given no surface water or terrestrial features exist within the subject lands, no pre-construction monitoring of these features is required; however, as outlined in the *Hydrogeological Investigation* (Stantec, July 2018), the pre-development groundwater monitoring program is currently underway and the two-year period will be completed in May 2019. During-construction monitoring begins at the start of pre-grading and continues until the subject lands are at least 90% stable/built out. Post-construction monitoring continues for two years following stabilization of the subject lands. The following program focuses on the during- and post-construction surface water monitoring programs only; the terrestrial and groundwater monitoring programs are outlined under separate cover. All of the monitoring programs should be established through consultation with the City, the GRCA, and the RMOW.

Monthly monitoring of the following surface water parameters at both the inlet and outlet of the SWM facility is required between March and November for the entire active construction period and for 2 years post-construction:

- Total Suspended Solids (TSS): discharge quality (from the SWM facility) should be less than 25 mg/L suspended solids; based on event mean concentrations and flow proportional sampling;
- Dissolved Oxygen (DO): Minimum concentration should be no less than 5 mg/L;
- Total Phosphorus (TP): Phosphorus levels should be 0.03 mg/L or less;
- Temperature: Maximum temperature should be no greater than 29°C from August 1 to October 31 and no greater than 26°C from June 1 to August 1; and
- Bacteria (*E. coli*): Bacterial levels should meet a level of 200 counts/100 mL of *E. coli*.

The above targets are based on the requirements for warm water fish habitats.

To ensure the stormwater infrastructure is functioning as designed, the following general maintenance and monitoring program is recommended for the site in perpetuity;

- Annual inspection and maintenance of the site storm system including catchbasins and manholes for sediment deposition and clogging; cleanout should occur on an as-needed basis (at least once a year); and
- Annual inspection of sediment accumulation in the forebay of the SWM facility.



The proponent will be responsible for the monitoring and inspection for the duration of the monitoring program as well as the long-term operation and maintenance of the stormwater management system and all of its components. It is recommended the City of Waterloo and the GRCA consult to confirm a Terms of Reference document for the long-term monitoring and maintenance plan for the subject lands.

Given the anticipated long-term build out of the subject lands and the potential for periods of construction inactivity and under the provision that all subject lands have been stabilized per OPSS 804, a less frequent interim monitoring program (i.e., seasonal) may be developed in consultation with the GRCA and other agencies as appropriate.



6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the preceding, the following summary can be drawn for the site:

- The current proposed and approved ultimate SWM facility provides sufficient water quantity and water quality control for the upstream employment lands assuming impervious levels for each block are 80% or less; and
- Infiltration/retention practices are required on each block to provide at-source retention and water quantity control; the target rooftop retention volume for each block is to infiltrate 97 mm/year; if this is not achieved through rooftop runoff then other forms of retention from impervious surfaces should be implemented.

Based on the findings of this report, the following recommendations are provided:

- A final stormwater management report be completed at the detailed design stage that meets the targets and recommendations outlined in this report;
- All proposed employment blocks within the subject lands provide a detailed infiltration/retention design on a site by site basis at Site Plan Approval to meet the target recharge volumes in this document;
- The erosion and sediment control measures documented herein be implemented during construction; and
- The monitoring and maintenance plan be revisited at detailed design in consultation with the City of Waterloo and the GRCA to determine Terms of Reference.



APPENDIX A

Draft Plan of Subdivision



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Key Map	N.T.S.
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Surveyor's Certificate

I hereby certify the boundaries of the subject land to be subdivided on this plan and their relationship to the adjoining lands have been accurately and correctly shown.

Date _____

Signed _____
Owner's Name
Company

Revision	By	Appd.	YY.MM.DD
File Name: 161413446_R-DP.dwg	JJ Dwn.	KW Chkd.	JJ Dsgn. 18.07.19 YY.MM.DD

Client/Project
CITY OF WATERLOO

WATERLOO WEST SIDE
EMPLOYMENT LANDS
WATERLOO, ON

DRAFT PLAN OF SUBDIVISION

Project No. 161413446 Scale 1:1500

DP-100 1 of 1 0

(C) (A) ending in 174344(4) does not fall in 174344(4) or above

APPENDIX B

Previously Approved (2014) Design Figures



March 2018
161413446



Stantec

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

Client/Project

CITY OF WATERLOO
WEST SIDE EMPLOYMENT LANDS

Figure No.

FIG. 1

Title

LOCATION PLAN

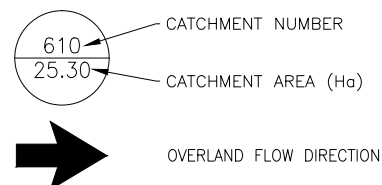
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2018/03/07 10:33 AM By: Rose, Martin

ORIGINAL SHEET - ANSI A

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2014/02/26 7:09 PM By: Rose, Martin



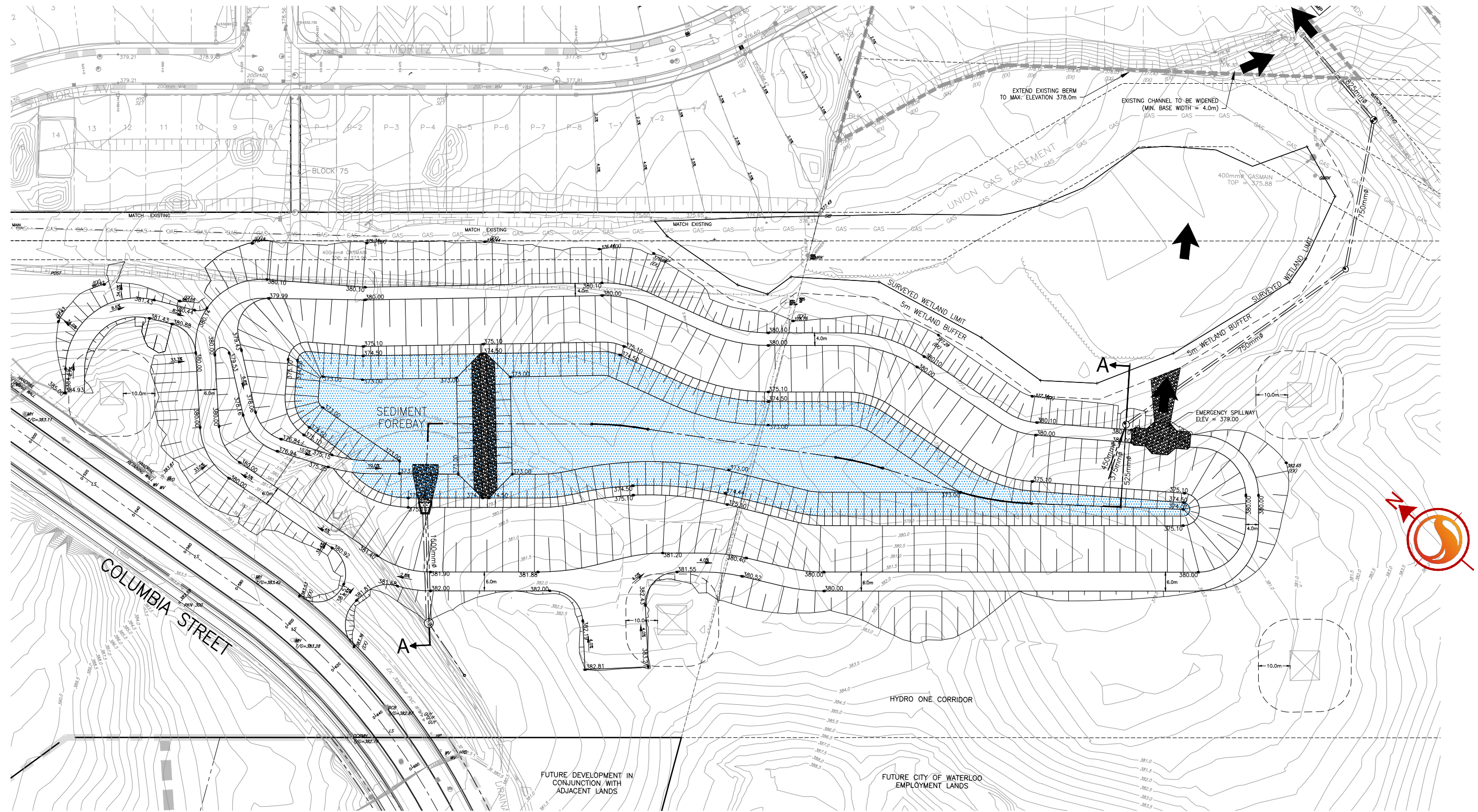
Legend



Notes



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2014/03/05 2:22 PM By: Rose, Martin



ORIGINAL SHEET - ANSI B

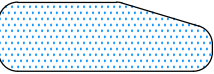
February 2014
160321331



Stantec

49 Frederick Street
Kitchener, ON, N2H 6M7
Tel. 519.579.4410
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Legend



AREA OF PERMANENT POOL



MAJOR OVERLAND FLOW DIRECTION

Notes

THIS FIGURE TO BE READ IN CONJUNCTION WITH DRAWING No. C-801 & C-802
SEE FIGURE 5.0 FOR SECTION A-A PROFILE



Client/Project

WEST WATERLOO RETAIL LP
WEST WATERLOO COMMERCIAL CENTRE
WATERLOO, ON

Figure No.

4.0

Title

**STORMWATER MANAGEMENT FACILITY
- PLAN**

V:\01603\active\160311331\design\drawing\civil-Option 2\sheet_files\Engineering Drawings\160321331_ULTIMATE SWMF.dwg
2014/03/05 1:42 PM By: Rose, Martin

ORIGINAL SHEET - ANSI B



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Legend

Notes

THIS FIGURE TO BE READ IN CONJUNCTION WITH DRAWING No. C-801 & C-802
SEE FIGURE 4.0 FOR SECTION A-A LOCATION



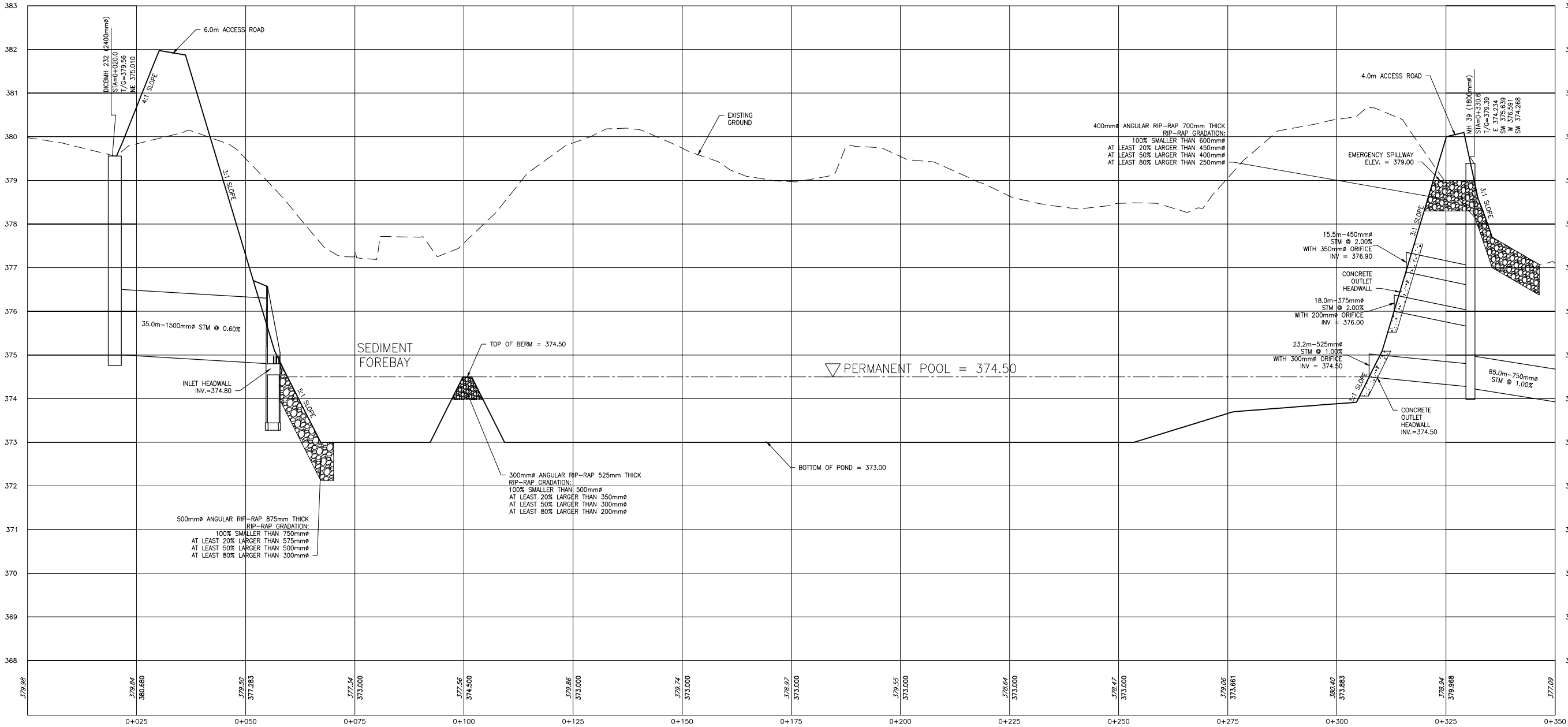
Client/Project
WEST WATERLOO RETAIL LP
WEST WATERLOO COMMERCIAL CENTRE
WATERLOO, ON

Figure No.

5.0

Title

STORMWATER MANAGEMENT FACILITY
- PROFILE AND OUTLET DETAILS



2 Year WL	376.20
5 Year WL	376.83
25 Year WL	377.53
100 Year WL	378.17
Regional WL	379.95

February 2014
160321331

APPENDIX C

Updated Hydrologic Model Input and Output (GAWSER)

```
00001> *****
00002> * SUBWATERSHED 314 - FUTURE CONDITIONS WITH SWM (Revised February, 2002)
00003> * REFINED AS PER FINAL DESIGN BASIN C (D.Eadie)
00004> *
00005> * Revised October 2002 - Addendum to Clair Meadows Draft Plan (N.Jamieson) 603-0
00006> * Revised February 2005 - Clair Hills Stage 8 Ph4 Final Design (NJ) 603-10682
00007> * For Active Greyerbiehl SE
00008> * Revised Feb 17, 2005 - Add development and Pond to Catchment 500 (Jinnes) 1603
00009> * Revised April 15, 2005 - separate reservoir from catchment (Jinnes)
00010> * May 12, 2005 - finalize catchment areas and pond design
00011> * Revised October 2013 - split Sub Area 500 to separate HONI lands, model subare
00012> * developed, Rice Lands (T.Fraser) 1603-1131
00013> * Revised April 2013 - Catchment 500 divided into 510, 512; Catchment 511 drains
00014> * to Monastery Creek under existing conditions; proposed to drain east to Clai
00015> * removed pond 5005 (Greyerbiehl temporary pond); removed pond 314 (wetland up
00016> * Clair Hills District)
00017> * Revised February 2014 (T.Fraser, Stantec) - Final design for Basin A in HONI co
00018> * Catchments 610 and 620 adjusted to reflect drainage to Erb St. from subject
00019> * Revised June 2018 (T.Fraser, Stantec) - Preliminary design for ZBA for City of
00020> * employment lands; model revised to check infiltration and runoff volume matc
00021> * to existing volumes and result of proposed infiltration for each employment
00022> * property.
00023>
00024> *****
00025> *****
00026> * WATERSHED CALIBRATION PARAMETERS BASED ON LWS
00027> *****
00028> *
00029> ***** ENTER SOILS DATA FOR BASINS 311 TO 327 *****
00030> *
00031> * Soil Parameters from LAUREL.WAT by H.O.Schroeter
00032> * Modified to consider one medium infiltration zone (instead of two)
00033> * and to take into account the effect of forest cover by Doug Jones
00034> *
00035> READ SOIL PARAMETERS NZONE=9
00036>
00037> DS= 1.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
00038> KEFF= 0 2.0 2.0 7.0 7.0 12.0 12.0 20.0 20.0
00039> CS= 0 1.4 1.4 5.0 5.0 8.0 8.0 15.0 15.0
00040> D= 0 1.0 1.0 4.0 4.0 6.0 6.0 10.0 10.0
00041> SAV= 0 200 200 200 200 250 250 250 250
00042> HI= 0 100 100 200 200 200 200 200 200
00043> SMCII= 0 0.60 0.60 0.55 0.55 0.50 0.50 0.55 0.55
00044> IMCI= 0 0.45 0.45 0.30 0.30 0.10 0.10 0.30 0.30
00045> PCAPI= 0 0.45 0.45 0.30 0.30 0.10 0.10 0.30 0.30
00046> WILTI= 0 0.25 0.25 0.12 0.12 0.04 0.04 0.12 0.12
00047> HII= 0 300 500 600 1000 600 1000 600 1000
00048> SMCII= 0 0.60 0.60 0.55 0.55 0.50 0.50 0.55 0.55
00049> IMCI= 0 0.45 0.45 0.30 0.30 0.10 0.10 0.30 0.30
00050> PCAPI= 0 0.45 0.45 0.30 0.30 0.10 0.10 0.30 0.30
00051> WILTI= 0 0.25 0.25 0.12 0.12 0.04 0.04 0.12 0.12
00052> X= 0 1 0 1 0 1 0 1 0
00053> FATR= 1 0.95 0.05 0.15 0.85 0.05 0.95 0.05 0.95
00054> *
00055> **** Go to event file to get rain and runoff
00056> CHANGE INPUT FILE
00057> *
00058> *****
00059> * REVISED OFF CHANNEL RATING CURVE TO CORRESPOND TO THAT USED IN TRAINING GUIDE
00060> * AND IN OTHER STUDIES
00061> *****
00062> *
00063> COMPUTE RATING CURVE ID=5 VS NO=1.1 NO SEG=3 MIN ELEV=100 m
00064> MAX ELEV=100.8 M CHNSLP=0.015 FLSP=0.015
00065> N=0.35 DIST=24.45 N=0.15 DIST=25.55
00066> N=0.35 DIST=50.00
00067> DIST ELEV DIST ELEV DIST ELEV
00068> 0.00 100.8 24.45 100.3 24.75 100.0
00069> 25.25 100.0 25.55 100.3 50.00 100.8
00070> RFN=0 PCODE=1
00071> *
00072> * Rating curve for basin mainchannel
00073> *
00074> COMPUTE RATING CURVE ID=2 VS NO=14.3 NO SEG=3 MIN ELEV=100.0
00075> MAX ELEV=102.0 m CHNSLP=0.0079 FLSP=0.0079
00076> N=0.050 DIST=19.2 N=0.040 DIST=20.8
00077> N=0.050 DIST=40.0
00078> DIST ELEV DIST ELEV DIST ELEV
00079> 0.0 102.0 19.2 101.0 19.25 100.5
00080> 20.0 100.0 20.75 100.5 20.8 101.0
00081> 40.0 102.0
00082> RFN=0 pcode=1
00083> *
00084> * RATING CURVE FUTURE CONDITIONS CHANNEL THROUGH SITE
00085> *
00086> COMPUTE RATING CURVE ID=3 VS NO=8.0 NO SEG=3 MIN ELEV=100.0
00087> MAX ELEV=104.0 m CHNSLP=0.0020 FLSP=0.0020
00088> N=0.050 DIST=28.0 N=0.040 DIST=33.0
00089> N=0.050 DIST=45.0
00090> DIST ELEV DIST ELEV DIST ELEV
00091> 0.0 104.0 19.0 104.0 28.00 101.0
00092> 31.0 100.0 33.00 100.0 36.0 101.0
00093> 45.0 104.0
00094> RFN=0 pcode=1
00095> *
00096> * Standard Urban Rating Curve for basin mainchannel (average slopes)
00097> *
00098> COMPUTE RATING CURVE ID=4 VS NO=25.3 NO SEG=1 MIN ELEV=0.0 m
00099> MAX ELEV=0.05 m CHNSLP=0.01 FLSP=0.01
00100> N=0.013 DIST=100.00
00101> DIST ELEV DIST ELEV DIST ELEV
00102> 0.0 1.0 0.01 0.0 99.99 0.0
00103> 100.0 1.0
00104> RFN=0 PCODE=1
00105> *
00106> *****
00107> * File Edited - Stantec Jan. 2005 (NJ)
00108> * Original Input File cropped to only include External lands draining
00109> * to Clair Hills Subdivision - Sub Areas 500 and 530
00110> *****
00111> *
00112> ----- SUB-WATERSHED 314 -----
00113> *
00114> * DESCRIPTION: - Headwater subwatershed
00115> *
00116> -----
00117> *
00118> COMPUTE FLOWRATE ID=1 NHD=150 DA=0.353 SQKM L=800 m W=450 m
00119> ZONE PROPORTIONS
00120> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00121> 40.0 1.0 1.0 59.0 59.0 0.0 0.0 0.0 0.0
00122> RATING CURVES IDC=2 IDOC=5 QRMC=1.420 QROC=0.05
00123> MODEL=0 AND CONSTANTS OVERLAND: KO=0.300 TLO=0.0 hr
00124> KSS=5 hr KGW=384 hr pcode=1
00125> *
00126> *****
00127> * Route flow through Waterloo Regions SWM Pond 4
```

```
00128> *****
00129> *
00130> ROUTE RESERVOIR ID=2 HYD NO=301 INFLOW=1 pcode=1 OPTION=4
00131> ELEV. OUTFLOW STORAGE
00132> M CU M/S HAMM
00133> 0.00 0.00 0.00 0.000
00134> 0.30 0.10 0.240
00135> 0.40 0.17 0.250
00136> 0.60 0.31 0.380
00137> 0.70 0.38 0.440
00138> 0.80 0.45 0.520
00139> 0.90 0.50 0.590
00140> 1.00 0.53 0.660
00141> 1.10 0.56 0.770
00142> 1.20 0.60 0.810
00143> 1.25 0.63 0.850
00144> 1.36 0.81 0.930
00145> 1.49 1.45 1.030
00146> 1.51 3.42 1.050
00147> *
00148> COMPUTE FLOWRATE ID=3 NHD=140 DA=0.495 SQKM L=900 m W=50 m
00149> ZONE PROPORTIONS
00150> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00151> 39.0 0.6 0.6 59.8 59.8 0.0 0.0 0.6 0.6
00152> RATING CURVES IDC=4 IDOC=4 QRMC=1.420 QROC=0.05
00153> MODEL=0 AND CONSTANTS OVERLAND: KO=0.210 TLO=0.0 hr
00154> KSS=5 hr KGW=384 hr pcode=1
00155> *
00156> ***** ADD SUBAREAS 140 AND 150 TO TOTAL *****
00157> *
00158> ADD HYD ID=4 HYD NO=302 IDA=2 IDB=3
00159>
00160> *****
00161> * Route flow through Dutton Lake
00162> *****
00163> *
00164> ROUTE RESERVOIR ID=5 HYD NO=303 INFLOW=4 pcode=1 OPTION=4
00165> ELEV. OUTFLOW STORAGE
00166> M CU M/S HAMM
00167> 0.00 0.00 0.000
00168> 0.40 0.10 0.110
00169> 0.90 0.20 0.520
00170> 1.90 0.57 3.540
00171> 2.90 0.84 10.390
00172> 3.90 1.00 22.190
00173> *
00174> *****
00175> * Clair Hills/Meadows catchment 131 - Ira Needles/Brandenburg
00176> *****
00177> *
00178> COMPUTE FLOWRATE ID=3 NHD=131 DA=0.1429 SQKM L=560 m W=198 m
00179> ZONE PROPORTIONS
00180> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00181> 51.6 0.0 0.0 48.0 48.0 0.5 0.5 0.0 0.0
00182> RATING CURVES IDC=4 IDOC=4 QRMC=1.420 QROC=0.05
00183> MODEL=0 AND CONSTANTS OVERLAND: KO=0.251 TLO=0.0 hr
00184> KSS=5 hr KGW=384 hr pcode=1
00185> *
00186> *****
00187> * Clair Meadows catchment 130 - South-central drainage area
00188> * Revised Oct. 7/02 - To include Commercial Block & Medium-High
00189> * Density Residential Block.
00190> *****
00191> *
00192> COMPUTE FLOWRATE ID=4 NHD=130 DA=0.241 SQKM L=680 m W=330 m
00193> ZONE PROPORTIONS
00194> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00195> 63.3 0.0 0.0 28.3 28.3 8.3 8.3 0.0 0.0
00196> RATING CURVES IDC=4 IDOC=4 QRMC=1.420 QROC=0.05
00197> MODEL=0 AND CONSTANTS OVERLAND: KO=0.369 TLO=0.0 hr
00198> KSS=5 hr KGW=384 hr pcode=1
00199> *
00200> *
00201> ***** ADD SUBAREA 130 TO 131 *****
00202> *
00203> ADD HYD ID=2 HYD NO=304 IDA=4 IDB=3
00204> *
00205> *****
00206> * Clair Meadows catchment 610 - External drainage area
00207> * Revised February 2014 (T.Fraser, Stantec) - additional 2 ha added to
00208> * represent proposed drainage to Erb St. from Rice Lands (originally
00209> * part of Catchment 620)
00210> *****
00211> COMPUTE FLOWRATE ID=1 NHD=610 DA=0.041 SQKM L=220 m W=143 m
00212> ZONE PROPORTIONS
00213> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00214> 50.00 0.0 0.0 50.0 50.0 0.0 0.0 0.0 0.0
00215> RATING CURVES IDC=2 IDOC=5 QRMC=1.420 QROC=0.05
00216> MODEL=0 AND CONSTANTS OVERLAND: KO=0.148 TLO=0.0 hr
00217> KSS=5 hr KGW=384 hr pcode=1
00218> *
00219> ADD HYD ID=4 HYD NO=355 IDA=1 IDB=2
00220> *
00221> *****
00222> * Clair Hills/Meadows catchment 132.1 - school block/St. Moritz Ave.
00223> * Revised Oct. 7/02 - To account for Drainage Boundary Relocation
00224> *****
00225> COMPUTE FLOWRATE ID=1 NHD=1321 DA=0.084 SQKM L=400 m W=95 m
00226> ZONE PROPORTIONS
00227> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00228> 38.90 0.0 0.0 14.7 14.7 46.4 46.4 0.0 0.0
00229> RATING CURVES IDC=4 IDOC=4 QRMC=1.420 QROC=0.05
00230> MODEL=0 AND CONSTANTS OVERLAND: KO=0.146 TLO=0.0 hr
00231> KSS=5 hr KGW=384 hr pcode=1
00232> *
00233> *****DIVERT MINOR FLOW (0.126 cms from St. Moritz Ave.) to Basin 'C'***
00234> * Flow taken from Basin 'C' Addendum Report **
00235> *****
00236> *
00237> DIVERT FLOWS INFLOW=1 DIVERT ID=3 HYD NO=590 PCODE=1 OPTION=2
00238> INLET CAPACITY=000.126 CMS THRUFLD ID=6 HYD NOB=580
00239>
00240> ***** ADD SUBAREA 132 TO TOTAL *****
00241> *
00242> ADD HYD ID=2 HYD NO=305 IDA=4 IDB=3
00243> *
00244> *
00245> *****
00246> * BASIN B - route total through basin
00247> *****
00248> *
00249> ROUTE RESERVOIR ID=1 HYD NO=307 INFLOW=2 pcode=1 OPTION=4
00250> ELEV. OUTFLOW STORAGE
00251> M CU M/S HAMM
00252> 368.50 0.000 0.000
00253> 368.80 0.014 0.321
00254> 369.30 0.024 0.929
```

```
00255> 369.40 0.025 1.060
00256> 369.50 0.184 1.194
00257> 369.70 0.194 1.468
00258> 370.00 1.219 1.895
00259> 370.30 4.432 2.339
00260> 370.40 6.700 2.492
00261> 370.50 9.272 2.646
00262> *
00263> *****
00264> * Clair Hills/Meadows catchment 132.2 - Open Space Blk draining to
00265> * Rehabilitated Creek
00266> * Added Oct.7/02
00267> *****
00268> COMPUTE FLOWRATE ID=4 NHD=1322 DA=0.026 SQKM L=200 m W=200 m
00269> ZONE PROPORTIONS
00270> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00271> 0.00 0.0 0.0 100.0 100.0 0.0 0.0 0.0 0.0
00272> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00273> MODEL=0 AND CONSTANTS OVERLAND: KO=0.183 TLO=0.0 hr
00274> KSS=5 hr KGW=384 hr pcode=1
00275> *
00276> *****
00277> * Clair Hills catchment 134 - Buffer Area d/s of SWM Basin B/Keats Way
00278> *
00279> *
00280> COMPUTE FLOWRATE ID=3 NHD=134 DA=0.017 SQKM L=200 m W=70 m
00281> ZONE PROPORTIONS
00282> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00283> 13.30 4.3 4.3 78.1 78.1 4.3 4.3 0.0 0.0
00284> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00285> MODEL=0 AND CONSTANTS OVERLAND: KO=0.089 TLO=0.0 hr
00286> KSS=5 hr KGW=384 hr pcode=1
00287> *
00288> ***** ADD SUBAREA 134 TO 132.2 *****
00289> *
00290> ADD HYD ID=2 HYD NO=502 IDA=4 IDB=3
00291> *
00292> *
00293> ***** ADD SUBAREAS 134/132.2 TO Basin 'B' Outflow****
00294> *
00295> ***** ADD SUBAREA 134 TO Basin B*****
00296> *
00297> ADD HYD ID=4 HYD NO=366 IDA=2 IDB=1
00298> *
00299> *
00300> ***** ADD SUBAREAS 130s TO TOTAL *****
00301> *
00302> ADD HYD ID=2 HYD NO=308 IDA=5 IDB=4
00303> *
00304> COMPUTE FLOWRATE ID=3 NHD=400 DA=0.209 SQKM L=550 m W=50 m
00305> ZONE PROPORTIONS
00306> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00307> 41.00 0.0 0.0 59.0 59.0 0.0 0.0 0.0 0.0
00308> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00309> MODEL=0 AND CONSTANTS OVERLAND: KO=0.143 TLO=0.0 hr
00310> KSS=5 hr KGW=384 hr pcode=1
00311> *
00312> *****
00313> * Route flow through existing Erbville detention facility
00314> *****
00315> *
00316> ROUTE RESERVOIR ID=4 HYD NO=309 INFLOW=3 pcode=1 OPTION=4
00317> ELEV. OUTFLOW STORAGE
00318> M CU M/S HAM
00319> 0.00 0.000 0.0000
00320> 0.20 0.036 0.0011
00321> 0.40 0.068 0.0055
00322> 0.60 0.090 0.0176
00323> 0.70 0.107 0.0433
00324> 0.90 0.122 0.0854
00325> 1.00 0.129 0.1129
00326> 1.10 0.135 0.1448
00327> 1.20 0.198 0.1812
00328> 1.30 0.305 0.2220
00329> 1.40 0.437 0.2665
00330> 1.50 0.577 0.3138
00331> 1.70 0.708 0.4166
00332> 1.90 0.830 0.5293
00333> 2.10 1.946 0.6506
00334> 2.15 2.090 0.6750
00335> 2.20 2.200 0.7100
00336> *
00337> ***** ADD SUBAREA 400 TO TOTAL *****
00338> *
00339> ADD HYD ID=5 HYD NO=310 IDA=4 IDB=2
00340> *
00341> *****
00342> * Edited Feb.15, 2005 - Stantec (NJ)
00343> * SubArea 530 updated to reflect revised catchment area as per
00344> * Dwg 6-852.
00345> * Catchment parameters updated to reflect existing conditions
00346> *****
00347> COMPUTE FLOWRATE ID=1 NHD=530 DA=0.043 SQKM L=325 m W=130 m
00348> ZONE PROPORTIONS
00349> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00350> 0.00 0.0 0.0 31.0 31.0 29.0 29.0 40.0 40.0
00351> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00352> MODEL=0 AND CONSTANTS OVERLAND: KO=0.170 TLO=0.0 hr
00353> KSS=5 hr KGW=384 hr pcode=1
00354> *
00355> *COMPUTE FLOWRATE ID=2 NHD=520 DA=0.082 SQKM L=250 m W=50 m
00356> ZONE PROPORTIONS
00357> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00358> 50.00 0.0 0.0 40.0 40.0 10.0 10.0 0.0 0.0
00359> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00360> MODEL=0 AND CONSTANTS OVERLAND: KO=0.084 TLO=0.0 hr
00361> KSS=5 hr KGW=384 hr pcode=1
00362> *
00363> ***** ADD SUBAREAS 530 AND 520 *****
00364> *
00365> *ADD HYD ID=4 HYD NO=311 IDA=1 IDB=2
00366> *
00367> *COMPUTE FLOWRATE ID=3 NHD=510 DA=0.332 SQKM L=400 m W=50 m
00368> ZONE PROPORTIONS
00369> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00370> 50.00 0.0 0.0 49.0 49.0 1.0 1.0 0.0 0.0
00371> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00372> MODEL=0 AND CONSTANTS OVERLAND: KO=0.114 TLO=0.0 hr
00373> KSS=5 hr KGW=384 hr pcode=1
00374> *
00375> *****
00376> * Edited Feb.15, 2005 - Stantec (NJ)
00377> * SubArea 500 updated to reflect revised catchment area as per
00378> * Dwg 6-852. Area consolidated with Subarea 530
00379> * Catchment parameters updated to reflect existing conditions
00380> *****
00381> * Edited Feb.17, 2005 - Stantec (JInnes)
00382> * Sub Area 500 split to reflect proposed development for Active Greyerbiehl SE
00383> * Catchment 500 split into 500 and 505
00384> * Catchment parameters updated to reflect existing conditions
00385> *****
00386> * Edited Apr.15, 2005 - Stantec (JInnes)
00387> * Reservoir split off of Catchment 505 to make 5005
00388> * Reservoir 5005 stage storage curve changed to match revised design
00389> *****
00390> * Edited May.12, 2005 - Stantec (JInnes)
00391> * Drainage areas changed to match revised design
00392> *****
00393> * Edited March, 2010 - Stantec (JInnes)
00394> * Drainage areas changed to match revised design - 11.1 ha to 11.2 ha for 505
00395> *****
00396> * Edited February 2014 (TFraser)
00397> * Pond 5005 removed (Greyerbiehl temporary pond); pond 6510 added, located in
00398> hydro corridor and receiving drainage from 77 ha including catchments 500,
00399> 505, 510, 512, 530, 600, 620; Catchments 510, 511, 512 and 620 all
00400> * assumed to be 80% imperviousness
00401> * SWM facility provides quality and quantity treatment for Regional event
00402> * Outlet of SWMF to existing 825 mm dia. storm pipe to St. Moritz Ave.
00403> * Emergency overflow outlet to St. Moritz
00404> * Catchment parameters updated to reflect current conditions
00405> *****
00406> COMPUTE FLOWRATE ID=4 NHD=500 DA=0.065 SQKM L=50 m W=430 m
00407> ZONE PROPORTIONS
00408> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00409> 50.00 0.0 0.0 50.0 50.0 0.0 0.0 0.0 0.0
00410> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00411> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
00412> KSS=5 hr KGW=384 hr pcode=1
00413> *
00414> *COMPUTE FLOWRATE ID=2 NHD=600 DA=0.026 SQKM L=280 m W=200 m
00415> ZONE PROPORTIONS
00416> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00417> 0.00 0.0 0.0 100.0 100.0 0.0 0.0 0.0 0.0
00418> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00419> MODEL=0 AND CONSTANTS OVERLAND: KO=0.202 TLO=0.0 hr
00420> KSS=5 hr KGW=384 hr pcode=1
00421> *
00422> ***** ADD SUBAREAS 500 AND 600 *****
00423> *
00424> *ADD HYD ID=4 HYD NO=312 IDA=3 IDB=2
00425> *
00426> *KEEP HYD IDA=4 CUTOFF=78 ICODE=2 ISTEPS=1 IFROM=2 IDB=5 IMET=1
00427> *
00428> *PRINT HYD ID=4 PCODE=1 MODE=11
00429> *****
00430> COMPUTE FLOWRATE ID=3 NHD=505 DA=0.112 SQKM L=500 m W=250 m
00431> ZONE PROPORTIONS
00432> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00433> 53.00 0.0 0.0 45.6 45.6 1.4 1.4 0.0 0.0
00434> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00435> MODEL=0 AND CONSTANTS OVERLAND: KO=0.173 TLO=0.0 hr
00436> KSS=5 hr KGW=384 hr pcode=1 wqcode=1
00437> *
00438> *****
00439> * Edited April 2013 - Stantec (TFraser)
00440> * Temporary Greyerbiehl pond 5005 removed; Pond 6510 ultimate SWM facility
00441> *****
00442> *
00443> *ROUTE RESERVOIR ID=3 HYD NO=5005 INFLOW=2 pcode=1 OPTION=4 ILEVEL=380.0
00444> * ELEVATION OUTFLOW STORAGE
00445> * (m) (cms) (ha-m)
00446> * 380.000 0.0000 0.0000
00447> * 380.200 0.0042 0.0509
00448> * 380.500 0.0070 0.1385
00449> * 380.900 0.0095 0.2728
00450> * 381.000 0.0365 0.3094
00451> * 381.500 0.0770 0.5059
00452> * 382.000 0.1020 0.7239
00453> * 382.500 1.1300 0.9652
00454> * 383.000 1.2150 1.2318
00455> *
00456> ***** ADD SUBAREAS 530 AND 505 *****
00457> *
00458> *ADD HYD ID=2 HYD NO=311 IDA=3 IDB=1
00459> *
00460> *KEEP HYD IDA=2 CUTOFF=78 ICODE=2 ISTEPS=1 IFROM=2 IDB=5 IMET=1
00461> *
00462> *PRINT HYD ID=2 PCODE=1 MODE=11
00463> *****
00464> *
00465> ***** ADD 311 AND 500 *****
00466> *
00467> *ADD HYD ID=3 HYD NO=313 IDA=2 IDB=4
00468> *
00469> *KEEP HYD IDA=3 CUTOFF=78 ICODE=2 ISTEPS=1 IFROM=2 IDB=5 IMET=1
00470> *
00471> *PRINT HYD ID=3 PCODE=1 MODE=11
00472> *****
00473> * Edited Oct.29, 2012 - Stantec (TFraser)
00474> * Sub Area 620 updated to reflect proposed development for Rice Commercial site
00475> * Sub Area 510 added as a split from 2010 Sub Area 500
00476> * Catchment parameters updated to reflect existing conditions
00477> * Revised June 2018 - Stantec (TFraser)
00478> * Sub area 510 split into 2 catchments to show rooftop area to infiltration
00479> * Assume roof area is 30% of total area and is 99% impervious coverage
00480> *****
00481> COMPUTE FLOWRATE ID=2 NHD=7510 DA=0.169 SQKM L=450 m W=50 m
00482> ZONE PROPORTIONS
00483> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00484> 72.00 0.0 0.0 27.4 27.4 0.6 0.6 0.0 0.0
00485> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00486> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
00487> KSS=5 hr KGW=384 hr pcode=1
00488> *****
00489> * Revised June 2018 (TFraser, Stantec) - Proposed rooftop area of
00490> * employment lands
00491> * Area of 7510 - 8510 = total area of 510
00492> *****
00493> COMPUTE FLOWRATE ID=4 NHD=8510 DA=0.073 SQKM L=450 m W=50 m
00494> ZONE PROPORTIONS
00495> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00496> 99.00 0.0 0.0 1.0 1.0 0.0 0.0 0.0 0.0
00497> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00498> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
00499> KSS=5 hr KGW=384 hr pcode=1
00500> *****
00501> * Revised June 2018 (TFraser, Stantec) - Proposed rooftop infiltration
00502> * Placeholder until final site plan designs are completed
00503> *****
00504> *
00505> ROUTE RESERVOIR ID=1 HYD NO=9510 INFLOW=4 pcode=1 OPTION=4
00506> ELEV. OUTFLOW STORAGE
00507> M CU M/S HAM
00508> 373.00 0.000 0.000
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00509> 373.50 0.001 0.092
00510> 374.00 0.002 0.183
00511> 374.01 10.000 0.184
00512> *
00513> ***** ADD 7510 AND 9510 *****
00514> *
00515> ADD HYD ID=4 HYD NO=510 IDA=2 IDB=1
00516> *
00517> *****
00518> COMPUTE FLOWRATE ID=2 NHD=7512 DA=0.094 SQKM L=450 m W=50 m
00519> ZONE PROPORTIONS
00520> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00521> 71.00 0.0 0.0 28.4 28.4 0.6 0.6 0.0 0.0
00522> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00523> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
00524> KSS=5 hr KGW=384 hr pcode=1
00525> *****
00526> * Revised June 2018 (TFraser, Stantec) - Proposed rooftop area
00527> * Area of 7512 + 8512 = total area of 512
00528> *****
00529> COMPUTE FLOWRATE ID=1 NHD=8512 DA=0.040 SQKM L=450 m W=50 m
00530> ZONE PROPORTIONS
00531> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00532> 99.00 0.0 0.0 1.0 1.0 0.0 0.0 0.0 0.0
00533> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00534> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
00535> KSS=5 hr KGW=384 hr pcode=1
00536> *****
00537> * Revised June 2018 (TFraser, Stantec) - Proposed rooftop infiltration
00538> *****
00539> *
00540> ROUTE RESERVOIR ID=1 HYD NO=9512 INFLOW=1 pcode=1 OPTION=4
00541> ELEV. OUTFLOW STORAGE
00542> M CU M/S HA*M
00543> 373.00 0.000 0.000
00544> 374.50 0.001 0.050
00545> 375.00 0.002 0.100
00546> 375.01 10.000 0.101
00547> *
00548> ***** ADD SUBAREAS 7512 AND 9512 *****
00549> *
00550> ADD HYD ID=1 HYD NO=512 IDA=2 IDB=1
00551> *
00552> ***** ADD SUBAREAS 510 AND 512 *****
00553> *
00554> ADD HYD ID=2 HYD NO=317 IDA=4 IDB=1
00555> *
00556> *****
00557> * Dummy facility on City Lands to determine quantity control required
00558> * if a second facility was proposed
00559> * Sept 2013 (TFraser)
00560> *****
00561> *
00562> *ROUTE RESERVOIR ID=4 HYD NO=6500 INFLOW=2 pcode=1 OPTION=4
00563> ELEV. OUTFLOW STORAGE
00564> M CU M/S HA*M
00565> 373.00 0.000 0.000
00566> 374.50 0.001 0.001
00567> 375.70 0.100 1.000
00568> 376.00 0.200 1.300
00569> 376.30 0.300 1.800
00570> 376.60 0.400 2.000
00571> 376.90 0.500 2.500
00572> 377.50 7.000 2.600
00573> *
00574> *****
00575> *
00576> ***** ADD 313 AND 317 *****
00577> *
00578> ADD HYD ID=1 HYD NO=3170 IDA=3 IDB=2
00579> *
00580> *****
00581> * Revised February 2014 (TFraser, Stantec) - area adjusted to reflect
00582> * proposed drainage; small area draining to Erb Street
00583> *****
00584> COMPUTE FLOWRATE ID=2 NHD=7620 DA=0.120 SQKM L=450 m W=50 m
00585> ZONE PROPORTIONS
00586> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00587> 71.00 0.0 0.0 29.0 29.0 0.0 0.0 0.0 0.0
00588> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00589> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
00590> KSS=5 hr KGW=384 hr pcode=1
00591> *****
00592> * Revised June 2018 (TFraser, Stantec) - Proposed rooftop area
00593> * Area of 7620 + 8620 = total area of 620
00594> *****
00595> COMPUTE FLOWRATE ID=4 NHD=8620 DA=0.051 SQKM L=450 m W=50 m
00596> ZONE PROPORTIONS
00597> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00598> 99.00 0.0 0.0 1.0 1.0 0.0 0.0 0.0 0.0
00599> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00600> ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
00601> KSS=5 hr KGW=384 hr pcode=1
00602> *****
00603> * Revised June 2018 (TFraser, Stantec) - Proposed rooftop infiltration
00604> *****
00605> *
00606> ROUTE RESERVOIR ID=3 HYD NO=9620 INFLOW=4 pcode=1 OPTION=4
00607> ELEV. OUTFLOW STORAGE
00608> M CU M/S HA*M
00609> 373.00 0.000 0.000
00610> 374.50 0.001 0.065
00611> 375.00 0.002 0.129
00612> 375.01 10.000 0.130
00613> ***** ADD SUBAREAS 7620 AND 9620 *****
00614> *
00615> ADD HYD ID=4 HYD NO=620 IDA=2 IDB=3
00616> *
00617> ***** ADD SUBAREAS 3710 AND 620 *****
00618> *
00619> ADD HYD ID=2 HYD NO=312 IDA=4 IDB=1
00620> *
00621> *****
00622> * Revised February 2014 (TFraser, Stantec) - Proposed ultimate SWM facility
00623> * located in sub area 500 and servicing 76.7 ha of developed upstream lands
00624> *****
00625> *
00626> ROUTE RESERVOIR ID=4 HYD NO=6510 INFLOW=2 pcode=1 OPTION=4
00627> ELEV. OUTFLOW STORAGE
00628> M CU M/S HA*M
00629> 373.00 0.000 0.000
00630> 374.50 0.001 0.001
00631> 375.00 0.111 0.448
00632> 375.20 0.139 0.648
00633> 375.60 0.183 1.074
00634> 376.20 0.260 1.771
00635> 376.80 0.345 2.540
00636> 377.40 0.552 3.381
00637> 378.00 0.705 4.298
00638> 378.60 0.821 5.292
00639> 379.20 1.294 6.367
00640> 379.40 2.206 6.744
00641> 379.60 3.648 7.130
00642> 379.80 5.753 7.526
00643> 380.00 9.309 7.932
00644> *
00645> *
00646> *****
00647> * BASIN A - Removed from original Clair Hills EIR model
00648> * Upstream lands of St.Moritz Stm Sewer modelled to reflect existing
00649> * conditions
00650> *****
00651> *
00652> ***** ADD SUBAREAS 600'S AND 500'S *****
00653> *
00654> *ADD HYD ID=2 HYD NO=318 IDA=4 IDB=3
00655> *
00656> *****
00657> * Divert flows for Regional Storm ONLY; minors and majors directed to
00658> * proposed 325 mm dia. outlet pipe, Regional discharge to larger pipe
00659> * and emergency spillway
00660> *****
00661> *DIVERT FLOWS INFLOW=4 DIVERT ID=1 HYD NO=6520 PCODE=1 OPTION=2
00662> * INLET CAPACITY=001.48 CMS THRUFLD ID=3 HYD NOB=6521
00663> *****
00664> *
00665> * Low area located west of Clair Hills subdivision, some minor detention
00666> * Added in 2002
00667> *****
00668> *ROUTE RESERVOIR ID=4 HYD NO=314 INFLOW=1 pcode=1 OPTION=4
00669> ELEV. OUTFLOW STORAGE
00670> M CU M/S HA*M
00671> 374.75 0.000 0.000
00672> 375.50 0.560 0.007
00673> 376.00 1.090 0.050
00674> 376.50 1.410 0.170
00675> 377.00 1.670 0.594
00676> 377.50 1.890 0.915
00677> 378.00 2.090 1.235
00678> 378.50 2.270 1.555
00679> 379.00 2.000 2.000
00680> 379.50 5.500 2.500
00681> *
00682> *****
00683> COMPUTE FLOWRATE ID=2 NHD=600 DA=0.074 SQKM L=490 m W=150 m
00684> ZONE PROPORTIONS
00685> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00686> 0.00 0.0 0.0 100.0 100.0 0.0 0.0 0.0 0.0
00687> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00688> MODEL=0 AND CONSTANTS OVERLAND: KO=0.202 TLO=0.0 hr
00689> KSS=5 hr KGW=384 hr pcode=1
00690> *****
00691> ***** ADD SUBAREAS 314 AND 600 *****
00692> *
00693> ADD HYD ID=3 HYD NO=318 IDA=4 IDB=2
00694> *
00695> *KEEP HYD IDA=4 CUTOFF=78 ICODE=2 ISTEP=1 IFROM=2 IDB=5 IMET=1
00696> *
00697> *PRINT HYD ID=4 PCODE=1 MODE=11
00698> *
00699> *****
00700> *COMPUTE FLOWRATE ID=2 NHD=500 DA=0.408 SQKM L=650 m W=500 m
00701> ZONE PROPORTIONS
00702> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00703> 0.00 0.0 0.0 97.0 97.0 3.0 3.0 0.0 0.0
00704> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00705> MODEL=0 AND CONSTANTS OVERLAND: KO=0.496 TLO=0.0 hr
00706> KSS=5 hr KGW=384 hr pcode=1
00707> *
00708> ***** ADD SUBAREAS 500 AND 510 *****
00709> *
00710> *ADD HYD ID=1 HYD NO=312 IDA=3 IDB=2
00711> *
00712> *****
00713> * Edited Jan.20-05 (Stantec Consulting - NJ)
00714> * Determine Flowrate & Volume of external flows to proposed Storm sewer
00715> * along St.Moritz Blvd (SubAreas 530A and 500A)
00716> ***** ADD SUBAREAS 500 AND 530 *****
00717> *
00718> *ADD HYD ID=4 HYD NO=313 IDA=1 IDB=2
00719> *
00720> *****
00721> *COMPUTE FLOWRATE ID=4 NHD=620 DA=0.144 SQKM L=600 m W=260 m
00722> ZONE PROPORTIONS
00723> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00724> 80.00 0.0 0.0 20.0 20.0 0.0 0.0 0.0 0.0
00725> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00726> MODEL=0 AND CONSTANTS OVERLAND: KO=0.094 TLO=0.0 hr
00727> KSS=5 hr KGW=384 hr pcode=1
00728> *
00729> *****
00730> * BASIN G - removed October 2012 (TFraser)
00731> *****
00732> *
00733> *ROUTE RESERVOIR ID=2 HYD NO=315 INFLOW=4 pcode=1 OPTION=4
00734> ELEV. OUTFLOW STORAGE
00735> M CU M/S HA*M
00736> 0.00 0.000 0.000
00737> 0.45 0.015 0.195
00738> 0.95 0.046 0.260
00739> 1.05 0.069 0.310
00740> 1.25 0.105 0.360
00741> 1.80 0.154 0.470
00742> 1.81 0.441 0.475
00743> 1.90 0.900 0.490
00744> 1.95 1.150 0.520
00745> 2.10 2.000 0.600
00746> *
00747> *
00748> ***** ADD SUBAREAS 600 - 620 *****
00749> *
00750> *ADD HYD ID=1 HYD NO=317 IDA=4 IDB=2
00751> *
00752> ***** ADD SUBAREAS 600'S AND 500'S *****
00753> *
00754> *ADD HYD ID=2 HYD NO=318 IDA=1 IDB=3
00755> *
00756> ***** ADD SUBAREAS 600'S & 500'S TO TOTAL *****
00757> *
00758> *ADD HYD ID=1 HYD NO=319 IDA=3 IDB=5
00759> *
00760> *
00761> *COMPUTE FLOWRATE ID=2 NHD=133 DA=0.042 SQKM L=220 m W=90 m
00762> ZONE PROPORTIONS
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00763> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00764> 42.00 2.9 2.9 43.5 43.5 11.6 11.6 0.0 0.0
00765> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00766> MODEL=0 AND CONSTANTS OVERLAND: KO=0.108 TLO=0.0 hr
00767> KSS=5 hr KGW=384 hr pcode=1
00768> *
00769> *****DIVERT MAJOR FLOWS DIRECTLY TO WATERCOURSE***
00770> *
00771> DIVERT FLOWS INFLOW=2 DIVERT ID=3 HYD NO=320 PCODE=1 OPTION=2
00772> INLET CAPACITY=000.28 CMS THRUFLU ID=4 HYD NOB=321
00773> *
00774> COMPUTE FLOWRATE ID=5 NHD=120 DA=0.150 SQKM L=600 m W=50 m
00775> ZONE PROPORTIONS
00776> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00777> 40.00 3.0 3.0 44.0 44.0 13.0 13.0 0.0 0.0
00778> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00779> MODEL=0 AND CONSTANTS OVERLAND: KO=0.153 TLO=0.0 hr
00780> KSS=5 hr KGW=384 hr pcode=1
00781> *
00782> ADD HYD ID=2 HYD NO=322 IDA=5 IDB=4
00783> *****
00784> * BASIN D
00785> *****
00786> *
00787> ROUTE RESERVOIR ID=5 HYD NO=324 INFLOW=2 PCODE=1 OPTION=4
00788> ELEV. OUTFLOW STORAGE
00789> M CU M/S HA*M
00790> 0.00 0.000 0.000
00791> 0.30 0.009 0.196
00792> 0.70 0.014 0.484
00793> 0.90 0.156 0.639
00794> 1.20 0.186 0.885
00795> 1.30 0.341 0.970
00796> 1.50 1.098 1.146
00797> 1.60 1.680 1.236
00798> 1.90 4.290 1.518
00799> *
00800> ***** ADD MAJOR FROM 133 TO TOTAL *****
00801> *
00802> ADD HYD ID=2 HYD NO=325 IDA=1 IDB=3
00803> *
00804> COMPUTE FLOWRATE ID=1 NHD=311 DA=0.0110 SQKM L= 200 m W=50 m
00805> ZONE PROPORTIONS
00806> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00807> 54.00 0.0 0.0 7.7 7.7 38.3 38.3 0.0 0.0
00808> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00809> MODEL=0 AND CONSTANTS OVERLAND: KO=0.075 TLO=0.0 hr
00810> *
00811> *****DIVERT MAJOR FLOWS DIRECTLY TO WATERCOURSE***
00812> *
00813> DIVERT FLOWS INFLOW=1 DIVERT ID=4 HYD NO=326 PCODE=1 OPTION=2
00814> INLET CAPACITY=000.11 CMS THRUFLU ID=3 HYD NOB=327
00815> *
00816> ***** ADD MAJOR FROM 311 TO TOTAL *****
00817> *
00818> ADD HYD ID=1 HYD NO=328 IDA=4 IDB=2
00819> *
00820> *****ROUTE TOTAL HYDROGRAPH THROUGH CHANNEL TO BASIN F*****
00821> *
00822> ROUTE CHANNEL ID=2 HYD NO=329 INFLOW=1 LENGTH=450 m SLOPE=0.002
00823> RC ID=3 NSECT=1 PCODE=1 INDEX=1 PIPE=0 CANOPY=50%
00824> *
00825> ***** ADD SUBAREAS 120s TO TOTAL *****
00826> *
00827> ADD HYD ID=1 HYD NO=330 IDA=2 IDB=5
00828> *
00829> COMPUTE FLOWRATE ID=2 NHD=110 DA=0.099 SQKM L=150 m W=50 m
00830> ZONE PROPORTIONS
00831> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00832> 6.10 0.0 0.0 54.2 54.2 39.7 39.7 0.0 0.0
00833> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00834> MODEL=0 AND CONSTANTS OVERLAND: KO=0.104 TLO=0.0 hr
00835> KSS=5 hr KGW=384 hr pcode=1
00836> *
00837> ***** ADD SUBAREA 110 TO TOTAL *****
00838> *
00839> ADD HYD ID=5 HYD NO=331 IDA=2 IDB=1
00840> *
00841> COMPUTE FLOWRATE ID=2 NHD=310 DA=0.136 SQKM L=550 m W=50 m
00842> ZONE PROPORTIONS
00843> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00844> 40.80 0.0 0.0 12.2 12.2 47.0 47.0 0.0 0.0
00845> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00846> MODEL=0 AND CONSTANTS OVERLAND: KO=0.143 TLO=0.0 hr
00847> KSS=5 hr KGW=384 hr pcode=1
00848> *
00849> ***** ADD SUBAREAS 310 & MINORS FROM 311 *****
00850> *
00851> ADD HYD ID=4 HYD NO=332 IDA=3 IDB=2
00852> *
00853> *
00854> COMPUTE FLOWRATE ID=3 NHD=300 DA=0.102 SQKM L=600 m W=50 m
00855> ZONE PROPORTIONS
00856> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00857> 45.00 0.0 0.0 40.0 40.0 15.0 15.0 0.0 0.0
00858> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00859> MODEL=0 AND CONSTANTS OVERLAND: KO=0.153 TLO=0.0 hr
00860> KSS=5 hr KGW=384 hr pcode=1
00861> *
00862> COMPUTE FLOWRATE ID=1 NHD=320 DA=0.085 SQKM L=300 m W=150 m
00863> ZONE PROPORTIONS
00864> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00865> 3.70 0.0 0.0 4.8 4.8 86.7 86.7
00866> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00867> MODEL=0 AND CONSTANTS OVERLAND: KO=0.166 TLO=0.0 hr
00868> KSS=5 hr KGW=384 hr pcode=1
00869> *
00870> ***** ADD SUBAREAS 320 & 300 *****
00871> *
00872> ADD HYD ID=2 HYD NO=432 IDA=3 IDB=1
00873> *
00874> *****DIVERT MAJOR FLOWS DOWN COLUMBIA STREET TO WATERCOURSE***
00875> *
00876> DIVERT FLOWS INFLOW=2 DIVERT ID=1 HYD NO=433 PCODE=1 OPTION=2
00877> INLET CAPACITY=000.67 CMS THRUFLU ID=3 HYD NOB=435
00878> *
00879> ***** ADD 300/320 MAJORS TO TOTAL *****
00880> *
00881> ADD HYD ID=2 HYD NO=434 IDA=5 IDB=1
00882> *
00883> ***** ADD 300/320 MINORS to Basin C *****
00884> *
00885> ADD HYD ID=5 HYD NO=436 IDA=3 IDB=4
00886> *
00887> ***** ADD ST. MORITZ MINORS to Basin C *****
00888> *
00889> ADD HYD ID=1 HYD NO=570 IDA=5 IDB=6
00890> *
00891> *****
00892> * BASIN C 90 mm orifice#1
00893> *****
00894> *
00895> ROUTE RESERVOIR ID=3 HYD NO=335 INFLOW=1 PCODE=1 OPTION=4
00896> ELEV. OUTFLOW STORAGE
00897> M CU M/S HA*M
00898> 0.00 0.000 0.000
00899> 0.30 0.009 0.105
00900> 0.70 0.034 0.274
00901> 1.00 0.017 0.423
00902> 1.10 0.018 0.477
00903> 1.30 0.106 0.591
00904> 1.60 0.115 0.779
00905> 1.70 0.775 0.845
00906> 1.80 2.014 0.914
00907> 1.90 3.663 0.985
00908> *
00909> COMPUTE FLOWRATE ID=6 NHD=201 DA=0.031 SQKM L=100 m W=100 m
00910> ZONE PROPORTIONS
00911> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00912> 0.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
00913> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00914> MODEL=0 AND CONSTANTS OVERLAND: KO=0.094 TLO=0.0 hr
00915> KSS=5 hr KGW=384 hr pcode=1
00916> *
00917> COMPUTE FLOWRATE ID=4 NHD=202 DA=0.026 SQKM L=100 m W=100 m
00918> ZONE PROPORTIONS
00919> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00920> 0.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
00921> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
00922> MODEL=0 AND CONSTANTS OVERLAND: KO=0.094 TLO=0.0 hr
00923> KSS=5 hr KGW=384 hr pcode=1
00924> *
00925> *
00926> ***** ADD SUBAREAS 201 - 202 *****
00927> *
00928> ADD HYD ID=1 HYD NO=336 IDA=4 IDB=6
00929> *
00930> COMPUTE FLOWRATE ID=5 NHD=200 DA=0.114 SQKM L=650 m W=50 m
00931> ZONE PROPORTIONS
00932> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00933> 41.50 0.0 0.0 35.0 35.0 23.5 23.5 0.0 0.0
00934> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00935> MODEL=0 AND CONSTANTS OVERLAND: KO=0.161 TLO=0.0 hr
00936> KSS=5 hr KGW=384 hr pcode=1
00937> *
00938> ***** ADD SUBAREAS 200 TO 200s *****
00939> *
00940> ADD HYD ID=6 HYD NO=337 IDA=1 IDB=5
00941> *
00942> COMPUTE FLOWRATE ID=1 NHD=203 DA=0.010 SQKM L=50 m W=50 m
00943> ZONE PROPORTIONS
00944> IMP MUCK HURON/BRANT BURFORD WOODLANDS
00945> 45.00 0.0 0.0 15.0 15.0 40.0 40.0 0.0 0.0
00946> RATING CURVES IDC=4 IDOC=4 QRCM=1.420 QROC=0.05
00947> MODEL=0 AND CONSTANTS OVERLAND: KO=0.046 TLO=0.0 hr
00948> KSS=5 hr KGW=384 hr pcode=1
00949> *
00950> ***** ADD SUBAREAS 203 - 200s *****
00951> *
00952> ADD HYD ID=4 HYD NO=338 IDA=1 IDB=6
00953> *
00954> *****DIVERT MAJOR FLOWS DIRECTLY TO REGIONAL BASIN***
00955> *
00956> DIVERT FLOWS INFLOW=4 DIVERT ID=6 HYD NO=353 PCODE=1 OPTION=2
00957> INLET CAPACITY=000.75 CMS THRUFLU ID=5 HYD NOB=354
00958> *
00959> *
00960> *****
00961> * BASIN E
00962> *****
00963> *
00964> ROUTE RESERVOIR ID=4 HYD NO=339 INFLOW=5 PCODE=1 OPTION=4
00965> ELEV. OUTFLOW STORAGE
00966> M CU M/S HA*M
00967> 0.00 0.000 0.000
00968> 0.30 0.0072 0.043
00969> 0.40 0.0084 0.060
00970> 1.00 0.013 0.180
00971> 1.10 0.095 0.204
00972> 1.40 0.110 0.280
00973> 1.60 0.549 0.336
00974> 1.80 2.360 0.496
00975> *
00976> ** ADD MAJORS FROM 200S TO FLOWS FROM BASIN C (major/minor)**
00977> *
00978> *
00979> ADD HYD ID=5 HYD NO=340 IDA=6 IDB=3
00980> *
00981> ***** ADD SUBAREAS 300'S & 200'S (MAJOR) TO TOTAL *****
00982> *
00983> ADD HYD ID=1 HYD NO=341 IDA=2 IDB=5
00984> *
00985> *****
00986> * BASIN F
00987> *****
00988> *
00989> ROUTE RESERVOIR ID=2 HYD NO=342 INFLOW=1 PCODE=1 OPTION=4
00990> ELEV. OUTFLOW STORAGE
00991> M CU M/S HA*M
00992> 54.50 0.00 0.000
00993> 54.75 0.28 0.006
00994> 55.00 0.60 0.029
00995> 55.50 1.70 0.134
00996> 56.50 3.22 0.751
00997> 57.00 3.72 1.321
00998> 57.50 5.44 2.055
00999> 58.00 8.39 3.019
01000> 59.00 12.14 6.037
01001> 60.00 14.80 10.359
01002> 60.50 15.95 12.705
01003> 60.75 16.49 13.283
01004> *
01005> COMPUTE FLOWRATE ID=6 NHD=100 DA=0.023 SQKM L=50 m W=50 m
01006> ZONE PROPORTIONS
01007> IMP MUCK HURON/BRANT BURFORD WOODLANDS
01008> 8.00 0.0 0.0 60.0 60.0 32.0 32.0 0.0 0.0
01009> RATING CURVES IDC=2 IDOC=5 QRCM=1.420 QROC=0.05
01010> MODEL=0 AND CONSTANTS OVERLAND: KO=0.048 TLO=0.0 hr
01011> KSS=5 hr KGW=384 hr pcode=1
01012> *
01013> ***** ADD SUBAREA 100 TO TOTAL *****
01014> *
01015> ADD HYD ID=1 HYD NO=343 IDA=2 IDB=6
01016> *

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01017> ADD HYD          ID=5 HYD NO=344 IDA=4 IDB=1
01018> *
01019> KEEP HYD         IDA=5 CUTOFF=78 ICODE=2 ISTEPS=1 IFROM=2 IDB=5 IMET=1
01020> *
01021> *PLOT HYD        IDA=2 IDB=1
01022> *PRINT HYD       ID=2 PCODE=0
01023> *PRINT HYD       ID=5 PCODE=0
01024> *
01025> FINISH
01026>
01027>
01028>
*PRINT HYD             ID=5 PCODE=0
01029> *
01030> FINISH
01031>
01032>
01033>
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00001> GAWSER V6.9.12 - Released -Sept. 30, 2010
00002> =====
00003>
00004> LAUREL CREEK WATERSHED MODEL (BASINS 301
00005> EVENT FILE : 2 Year Return Period, SCS T
00006> OCTOBER,1991
00007> =====
00008>
00009> Input file 1=002.evt
00010> Input file 2=9349.SWM
00011> Output file =9349.2.LST
00012> * =====
00013> * CODING BY D.G. JONES, OCTOBER, 1991 (revised February 2002, D.Eadie)
00014> * =====
00015> *
00016> ***** CALIBRATION PARAMETERS FOR DOWNSTREAM OF *****
00017> ***** THE LAUREL CREEK RESERVOIR *****
00018> *
00019> * Revised Calibration parameters by Dwight Boyd, July 1992
00020> *
00021> START KUNITS=2 TOTAL DRAINAGE AREA: TDA=42.736 SQ KM
00022> BASEFLOW AT OUTLET: QBSS=0.0 QBGW=0.01 CMS
00023> PRINT OPTIONS: ECHO=3 OUTPUT=1 PLOTS=1 RCS=1 SUBW=1
00024> PLOT CUTOFF TIME =75 HRS SUM=0 PRES=1000
00025> PARAMETER ADJUSTMENT FACTORS: FDS=1.00 FKEFP=0.60
00026> FCS=1.0 FD=1.0 FSAV=1.0 FKO=2.50 FKSS=1.0 FKMP=1
00027> INITIAL SOIL/SNOW WATER CONTENT FACTORS:
00028> FIMCI=1.0 FIMCII=1.0 FIWE=1.0
00029> GLOBAL RAINFALL SCALING FACTOR: GPRF=0.435
00030> SIMULATION CONTROLS: TTI=0.25 IDEL=2 HOURS=120
00031> SUBWATERSHED INITIAL BASEFLOWS IN CMS -999
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00041> OUTFLOW HYDROGRAPH SUMMARY
00042> =====
00043>
00044> LAUREL CREEK WATERSHED MODEL (BASINS 301
00045> EVENT FILE : 2 Year Return Period, SCS T
00046> OCTOBER,1991
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HYDROGRAPH NUMBER	UPSTREAM DRAINAGE AREA-Sq. km.	VOLUME mm	PEAK DISCHARGE cms	TIME TO PEAK HRS.
150	0.3530	28.42	0.990	12.000
301	0.3530	28.28	0.306	13.250
140	0.4950	27.93	1.615	12.000
302	0.8480	28.07	1.710	12.000
303	0.8480	28.03	0.244	16.000
131	0.1429	31.72	0.497	12.000
130	0.2410	34.85	0.755	12.000
304	0.3839	33.68	1.252	12.000
610	0.0410	31.22	0.172	11.750
355	0.4249	33.45	1.421	12.000
1321	0.0840	24.05	0.244	11.750
580	0.0840	21.47	0.126	11.750
590	0.0840	2.57	0.118	11.750
305	0.4249	33.95	1.524	12.000
307	0.4249	25.80	0.054	19.750
1322	0.0260	15.48	0.048	12.000
134	0.0170	20.34	0.105	11.750
502	0.0430	17.40	0.139	11.750
366	0.4679	25.03	0.154	11.750
308	1.3159	26.96	0.288	18.500
400	0.2090	28.39	0.791	11.750
309	0.2090	28.39	0.206	12.750
310	1.5249	27.16	0.454	12.750
530	0.0430	11.50	0.026	12.000
500	0.0650	31.30	0.189	12.000
505	0.1120	32.07	0.453	12.000
311	0.1550	26.36	0.479	12.000
313	0.2200	27.82	0.668	12.000
7510	0.1690	38.10	1.002	11.750
8510	0.0730	46.67	0.546	11.750
9510	0.0730	31.21	0.543*	12.250
510	0.2420	36.02	1.053	12.250
7512	0.0940	37.79	0.552	11.750
8512	0.0400	46.67	0.299	11.750
9512	0.0400	15.22	0.002	24.000
512	0.1340	31.05	0.553	11.750
317	0.3760	34.25	1.556	11.750
3170	0.5960	31.88	2.177	11.750
7620	0.1200	37.83	0.706	11.750
8620	0.0510	46.67	0.381	11.750
9620	0.0510	33.95	0.374	12.250
620	0.1710	36.68	0.733	12.250
312	0.7670	32.95	2.885	11.750
6510	0.7670	32.83	0.217	15.000
600	0.0740	15.50	0.130	12.000
318	0.8410	31.30	0.284	12.000

Note: * Storage/outflow table exceeded
Rating curve exceeded

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HYDROGRAPH NUMBER	UPSTREAM DRAINAGE AREA-Sq. km.	VOLUME mm	PEAK DISCHARGE cms	TIME TO PEAK HRS.
319	2.3659	28.63	0.684	12.750
133	0.0420	28.54	0.180	11.750
321	0.0420	28.54	0.180	11.750
320	0.0420	0.00	0.000	12.000
120	0.1500	27.84	0.521	12.000
322	0.1920	28.00	0.699	11.750
324	0.1920	23.25	0.012	24.000
325	2.3659	28.63	0.684	12.750
311	0.0110	42.58	0.065	11.750
327	0.0110	42.58	0.065	11.750
326	0.0110	0.00	0.000	11.750
328	2.3659	28.63	0.684	12.750
329	2.3659	28.63	0.684	12.750
330	2.5579	28.23	0.695	12.750
110	0.0990	14.21	0.160	12.000

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00128> 331 2.6569 27.71 0.813 12.000
00129> 310 0.1360 24.60 0.411 11.750
00130> 332 0.1470 25.94 0.476 11.750
00131> 300 0.1020 28.46 0.369 11.750
00132> 320 0.0850 12.61 0.027 12.000
00133> 432 0.1870 21.26 0.396 11.750
00134> 435 0.1870 21.26 0.396 11.750
00135> 433 0.1870 0.00 0.000 12.000
00136> 434 2.6569 27.71 0.813 12.000
00137> 436 0.3340 23.32 0.872 11.750
00138> 570 0.4180 22.95 0.998 11.750
00139> 335 0.4180 20.38 0.057 15.500
00140> 201 0.0310 11.06 0.001 30.750
00141> 202 0.0260 11.06 0.001 30.750
00142> 336 0.0570 11.06 0.002 30.750
00143> 200 0.1140 26.68 0.367 12.000
00144> 337 0.1710 21.47 0.367 12.000
00145> 203 0.0100 26.39 0.054 11.750
00146> 338 0.1810 21.75 0.421 11.750
00147> 354 0.1810 21.75 0.421 11.750
00148> 353 0.1810 0.00 0.000 12.000
00149> 339 0.1810 21.53 0.040 13.750
00150> 340 0.4180 20.38 0.057 15.500
00151> 341 3.0749 26.71 0.828 12.000
00152> 342 3.0749 26.71 0.765 12.250
00153> 100 0.0230 15.31 0.097 11.750
00154> 343 3.0979 26.62 0.769 12.250
00155> 344 3.2789 26.34 0.781 12.250

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Note: * Storage/outflow table exceeded
Rating curve exceeded

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WATERSHED RESPONSE VOLUMES (mm)			
RAIN/SNOWMELT=	47.898	OVERLAND=	23.329
SUBSURFACE=	2.878	GROUNDWATER=	16.881
SS NET=	3.118	GW NET=	21.000
EVAPORATION=	0.000	SUBLIMATION=	0.000
DRAINAGE AREA IN RUNOFF COMPUTATIONS=		3.279 km^2	

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00001> GAWSER V6.9.12 - Released -Sept. 30, 2010
00002> =====
00003>
00004> LAUREL CREEK WATERSHED MODEL (BASINS 301
00005> EVENT FILE : 5 Year Return Period, SCS T
00006> OCTOBER,1991
00007> =====
00008>
00009> Input file 1=005.evt
00010> Input file 2=9349.SWM
00011> Output file =9349 5.LST
00012> * =====
00013> * CODING BY D.G. JONES, OCTOBER, 1991 (revised September 2001, D.Eadie)
00014> * =====
00015>
00016> ***** CALIBRATION PARAMETERS FOR DOWNSTREAM OF *****
00017> ***** THE LAUREL CREEK RESERVOIR *****
00018> *
00019> * Revised Calibration parameters by Dwight Boyd, July 1992
00020> *
00021> START KUNITS=2 TOTAL DRAINAGE AREA: TDA=42.736 SQ KM
00022> BASEFLOW AT OUTLET: QBSS=0.0 QBGW=0.01 CMS
00023> PRINT OPTIONS: ECHO=3 OUTPUT=1 PLOTS=1 RCS=1 SUBW=1
00024> PLOT CUTOFF TIME =75 HRS SUM=0 FREQ=1000
00025> PARAMETER ADJUSTMENT FACTORS: FDS=1.00 FKEPF=0.60
00026> FCS=1.0 FD=1.0 FSAV=1.0 FKO=2.50 FKSS=1.0 FKMP=1
00027> INITIAL SOIL/SNOW WATER CONTENT FACTORS:
00028> FIMCI=1.0 FIMCII=1.0 FIWE=1.0
00029> GLOBAL RAINFALL SCALING FACTOR: GPRF=0.598
00030> SIMULATION CONTROLS: TTI=0.25 IDLE=2 HOURS=120
00031> SUBWATERSHED INITIAL BASEFLOWS IN CMS -999
00032> #
00033> #
00034> #
00035> #
00036> #
00037> #
00038> #
00039> #
00040> #
00041>
00042> OUTFLOW HYDROGRAPH SUMMARY
00043> =====
00044>
00045> LAUREL CREEK WATERSHED MODEL (BASINS 301
00046> EVENT FILE : 5 Year Return Period, SCS T
00047> OCTOBER,1991
00048>
00049> HYDROGRAPH UPSTREAM PEAK TIME TO
00050> NUMBER DRAINAGE AREA-Sq.km. VOLUME DISCHARGE PEAK
00051> ----- mm cms HRS. -----
00052> 150 0.3530 41.94 1.644 12.000
00053> 301 0.3530 41.74 0.496 13.250
00054> 140 0.4950 41.30 2.686 12.000
00055> 302 0.8480 41.48 2.973 12.000
00056> 303 0.8480 41.42 0.327 16.750
00057> 131 0.1429 46.01 0.784 12.000
00058> 130 0.2410 49.64 1.135 12.000
00059> 304 0.3839 48.29 1.919 12.000
00060> 610 0.0410 45.41 0.282 11.750
00061> 355 0.4249 48.01 2.185 12.000
00062> 1321 0.0840 35.05 0.399 11.750
00063> 580 0.0840 27.39 0.126 11.500
00064> 590 0.0840 7.66 0.273 11.750
00065> 305 0.4249 49.52 2.441 12.000
00066> 307 0.4249 40.60 0.192 15.250
00067> 1322 0.0260 25.91 0.108 12.000
00068> 134 0.0170 31.81 0.180 11.750
00069> 502 0.0430 28.24 0.279 11.750
00070> 366 0.4679 39.46 0.296 11.750
00071> 308 1.3159 40.72 0.519 16.500
00072> 400 0.2090 41.90 1.367 11.750
00073> 309 0.2090 41.90 0.610 12.500
00074> 310 1.5249 40.89 0.932 12.500
00075> 530 0.0430 18.18 0.076 12.000
00076> 500 0.0650 45.51 0.300 12.000
00077> 505 0.1120 46.41 0.716 11.750
00078> 311 0.1550 38.58 0.785 12.000
00079> 313 0.2200 40.63 1.085 12.000
00080> 7510 0.1690 53.91 1.493 11.750
00081> 8510 0.0730 64.54 0.752 11.750
00082> 9510 0.0730 49.07 0.748* 12.000
00083> 510 0.2420 52.45 2.029 12.000
00084> 7512 0.0940 53.52 0.826 11.750
00085> 8512 0.0400 64.54 0.412 11.750
00086> 9512 0.0400 29.19 0.035 13.750
00087> 512 0.1340 46.26 0.827 11.750
00088> 317 0.3760 50.24 2.739 12.000
00089> 3170 0.5960 46.69 3.824 12.000
00090> 7620 0.1200 53.60 1.057 11.750
00091> 8620 0.0510 64.54 0.525 11.750
00092> 9620 0.0510 51.81 0.523* 12.000
00093> 620 0.1710 53.07 1.430 12.000
00094> 312 0.7670 48.11 5.254 12.000
00095> 6510 0.7670 47.99 0.305 15.250
00096> 600 0.0740 25.94 0.296 12.000
00097> 318 0.8410 46.05 0.496 12.000
00098>
00099> Note: * Storage/outflow table exceeded
00100> # Rating curve exceeded
00101> #
00102>
00103> OUTFLOW HYDROGRAPH SUMMARY
00104> =====
00105>
00106> LAUREL CREEK WATERSHED MODEL (BASINS 301
00107> EVENT FILE : 5 Year Return Period, SCS T
00108> OCTOBER,1991
00109>
00110> HYDROGRAPH UPSTREAM PEAK TIME TO
00111> NUMBER DRAINAGE AREA-Sq.km. VOLUME DISCHARGE PEAK
00112> ----- mm cms HRS. -----
00113> 319 2.3659 42.72 1.308 12.500
00114> 133 0.0420 41.73 0.302 11.750
00115> 321 0.0420 41.24 0.280 11.750
00116> 320 0.0420 0.48 0.022 11.750
00117> 120 0.1500 40.82 0.883 11.750
00118> 322 0.1920 40.92 1.163 11.750
00119> 324 0.1920 33.50 0.045 15.250
00120> 325 2.3659 42.73 1.308 12.500
00121> 311 0.0110 59.09 0.106 11.750
00122> 327 0.0110 59.09 0.106 11.750
00123> 326 0.0110 0.00 0.000 11.750
00124> 328 2.3659 42.73 1.308 12.500
00125> 329 2.3659 42.73 1.308 12.500
00126> 330 2.5579 42.04 1.321 12.500
00127> 110 0.0990 23.07 0.404 11.750

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00001> GAWSER V6.9.12 - Released -Sept. 30, 2010
00002> =====
00003> LAUREL CREEK WATERSHED MODEL (BASINS 301
00004> EVENT FILE : 25 Year Return Period, SCS
00005> OCTOBER,1991
00006> =====
00007>
00008>
00009> Input file 1=025.evt
00010> Input file 2=9349.SWM
00011> Output file =9349 25.LST
00012> * =====
00013> * CODING BY D.G. JONES, OCTOBER, 1991
00014> * =====
00015> *
00016> ***** CALIBRATION PARAMETERS FOR DOWNSTREAM OF *****
00017> ***** THE LAUREL CREEK RESERVOIR *****
00018> *
00019> * Revised Calibration parameters by Dwight Boyd, July 1992
00020> *
00021> START KUNITS=2 TOTAL DRAINAGE AREA: TDA=42.736 SQ KM
00022> BASEFLOW AT OUTLET: QBSS=0.0 QBGW=0.01 CMS
00023> PRINT OPTIONS: ECHO=3 OUTPUT=1 PLOTS=1 RCS=1 SUBW=1
00024> PLOT CUTOFF TIME =75 HRS SUM=0 PREP=1000
00025> PARAMETER ADJUSTMENT FACTORS: FDS=1.00 FKEPF=0.60
00026> FCS=1.0 FD=1.0 FSAV=1.0 FKO=2.50 FKSS=1.0 FKMP=1
00027> INITIAL SOIL/SNOW WATER CONTENT FACTORS:
00028> FIMCI=1.0 FIMCII=1.0 FIWE=1.0
00029> GLOBAL RAINFALL SCALING FACTOR: GPRF=0.815
00030> SIMULATION CONTROLS: TTI=0.25 IDEL=2 HOURS=120
00031> SUBWATERSHED INITIAL BASEFLOWS IN CMS -999
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00041> OUTFLOW HYDROGRAPH SUMMARY
00042> =====
00043>
00044> LAUREL CREEK WATERSHED MODEL (BASINS 301
00045> EVENT FILE : 25 Year Return Period, SCS
00046> OCTOBER,1991
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HYDROGRAPH NUMBER	UPSTREAM DRAINAGE AREA-Sq. Km.	VOLUME mm	PEAK DISCHARGE cms	TIME TO PEAK HRS.
150	0.3530	60.25	2.505	12.000
301	0.3530	59.94	0.739	13.250
140	0.4950	59.47	4.104	12.000
302	0.8480	59.67	4.556	12.000
303	0.8480	59.57	0.439	17.500
131	0.1429	65.31	1.163	12.000
130	0.2410	69.98	1.666	12.000
304	0.3839	68.24	2.829	12.000
610	0.0410	64.56	0.424	11.750
355	0.4249	67.89	3.225	12.000
1321	0.0840	52.66	0.707	11.750
580	0.0840	34.17	0.126	11.500
590	0.0840	18.50	0.581	11.750
305	0.4249	71.55	3.768	12.000
307	0.4249	61.31	0.688	13.750
1322	0.0260	40.32	0.187	12.000
134	0.0170	47.77	0.275	11.750
502	0.0430	43.27	0.455	11.750
366	0.4679	59.65	0.695	13.750
408	1.3159	59.60	1.091	13.750
400	0.2090	60.20	2.111	11.750
309	0.2090	60.20	1.573	12.250
310	1.5249	59.68	2.194	12.250
530	0.0430	32.22	0.226	12.000
500	0.0650	64.68	0.446	12.000
505	0.1120	65.83	1.073	11.750
311	0.1550	56.51	1.285	11.750
313	0.2200	58.92	1.722	12.000
7510	0.1690	75.14	2.140	11.750
8510	0.0730	88.34	1.026	11.750
9510	0.0730	72.84	1.021*	11.750
510	0.2420	74.45	3.162	11.750
7512	0.0940	74.65	1.186	11.750
8512	0.0400	88.34	0.562	11.750
9512	0.0400	52.95	0.285	12.250
512	0.1340	68.17	1.187	11.750
317	0.3760	72.21	4.349	11.750
3170	0.5960	67.31	6.026	11.750
7620	0.1200	74.74	1.516	11.750
8620	0.0510	88.34	0.717	11.750
9620	0.0510	75.58	0.713*	11.750
620	0.1710	74.99	2.230	11.750
312	0.7670	69.02	8.255	11.750
6510	0.7670	68.88	0.521	14.500
600	0.0740	40.35	0.512	12.000
318	0.8410	66.37	0.789	12.000

Note: * Storage/outflow table exceeded
Rating curve exceeded

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HYDROGRAPH NUMBER	UPSTREAM DRAINAGE AREA-Sq. Km.	VOLUME mm	PEAK DISCHARGE cms	TIME TO PEAK HRS.
319	2.3659	62.06	2.864	12.250
133	0.0420	60.24	0.477	11.750
321	0.0420	53.53	0.280	11.750
320	0.0420	6.71	0.197	11.750
120	0.1500	59.15	1.408	11.750
322	0.1920	57.92	1.698	11.750
324	0.1920	49.57	0.162	13.500
325	2.3659	62.18	2.864	12.250
311	0.0110	81.72	0.175	11.750
327	0.0110	73.89	0.110	11.500
326	0.0110	7.83	0.065	11.750
328	2.3659	62.22	2.864	12.250
329	2.3659	62.22	2.864	12.250
330	2.5579	61.27	2.958	12.250
110	0.0990	37.63	0.842	11.750

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00001>          GAWSER V6.9.12 - Released -Sept. 30, 2010
00002>          =====
00003>
00004>          LAUREL CREEK WATERSHED MODEL (BASINS 301
00005>          EVENT FILE : 100 Year Return Period, SCS
00006>          OCTOBER,1991
00007>          =====
00008>
00009>          Input file 1=100a.evt
00010>          Input file 2=9349.SWM
00011>          Output file =9349 100.LST
00012> * =====
00013> * CODING BY D.G. JONES, OCTOBER, 1991 (revised September 2001, D.Eadie)
00014> * =====
00015> *
00016> ***** CALIBRATION PARAMETERS FOR DOWNSTREAM OF *****
00017> ***** THE LAUREL CREEK RESERVOIR *****
00018>
00019> * Revised Calibration parameters by Dwight Boyd, July 1992
00020> *
00021> START          KUNITS=2  TOTAL DRAINAGE AREA:  TDA=42.736 SQ KM
00022>          BASEFLOW AT OUTLET:  QBSS=0.0  QBGW=0.01 CMS
00023>          PRINT OPTIONS:  ECHO=3  OUTPUT=1  PLOTS=0  RCS=1  SUBW=1
00024>          PLOT CUTOFF TIME =75 HRS  SUM=0  FREE=1000
00025>          PARAMETER ADJUSTMENT FACTORS:  FDS=1.00  FKEPF=0.60
00026>          FCS=1.0  FD=1.0  FSAV=1.0  FKO=2.50  FKSS=1.0  FKMP=1
00027>          INITIAL SOIL/SNOW WATER CONTENT FACTORS:
00028>          FIMCI=1.0  FIMCII=1.0  FIWE=1.0
00029>          GLOBAL RAINFALL SCALING FACTOR:  GPRF=1
00030>          SIMULATION CONTROLS:  TTI=0.25  IDEL=2  HOURS=120
00031>          SUBWATERSHED INITIAL BASEFLOWS IN CMS -999
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00040>
00041>          OUTFLOW HYDROGRAPH SUMMARY
00042>          =====
00043>
00044>          LAUREL CREEK WATERSHED MODEL (BASINS 301
00045>          EVENT FILE : 100 Year Return Period, SCS
00046>          OCTOBER,1991
00047>
00048>
00049>          HYDROGRAPH      UPSTREAM      PEAK      TIME TO
00050>          NUMBER          DRAINAGE      DISCHARGE      PEAK
00051>          -----          AREA-Sq.km.      cms          HRS.
00052>          -----
00053>          150      0.3530      76.08      3.242      12.000
00054>          301      0.3530      75.71      1.583      12.750
00055>          140      0.4950      75.18      5.321      12.000
00056>          302      0.8480      75.40      5.851      12.000
00057>          303      0.8480      75.28      0.543      17.250
00058>          131      0.1429      81.94      1.488      12.000
00059>          130      0.2410      87.40      2.115      12.000
00060>          304      0.3839      85.37      3.603      12.000
00061>          610      0.0410      81.07      0.544      11.750
00062>          355      0.4249      84.96      4.110      12.000
00063>          1321      0.0840      67.54      0.966      11.750
00064>          580      0.0840      39.62      0.126      11.500
00065>          590      0.0840      27.92      0.840      11.750
00066>          305      0.4249      90.48      4.881      12.000
00067>          307      0.4249      79.60      1.838      12.750
00068>          1322      0.0260      52.98      0.255      12.000
00069>          134      0.0170      61.67      0.353      11.750
00070>          502      0.0430      56.42      0.600      11.750
00071>          366      0.4679      77.47      1.905      12.750
00072>          308      1.3159      76.06      2.328      12.750
00073>          400      0.2090      76.02      2.732      11.750
00074>          309      0.2090      76.02      1.714      12.250
00075>          310      1.5249      76.05      3.823      12.750
00076>          530      0.0430      44.05      0.341      12.000
00077>          500      0.0650      81.21      0.571      12.000
00078>          505      0.1120      82.56      1.373      11.750
00079>          311      0.1550      71.88      1.710      11.750
00080>          313      0.2200      74.63      2.253      12.000
00081>          7510      0.1690      93.34      2.687      11.750
00082>          8510      0.0730      108.63      1.260      11.750
00083>          9510      0.0730      93.14      1.214      12.000
00084>          510      0.2420      93.28      3.796      11.750
00085>          7512      0.0940      92.77      1.490      11.750
00086>          8512      0.0400      108.63      0.691      11.750
00087>          9512      0.0400      73.22      0.581      12.000
00088>          512      0.1340      86.94      1.850      12.000
00089>          317      0.3760      91.02      5.352      12.000
00090>          3170      0.5960      84.97      7.606      12.000
00091>          7620      0.1200      92.87      1.904      11.750
00092>          8620      0.0510      108.63      0.880      11.750
00093>          9620      0.0510      95.88      0.855      12.000
00094>          620      0.1710      93.77      2.672      11.750
00095>          312      0.7670      86.93      10.186      11.750
00096>          6510      0.7670      86.79      0.686      14.250
00097>          600      0.0740      53.02      0.698      12.000
00098>          318      0.8410      83.82      1.049      12.000
00099>
00100> Note: * Storage/outflow table exceeded
00101> # Rating curve exceeded
00102>
00103>          OUTFLOW HYDROGRAPH SUMMARY
00104>          =====
00105>
00106>          LAUREL CREEK WATERSHED MODEL (BASINS 301
00107>          EVENT FILE : 100 Year Return Period, SCS
00108>          OCTOBER,1991
00109>
00110>          HYDROGRAPH      UPSTREAM      PEAK      TIME TO
00111>          NUMBER          DRAINAGE      DISCHARGE      PEAK
00112>          -----          AREA-Sq.km.      cms          HRS.
00113>          -----
00114>          319      2.3659      78.81      4.648      12.750
00115>          133      0.0420      76.15      0.622      11.750
00116>          321      0.0420      63.43      0.280      11.500
00117>          320      0.0420      12.72      0.342      11.750
00118>          120      0.1500      74.90      1.847      11.750
00119>          322      0.1920      72.39      2.127      11.750
00120>          324      0.1920      63.19      0.185      13.500
00121>          325      2.3659      79.04      4.648      12.750
00122>          311      0.0110      100.97      0.225      11.750
00123>          327      0.0110      84.76      0.110      11.500
00124>          326      0.0110      16.21      0.115      11.750
00125>          328      2.3659      79.11      4.648      12.750
00126>          329      2.3659      79.11      4.393      12.750
00127>          330      2.5579      77.92      4.574      12.750
00128>          110      0.0990      50.08      1.204      11.750

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00001>          GAWSER V6.9.12 - Released -Sept. 30, 2010
00002>          =====
00003>          LAUREL CREEK WATERSHED MODEL (BASINS 301
00004>          EVENT FILE : REGIONAL STORM
00005>          OCTOBER, 1991
00006>          =====
00007>
00008>
00009>          Input file 1=REG1.EVT
00010>          Input file 2=9349.swm
00011>          Output file =9349_reg.LST
00012> * =====
00013> * CODING BY D.G. JONES, OCTOBER, 1991
00014> * =====
00015> * REG1.EVT CREATED BY D.BOYD SEPT/92 PKEFF SET TO 0.3, PCS SET TO 0.35
00016> * AND PD SET TO 0.35 THESE PARAMETER SETTINGS ARE CONSISTENT WITH REGIONAL
00017> * RUNS IN THE GRAND RIVER HYDROLOGY STUDY AND THE SPEED AND ERAMOSA STUDY
00018>
00019> ***** CALIBRATION PARAMETERS FOR DOWNSTREAM OF *****
00020> ***** THE LAUREL CREEK RESERVOIR *****
00021> *
00022> START          KUNITS=2  TOTAL DRAINAGE AREA:  TDA=42.736 SQ KM
00023>          BASEFLOW AT OUTLET:  QBSS=0.0  QBGW=0.01 CMS
00024>          PRINT OPTIONS:  ECHO=3  OUTPRT=1  PLOT=0  RCS=1  SUBW=1
00025>          PLOT CUTOFF TIME =75 HRS  SUM=0  FREE=1000
00026>          PARAMETER ADJUSTMENT FACTORS:  FDS=1.0  FKFEFF=0.30
00027>          PCS=0.35  PD=0.35  FSAV=1.0  FK0=3.00  FKSS=1.0  FKMF=1
00028>          INITIAL SOIL/SNOW WATER CONTENT FACTORS:
00029>          FIMCI=1.0  FIMCII=1.0  FIWE=1.0
00030>          GLOBAL RAINFALL SCLING FACTOR:  GFRF=0.963
00031>          SIMULATION CONTROLS:  TTI=0.25  IDEL=2  HOURS=72
00032>          SUBWATERSHED INITIAL BASEFLOWS IN CMS -999
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00042>          OUTFLOW HYDROGRAPH SUMMARY
00043>          =====
00044>
00045>          LAUREL CREEK WATERSHED MODEL (BASINS 301
00046>          EVENT FILE : REGIONAL STORM
00047>          OCTOBER, 1991
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HYDROGRAPH NUMBER	UPSTREAM DRAINAGE AREA-Sq. km.	VOLUME mm	PEAK DISCHARGE cms	TIME TO PEAK HRS.
150	0.3530	209.16	3.593	46.250
301	0.3530	208.62	3.580*	46.750
140	0.4950	207.56	5.537	46.250
302	0.8480	208.00	9.112	46.250
303	0.8480	207.01	9.868	49.750
131	0.1429	219.84	1.538	46.250
130	0.2410	228.70	2.329	47.000
304	0.3839	225.41	3.839	46.250
610	0.0410	218.43	0.500	46.000
355	0.4249	224.73	4.328	46.250
1321	0.0840	189.47	0.997	46.000
580	0.0840	84.78	0.126	40.000
590	0.0840	104.69	0.871	46.000
305	0.4249	245.43	5.180	46.250
307	0.4249	234.72	5.053	46.500
1322	0.0260	168.33	0.294	46.250
134	0.0170	182.78	0.223	46.000
502	0.0430	174.04	0.517	46.000
366	0.4679	229.15	5.509	46.500
308	1.3159	214.88	6.264	46.500
400	0.2090	209.41	2.563	46.000
309	0.2090	209.41	1.905	47.250
310	1.5249	214.13	8.114	46.500
530	0.0430	138.09	0.471	46.000
500	0.0650	218.51	0.634	46.250
505	0.1120	220.92	1.314	46.000
311	0.1550	197.94	1.785	46.000
313	0.2200	204.02	2.410	46.250
7510	0.1690	240.26	2.175	46.000
8510	0.0730	267.57	0.949	46.000
9510	0.0730	250.59	0.944*	46.000
510	0.2420	243.37	3.119	46.000
7512	0.0940	239.26	1.209	46.000
8512	0.0400	267.56	0.520	46.000
9512	0.0400	221.76	0.520	46.000
512	0.1340	234.03	1.729	46.000
317	0.3760	240.05	4.848	46.000
3170	0.5960	226.75	7.234	46.000
7620	0.1200	239.49	1.544	46.000
8620	0.0510	267.57	0.663	46.000
9620	0.0510	253.00	0.654	46.000
620	0.1710	243.52	2.198	46.000
312	0.7670	230.49	9.432	46.000
6510	0.7670	230.35	8.371	46.500
600	0.0740	168.35	0.821	46.250
318	0.8410	224.89	9.152	46.500

Note: * Storage/outflow table exceeded
Rating curve exceeded

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00102>
00103>          OUTFLOW HYDROGRAPH SUMMARY
00104>          =====
00105>
00106>          LAUREL CREEK WATERSHED MODEL (BASINS 301
00107>          EVENT FILE : REGIONAL STORM
00108>          OCTOBER, 1991
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HYDROGRAPH NUMBER	UPSTREAM DRAINAGE AREA-Sq. km.	VOLUME mm	PEAK DISCHARGE cms	TIME TO PEAK HRS.
319	2.3659	217.96	17.266	46.500
133	0.0420	207.85	0.541	46.000
321	0.0420	178.64	0.280	45.500
320	0.0420	29.21	0.261	46.000
120	0.1500	205.40	1.797	46.000
322	0.1920	199.55	2.077	46.000
324	0.1920	191.44	1.912	46.500
325	2.3659	218.48	17.439	46.500
311	0.0110	213.17	0.150	46.000
327	0.0110	200.75	0.110	45.250
326	0.0110	12.42	0.040	46.000
328	2.3659	218.53	17.439	46.500
329	2.3659	218.53	17.315	46.750
330	2.5579	216.50	19.205	46.750

APPENDIX D

Water Balance Calculations

TABLE 5 - PRE-DEVELOPMENT WATER BALANCE

Model Type: Thornthwaite and Mather (1955)
Client: City of Waterloo
Location: **Water Balance - West Side Employment Lands**
Total Site Area (ha): 43.74

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Hilly, Fine Glaciolacustrine (Silt to Clay), Moderately Rooted Crops
Sub-Area B	Hilly, Fine Glaciolacustrine (Silt to Clay), Pasture to Bare Soil
Sub-Area C	Hilly, Fine Glaciolacustrine (Silt to Clay), Urban Lawn (Golf Course)

Land Description Factors	Sub-Area A	Sub-Area B	Sub-Area C											Total
Topography	0.10	0.10	0.10											
Soils	0.15	0.15	0.15											
Cover	0.10	0.15	0.05											
Sum (Infiltration Factor) [†]	0.35	0.40	0.30											
Soil Moisture Capacity (mm)	200	250	113											
Site area (ha)	15.22	10.52	18.00											43.74
Imperviousness Coefficient	0.00	0.07	0.00											
Impervious Area (ha)	0.00	0.74	0.00											0.74
Percentage of Total Site Area	0.0%	1.7%	0.0%											2%
Remaining Pervious Area (ha)	15.22	9.78	18.00											43.00
Total Pervious Site Area (ha)	15.22	9.78	18.00											43.00
Percentage of Total Site Area	34.8%	22.4%	41.2%											98%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Climate Data [†]													
Average Daily Temperature (°C)	-6.5	-5.4	-1	6.5	12.7	18.2	20.5	19.5	15.2	8.7	2.6	-3.5	7.3
Precipitation (mm)	68.1	54.6	55.0	77.2	87.9	76.3	98.2	83.9	85.4	75.3	88.4	68.5	919

Potential Evapotranspiration Analysis for Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heat Index	0.0	0.0	0.0	1.5	4.1	7.1	8.5	7.9	5.4	2.3	0.4	0.0	37
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.4	60.6	89.5	101.8	96.4	73.6	40.3	10.9	0.0	502
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET) (mm)	0	0	0	33	75	115	128	112	77	37	9	0	585
Precipitation - PET (mm)	68	55	55	44	13	-39	-30	-28	9	38	80	69	333

Evapotranspiration Analysis													
Sub-Area A	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-39	-69	-97	-88	-50	0	0	
Storage (S)	200	200	200	200	200	165	117	72	81	119	200	200	
Change in Storage	0	0	0	0	0	-35	-48	-45	9	38	81	0	
Actual Evapotranspiration (mm)	0	0	0	33	75	112	146	129	77	37	9	0	616
Recharge/Runoff Analysis													
Water Surplus (mm)	68	55	55	44	13	0	0	0	0	0	-1	69	302
Potential Infiltration (I)	24	19	19	16	5	0	0	0	0	0	-1	24	106
Potential Direct Surface Water Runoff (R)	44	35	36	29	9	0	0	0	0	0	-1	45	197
Potential Infiltration (mm)	0	0	0	102	5	0	0	0	0	0	-1	0	106
Pervious Evapotranspiration (m ³)	0	0	0	5004	11339	16973	22231	19610	11682	5630	1339	0	93,808
Pervious Runoff (m ³)	6737	5402	5441	4385	1325	0	0	0	0	0	-145	6777	29,922
Pervious Infiltration (m ³)	0	0	0	15476	714	0	0	0	0	0	-78	0	16,112
Potential Impervious Evaporation (mm)	7	5	6	8	9	8	10	8	9	8	9	7	92
Potential Impervious Runoff (mm)	61	49	50	69	79	69	88	76	77	68	80	62	827
Impervious Runoff (m ³)	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 5 - PRE-DEVELOPMENT WATER BALANCE

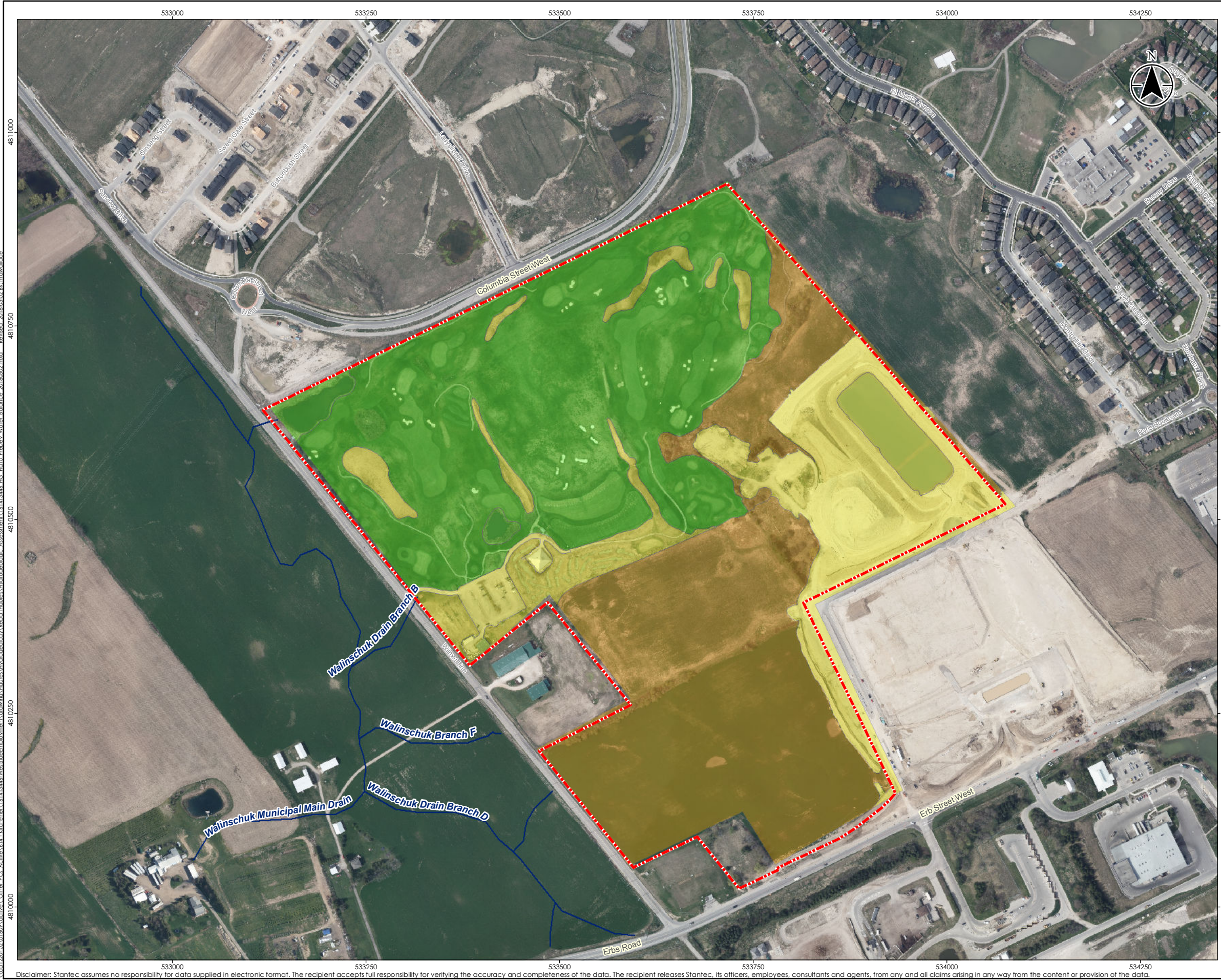
Evapotranspiration Analysis													
Sub-Area B	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-39	-69	-97	-88	-50	0	0	
Storage (S)	250	250	250	250	250	214	163	110	119	157	250	250	
Change in Storage	0	0	0	0	0	-36	-51	-52	9	38	93	0	
Actual Evapotranspiration (mm)	0	0	0	33	75	112	150	136	77	37	9	0	628
Recharge/Runoff Analysis													
Water Surplus (mm)	68	55	55	44	13	0	0	0	0	0	-13	69	291
Potential Infiltration (I)	27	22	22	18	5	0	0	0	0	0	-5	27	116
Potential Direct Surface Water Runoff (R)	41	33	33	27	8	0	0	0	0	0	-8	41	175
Potential Infiltration (mm)	0	0	0	116	5	0	0	0	0	0	-5	0	116
Pervious Evapotranspiration (m ³)	0	0	0	3216	7289	10976	14636	13329	7510	3619	861	0	61,436
Pervious Runoff (m ³)	3998	3205	3229	2602	786	0	0	0	0	0	-767	4021	17,074
Pervious Infiltration (m ³)	0	0	0	11370	524	0	0	0	0	0	-511	0	11,382
Potential Impervious Evaporation (mm)	7	5	6	8	9	8	10	8	9	8	9	7	92
Potential Impervious Runoff (mm)	61	49	50	69	79	69	88	76	77	68	80	62	827
Impervious Runoff (m ³)	451	362	365	512	583	506	651	556	566	499	586	454	6,089

Evapotranspiration Analysis													
Sub-Area C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-39	-69	-97	-88	-50	0	0.0	
Storage (S)	113	113	113	113	113	80	44	19	27	65	113	113.0	
Change in Storage	0	0	0	0	0	-33	-37	-25	9	38	48	0	
Actual Evapotranspiration (mm)	0	0	0	33	75	109	135	109	77	37	9	0	583
Recharge/Runoff Analysis													
Water Surplus (mm)	68	55	55	44	13	0	0	0	0	0	32	69	336
Potential Infiltration (I)	20	16	17	13	4	0	0	0	0	0	10	21	101
Potential Direct Surface Water Runoff (R)	48	38	39	31	9	0	0	0	0	0	22	48	235
Potential Infiltration (mm)	0	0	0	87	4	0	0	0	0	0	10	0	101
Pervious Evapotranspiration (m ³)	0	0	0	5917	13410	19637	24248	19634	13816	6658	1584	0	104,905
Pervious Runoff (m ³)	8581	6880	6930	5585	1688	0	0	0	0	0	4041	8631	42,335
Pervious Infiltration (m ³)	0	0	0	15688	723	0	0	0	0	0	1732	0	18,144
Potential Impervious Evaporation (mm)	7	5	6	8	9	8	10	8	9	8	9	7	92
Potential Impervious Runoff (mm)	61	49	50	69	79	69	88	76	77	68	80	62	827
Impervious Runoff (m ³)	0	0	0	0	0	0	0	0	0	0	0	0	0

Pre-Development Infiltration	45,638	(m ³ /yr)	104	mm/yr	1.4	L/s
Pre-Development Runoff	95,420	(m ³ /yr)	218	mm/yr	3.0	L/s
Pre-Development Evapotranspiration	260,149	(m ³ /yr)	595	mm/yr	8.2	L/s

Notes:
† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995.
MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.
* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.
‡ Climate Data after Environment Canada, 2017. Canadian Climate Normals 1981-2010, Roseville, Climate ID 6147188. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html Accessed August 17 2017.
N/A - Not Applicable

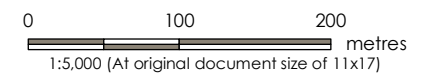
Assumptions:
[1] The monthly average precipitation collected at the Roseville climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration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



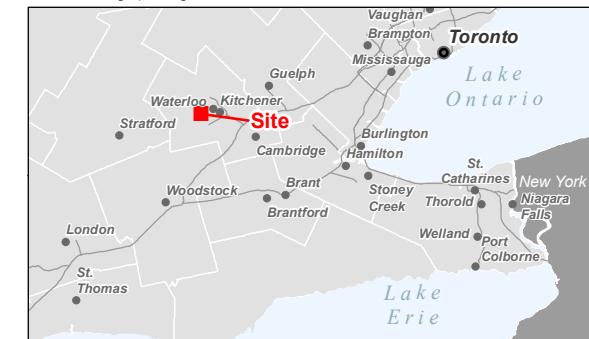
Legend

- Site
- Constructed Drain
- A - Moderate Rooted Crops
- B - Pasture / Bare Soil
- C - Urban Lawn

Sub-Area	Area (ha)
A - Moderate Rooted Crops	15.22
B - Pasture / Bare Soil	10.52
C - Urban Lawn	18.00



- Notes**
- Borehole Locations are Approximate
 - Existing Boreholes from 2004/2010 CH2MHILL Investigation and 2013 Stantec Investigation.
 - Coordinate System: NAD 1983 UTM Zone 17N
 - Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2016.
 - Orthomagery © Region of Waterloo, 2016.



Project Location
Waterloo, Ontario

161413446 REV A
Prepared by PRM on 2018-03-02
Technical Review by GW on 2017-11-30

Client/Project
WEST SIDE EMPLOYMENT LANDS
CITY OF WATERLOO
HYDROGEOLOGIC ASSESSMENT

Figure No.
10

Title
Pre-Development Water Balance Sub-Areas

Monthly Water Balance Analysis - Subdivision
161413446 - Waterloo Westside Employment Lands
Post-Development

Land Cover Descriptions
urban lawn

Clay loam

Rolling Land, average slope 2.8 m to 3.8 m/km (0.3%)

Main Site Area (ha)	43.0			
Impervious Cover	80%			
Land Description Factors			Impervious	Perm. Pool
Topography	0.20		-	-
Soils	0.15		-	-
Cover	0.05		-	-
Sum (Infiltration Factor)	0.40		-	-
Soil Moisture Capacity (mm)	100		-	-
Site Area	8.6		34.40	
Percentage of Total Site Area	20%		80%	0%

100% OK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Comment
Climate Data (Data from Roseville Climate Station, Canadian Climate Normals, 1981-2010)														
Average Daily Temperature (°C)	-6.5	-5.4	-1.0	6.5	12.7	18.2	20.5	19.5	15.2	8.7	2.6	-3.5		Daily average temperature in each month
Precipitation (mm)	68.1	54.6	55.0	77.2	87.9	76.3	98.2	83.9	85.4	75.3	88.4	68.5	918.8	
Evapotranspiration Analysis														
Saturation Vapour Pressure (mb)	3.75	4.08	5.68	9.69	14.71	20.95	24.18	22.73	17.31	11.27	7.37	4.72		
PET (Malstrom, 1969) (mm/month)	0.00	0.00	0.00	39.63	60.18	85.70	98.90	92.96	70.80	46.08	30.14	0.00	524.4	
Infiltration - PET (mm)	68.10	54.60	55.00	37.57	27.72	-9.40	-0.70	-9.06	14.60	29.22	58.26	68.50		
Weighted Soil Storage Capacity (mm)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Actual Soil Moisture (mm)	100.00	100.00	100.00	100.00	100.00	90.60	89.90	80.84	95.44	100.00	100.00	100.00		Assume April soil moisture is at max capacity (i.e., saturated)
Change in Soil Moisture (mm)	0.00	0.00	0.00	0.00	0.00	-9.40	-0.70	-9.06	14.60	4.56	0.00	0.00		
Actual Evapotranspiration (mm)	0.00	0.00	0.00	39.63	60.18	85.70	98.90	92.96	70.80	46.08	30.14	0.00	524.4	
Recharge/Runoff Analysis - Pervious Areas														
Surplus	68.1	54.6	55.0	37.6	27.7	0.0	0.0	0.0	0.0	24.7	58.3	68.5	394.4	
Deficit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Weighted Infiltration Factor	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40		Based on MOE SWM Manual (2003)
Runoff (mm)	0.00	0.00	0.00	170.26	16.63	0.00	0.00	0.00	0.00	14.80	34.95	0.00	236.6	Assume no runoff in sub-zero months
Recharge (mm)	0.00	0.00	0.00	113.51	11.09	0.00	0.00	0.00	0.00	9.87	23.30	0.00	157.8	

Volume-Based Balance (m³)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Precipitation	29,283	23,478	23,650	33,196	37,797	32,809	42,226	36,077	36,722	32,379	38,012	29,455	395,084	Roseville Climate Station
Evapotranspiration	0	0	0	3,409	5,175	7,370	8,506	7,994	6,089	3,963	2,592	0	45,098	
Total Evap	0	0	0	3,409	5,175	7,370	8,506	7,994	6,089	3,963	2,592	0	45,098	105 mm/year
Pervious Runoff	0	0	0	14,642	1,430	0	0	0	0	1,273	3,006	0	20,351	47 mm/year
Impervious Runoff	0	0	0	111,250	30,238	26,247	33,781	28,862	29,378	25,903	30,410	0	316,067	735 mm/year
Total Runoff	0	0	0	125,892	31,668	26,247	33,781	28,862	29,378	27,176	33,416	0	336,419	782 mm/year
Groundwater Recharge from Pervious Areas	0	0	0	9,762	954	0	0	0	0	848	2,004	0	13,568	32 mm/year

Infiltration Augmentation														
Rooftop Recharge	0	0	0	14,639	3,979	3,454	4,445	3,798	3,866	3,408	4,001	0	41,590	97 mm/year - Assuming 80% of roof top runoff is captured and infiltrated and the first 25 mm of rainfall accounts for 80% of the annual rainfall volume
Final Recharge	0	0	0	24,400	4,932	3,454	4,445	3,798	3,866	4,257	6,005	0	55,157	128 mm/year - Including infiltration from pervious and rooftop areas and potentially other LID features in the multi block
Final Runoff	0	0	0	111,253	27,689	22,793	29,336	25,064	25,512	23,767	29,414	0	294,829	686 mm/year - assuming infiltration of rooftop areas
Final Recharge Surplus	0	0	0	-6,629	1,901	3,454	4,445	3,798	3,866	1,560	-365	0	9,519	22 mm/year
Final Runoff Surplus	0	0	0	18,164	18,595	22,793	29,336	25,064	25,512	15,676	10,303	0	199,409	464 mm/year

Notes:
Existing recharge, runoff and ET values taken from Hydrogeological Investigation (Stantec, 2017) and applied to this analysis to determine surplus and deficit values
Impervious coverage of 80% taken from assumptions made in *West Waterloo Commercial Centre, Waterloo, Ontario Final Stormwater Management Report* (Stantec, 2014)
Area of development blocks is total area of subject lands (43 ha) minus the Draft Plan of Subdivision areas of roads, walkways, servicing corridors, and reserve (total area 5.3 ha)
The 25 mm rainfall event represents 80% of the average annual rainfall volume (from the *Former Sun Valley Property Stormwater Management Report* , July 1992)
The 10 mm rainfall event represents 60% of the average annual rainfall volume (from the *Former Sun Valley Property Stormwater Management Report* , July 1992)

Assumptions:
Target is to match pre-development infiltration rates; assume approval will be received prior to MOECP retention guidelines being released
Employment lands have average rooftop coverage of 25% of the total lot