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ORO-MEDONTE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

Township of Oro-Medonte

Municipal Class Environmental Assessment

Final Report

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1 Introduction

C.C. Tatham & Associates Ltd. (CCTA) was retained by the Township of Oro-Medonte (Township) to prepare a Comprehensive Stormwater Management (SWM) Master Plan for all settlement areas within the Township that are located in the Lake Simcoe watershed in accordance with the Lake Simcoe Protection Act, 2008.

The Township is located along the northwest shoreline of Lake Simcoe and is bounded by Lake Simcoe to the southeast, the City of Orillia to the northeast, the City of Barrie to the southwest, and the Townships of Severn, Tay, Springwater to the north, northwest and west, respectively. Seven settlement areas are the focus of this study and are located within the Lake Simcoe Region Conservation Authority (LSRCA) jurisdiction area. Their locations are shown on Figure .

1.1 General Background

In December 2008, the Lake Simcoe Protection Act was passed by the Ontario Legislature and the Lake Simcoe Protection Plan (LSPP) followed in July 2009. The intent of the LSPP is to protect and restore the ecological health of Lake Simcoe and its watershed and it includes SWM policies to improve the management of stormwater runoff from both existing and future development. LSPP Policy 4.5 SA states that within 5 years of the date the plan came into effect (i.e by July 2014) municipalities in collaboration with the LSRCA, must prepare and implement Comprehensive SWM Master Plans for their settlement areas located in the Lake Simcoe watershed. The SWM Master Plans will serve as a tool for municipalities to use for improving existing drainage infrastructure (including SWM ponds). It will also define a strategy to establish guidelines to manage stormwater and reduce phosphorus loadings prior to and following development including an evaluation of stormwater retrofit opportunities.

1.2 Background Reports and Data Gap Analysis

This report was prepared using a number of past reports and guidelines on water resources and the environment, including the following publications:

Provincial Policy Statement, Ministry of Municipal Affairs and Housing, 2014;

Technical Guidelines for Stormwater Management Submissions, LSRCA, April 26, 2013;

Township of Oro-Medonte Engineering Design Criteria, CCTA, 2013;

Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed, Hutchinson Environmental Sciences Ltd, Greenland International Consulting Ltd. and Stoneleigh Associates Inc., March 2012;

Lake Simcoe Region Conservation Authority Watershed Development Policies, LSRCA, March 2012;

The Approved Assessment Report Lake Simcoe and Couchiching – Black River Source Protection Area, Part 1: Lake Simcoe Watershed, LSRCA, Nottawasaga Valley Conservation Authority and Severn Sound Environmental Associations, November 2011;

Comprehensive Stormwater Management Master Plan Guidelines, LSRCA, April 2011;

Township of Oro-Medonte Zoning By-Law Schedule Drawings, Township of Oro-Medonte, January 2011;

Estimation of the Phosphorus Loadings to Lake Simcoe, The Louis Berger Group Inc., September 2010;

Lake Simcoe Phosphorus Reduction Strategy, Ministry of the Environment, June 2010;

Lake Simcoe Protection Plan, Ministry of the Environment (MOE), July 2009;

Hawkestone Creek Watershed Hydrology Study, LSRCA, February 2009

Lake Simcoe Region Conservation Authority Integrated Watershed Management Plan, LSRCA, June 2008;

County of Simcoe Official Plan, County of Simcoe, August 2007;

Natural Heritage System for the Lake Simcoe Watershed Phase 1: Components and Policy Templates, LSRCA, July 2007;

Stormwater Management Practices Planning and Design Manual, MOE 2003;

Natural Hazard Technical Guide, Ministry of Natural Resources, 2001.

1.2.1 Data Gap Analysis

CCTA reviewed the background reports and has utilized the available information from the LSRCA, County of Simcoe (County) and the Township to identify data gaps that are required in order to fulfil the completion of a Master Plan.

Specifically, for this study, an existing and future condition hydrologic analysis of the Study Area is required as well as identification of development constraint areas. Phosphorus loading and water balance calculations are also required. A data gap with respect to erosion analyses along the receiving watercourses downstream of future development areas was identified by the LSRCA in our preconsultation for inclusion as part of the Master Plan and is required to meet the policies of the LSPP.

The available sources of land use data were also reviewed in detail and it was determined it could lead to discrepancies in the modelling due to the varying land use designations used by different data

sources. The land use categories in the Existing Land Category (ELC) GIS file provided by the LSRCA differ from the land use categories in the Township of Oro-Medonte Zoning By-Law Schedule Drawings (Official Plan, OP) CAD file used by the Township. This presented challenges when trying to accurately represent the land types as curve numbers (CN), runoff coefficients (RC), impervious percentages, and phosphorus loading categories (which are based on existing land uses, but again can differ from both the ELC and OP categories). The most frequent occurrence to consider was presented when an existing developed area had a different zoning category for future development (i.e. existing development that is categorized as urban by ELC is classified as rural residential or open space in the OP thus requiring different corresponding design parameters). We reviewed this issue in detail, and have created 'Land Use Conversion Tables' to most accurately interpret and adjust the land uses.

A SWM facility inventory created by CCTA in 2009 was used as a major data source related to information on existing SWM facilities. This information was derived from the available background SWM reports and drainage studies and plan and was verified in the field in August 2014 as a component of this study.

1.3 Master Planning Class Environmental Assessment Process

The Comprehensive SWM Master Plan (CSWM MP) was developed following the Municipal Engineers Association Municipal Class EA process for Master Plans to meet the requirements of the Ontario Environmental Assessment Act (OEAA) for municipal infrastructure without having to undertake individual EAs or requesting a specific exemption from the project. The Municipal Class EA is a planning and design process to identify, compare and evaluate alternative solutions to a problem. It considers all aspects of the environment: natural, social, cultural and economic, and involves consultation with the public, affected parties and review agencies throughout the process.

Master Plans are long-range plans that integrate infrastructure improvements for existing and future land uses with environmental assessment planning principles.

This CSWM MP is proceeding through the first two phases of the Class EA process:

Phase 1: Identify the problem

Phase 2: Identify and assess, at a strategic level, alternative solutions, then recommend the preferred Master Plan that can be implemented as separate subsequent projects.

A Public Information Centre (PIC) was held on September 18, 2014 at the Township Administration Centre.

This CSWM MP has been prepared at the conclusion of Phases 1 and 2 of the Class EA process and made available for public comment prior to being approved and adopted by the Township.

Projects undertaken to implement the specific recommendations of this CSWM MP will be the subject of more detailed investigations to fulfil the documentation requirements of the Class EA process.

2 Problem and Opportunity Statement

Over the past several decades, the Lake Simcoe watershed has experienced pressures from human-related activities including urban and rural uses, which have impaired the heath of Lake Simcoe and its watershed. Excessive phosphorus loading has been identified as a key cause of the water quality degradation in Lake Simcoe. An estimated 1/3 of the phosphorus loadings to Lake Simcoe are from stormwater runoff.

The SWM policies of the LSPP require municipalities to prepare a CSWM MP for all settlement areas that are located in the Lake Simcoe watershed to improve the management of stormwater from existing and future development.

2.1 Study Goals, Objectives and Scope of Work

This CSWM MP will establish opportunities and constraints as they relate to stormwater quality and quantity and serve to establish a comprehensive master drainage and SWM framework to identify existing SWM improvement opportunities and to guide all future development in each settlement area. The implementation of drainage improvements will result in opportunities to minimizing erosion, phosphorus loadings, and changes in water balance throughout the Lake Simcoe watershed which are in alignment with the overall objectives of the LSPP.

This CSWM MP has been developed according to the LSRCA Comprehensive Stormwater Management Master Plan Guidelines, dated April 26, 2011 to meet the intent of the LSPP.

This CSWM MP has been organized according to the ten steps of the LSRCA's Comprehensive Stormwater Management Master Plan Guidelines as follows:

- Step One - Scoping
- Step Two - Determine the Study Area for the Settlement Area
- Step Three – Develop a Characterization of the Study Area
- Step Four – Divide the Area into Management Units
- Step Five – Evaluate the Cumulative Environmental Impact of Stormwater from Existing and Planned Development
- Step Six – Determine the Effectiveness of Existing Stormwater Management Systems

- Step Seven – Identify and Evaluate Stormwater Improvement and Retrofit Opportunities
- Step Eight – Establish a Recommended Approach for Stormwater Management for the Study Area
- Step Nine – Develop an Implementation Plan for the Recommended Approaches
- Step Ten – Develop Programs for Inspection and Maintenance of Stormwater Management Facilities

3 Scoping (Step One)

The Township settlement areas that were considered in the CSWM MP were identified based on land use designations in the Township and County OP. All areas identified as Urban or Village Settlement that are located within the Lake Simcoe watershed were included. The selection of these areas is consistent with the requirements of Policy 4.5 of the LSPP, which defines settlement areas as "urban areas and rural settlement areas (e.g. cities, towns, villages and hamlets) where development is concentrated and lands are designated in municipal official plans for development over the long term". The following is the list of settlement areas that were considered. The locations of the settlement areas are shown on Figure .

- East Oro
- Forest Home
- Guthrie
- Hawkestone
- Oro Station
- Rugby
- Shanty Bay

The majority of the land within the Township of Oro-Medonte is not included within the boundary of these settlement areas and is agricultural/rural, with limited proposed future development. As such, these areas are not studied in as much detail due to limited opportunities for SWM improvements. They are considered from a general sense and many recommended SWM measures can be applied to these other Township areas not within the defined settlement areas.

Portions of Shanty Bay and Guthrie settlement areas are located outside of the Lake Simcoe watershed and instead drain to Georgian Bay via the Nottawasaga River. These areas have been included in the modelling analyses as described herein for completeness. The general characteristics of each settlement area are described in Section 5.

4 Determine the Study Area (Step Two)

The primary Study Area is comprised of the seven settlement areas (as listed above) including permanent and intermittent streams and upstream drainage areas which drain to each. The Study Area also includes land that is located downstream of the settlement areas to Lake Simcoe.

For the purposes of hydrologic modelling, all area upstream of the settlement areas, which are included in the overall Study Area and which drain through the settlement area have been modelled in order to determine peak flows at and downstream of the settlement areas. However, the areas upstream were not considered in the water balance and phosphorus budget calculations. The Study Area is illustrated on Figure .

5 Study Area Characterization (Step Three)

The Study Area has been characterized according to the applicable direction and policies and physical watershed characteristics separately as follows:

5.1 Direction and Policies

5.1.1 Provincial Policy Statement (April 2014)

The Provincial Policy Statement is issued under Section 3 of the Planning Act and is used by municipalities to develop their official plans and to make decisions on planning matters. All planning matters within the Study Area must be consistent with the Provincial Policy Statement.

5.1.2 Township of Oro-Medonte Engineering Design Criteria (May 2013)

The Township of Oro-Medonte Engineering Design Criteria May, 2013 includes requirements related to SWM for all development applications. Specifically, *Section 4.2.2 Stormwater Management* describes the SWM design requirements which are summarized as follows:

- Site specific stormwater management reports shall be consistent with any applicable background reports prepared by the Township or Conservation Authority (i.e., Watershed Planning Studies and/or SWM Master Plans, etc.), including the Lake Simcoe Protection Plan. SWM designs must also be prepared in accordance with LSRCA requirements.
- SWM reports shall address stormwater quality, stormwater quantity, sediment and erosion control, and baseflow maintenance. The hydrology of rural catchments and urban catchments shall be modelled with OTTHYMO using the SCS 24 hr design storm and 4 hr Chicago design storms respectively in addition to other design storms required by the LSRCA.

The above document also specifies SWM facility design requirements for dry ponds, wet ponds and wetlands.

5.1.3 LSRCA Technical Guidelines for SWM Submissions (April 2013)

The LSRCA Technical Guidelines for SWM Submissions applies to all future development located in areas regulated by LSRCA. This document provides detailed guidance regarding SWM requirements to satisfy the LSRCA Watershed Development Policies and the LSPP. A number of key policies from this document are summarized below:

- A 'treatment train' approach to SWM is encouraged, using lot level (including rooftop storage, rear yard storage, disconnected roof leaders), conveyance controls (including grassed swales pervious pipe systems) and end-of –pipe controls (including infiltration basins/trenches, oil grit separators, sand filters, dry ponds, wet ponds, hybrid ponds etc.).
- Quantity control is not required if a site is directly adjacent to Lake Simcoe with a safe outlet or connected to a municipal system that is designed to discharge uncontrolled flows from the site to the Lake.
- Unless specified otherwise by a subwatershed study, or fluvial geomorphic analysis, the post-development peak flow rates must not exceed pre-development peak flow rates for the 2, 5, 10, 25, 50 and 100 year design storm events.
- It is a developer's responsibility to demonstrate safe conveyance of the Regulatory Storm (the greater of the 100 year design storm or Hurricane Hazel/Timmins) through the development to a sufficient outlet, such that there are no adverse impacts to downstream landowners that result.
- The minimum level of water quality treatment required for any development within the LSRCA watershed is the Enhanced Protection Level as per MOE's SWM Planning and Design Manual (March 2003). This corresponds to the long-term removal of 80% of suspended solids.
- For all new major developments within the LSRCA, a phosphorous loading study is to be completed. Best efforts shall be employed to minimize any increase in loading.
- For all new major developments within the LSRCA, an evaluation of the site water balance must be completed.
- An erosion and sediment control plan must be provided for all new developments.
- The following design storms are to be used for modelling sites with drainage areas greater than 5 ha: Regional Storm event, 4 hour Chicago Distribution, 12 hour SCS Type II distributions, and any sub-watershed, watershed or master drainage plan storm distributions.

5.1.4 Growth Plan (2006, Office Consolidation 2013)

The Study Area is located within the Greater Golden Horseshoe as defined in the Growth Plan. The Growth Plan for the Greater Golden Horseshoe was prepared under the Places to Grow Act (2005)

and provides the principles for guiding decisions on how land is to be developed and how resources are to be managed. The Growth Plan provides population and employment forecasts and policies for municipalities to plan for forecasted growth.

5.1.5 LSRCA Watershed Development Policies (March 2012)

Section 6 of the LSRCA Watershed Development Policies identifies SWM criteria for development located within the Lake Simcoe watershed. The SWM criteria are defined in greater detail in the LSRCA technical guidelines for SWM submissions described above.

5.1.6 Phosphorus Reduction Strategy of LSPP (June 2010)

The Phosphorus Reduction Strategy is intended to serve as a long term framework to reduce annual phosphorus loading into Lake Simcoe to approximately 44 T/yr. Urban runoff and stormwater account for an estimated 31% of total phosphorus loads to Lake Simcoe. Specifically related to SWM, 160 retrofit opportunities have been identified in the Lake Simcoe watershed to reduce phosphorus loadings by approximately 4.2 T/yr via retrofitting quantity facilities (i.e. dry ponds) into water quantity and quality facilities (i.e. wet ponds. wet/dry ponds, and wetlands). Low Impact Development (LID) practices are encouraged for all new development to promote water retention onsite and to enhance the percolation of water through the soil. The goal of Phosphorus Reduction Strategy Direction #3 is no net increase in phosphorus loading from new development. Phosphorus reduction tools identified in the phosphorus reduction strategy document include:

- Enhanced level protection for all new SWM systems;
- Retrofit existing SWM facilities;
- Municipal options, e.g. Cash-In-Lieu offsetting program;
- Explore potential for treating stormwater before it is released into the watershed from new and existing developments;
- Improved clean-out frequency and maintenance of SWM systems;
- Implement innovative technologies and approaches (i.e LID, water re-use);
- Oil-grit separators in SWM systems;
- Public education and outreach programs;
- Reduce or eliminate phosphorus rich lawn fertilizers;
- Promote natural meadow field lawns that require little or no fertilizer and reduced lawn cutting; and
- Use of rain barrels to harvest rainwater for watering lawns.

5.1.7 Lake Simcoe Protection Plan (July 2009)

The LSPP was developed following the passing of the Lake Simcoe Protection Act, in December 2008. Chapter four of the LSPP describes the policies related to SWM for both existing and planned development. The specific policies from the LSPP related to SWM are summarized as follows:

4.5-SA Within five years, municipalities will prepare and implement comprehensive SWM Master Plans in accordance with the Municipal Class Environmental Assessment.

4.6 – SA Municipalities are encouraged to implement stormwater retrofits prior to completing a SWM master plan if a stormwater retrofit opportunity has been identified as a priority for a settlement area and is economically feasible.

4.7 – DP Municipalities incorporate into their official plans policies related to reducing stormwater runoff volume and pollutant loadings from major and existing development.

4.8 –DP An application for major development shall be accompanied by a SWM plan that demonstrates:

a. consistency with SWM master plans prepared under policy 4.5, when completed.

b. consistency with subwatershed evaluations prepared under policy 8.3 and water budgets prepared under policy 5.2 of the LSPP, when completed.

c. an integrated treatment train approach to minimize SWM flows and reliance on end-of-pipe controls through measures including source controls, lot-level controls and conveyance techniques.

d. through an evaluation of anticipated changes in the water balance between pre-development and post-development, how such changes shall be minimized; and

e. through an evaluation of anticipated changes in phosphorous loading between pre-development and post-development, how the loadings shall be minimized.

4.9-DP SWM works that are established to serve new major development must be designed to satisfy the Enhanced Protection level specified in Chapter 3 of the MOE's Stormwater Management Planning and Design Manual 2003.

4.10-DP Every owner and operator of a new SWM system shall be required to inspect and maintain the works on a periodic basis.

4.11-DP Every owner and operator of a new priority SWM system shall be required to monitor the operation of works, including monitoring the quality of the effluent from the work, on a periodic basis.

4.12-SA The MOE will review the approvals issued under section 53 of the Ontario Water Resources Act in respect of existing priority SWM works. If a review of an approval for an existing priority SWM system determines that the conditions in the approval are inadequate, having regard to the objectives of the Plan, including the conditions related to inspection, maintenance and monitoring, the approval will be referred to the Director for the purposes of determining whether an amendment to the approval is necessary to assist in meeting the objectives of the plan.

5.1.8 LSRCA Integrated Watershed Management Plan (June 2008)

The LSRCA Integrated Watershed Management Plan was prepared under Section 21 of the Conservation Authorities Act and provides expanded and updated information on the Lake Simcoe Environmental Management Strategy Document, State of the Lake Simcoe Watershed (2003). The Plan is intended to be a holistic road-map to provide future direction for the protection and rehabilitation of the Lake Simcoe watershed ecosystem.

5.1.9 County of Simcoe Official Plan (August 2007)

Section 3.3.16 of the County of Simcoe Official Plan requires a SWM report to accompany all plans of subdivision and condominium, the creation of more than five lots or units and all industrial, commercial and institutional development where impervious areas of over 1,000 square metres and/or chemical storage and use is proposed. The SWM report is to be prepared according to municipal, provincial and conservation authority requirements.

5.1.10 Township of Oro-Medonte Official Plan (March 2007)

The Township of Oro-Medonte Official Plan (OP) was approved by the County of Simcoe and the Ontario Municipal Board as of January, 2007. The OP characterizes the Township lands into landuse designations including: Environmental Protection, Agriculture, Rural, Economic Development, Institutional, Shoreline Residential Area, Rural Residential, Industrial, General Commercial, Local Commercial and Mineral Aggregate Resource Area, etc.

Section B5.1.6 of the Township's Official Plan identifies the requirements of Water Resource and Stormwater Management reports for all development proposals for any development that exceeds a combined area of 500 m^2. All SWM systems must be designed and operated according to provincial and LSRCA standards and regulations.

SWM facilities are permitted in any land use designation except the "Environmental Protection" designation.

5.1.11 MOE Stormwater Management Planning and Design Manual (March 2003)

The Ministry of the Environment (MOE) SWM Planning and Design Manual provides technical and procedural guidance for the planning, design, and review of SWM practices across Ontario. It is considered a baseline reference document for design and review of SWM applications for approval under Section 53 of the Ontario Water Resources Act as administered by the Ministry of the Environment. The following provides a summary of where to find key aspects in the document regarding SWM quality controls.

- Section 3.3.1.1 outlines the three water quality protection levels: Enhanced, Normal, and Basic.
- Section 3.3.2 (Table 3.2) outlines SWM facility volumetric sizing requirements based on the water quality protection level required, and the level of imperviousness of the contributing drainage area. The Enhanced Level is applicable to all developments within the LSRCA boundary.

5.1.12 Oro and Hawkestone Creeks Subwatershed Plan (2013)

The following are a number of relevant recommendations and conclusions from the Subwatershed Plan. Please refer to the Subwatershed Plan for a complete list of recommendations.

Recommendation 8-2 (3-21): That the LSRCA, MNR and MOE analyse and report the results of the existing and proposed water quality, water quantity, and aquatic and terrestrial natural heritage monitoring programs annually, and that the information be used to update the LSRCA Watershed Report Card. Further, stakeholders should be made aware when updates are available, and be provided access to the monitoring data collected via a web portal, to increase distribution and communication of this data.

Sections 8.1.2 Adaptive Watershed Planning Process, 8.1.5 Promoting Low Impact Development, 8.1.7 and 8.2.1 Improving Stormwater Management are also particularly relevant.

5.2 Physical Watershed Characteristics

The Township of Oro-Medonte is partially located within the Lake Simcoe watershed. This area consists of 172.1 km^2 and has been further subdivided by the LSRCA into three major subwatersheds: Hawkestone Creek, Oro Creeks North and South. A 2.9 km^2 of the area of Township lands is located in the Barrie Creek Subwatershed which is also part of the Lake Simcoe watershed. The majority of the subwatershed areas are undeveloped and consist of 57% natural heritage, 32% agricultural (intensive and non-intensive) and 11% urbanized areas, including road, commercial, estate residential Industrial, institutional, rural development and urban area. The characteristics of each subwatershed will be described in detail below. The location of the Study Area is illustrated on Figure .

5.2.1 Oro Creeks North Subwatershed

The Oro Creeks North Subwatershed is located on the northeast portion of the overall study area. It has a total drainage area of 63.5 km^2. Three small settlement areas are located in the Oro Creeks North Subwatershed including: Rugby, East Oro and Forest Home. There are two SWM facilities features located near Highway 11 (Old Barrie Road East) between 9 Line North and 10 Line North including a wet SWM pond (Pond #1) on the north side of Highway 11, and a dry SWM pond (Pond #5) near Nevis Ridge Drive. As neither of these two ponds are located within settlement areas, they have been included in this study with respect to retrofit opportunities but not in the overall hydrologic modelling. Currently there are no SWM facilities located in this watershed in the settlement areas.

5.2.2 Hawkestone Creek Subwatershed

The Hawkestone Creek Subwatershed is located in the middle of the overall study area. It has a total drainage area of 47.9 km^2. Hawkestone is the only settlement area located in the Hawkestone Creek Subwatershed and is located in the downstream reaches of Hawkestone Creek in close proximity to Lake Simcoe. Currently there are no SWM facilities located in the subwatershed.

5.2.3 Oro Creeks South Subwatershed

The Oro Creeks South Subwatershed is located on the southwest portion of the overall study area. It has a total drainage area of 57.7 km^2. Three settlement areas are located in the Oro Creeks South Subwatershed including: Shanty Bay, Guthrie and Oro Station. There are five SWM facilities located in the subwatershed, including one dry SWM facility (Pond #3) in Guthrie, located at the northwest corner of Highway 11 and 5 Line North; and a wet SWM facility (Pond #4) and three dry SWM facilities (Pond #6, #7 and #8) within Shanty Bay. As limited data is available, Pond #8 is included in this report in respect to retrofit opportunities only.

5.2.4 Barrie Creeks Subwatershed

The Barrie Creeks Subwatershed is located on the southwest portion of the overall study area. It has a total drainage area of 2.9 km^2. There are no settlement areas or SWM facilities located in the subwatershed.

The subwatersheds and existing SWM facility locations are illustrated in Figure 2.

5.3 Natural Heritage Systems

The LSRCA Natural Heritage System for the Lake Simcoe Watershed (July 2007) identifies components of the Natural Heritage System (NHS) across the Study Area including significant habitats for endangered and threatened species, wetland, woodlands, valley lands, wildlife and fish habitats, areas of natural and scientific interest and linkages.

The NHS area for the Study Area was mapped using land use mapping for the entire Lake Simcoe watershed which is included in the LSRCA Natural Heritage system for the Lake Simcoe Watershed Phase 1: Components and Policy Templates (LSRCA, June 2007) document. The NHS throughout the Study area is illustrated on Figure . A four-tiered policy approach was utilized to direct the protection of the natural features of the NHS where tier 1 and 2 are assigned a "provincially significant" designation and considered to be those features that would be identified if following the guidelines and intent of the Provincial Policy Statement (2005). Tier 3 applies to features with significance at the watershed level. Tier 4 applies to supporting features that support elements of the natural heritage system within the watershed. The recommended policy levels (i.e. Level 1 – 4) and the implications on development or land use change are explained in detail in the natural heritage system for the Lake Simcoe watershed document. All future development located in any of these areas is to be accompanied by an updated natural heritage investigation analysis.

Table 5-1 below is a breakdown of Level 1-4 features that are located in the individual subwatersheds.

Table 5-1: Natural Heritage Features by Subwatershed

Subwatershed	Area of Subwatershed (km^2)	Percent of Subwatershed in NHS	Percent of Subwatershed by Level			
			Level 1	Level 2	Level 3	Level 4
Oro Creeks North	63.6	45.8%	34.0%	3.1%	4.3%	4.3%
Hawkestone Creek	47.9	49.3%	34.7%	5.5%	4.4%	4.7%
Oro Creeks South	57.7	43.9%	25.6%	8.9%	5.8%	3.6%
Barrie Creeks	2.9	24.4%	11.0%	3.7%	8.7%	1.0%

Table 5-2 provides a brief summary of natural heritage features by each Settlement Area.

Table 5-2: Summary of Natural Heritage Features by Settlement Area

Subwatershed	Settlement	Total Area	NHS Area by Level (ha)			
		(ha)	Level 1	Level 2	Level 3	Level 4
Oro Creeks North	Rugby	10.0	-	0.5	-	-
	East Oro	19.7	1.5	-	0.3	-
	Forest Home	20.1	0.8	-	5.3	-
Hawkestone Creek	Hawkestone	204.4	53.4	18.6	20.5	5.8
Oro Creeks South	Guthrie	59.9	2.9		4.5	-
	Oro Station	26.4	4.1	0.1	0.2	0.0

	Shanty Bay	177.8	-	19.3	3.6	-
Total		518.3	62.7	38.4	34.4	5.8

The natural heritage land is further divided into detailed land uses (forest, swamp, marsh, meadow, etc.) as can be referenced with attached mapping.

The Township Official Plan identifies natural heritage system areas as "Environmental Protection". The purpose of the Environmental Protection designation in the Official Plan is to protect, conserve and enhance natural areas features and functions.

5.4 Soil Conditions

Soil characterization for the Study Area was provided by the County of Simcoe in GIS file format, originally from the Soil Survey of Ontario County (Report 23 of the Ontario Soil Survey, Research Branch Canada Department of Agriculture and Ontario Agricultural College, 1950) and is illustrated on Figure 5. The predominant soil types in the overall study area are classified as hydrologic soil group 'AB' (48%), 'B' (34%) and 'A' (17%). Please see Appendix A for the detailed soil breakdown for each Settlement Area.

5.5 Natural Hazards

The LSRCA regulates potential natural hazard lands which present a natural threat to human safety and/or the environment. These include floodplain, erosion prone (hazard slope), meander belt, wave uprush, and wetland areas.

In most circumstances, the natural hazard areas are conservatively estimated by the LSRCA however detailed floodplain, erosion and wetland evaluations are available for certain areas. All future development located in an LSRCA regulated area requires permitting from the LSRCA including detailed analysis and confirmation of the natural hazard areas in accordance with the Conservation Authorities Act (O.Reg. 179/06) and the Planning Act.

5.6 Significant Groundwater Features and Functions

Following the Walkerton tragedy in 2000, the province enacted the Clean Water Act (2006) introducing source water protection for the Province's drinking water resources. The Approved Assessment Report Lake Simcoe and Couchiching – Black River Source Protection Area, Part 1: Lake Simcoe Watershed (November 2011) was prepared and is applicable to areas located within the Lake Simcoe watershed including the Study Area. Chapter 11 of the above document discusses source water protection areas in the Township of Oro-Medonte.

Figure 4.3-2, from the above-referenced report, illustrates Significant Groundwater Recharge Areas (SGRA) and Vulnerability Scores. SGRA's are defined as areas where the recharge is 15% greater than the average recharge in the Lake Simcoe watershed, which allow surface water to infiltrate into the ground and flow to an aquifer. These areas are characterized as significant in maintaining the water level in an aquifer that supplies a community with drinking water or contributes groundwater to an ecosystem that depends on recharge to maintain its ecological function (i.e. a surface watercourse). The Vulnerability Score of an SGRA is determined by its proximity to a well and how easily water can travel through it including factors such as soil type, water table elevation, contaminant concentration, and the confined/unconfined nature of the aquifer. A Vulnerability Score of 2 represents a low risk area, a Score of 4 represents a medium risk area, and a Score of 6 represents a high risk area. The highly vulnerable aquifers confirmed by the above study are shown on the attached Figure 6.

Table 5-3 provides a general estimate of SGRA scores based on the aforementioned report. The Settlement Areas are located in areas characterized as having high risk (score=6) to minimal risk area (score<2). On this basis, the use of SWM practices to infiltrate stormwater will need to consider if there are any anticipated impacts to an existing aquifer.

Table 5-3 Summary Description of Significant Ground water Features by Settlement

Settlement Area	SGRA Score and descriptions
East Oro	Minimal SGRA.
Forest Home	large area of Score 4 SGRA, and small area of Scores 2, and 6.
Guthrie	Large area of Score 6 SGRA.
Hawkestone	Portion of right bank area Score 2 SGRA.
Oro Station	Small area Score 2 SGRA.
Rugby	Large area Score 6, small area Score 4 SGRA.
Shanty Bay	Small area Score 2, and other minimal SGRAs.

Ecologically Significant Groundwater Recharge Areas (ESGRA) were defined in the Ecologically Significant Groundwater Recharge Area Assessment for the Oro-North, Oro South and Hawkestone Creeks Subwatersheds (Earth fx Inc, September 2013) which utilized an integrated surface water and groundwater flow model which was prepared as part of the Tier 2 Water Budget Analysis and Water Quantity Stress Assessment for the Oro North, Oro South, and Hawkestone Creeks Subwatersheds (Earth fx inc., May 2013). The ESGRAs confirmed by the above studies are shown on the attached Figure 7.

Groundwater discharge areas are shown on the attached Figure 8.

5.7 Surface Water Features and Functions

Surface drainage across the Overall Study Area is generally towards the east and south east via numerous watercourses which drain into Lake Simcoe. Major creeks include Hawkestone Creek and Maplewood Creek in the Hawkestone Creek Subwatershed, Bluffs Creek, Carthew Creek, Cedarmount Creek and Mill Creek in the Oro Creeks North Subwatershed, and Allingham Creek, Shelswells Creek, Burls Creek, Orolea Creek and Shanty Bay Creek in the Oro Creeks South Subwatershed.

Oro and Hawkestone Creeks Subwatershed Plan, (LSRCA 2013) has assessed the streams of subwatersheds in the fish habitat perspective. Generally, Hawkestone Creek is a warm water stream with cold fish habitat at the mouth; Oro Creeks North are cold water fish streams, mainly referencing Mill Creek and Bluffs Creek; Oro Creeks South has a variety of cold and warm water areas. Refer to Figure 5-2 LSRCA 2013 Subwatershed Plan for Oro Creeks for more detailed information on the fish habitat and water temperature characterization.

5.8 Wellhead and Intake Protection Areas

There are 11 drinking water systems in the Township of Oro-Medonte as documented in the Lake Simcoe and Couchiching-Black River SPA Part 1 Updated Assessment Report (January 2015). Five of these are located in the Lake Simcoe watershed, and service over 700 people. The wellhead protection areas (WHPAs) for each settlement area are briefly summarized in Table 5-4 below.

Table 5-4: Summary Description of Wellhead Protection Areas by Study Area

Study Area	Summary of Wellhead Protection Areas
East Oro	No WHPAs
Forest Home	No WHPAs
Guthrie	No WHPAs
Hawkestone	Two wells of Cedar Brook Well Supply are located within the Hawkestone settlement. The system services approximately 68 people, and the WHPA extends to the northwest across Hwy 11 N.
Oro Station	Two wells are located in Oro Station which service approximately 81 people. The WHPA is very long and narrow and extend outside of the study area
Rugby	No WHPAs
Shanty Bay	Three wells are located in Shanty Bay which service approximately 210 people. The WHPA extends north, away from the higher density portion of the community.

The wellhead and intake protection areas across on Township lands located in the Lake Simcoe Watershed, including the wellhead protection areas located in the Study Areas, described in Table 5-4, are shown on Figure 9. There have been no issues noted in the identified Wellhead Protect areas located in the Township and that are within the Lake Simcoe Watershed.

5.9 Existing SWM Facilities

There are 24 existing SWM facilities providing stormwater quantity and quality control throughout the Township. These facilities range in age, design criteria and function. An existing SWM facility inventory and inspection program was completed by CCTA in 2009. Among the total of 24 SWM ponds in the Township, 9 are located in the Lake Simcoe watershed. These existing SWM facilities are listed in Table 5-5 overleaf.

Table 5-5 Existing SWM Facilities within Lake Simcoe Watershed

Pond ID	Site Location	Year of Construction	Type	Estimated service area (ha)	Settlement Area (if applicable)
1	Houben Subdivision	N/A	Wet	44.4	
2*	Guthrie Industrial Subdivision	1998	Dry	38.2	Guthrie
3	Hastings Estates Subdivision	N/A	Dry	5.2	Guthrie
4	Arbourwood Estates	N/A	Wet	37.5	Shanty Bay
5	Sprucewood Subdivision (Greenshields Drive)	1993	Dry	10	
6	Martine Crescent and Ridge Road West	1987	Dry	7.5	Shanty Bay
7	Martine Crescent	1987	Dry	2.3	Shanty Bay
8	Spencer Trail	1995	Dry	2.0	Shanty Bay
9	Windfields Drive (Roberta Park Area)	1978	Dry	N/A	

Pond 2 is located near the Lake Simcoe watershed divide and drains towards the Nottawasaga River watershed. The majority of the contributing area to Pond 2 is also from outside of the Lake Simcoe watershed. It is included in the above table for completeness and retrofit potential but not modelled or as part of this study.

Ponds 1, 5 and 9 are located in the Lake Simcoe watershed but outside of the identified settlement areas. These ponds were analysed for retrofit opportunities in this study.

Ponds 3, 4, 6 and 7 are located in settlement area which control stormwater runoff from existing residential development. The stage-storage functions of these facilities have been modelled in the hydrologic modelling completed herein. Figure 2 illustrates all the existing SWM facilities identified within the Lake Simcoe watershed.

Pond #8 is identified, but not incorporated in the hydrologic model due to limited information available on its function.

5.10 Existing Land Uses

For the purposes of this study, the LSRCA provided a GIS "Existing Land Condition" file (ELC) for the overall study area. We have confirmed this information using current aerial photography to classify the existing land uses throughout the Study Area. The existing land use designations include: natural heritage feature, agriculture (intensive and non-intensive), industrial, estate residential, commercial, rural development, road, institutional etc. The natural heritage features are sub-categorized according to vegetation type. The existing land use designations for the Study Area are illustrated on Figure 10. The existing land condition within each settlement is summarized in Table 5-6.

Table 5-6 Existing Land Conditions within the Settlement Areas and Overall Study Area

ELC Landuse Type	Area (ha)							
	East Oro	Forest Home	Guthrie	Hawkestone	Oro Station	Rugby	Shanty Bay	Overall Study area
Active Aggregate	-	-	-	-	-	-	-	314.7
Commercial	-	-	3.51	-	-	-	-	65.7
Estate Residential	-	-	-	0.21	0.21		0.11	77.0
Golf Course	-	-	-	-	-	-	-	52.1
Industrial	-	-	2.43	-	-	-	-	74.3
Institutional	2.89	-	3.87	0.44	-	-	2.13	52.2
Intensive Agriculture	-	-	-	-	0.03	-	-	2740.0
Manicured Open Space	0.87	-	1.91	7.99	-	-	2.92	174.0
Natural Heritage Feature	2.03	4.15	6.67	100.71	4.43	0.50	29.48	12847.3
Non-intensive Agriculture	7.82	-	1.31	27.79	5.38	4.09	31.89	4595.2
Road	0.50	0.81	3.47	4.88	1.00	0.44	8.00	278.2
Rural Development	2.32	-	4.28	15.71	-	4.98	24.05	540.9
Urban	3.23	15.12	18.92	46.72	15.34	-	79.27	846.4
Outside of LSRCA	-	-	13.49*	-	-	-	-	13.5*

Total	19.7	20.1	59.9	204.5	26.4	10.0	177.8	22671.4

Note*: the ELC GIS file does not include areas outside of the Lake Simcoe watershed.

5.11 Land Use Designations in the Official Plan and Zoning By-Law

Land use designations as depicted in the Township of Oro-Medonte zoning by-law Schedule A were provided in AutoCAD and converted into GIS format and used in the OP land use analysis. This analysis focused on OP land use within settlement areas only. The OP Land Use Plan designations for the Settlement Areas are illustrated on Figures 11-1 to 11-7 and summarized in the Table 5-7 below.

Table 5-7 Future Land Use Summary by Settlement Area

OP Landuse	Area (ha)						
	East Oro	Forest Home	Guthrie	Hawkestone	Oro Station	Rugby	Shanty Bay
Agriculture/Residential 1	-	-	-	-	-	-	11.8
Agriculture/ Rural	4.0	-	2.5	101.6	7.5	4.2	31.2
Environmental Protection	3.5	0.2	-	9.8	-	-	0.0
General Commercial	-	-	3.5	-	-	-	-
Industrial	3.4	-	4.3	1.2	0.6	1.0	3.6
Local Commercial	-	-	6.1	0.6	0.1	-	0.7
Local Industrial	-	1.5	-	1.6	-	-	-
Open Space	-	-	7.8	9.1	0.4	-	7.0
Private Recreational	-	-	-	8.5	-	-	-
Residential 1	6.0	15.7	24.1	40.5	14.3	3.1	74.0
Residential Limited Service	-	-	-	2.7	-	-	-
Rural Residential 1	-	-	-	-	-	-	16.9
Rural Residential 2	0.9	-	-	-	-	-	-
Shoreline Residential	-	-	-	3.4	-	-	9.5
Rest	1.9	2.7	11.7	25.5	3.4	1.6	23.0
Total	19.7	20.1	59.9	204.4	26.4	10.0	177.8

5.12 Previously Identified SWM Facility and System Retrofit Opportunities

During recent years the LSRCA has conducted research and investigations into the treatment level of existing SWM ponds and the retrofit opportunities for existing SWM ponds located throughout the Lake Simcoe watershed.

These studies were focused on larger urban areas and areas of significant growth such as Aurora, Barrie, and Newmarket etc. There have been no analyses with regards to the existing SWM ponds or SWM retrofit opportunities in the study area. SWM pond retrofit opportunities for ponds located in the study area will be evaluated in detail in Section 8.1.

5.13 Potential Land Use Changes

The land designations provided in the Township Official Plan have been used to represent the future land use scenario, which show increases in development in comparison with the existing land use categories. The Official Plan will be updated in the future which may alter the land uses shown and the limits of the settlement boundaries. All future development not currently addressed in this CSWM MP will be required to follow Township and LSRCA guidelines in addition to any applicable recommendations made in this report.

6 Management Units (Step Four)

The seven Settlement Areas and their associated catchment areas (where appropriate), as previously outlined, will serve as individual management units for modelling and discussion purposes. These will be discussed in detail in the sections to follow.

7 Cumulative Environmental Impact of Stormwater from Existing and Planned Development (Step Five)

An evaluation of the cumulative environmental impact of stormwater from existing and future development is required based on the anticipated changes in land use contained in the Township's Official Plan. The existing landuse (ELC) breakdown for each settlement areas shown in Table 5-6. The official plan for future land use in different settlement areas are breakdown in the Table 5-7.

An analysis of the impacts of stormwater in terms of peak flow, erosion, phosphorus and water budget will be assessed in the sections to follow.

7.1 Water Quantity

In 2009, the Hawkestone Creek watershed Hydrology Study was completed by the LSRCA including a hydrologic analysis using Visual OTTHYMO (VO2) hydrologic model software. The results from the analysis were used as reference in this study.

A hydrologic model of each Study Area was completed using the single event Visual Otthymo Hydrologic Model Version 2.3.3. Peak flow rates for the 2 -100-year storm events and Regional (Hurricane Hazel) were calculated. Rainfall data from the City of Barrie (Barrie WPCC Gauge, AES States ID 6110557) 12-hour SCS Type II, 24-hour SCS Type II, and Hurricane Hazel rainfall events were utilized as per LSRCA and Township criteria.

Each Study Area was divided up into individual catchment areas based on a combination of 2.0 m contour mapping and 125 hectare catchment mapping provided by the County of Simcoe and LSRCA respectively. The catchments were subdivided further according to the settlement area boundaries provided by the County. Hydrologic reference points were created to evaluate existing and future condition hydrographs at specific locations throughout the Study Area. Catchment areas were cross-referenced with existing catchment delineation mapping prepared for the previously completed studies.

Land uses and necessary catchment parameters were established using a combination of digital land use information provided by the LSRCA and the Township, and were verified with current aerial photography. The calculated total impervious (TIMP) and directly connected impervious (XIMP) values for existing developed areas and future expansion areas were derived using a number of sources including the Township's Zoning By-Law, the LSRCA SWM Guidelines and aerial photography. As the land use categories differ between the ELC and future OP conditions, conversion tables were created to equate the land use categories and define parameters for each. Tables in Appendix A show the corresponding hydrologic input parameters for each land use, and the source the value was derived from. These tables summarize the assumed CN numbers corresponding to each land use (existing and future), the TIMP and XIMP values, and the runoff coefficients. The Time to Peak (tp) values for the catchment areas were calculated using the Bransby Williams Formula and the Airport Method for runoff coefficients greater than and less than 0.4 respectively.

The total rainfall depths used in the hydrologic model reflect the Barrie WPCC station, utilizing rainfall data between 1979 and 2003. The total rainfall depths for each storm are summarized in Table 7-1.

Table 7-1 Total Rainfall Depths

Storm Event	Depth (mm)		
	12-hr SCS	24-hr SCS	4-hr Chicago
2-year	40.6	47.8	32.1
5-year	55.9	66.1	43.9
10-year	66.1	78.2	51.9
25-year	78.9	93.5	61.9
50-year	88.4	104.9	69.1
100-year	97.8	116.2	76.2
Regional (Hazel)	212		

7.1.1 Existing Conditions Hydrology

The existing condition hydrologic model incorporates all existing SWM facilities to reflect the quantity controls currently provided. The stage-storage-discharge tables used in the model were determined using the information contained in the MOE certificates of approval (CofA) for each facility. Where CofAs were not available, the stage storage discharge relationship was estimated based on the typical post to pre-development peak flow control for the contributing area upstream, where the pre-development peak flows were estimated based on an undeveloped upstream catchment area . The ponds included in the existing model and the service catchment areas are listed in Table 7-2.

Table 7-2 Existing Pond Inventory

Settlement Area	Pond location	Pond ID	VO2 ID	Service Catchment Area (ha)*	Land Use of Area Serviced
Guthrie	Hastings Estates Subdivision	3	30	5.2	Residential
Shanty Bay	Arbourwood Estates	4	40	37.5	Residential
Shanty Bay	Martine Cr & Ridge Rd W	6	60	7.5	Residential
Shanty Bay	Martine Cr	7	70	2.3	Residential

* All areas are estimated based on best available information.

Pond 8 is located on Spencer Trail in Shanty Bay and has an approximate service area of 2.0 ha. It was not incorporated in the hydrologic model due to limited information available. Ponds that are not located in or have contributing area from the settlement areas are summarized in the Lake Simcoe watershed SWM facility inventory in Section 5. They have not been included in the hydrologic modelling included herein.

A detailed description of each of the above ponds can be found in Section 8.

The existing condition catchment parameters (weighted curve numbers, runoff coefficients and total imperviousness) were calculated using ArcGIS. The detailed catchment parameters for the existing conditions can be found in Appendix A. A catchment map illustrating the catchment area breakdown and hydrologic reference points is included as Figure 3.

The existing condition peak flows have been summarized at significant hydrologic reference points (HRPs) in the model to allow for comparison with the future conditions peak flows at the same points. The existing condition peak flows during the 12-hour SCS type II design storm have been summarized in Table 7-3 at selected HRPs. Detailed model results, including results for the 24-hour SCS type II design storm and the 4-hour Chicago design storm are included in Appendix A (VO2 Output).

Table 7-3 Existing Condition Peak Flow Summary at Hydrologic Reference Points

Study Area	HRP	Model ID	Catchment Area	12-hr SCS Type II Peak Flow (m^3/s) (no climate change)						Regional Storm Event (Hazel) (m^3/s)
			(ha)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
East Oro	E5	6070	997.9	1.74	3.56	5.06	7.23	9.02	10.93	56.82
Forest Home	F3	6353	88.2	0.83	1.29	1.67	2.20	2.61	3.11	8.87
Guthrie	G1	6140	153.8	1.22	1.84	2.29	3.00	3.51	4.04	12.88
Hawkestone	H1	6207	359.9	1.06	2.13	2.98	4.20	5.19	6.23	25.27
Hawkestone	H4	6204	29.6	0.18	0.38	0.54	0.77	0.96	1.16	3.07
Hawkestone	H5	6301	235.5	1.31	2.65	3.73	5.26	6.50	7.80	23.16
Rugby	R3	2045	8.2	0.06	0.11	0.16	0.22	0.28	0.34	0.87
Rugby	R4	6048	734.3	1.52	3.23	4.67	6.78	8.55	10.46	52.94
Shanty Bay	S2	5250	20.1	0.10	0.21	0.30	0.43	0.54	0.65	2.00
Shanty Bay	S3	6256	103.3	1.34	2.10	2.79	3.72	4.47	5.42	10.91

7.1.2 Future Condition Hydrology

The future land use hydrologic model uses the same catchment delineations as for the existing model. The catchment parameters have been altered to reflect proposed changes in land use within the Study Area based on the land use categories specified in the Township OP. All catchments that are located outside of settlement boundaries remain unchanged from the existing model in order to achieve the best comparison between existing and future land uses.

Route Reservoir commands were added in the future conditions hydrologic model on an individual land unit basis, to simulated future development peak flows attenuated to pre development peak flow rates for the 2 to 100-year design storms. It should be noted that the route reservoir commands that were used are not based on a physical pond design but are instead conceptual in origin to predict estimated

pond size and flow restriction requirements for future development. Detailed sizing of these facilities should occur as part of the development application process for the lands in question.

The future condition peak flows in watercourses that will be receiving future condition runoff have been determined at the HRPs and summarized in Table 7-4. Detailed model results for the complete Study Area are included in Appendix C.

Table 7-4: Future Condition Peak Flow Summary (Post to Pre-Development Peak Flow Control)

Settlement	Contributing Area (ha)	HRP	Scenario	Model ID (existing Future)	12-hr SCS Type II Existing Peak Flow (m^3/s) / Future Peak Flow (m^3/s) / (% Increase/Decrease)						Regional
					2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	Hazel
East Oro	997.9	E5	Existing	6070	1.74	3.56	5.06	7.23	9.02	10.93	56.82
			Future Unctr.	6070	1.75	3.57	5.06	7.22	9.01	10.92	56.69 (-0.2%)
			Future Contr. (% increase /decrease)		1.79 (2.9%)	3.61 (1.4%)	5.12 (1.2%)	7.30 (1.0%)	9.10 (0.9%)	11.02 (0.8%)	
Forest Home	88.2	F3	Existing	6353	0.83	1.29	1.67	2.20	2.61	3.11	8.87
			Future Unctr.	6353	0.97	1.51	1.96	2.54	3.00	3.56	8.90 (0.3%)
			Future Contr. (% increase /decrease)		0.90 (8.4%)	1.45 (12.4%)	1.89 (13.2%)	2.47 (12.3%)	2.95 (13.0%)	3.51 (12.9%)	
Guthrie	153.8	G1	Existing	6140	1.22	1.84	2.29	3.00	3.51	4.04	12.88
			Future Unctr.	6140	1.42	2.12	2.63	3.40	3.96	4.55	13.01 (1.0%)
			Future Contr. (% increase /decrease)		1.21 (-0.8%)	1.83 (-0.5%)	2.27 (-0.9%)	2.96 (-1.3%)	3.47 (-1.1%)	3.99 (-1.2%)	
Hawkestone	359.9	H1	Existing	6207	1.06	2.13	2.98	4.20	5.19	6.23	25.27
			Future Unctr.	6207	1.14	2.25	3.14	4.40	5.43	6.50	25.41 (0.6%)
			Future Contr. (% increase /decrease)		1.1 (3.8%)	2.21 (3.8%)	3.10 (4.0%)	4.37 (4.0%)	5.41 (4.2%)	6.53 (4.8%)	
Hawkestone	29.6	H4	Existing	6204	0.18	0.38	0.54	0.77	0.96	1.16	3.07
			Future Unctr.	6204	0.29	0.55	0.76	1.05	1.28	1.52	3.20 (4.2%)
			Future Contr. (% increase /decrease)		0.17 (-5.6%)	0.37 (-2.6%)	0.54 (0.0%)	0.76 (1.3%)	0.97 (1.0%)	1.19 (2.6%)	
Hawkestone	235.5	H5	Existing	6301	1.31	2.65	3.73	5.26	6.50	7.80	23.16
			Future Unctr.	6301	1.45	2.88	4.02	5.62	6.91	8.26	23.33 (0.7%)

			Future Contr. (% increase /decrease)		1.25 (-4.6%)	2.55 (-3.8%)	3.61 (-3.2%)	5.12 (-2.7%)	6.38 (-1.8%)	7.72 (-1.0%)	
Rugby	8.2	R3	Existing	2045	0.06	0.11	0.16	0.22	0.28	0.34	0.87
			Future Unctr.		0.22	0.33	0.40	0.52	0.61	0.70	0.97 (10.6%)
			Future Contr. (% increase /decrease)	8045	0.04 (-33.3%)	0.10 (-9.1%)	0.13 (-18.8%)	0.21 (-4.5%)	0.27 (-3.6%)	0.34 (0.0%)	
Rugby	734.3	R4	Existing	6048	1.52	3.23	4.67	6.78	8.55	10.46	52.94
			Future Unctr.	6048	1.53	3.25	4.69	6.79	8.56	10.46	52.86 (-0.2%)
			Future Contr. (% increase /decrease)		1.54 (1.3%)	3.29 (1.9%)	4.75 (1.7%)	6.86 (1.2%)	8.65 (1.2%)	10.57 (1.1%)	
Shanty Bay	20.1	S2	Existing	5250	0.10	0.21	0.30	0.43	0.54	0.65	2.00
			Future Unctr.		0.22	0.41	0.56	0.77	0.94	1.11	2.29 (14.6%)
			Future Contr. (% increase /decrease)	8250	0.10 (0.0%)	0.19 (-9.5%)	0.27 (-10.0%)	0.41 (-4.7%)	0.53 (-1.9%)	0.65 (0.0%)	
Shanty Bay	103.3	S3	Existing	6256	1.34	2.10	2.79	3.72	4.47	5.42	10.91
			Future Unctr.	6256	1.54	2.44	3.21	4.26	5.09	6.14	11.06 (1.4%)
			Future Contr. (% increase /decrease)		1.34 (0.0%)	2.15 (2.4%)	2.86 (2.5%)	3.81 (2.4%)	4.56 (2.0%)	5.5 (1.5%)	

Even though SWM controls will provide a minimum of post to pre development peak flow control, changes in peak flows from existing to future conditions at the selected flow nodes (which combine catchments were no land use changes are planned with catchments were development including SWM controls is planned) are expected to range within +/-5%, for design storms ranging from the 2-100 year, as shown in Table 7-4. For some of the settlement areas (Guthrie, Hawkstone, Rugby and Shanty Bay) the future conditions peak flows with synthetic ponds have decreased in comparison to existing. This can be explained by changes to the post development hydrograph peak timing, which is resulting in non-coinciding hydrograph peaks at the HRPs. For the most part the size of the settlement areas are small in relation to the overall watershed and thus the total creek flows are not sensitive to the changes as a result of the development in the settlement areas.

However in Forest Home the model indicates a specific need for peak flow control criteria via unit flow rates where future peak flows are reported in the model as increasing between 8.4% and 13.2% compared to existing. The majority of planned development in Forest Home is located in Catchment 2025, which consists of undeveloped lands located on the west side of Highway 11, south of Memorial Avenue. The unit flow requirements were conservatively calculated by subtracting the peak flows from catchment areas that are unchanged in future condition from the total peak flows at the HRP and dividing the remaining peak flow by the total future development area, for each design storm. The unit flow rates for future development in Catchment 2025 are summarized in Table 7-5 and will slightly

overcontrol the peak flows from the future contributing development areas in order to match the existing peak flow rates at HRP F3 located downstream.

Table 7-5: Unit Flow Requirement for Catchment 2025

Total Area (ha)	Unit Flow Rate ($m^3/s/ha$)					
	2-year	5-year	10-year	25-year	50-year	100-year
10.2	0.019	0.023	0.024	0.028	0.034	0.036

A detailed SWM design is required as part of all future development and is to be prepared in accordance with the applicable Municipal, Provincial and LSRCA SWM guidelines including the LSPP. At a minimum all future development is required to control post development peak flows to pre development peak flows rates for all design storms ranging from the 2-100 year storms, regardless of any possible scenarios that support the use of no or partial water quantity controls based on peak flow reductions calculated in the model. It is recommended that the hydrologic model contained herein be updated as development proceeds to ensure future SWM controls designed at the site level also consider potential impacts downstream in the watershed with the goal of 0% increases in peak flows to the outlet.

7.1.3 Climate Change

To assess the potential impacts of climate change in relation to the SWM quantity control criteria the input IDF data was increased by 35% based on the estimated impacts of climate change over the period of 2015-2045 (www.ontarioccdp.ca, May 2015). A copy of the theorized IDF curves are included in Appendix A. Comparison of the current 12-hr SCS Type II design storm rainfall depths and the anticipated depths based on a 50% percentile statistical analysis are shown in Table 7-6.

Table 7-6: Total Rainfall Depth Comparison

Storm Event	Depth (mm)	
	12-hr SCS 2015	12-hr SCS 2045
2-year	40.6	55.1
5-year	55.9	75.7
10-year	66.1	89.4
25-year	78.9	106.8
50-year	88.4	119.6
100-year	97.8	132.5

The model results confirmed a 60-80% increase in peak flows during the 100-year 12 hr SCS design storm at the HRPs could result thus having the potential to increase flood and erosion hazards of the receiving tributary systems. The impact of the increased storm intensities on peak flows should be considered in the Township design standards and sizing of future infrastructure and development.

7.2 Water Budget

7.2.1 General

A surface water budget assessment has been completed for each settlement area in the Study Area. Existing and future land uses, in combination with soil types and land topography, were analysed to calculate evapotranspiration, infiltration and runoff produced from precipitation during existing and future conditions. The overall intent of the water budget assessments is identify the need to incorporate infiltration mechanisms into all future development with the goal of mitigating any changes in infiltration following development. In particular, infiltration measures are strongly encouraged in existing areas classified as SGRA's with consideration for areas with highly vulnerable aquifers. Extra precautions should be taken for infiltration in these areas.

7.2.2 Background

The development of land typically involves converting pervious surfaces such as pasture, open field, and wooded areas into impervious surfaces including roads, driveways, buildings etc. This results in changes to the existing hydrologic regime including increases in runoff volume and decreases in infiltration and evapotranspiration.

In accordance with Section 4.8-DP of the Lake Simcoe Protection Plan, all major development requires a water budget assessment including an evaluation of existing and future development conditions and any impacts to the existing hydrologic regime are to be minimized as much as possible.

7.2.3 Water Balance Assessment

In accordance with the Hydrogeological Assessment Submissions Guidelines, Conservation Authority Guidelines to Support Development Applications (June 2013), a water budget was developed for each settlement area. The Thornthwaite method was determined to be an appropriate method for calculating evapotranspiration based on average temperature and precipitation from the Barrie WPCC climate normal data (1981-2010) from Environment Canada. Average annual precipitation data from the Barrie WPCC station was also used over the same period. An infiltration factor was developed for each settlement area based on a combination of the topography infiltration factor, soil infiltration factor and land cover infiltration factors, which were estimated based on the MOECC SWM planning and drainage manual, for each individual settlement area. The evapotranspiration, infiltration and runoff

components were calculated for each settlement area. The water budget assessment calculations are attached in Appendix C and are summarized for each settlement area in Table 7-5 below.

Table 7-5 Existing and Future Annual Water Budget Summary

		East Oro		Forest Home		Guthrie		Hawkestone		Oro Station		Rugby		Shanty Bay	
		Ex.	Fut.	Ex.	Fut.	Ex.	Fut.	Ex.	Fut.	Ex.	Fut.	Ex.	Fut.	Ex.	Fut.
Area (ha)		19.7		20.1		37.9		203.5		26.4		10.0		168.2	
Precipitation	mm	933.1													
	m^3	183.454		187,304		354,002		1,899,069		246,246		93,393		1,569,912	
Evapo-transpiration	mm	431.8	406.6	376.2	355.7	366.8	350.8	446.8	431.9	399.7	384.3	454.8	413.8	408.8	391.0
	m^3	84,902	79,931	75,521	71,400	139,159	133,077	909,416	879,101	105,478	101,404	45,520	41,412	687,875	657,889
Infiltration	mm	199.2	178.6	169.8	148.2	144.8	132.0	192.9	182.1	187.7	164.4	238.7	198.0	173.6	159.7
	m^3	39,173	35,117	34,080	29,759	54,918	50,070	392,572	370,708	49,543	43,398	23,892	19,813	292,154	268,670
Runoff	mm	302.0	247.9	387.1	429.2	421.5	450.3	293.4	319.0	345.7	384.4	239.6	321.4	350.6	382.4
	m^3	59,379	68,407	77,704	86,145	159,924	170,855	597,081	649,260	91,225	101,444	23,981	32,167	589,883	643,353

Based on the results future development in the settlement areas will generally increase runoff volume while decreasing infiltration volume. SWM design measures are required to mitigate changes in infiltration for all new development. Infiltration rate targets have been calculated based on the total impervious expansion area of each settlement area. Table 7-6 illustrates the annual infiltration targets to mitigate changes in the existing water budget to be applied to each settlement area. These values provide a reasonable estimate based on a broad level assessment and the information available at the time of this study.

Table 7-6 Annual Infiltration Targets Summary

Settlement Area*	Percent Imperviousness (%)		Future Infiltration Deficit Compared to Existing		Annual Infiltration Target in Future Expansion Area
	Ex.	Fut.	(mm)	(m^3)	(m^3/imp.ha)
East Oro Total Area = 19.7 ha	16.7	26.8	20.6	4,056	2,043
Forest Home Total Area = 20.1 ha	36.9	43.8	21.5	4,321	3,151

Guthrie Total Area = 37.9 ha	38.0	41.4	12.8	4,848	2,423
Hawkestone Total Area = 203.5 ha	13.4	19.0	10.7	21,864	1,921
Oro Station Total Area = 26.4 ha	29.1	24.3	23.3	6,145	4,529
Rugby Total Area = 10.0 ha	10.8	24.4	40.7	4,078	2,985
Shanty Bay Total Area = 168.2 ha	26.1	31.7	14	2,3484	2,353

Note: Settlement area excludes areas outside of the Lake Simcoe watershed.

Individual water budget assessments completed at a suitable level of detail are required as part of all future individual development applications. The feasibility of infiltration practices is dependent on many factors including the infiltration capacity of the native soil, depth to bedrock, depth to the groundwater table etc. Proposed infiltration measures must also recognize the constraints specific to water quality and well head protection areas.

Maintaining a water balance via infiltration is an objective of the LSPP and opportunities should be investigated wherever soil, bedrock, and groundwater conditions permit to maximize infiltration as part of all future development.

A Tier 2 water budget for Oro-Medonte was completed by the LSRCA (Earthfx, 2013). In addition the LSRCA 2013 Subwatershed study for this area identified the characteristics of the various watercourses specific to fish habitat and baseflow sensitivity. The information included in these reports should be read in conjunction with the annual infiltration targets for each settlement area, to ensure all of the background analyses are considered as part of all future development.

7.2.4 Water Balance and Climate Change

In order to assess how a changing climate will affect water balance and infiltration rates, a number of scenarios have been modelled. The future water balance scenario has been used as a baseline infiltration value, and has been compared to 11 other scenarios. The scenarios account for a +/- 10 % monthly precipitation variation, coupled with an average monthly temperature increase of up to 4°C.

The sources for the climate change values used are projections for the Province of Ontario referenced from the following sources:

- *Climate Change – Climate Science – Trends and Forecasts,* Toronto and Region Conservation Authority (TRCA)
- *Climate Change Projections for Ontario: Practical Information for Policymakers and Planners*, Ontario Ministry of Natural Resources (2007)

Since the precipitation and temperature values are consistent for each settlement area, the percent increase/decrease in infiltration compared to the baseline value is the same for each. On this basis, only the East Oro settlement area has been analyzed for this climate change scenario and is included in this report. Table 7-7 summarizes the assumptions made in each scenario, as well as the increase/decrease in infiltration.

Table 7-7 Water Balance Climate Change Summary

Scenario #	Precipitation Change (%)	Temperature Change (°C)	Annual Infiltration Change (%)
1 (Baseline)	0	0	0
2	0	1	-2
3	0	2	-5
4	0	4	-10
5	-10	0	-13
6	-10	1	-16
7	-10	2	-18
8	-10	4	-22
9	10	0	13
10	10	1	11
11	10	2	9
12	10	4	3

The worst case scenario is represented by a 10% decrease in monthly precipitation in combination with a significant average monthly temperature increase of 4^0C. This scenario results in a 22% reduction in annual infiltration.

The proposed infiltration targets specified will need to offset the potential differences in water balance that may occur under different climate change scenarios. The possibility of decreased infiltration rates further stresses the importance of implementing the use of LID at-source infiltration methods.

7.3 Water Quality

7.3.1 Phosphorus Loading

Excessive phosphorus has been the most significant cause for the water quality impairment in Lake Simcoe and its tributaries. It leads to the excessive growth of plants and algae in the lake which contributes to the depletion of dissolved oxygen in the deep waters of the lake and degradation of the critical habitat of coldwater species.

In June 2010, the MOE released the *Lake Simcoe Phosphorus Reduction Strategy*. The strategy sets an aggressive phosphorus reduction target in order to improve water quality. The goal is to reduce overall annual loading to the Lake to 44 tonnes or approximately 38.9% (ultimate target) reduction over existing annual loading levels (72 tonnes per year). However, the strategy also recognizes that opportunities and technology presently exists to reduce loading to 58 tonnes annually or approximately 19.4% (feasible target reduction).

The Area within the Township of Oro-Medonte municipality which drains into Lake Simcoe is approximately 172 square kilometres. The combined area of the seven settlement areas identified in the Official Plan is approximately 487 hectares, which is approximately 2.8% of the total Township area which drains into Lake Simcoe.

Since the combined area of all seven settlement areas, where the majority of efforts to reduce phosphorus loadings from stormwater runoff to Lake Simcoe are focussed, is less than 750 ha, a desktop based unit area load approach (i.e. spreadsheet) was deemed appropriate and used for estimating the existing and future condition phosphorus loading on Lake Simcoe. This was determined in consultation with LSRCA staff.

Unit area loading rates were used from the MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012), prepared by Hutchinson Environmental Sciences Ltd. as these were determined to be the most appropriate rates to be applied to the Study Area. These loading rates were developed using the Estimation of Phosphorus Loading to Lake Simcoe (2010), prepared by the Louis Berger Group Inc. as a base but were modified to address unexplained variance in loading rates between land uses and subwatersheds in the Lake Simcoe watershed. The phosphorus loading coefficients are summarized in Table 7-8.

Table 7-8: Phosphorus Loading Coefficients (MOE P-Tool)

MOE Phosphorus Tool Land Use	P Loading Coefficient (kg/ha/yr)		
	Hawkestone Creek	Oro Creeks North	Oro Creeks South
Cropland	0.19	0.36	0.19
Hay - Pasture	0.10	0.12	0.07
Sod farm/ Golf Course	0.06	0.24	0.12
Quarry	0.10	0.08	0.08
Low Intensity Development	0.09	0.13	0.13
Unpaved Road	0.83	0.83	0.83
High Intensity Development - Commercial/Industrial	1.82	1.82	1.82
High Intensity Development - Residential	1.32	1.32	1.32
Transition	0.04	0.16	0.06
Forest	0.03	0.10	0.05
Open Water	0.26	0.26	0.26
Wetland	0.03	0.10	0.05

The Hutchinson report has also provided phosphorus reduction rates for a number of different kinds of SWM Best Management Practices (BMPs). These rates have been applied to existing controlled areas, and have also been used to model the retrofit scenario. They have also been applied to future developed areas to help assess the potential phosphorus reduction for each option. The reduction rates applied to existing and future SWM facilities are summarized in Table 7-9.

Table 7-9: Phosphorus Removal Rates

SWM Control	Removal Efficiency
Dry Pond (proper function)	10%
Wet Pond (proper function)	63%
*Wet Pond (in need of some retrofits)	30%
Enhanced Grass Swale	30%
Bioretention	65%
Porous Pavement	65%
Infiltration Trench/Soakaways	60%
Perforated Pipe System	87%

The source of these removal rates are the Hutchison Report and National Pollutant Removal Database for Stormwater Treatment. For full LID implementation the LID option assumes that new developments will consist of a 'treatment train' approach incorporating multiple LID controls. Therefore, the value of 85% was chosen to be representative for 'treatment train' target LID SWM computations.

The total settlement areas cover approximately 487 ha of land. Future development of these areas results in the reduction of forest and cultivated areas replaced with high and low intensity development. The phosphorus loading coefficients were applied to each catchment in each of the settlement areas for comparing phosphorus loadings from existing to future conditions. Table 7-10 summarizes the phosphorus loading for both the existing conditions with the existing SWM controls, as well as the loading for existing land use with retrofit controls.

Table 7-10 Existing Phosphorus Loading Summary with and without retrofits

Settlement	Total Area (ha)	Existing Phosphorus Loading (kg/year)	Existing Phosphorus Loading with Retrofits (kg/year)	Annual Decrease in Phosphorous (kg)	% Decrease
East Oro	19.7	14.8	14.8	-	No retrofits
Forest Home	20.1	21.9	21.9	-	No retrofits
Guthrie	37.9	46.8	43.1	3.6	7.8
Hawkestone	204.5	99.3	99.3	-	No retrofits
Oro Station	26.4	22.9	22.9	-	No retrofits
Rugby	10.0	7.9	7.9	-	No retrofits
Shanty Bay	168.3	119.2	111.0	8.3	6.9
Total	486.9	332.8	320.9	11.9	3.6

Existing phosphorus loading calculations within the seven settlement areas have included the controls of four (4) existing SWM facilities. Three of these facilities are in Shanty Bay, and one in Guthrie. Only one facility (pond #4) in Shanty Bay is a wet pond whereas the other three are dry ponds. The dry ponds have been assigned an existing removal efficiency of 10% and are proposed to be retrofit into wet ponds having a removal efficiency of 63%.

In order to assess the benefit of controlling future developments with typical end-of-pipe controls (wet ponds) in comparison to LID controls, these two scenarios have been modeled. The scenarios assume all future development (all High and Low intensity development areas) will be designed and constructed with either LID or Wet Pond SWM controls. The two scenarios have also included the removal efficiency rates of any proposed SWM facility retrofits (where applicable). Table 7-10 provides a future condition summary for each Study Area. Detailed calculation sheets including all assumptions are provided in Appendix B.

Table 7-11 Future Phosphorous Loading with Wet Pond and LID Controls

Study Area	Total Area (ha)	Existing Phosphorus Loading (kg/year)	Future Phosphorus Loading with Retrofits and Wet Pond (63%) Controls (kg/year)	Future Phosphorus Loading with Retrofits and LID (85%) Controls (kg/year)	% Increase / Decrease Compared to Existing
East Oro	19.7	14.8	16.7	15.2	+ 2.7
Forest Home	20.1	21.9	23.6	22.3	+ 1.8
Guthrie	37.9	46.8	46.0	44.1	- 5.8
Hawkestone	204.5	99.3	127.2	110.2	+ 11.0
Oro Station	26.4	22.9	25.6	23.8	+ 3.9

Rugby	10.0	7.9	9.0	8.2	+ 3.8
Shanty Bay	168.3	119.2	126.7	116.2	- 2.5
Total	486.9	332.8	374.8	340.0	+ 2.2

Table 7-11 confirms phosphorus loading from future development, even considering typical wet SWM pond type facilities (i.e. 63% phosphorus removal) is expected to result in an annual increase in phosphorus loading. Utilizing LID/SWM measures having a phosphorous removal efficiency of 85%, will result in annual decrease in phosphorus loading from Guthrie and Shanty Bay and increases from all other settlement areas. This assumes that no retrofits occur to the existing drainage systems in the settlement areas. The total increase in phosphorus loading from all settlement areas assuming retrofits for existing SWM ponds and LID measures for all future development was determined to be approximately 7 kg or 2% compared to existing. Based on these results, LID measures to achieve maximum 'best efforts' removal are recommended in all future development areas wherever feasible.

A detailed phosphorus budget is required as part of each development application and must conform to the LSPP (4-8-DP) with the goal of no net increase in phosphorus from existing conditions.

7.4 Stream Channel Characteristics & Erosion Threshold Analysis

As per the CSWM-MP guidelines, a stream channel characterization and erosion susceptibility analysis was completed. The assessment was completed by a fluvial geomorphologist, Aqualogic, and included erosion threshold analysis for seven watercourse locations downstream of existing settlement areas. The investigation included a rapid assessment analysis followed by an erosion threshold characterization. The threshold characterization was completed to assist in establishing benchmark targets for discharge control for stormwater.

Results confirmed three of the seven sites were dynamically stable while four sites will require over-control of stormwater, for storms greater than the 2 year storm, to achieve long term stability. The Bluff's Creek and Hawkestone Creek tributaries were identified as the most stable while the Shanty Bay tributaries were observed to be experiencing erosion. From the outset the analysis assumed 25 mm / 2 year overcontrol and extended detention is required for all watercourses. Additional control and unit rate flow targets were also determined for specific tributaries to achieve the desired flow regime. The unit rate values were presented as SWM control targets for the watercourses that were observed to be unstable or projected to require additional control. For example, at Hydrologic Reference Point S3 (Shanty Bay), the channel is entrenched and has a calculated unit area flow rate, based on an assessment of the channel forming and dynamic stability discharge, of 3.69 L/s/ha during all storms up to and including the 25-year storm. Where the unit flow rate targets are deemed inappropriate additional study can be completed to verify overcontrol requirements based on the development specifics. The unit-area flow rates for each site are summarized in Table 7-13 below. A complete report with calculations is included in Appendix D for reference.

Table 7-12 Unit Area Flow Rate Summary

Settlement Area	Hydrologic Reference Point[1]	Unit-Area Flow Rate Target for SWM (L/s/ha)[2]	Control Events
Shanty Bay	S3	3.69	25 mm, 2 – 25 yr
Shanty Bay	S2	4.50	25 mm, 2 – 5 yr
Guthrie	G1	3.40	25 mm , 2- 5 yr
Hawkestone	H1	2.27	25 mm, 2 yr
Hawkestone	H4	1.53	25 mm, 2-5 yr
East Oro	E5	1.71	25 mm, 2 yr
Forest Home	F3	7.84	25 mm, 2-10 yr

1. Refer to Figures 11-1 to 11-7 for Hydrologic Reference Point locations.

2. Unit-area flow rates apply to all future development upstream of the noted HRP.

For all future development that is greater than 2 ha and that is proposed outside of areas analysed by the stream channel and erosion threshold analysis, the minimum LSRCA erosion control requirement of 24 hour detention for run-off from the 25 mm 4-hr Chicago storm is required.

8 Determine the Effectiveness of Existing SWM Systems (Step Six)

The following section describes the overall effectiveness of the existing SWM systems including the potential long and short-term impacts of climate change that could affect the function of the existing SWM systems over time. For the most part the existing SWM systems in the settlement areas of East Oro, Rugby, Oro Station and Hawkestone consist of rural roadside ditch systems that reportedly function in a satisfactory manner subject to routine maintenance. There were reports of flooding and poor drainage in the industrial lands downstream of Forest Home. We understand this is an ongoing issue with the outlet requiring maintenance and the backwater created in the system due to downstream water levels. The Guthrie and Shanty Bay area drainage systems are described in the following subsections.

8.1 Guthrie

Highway 11 is fully urbanized and bisects Guthrie north and south. 5 Line N, perpendicular to Hwy 11, further divides the Guthrie into east and west parts. The west portion of Guthrie drains north-westerly and is located in the upper headwaters of the Nottawasaga River. The east portion drains to Lake Simcoe. Runoff from a wetland area north of Guthrie drains south-westerly through the settlement which eventually discharges into Shelswells Creek.

Pond 2 was constructed in 1988 as a dry SWM facility to control runoff from approximately 38.2 ha including the industrial park on the west side of Guthrie (NVCA watershed). The SWM pond has a total

storage capacity of approximately 25,000 m^3. The pond was designed to control the post development peak flow rate to match pre-development conditions for the 25-year, 100-year storm events and Timmins storm event. Overgrown vegetation was observed throughout the pond which can be expected to provide minimal water quality control. Potential retrofit opportunities for Pond 2 include: conversion to a wet pond or a hybrid wet pond/wetland; or provide check dams in the ditch immediately upstream of the pond. Since a large portion of the serviced area is industrial, installing an OGS upstream of the pond should be considered to provide pre-treatment for the pond and capture any floatables, such as oil and gas from being transported downstream. Pond 3 is a dry SWM facility servicing approximately 5.2 hectare drainage area consisting of the Hasting Estate residential Subdivision and additional area located upstream. It has an active storage capacity of approximately 2,900 m^3. The pond was originally designed to control post-development peak flows to pre-development peak flow rates up to 100 year storm at Hwy 11. Heavy vegetation was observed in the pond. The pond outlets to a drainage channel with known deficiencies and conveyance problems. Potential retrofit opportunities include: conversion into a hybrid wet pond/wetland and consideration of improving the function of the adjacent drainage channel.

The adjacent drainage channel from the SWM pond to Hwy 11 has documented flood and flow conveyance issues. Measures to improve this should be considered which would include:

- Ditch cleanout and conveyance improvement;
- Assessment of upstream drainage area for possible added control or flow diversion possibilities; and
- Re-align ditch / pond as part of pond retrofit project.

8.2 Shanty Bay

Shanty Bay has 4 existing SWM facilities controlling a total of 49 ha of residential area.

Pond 4 is located between Lake County Rail Trail and Jenna Court and was constructed in 2002 to serve the Arbourwood Estates development. It was designed as a wet pond to service approximately 37.5 ha of the residential area. It has a design storage capacity of 27,160 m^3, including extended detention storage. The pond has been designed to control post development peak flows from the 2 to 100-year storm event to match pre-development peak flow rates. The pond discharges to a 900 mm diameter culvert draining to the existing Audubon Detention Pond (Pond 6), which outlets to a dry ditch leading to Lake Simcoe. Upon field inspection, there appears to be excessive algae or vegetation growth in the pond. Potential retrofit opportunities include improving education to residents to reduce use of phosphorous laden lawn care products or installing an aeration device to assist with decomposition of organic matter thereby improving the pond's water quality function.

Pond 6, Aubudon Detention Pond, is located between Martin Crescent and Ridge road west. It is a dry pond with a drainage area of approximately 7.5 ha. It receives outflow from Pond 4 via a 900 mm

diameter CSP and swale. Pond 6 discharges into a 400 mm diameter CSP culvert beneath Ridge Road west and eventually Lake Simcoe. Pond 6 was constructed in 1987 and heavy vegetation was observed throughout the pond during a recent site visit. Potential retrofit opportunities include converting the dry pond into a hybrid wet pond/wetland and constructing rock check dams in the ditches immediately upstream of the pond.

Pond 7 is located at the east end of Martine Crescent. It is a dry SWM facility with a drainage area of approximately 2.3 ha. Pond 7 was constructed in 1987 and consists of a dry swale parallel to the rail trail on the north boundary and berm on the south. The SWM facility is overgrown with very little detention storage capacity.

Pond 8 is located to the east of Spencer Trail and William Street. It is a dry pond with a drainage area of approximately 2.0 ha. The estimated construction date is 1995. The pond discharges westerly through a 150mm pipe and then a ditch inlet to a swale between two residential properties. The existence of this pond is not obvious in the field. The pond was observed as having heavily treed vegetation.

As documented in Section 7.4, the watercourses of Shanty Bay are exhibiting signs of erosion and instability in some areas. This concern was highlighted at the PIC through comments received from local residents. This should be considered when evaluating and implementing retrofit alternatives.

8.3 SWM Facilities Located Outside of the Settlement Areas

There are three SWM facilities located outside of the settlement areas.

Pond 1 is located on the north side of the County Road 11, east of 9 Line N. It is a wet SWM facility with active storage volume of 7,106 m^3. It consists of a sediment forebay, a 1 m wide forebay berm, a dry pond and wet pool inter connected with the sediment forebay. It has a drainage area of approximately 44.4 ha consisting of 17.2 ha from the Houben Subdivision and 27.1 ha from external drainage. Pond 1 was designed to provide basic level water quality protection and erosion control and to attenuate post–development peak flows to pre-development peak flow rates for all storm events up to and including Regional (Timmins) Storm event. Excessive vegetation was observed throughout the pond. Potential retrofit opportunities include: conversion into a hybrid wet pond/wetland system and/or adding pre-treatment measures such as rock check dams in the ditches immediately upstream of the pond.

Pond 5 is located on the south side of Nevis Ridge Drive and Greenshields Crescent. It is a dry pond with a drainage area of approximately 10 ha. It provides SWM control for the Sprucewood Subdivision residential area. It collects runoff from north of Greenshields Crescent via a 600 mm diameter CSP. The vegetation in the pond area is not excessive in its current station and is not in need of immediate maintenance. The pond is generally functioning as designed and does not require any retrofit at this time.

Pond 9 is located west of Line 5 S and north of Windfield drive E and services the low density residential area (1/2 acre lots of greater) and forestry area. A site visit was conducted to Pond 9 however the exact location, contributing drainage area and other pond details could not be confirmed. Further field investigations are recommended to confirm these details and to develop potential retrofit opportunities.

8.4 Effectiveness of Existing SWM Systems in a Changing Climate

Only a small portion of the land located in just two out of seven settlement areas is controlled by existing SWM facilities. On this basis, the majority of the Study Area does not rely on upstream SWM systems for either water quality or quantity controls and thus the receiving watercourses or water bodies are especially vulnerable to the effects of stormwater caused by climate chance. The following is a list of potential effects of climate change that have the potential to affect the existing and future SWM systems and are to be considered for retrofit opportunities and for the design of all future SWM systems:

- More frequent and intense storm events;
- More frequent and extended droughts;
- More frequent winter thaws;
- Earlier spring thaws and associated freshets; and
- Plant community die-offs due to the above environmental conditions.

Managing for climate change is an ongoing process and not a one-time task. Consideration of the above factors will assist in managing the effects of climate change in the Study Area into the future. These considerations will be discussed further in Section 9.

9 Identify and Evaluate Stormwater Improvement and Retrofit Opportunities (Step Seven)

Integral to the planning process is the consideration of improvement and retrofit opportunities/alternatives to address the problem statement and where possible, correct the noted deficiencies.

Since there are a limited number of existing SWM systems in place, the Township is well positioned to implement measures and guidelines targeting future development that consider the effects of climate change and that will result in more flexible and robust SWM systems for a wide range of environmental conditions and storm events. On this basis the majority of the SWM improvement alternatives are

focussed on SWM policy and guidelines for all future development as opposed to physical retrofits to existing systems.

The SWM improvement alternatives presented below are intended to meet the objectives of the LSPP including consideration for climate change thereby improving the overall health of the Lake Simcoe watershed. The alternatives have been organized into a number of categories including: Do Nothing, Existing Developments, Future Developments (Quantity Controls), Future Developments (Quality Controls), and General SWM Improvement Alternatives.

9.1 "Do Nothing"

The "Do Nothing" alternative represents a scenario where no SWM controls are provided for any future developments, and no retrofits or maintenance are provided for any of the existing SWM facilities and development areas. This scenario results in increased peak flows, increased flooding and increased erosion. Water quality is not addressed in this alternative. As such the phosphorus loadings to Lake Simcoe will increase. Infiltration rates in developed areas are also expected to decrease without efforts to maintain existing infiltration rates through a water budget exercise. This alternative is does nothing to improve stormwater management in the Township, and is therefore not a viable option.

The "Do Nothing" alternative is not compliant with the Lake Simcoe Protection Act.

9.2 SWM Alternatives with Focus on Existing Developments

9.2.1 Alternative 1 – Existing SWM Facility Retrofit Opportunities

Based on the existing SWM facility analyses provided in Section 8, a number of retrofit opportunities have been identified to increase the performance of existing SWM facilities. These opportunities include partial re-design and modifications to a facility and improvements to inlet/outlet structures. Implementing these changes provides various improvements to the existing stormwater runoff by improving water quantity and quality control and reducing erosion. Each existing SWM facility presents different opportunities for retrofits which result in different impacts. The effectiveness of retrofits is discussed in further detail in the selection of preferred solutions in Section 10.

9.2.2 Alternative 2 – Improve Existing Conditions Stormwater Runoff Using LIDs

LID measures can be implemented in areas where runoff is controlled or uncontrolled to provide additional stormwater runoff quality and quantity controls. There are many existing developed areas in the Study Area which release stormwater completely uncontrolled into neighbouring watercourses or directly into Lake Simcoe. These uncontrolled areas present opportunities for SWM BMPs to be implemented to increase quality and quantity control, as well as promote infiltration.

For existing developments which are controlled by traditional end-of-pipe SWM facilities, it is also possible to incorporate LID measures to increase runoff quality (depending on available space and development type). A detailed description of the various LID controls is provided in Sections 9.4.2 and 9.4.3. Common measures include:

- Bio-retention;
- Soakaway/infiltration pits and trenches;
- Green Roofs;
- Rainwater Harvesting;
- Downspout Disconnection;
- Permeable Pavement;
- Vegetated Filter Strips;
- Perforated Pipe Systems;
- Enhanced Grass Swales.

9.2.3 Alternative 3 – Improve Existing Condition Uncontrolled Stormwater Using End-of-Pipe Controls

It may be possible to construct new end-of-pipe SWM facilities (dry pond, wet pond, constructed wetland) downstream of existing developed areas to provide water quality and/or quantity control of stormwater runoff. This option is dependent on the availability of land downstream of existing development. The traditional end-of-pipe facilities are described below.

Wet SWM Pond

Wet ponds are the most common end-of-pipe SWM facility employed in Ontario. They are less land-intensive than wetland systems and are normally reliable in operation, especially during adverse conditions (winter/spring). A few benefits of wet SWM ponds are:

- Performance does not depend on soil characteristics;
- The permanent pool minimizes re-suspension;
- The permanent pool minimizes blockage of the outlet;
- The permanent pool provides for extended settling;
- MOE Enhanced Stormwater Quality control can be achieved with proper design; and

- Can attenuate stormwater runoff with proper orifice/outlet design.

It is noted that under certain circumstances, there are issues with dissolved phosphorus being released from wet ponds due to anoxic conditions. Specifically, under normal conditions dissolved phosphorus has a strong affinity to iron which when they are combined precipitate to the bottom of a wet SWM pond. However, under low or no oxygen conditions phosphorus can be released into the water column and the potential exists for the wet SWM pond to act as a source of phosphorus. Ponds will depths less than 2.0 m are less susceptible to anoxic conditions compared to depths of up to 3.0 m (maximum depth per MOECC guidelines). Diligent pond maintenance and ongoing sediment removal will reduce the available phosphorus in a wet SWM pond and reduce the potential for phosphorus re-suspension and release.

Dry SWM Pond

Dry SWM ponds have no permanent pool of water. While they can be effectively used for erosion and flood (quantity) control, the removal of sediments is a function of the detention time in the pond. For a 24 hour retention period, this normally means a lower contaminant removal, as inter event settling time does not exist. Dry SWM ponds cannot achieve MOE Enhanced stormwater quality control; they are only capable of providing Basic Level control. They should be used where other SWM options are not feasible, or as part of a treatment train approach.

Constructed Wetlands

The constructed wetland is one of the preferred end-of-pipe SWM facilities for water quality enhancement. Wetlands are normally more land-intensive than wet ponds because of their shallower depth (both in permanent pool and active storage). They are suitable for providing the storage needed for erosion control purposes, but will generally be limited in their quantity control capabilities due to restricted active storage depth.

The benefits of constructed wetlands are similar to wet ponds and include:

- Performance does not depend on soil characteristics;
- The permanent pool minimizes re-suspension;
- The permanent pool minimizes blockage of the outlet;
- The biological removal of pollutants (enhanced nutrient removal) occurs; and
- The permanent pool provides extended settling.

9.3 SWM Alternatives with Focus on Future Developments (Quantity and Erosion Control)

The following options have been assessed in regards to providing stormwater quantity and erosion controls for future development.

9.3.1 Alternative 4 - Standard Post to Pre Development Peak Flow Control

This option would require all future developments to control the post development runoff to the pre development peak flow rate using a standard end-of-pipe SWM facility (wet/dry pond or wetland) for each proposed new development. This option will reduce the peak flow rates for the 2-100 year storm events, however, the Regional Storm event will not be controlled. This option has been modeled in the Future Conditions Hydrologic Model in Section 7.1.2. This option does not address reducing potential flood problems or prevent erosion. In the larger watershed areas with small settlement areas (Hawkestone, Oro Station, etc.) this magnitude of control may be acceptable. For the smaller watersheds (Shanty Bay, Guthrie etc.), this option may lead to increased peak flow in some watercourses due to coincident peak flows and overcontrol or design targets may need to be specified.

9.3.2 Alternative 5 - Peak Design Flow Targets (Overcontrol)

As an alternative to the standard post-to pre development peak flow control, post development peak flow control criteria for new development can also be determined by establishing peak design flow targets ($m^3/s/ha$) for each design storm on a larger scaled drainage area basis. This is done by calculating the total existing condition design peak flow rates (i.e. 2-year to 100-year) to a given HRP and dividing the peak flows for each design storm by the total area upstream. All future development in the larger scaled upstream drainage area will design future condition peak flow controls according to the peak design flows targets established for each design storm. The benefit of peak design flow targets is that the potential for coincident peak flows has been considered in the overall peak design flow targets and therefore will not exceed the pre development peak flow rate for the overall area. This alternative can also address and include the unit rate targets identified in the erosion threshold analysis.

9.3.3 Alternative 6 - Centralized New SWM Pond Locations

Centralized SWM facilities that are intended to provide quantity controls for multiple upstream properties are an effective and efficient means of providing SWM. These facilities are typically located at the downstream limit of a settlement area immediately upstream of a receiving watercourse. Specifically centralized SWM facilities have the following overall benefits:

- Reduced potential for coincident peak flows from multiple upstream SWM facilities;

- Less overall total land required compared to the combined land that is required for individual SWM ponds; and
- Reduced long-term operation and maintenance required by the Township.

In a general sense development is not extensive or large enough in the settlement areas in question to warrant the benefits of this alternative for implementation.

9.3.4 Alternative 7 - Extended Detention Over-control

This option involves increasing the extended detention draw-down time beyond 24 – 48 hours. This will provide increased time for particle settling, reducing the total sediment transported to the receiving watercourse. It can be used to meet specific erosion control targets if required. However, by increasing the extended detention draw-down time a greater potential exists for insufficient extended detention storage volume during a consecutive storm when a SWM facility has not fully drawn down.

9.4 SWM Alternatives with Focus on Future Development (Infiltration and Quality Controls)

9.4.1 Alternative 8 - MOE Enhanced Level Water Quality Control

This option involves all future development providing MOE Enhanced Level stormwater quality control by whatever means necessary including: wet pond, wetland, OGS, LID or a combination thereof.

9.4.2 Alternative 9 - Water Balance and Infiltration Measures (LID Measures)

This option involves implementing LID measures (see alternatives 11 and 12 for specific measures) to increase infiltration rates for new developments. In this option, new developments are required to match pre-development infiltration rates. Recommended approaches are listed below:

- In areas where soil/groundwater conditions permit, at source infiltration measures such as soakaway pits or equivalent measures installed at the lot level are recommended. In these areas, roof leaders and other impervious surfaces are to be directed towards pervious surfaces including lawns, side and rear yard swales, boulevards, parks and other open space areas throughout the development to promote infiltration;
- Road infiltration trenches should be installed where soil/groundwater conditions permit; and
- End-of-pipe infiltration and exfiltration systems should be installed where soil and groundwater conditions permit.

9.4.3 Alternative 10 - Over-Control Infiltration Rates

This option requires that the post development infiltration rates for future developments be increased beyond the pre development infiltration rate. This increase in infiltration at a site level is intended to

help offset the existing development which did not consider any infiltration measures. This increase in infiltration rate may also help to offset the potential decrease in infiltration due to climate change.

9.4.4 Alternative 11 - LID At-Source Controls (both quality and infiltration)

The following sections describe various LID at-source control measures which are recommended for consideration in the Township. These alternatives involve measures that are located at the source where runoff is generated. At-Source controls will improve stormwater runoff quality by promoting filtration and infiltration, as well as reducing stormwater runoff volumes and peak flows generated from impervious surfaces which for the most part originate in developed areas. At-Source controls can be used in a variety of different land uses including residential, industrial and commercial. At-Source controls can be retrofitted in existing developments, and should be implemented in all new proposed developments.

Roof Downspout Disconnection

Downspout disconnection involves directing flow from roof downspouts to a pervious area that drains away from a building. This prevents stormwater from directly entering the storm sewer system or flowing across a directly connected impervious surface, such as a driveway, and into a storm sewer. Downspout disconnection recommends a minimum flow path length of 5 m across a pervious area.

When the infiltration rate of the soil in the pervious area is less than 15 mm/hr (i.e. hydraulic conductivity of less than $1x10^{-6}$ cm/s), the area should be tilled to a depth of 300 mm and amended with compost to achieve an organic content in the range of 8 to 15% by weight or 30 to 40% by volume.

Bioretention

As a stormwater filter and infiltration practice, bioretention temporarily stores, treats and infiltrates stormwater runoff. Depending on the native soil infiltration rate, the system may be designed without an underdrain for full infiltration, with an underdrain for partial infiltration, or with an impermeable liner and underdrain for filtration only, which can also be referred to as a biofilter. The primary component of a bioretention practice is the filter bed with a mixture of sand, fines and organic material. Other important elements of bioretention include a mulch ground cover and plants adapted to the conditions of the stormwater practice. Pre-treatment, such as a settling forebay, vegetated filter strip, or stone diaphragm, often precedes the bioretention to remove particles that would otherwise clog the filter bed. Bioretention is designed to capture small storm events or the water quality storage requirements. An overflow bypass is necessary to pass large storm events.

Bioretention can be adapted to fit into many different development contexts and provides a convenient area for snow storage and treatment. In a low density development, it might have a soft edge and gentle slopes, while a high density application might have a hard edge with vertical slopes.

Green Roofs (Roof Gardens)

Green roofs consist of a thin layer of vegetation and growing medium installed on top of a conventional flat or sloped roof. Green roofs are publicized for their benefits to cities, as they improve energy efficiency, reduce urban heat island effects, and create green space for passive recreation or aesthetic enjoyment. With regards to water resources, they are attractive for their water quality, water balance, and peak flow control benefits. From a hydrologic perspective, the green roof acts like a lawn or meadow by storing rainwater in the growing medium and ponding areas. Excess rainfall enters underdrains and overflow is conveyed in the building drainage system. After the storm, a large portion of the stored water is evapotranspirated by the plants, evaporates or slowly drains away.

Soakaway Pits, Infiltration Trenches and Chambers

On sites suitable for underground stormwater infiltration practices, there are a variety of facility design options to consider, such as soakaway pits, infiltration trenches and infiltration chambers. Soakaway pits are rectangular or circular excavations lined with geotextile fabric and filled with clean granular stone or other void forming material, which receives runoff from a perforated pipe inlet and allows it to infiltrate into the native soil. They typically service individual lots and receive only roof and walkway runoff, but can also be designed to receive flows from other sources. Soakaway pits can also be referred to as infiltration galleries or dry wells.

Infiltration trenches are rectangular trenches lined with geotextile fabric and filled with clean granular stone or other void forming material. Like soakaway pits, they typically service an individual lot and receive only roof and walkway runoff. This design variation is well suited to sites where available space for infiltration is limited to narrow strips of land between buildings or properties, or along road right of ways. They can also be referred to as infiltration galleries or linear soakaways.

Infiltration chambers are another design variation of soakaway pits. They include a range of proprietary manufactured modular structures installed underground, typically under parking or landscaped areas that create large void spaces for temporary storage of stormwater runoff and allow it to infiltrate into the underlying native soil. Structures typically have open bottoms, perforated side walls, and optional underlying granular stone reservoirs. They can be installed individually or in series in trench or bed configurations. They can infiltrate roof, walkway, parking lot and road runoff with adequate pre-treatment. Due to the large volume of underground void space they create in comparison to a soakaway of the same dimensions, and the modular nature of their design, they are well suited to sites where available space for other types of LID practices are limited, or where it is desirable for the facility to have little or no surface footprint (high density developments).

Permeable Pavement

Permeable pavements, an alternative to traditional impervious pavement, allow stormwater to drain through them into a stone reservoir where it is infiltrated into the underlying native soil or temporarily

detained. They can be used for low traffic roads, parking lots, driveways, pedestrian plazas and walkways. Permeable pavement is ideal for sites with limited space for other surface stormwater BMPs. Depending on the native soils and physical constraints, the system may be designed with no underdrain for full infiltration, with an underdrain for partial infiltration, or with an impermeable liner and underdrain to provide filtration only. Permeable paving allows for filtration, storage, or infiltration of runoff, and can reduce or eliminate surface stormwater flows compared to traditional impervious paving surfaces.

Rainwater Harvesting

Rainwater harvesting is the process of intercepting, conveying and storing rainfall for future use. Harvesting rainwater for domestic uses has proved to be practical in rural Ontario for over a century. Interest in adapting this practice to urban areas is increasing as it provides combined benefits of conserving potable water and reducing stormwater runoff. When harvested rainwater is used to irrigate landscaped areas, the water is either evapotranspirated by vegetation or infiltrated into the soil, thereby helping to maintain predevelopment water balance.

A full list of LID at-source controls including design guidelines are described in detail in the *Low impact Development Stormwater Management Planning and Design Guide (TRCA/CVC, 2010)*.

9.4.5 Alternative 12 - LID Conveyance Controls

Conveyance controls involve controlling the stormwater runoff as it travels along a designed drainage path. There are a variety of existing drainage features within the Study Area which could be retrofitted to provide specific LID treatment targets for stormwater runoff. These LID measures increase water quality by promoting filtration and infiltration, as well as reducing the stormwater runoff volume and peak flows. The proposed LID conveyance controls are listed in the following section.

Vegetated Filter Strips

Vegetated filter strips (also known as buffer strips and grassed filter strips) are gently sloping, densely vegetated areas that treat runoff as sheet flow from adjacent impervious areas. They function by slowing runoff velocity and filtering out suspended sediment and associated pollutants, and by providing some infiltration into underlying soils. Originally used as an agricultural treatment practice, filter strips have evolved into an urban SWM practice. Vegetation may be comprised of a variety of trees, shrubs and native plants to add aesthetic value as well as water quality benefits. With proper design and maintenance, filter strips can provide relatively high pollutant removal. Maintaining sheet flow into the filter strip through the use of a level spreading device is essential. Using vegetated filter strips as pre-treatment practices to other BMPs is highly recommended. They also provide a convenient area for snow storage and treatment, and are particularly valuable due to their capacity for snowmelt infiltration. If used for snow storage, the area should be planted with salt-tolerant, non-

woody plant species. Because of the simplicity of filter strip designs, physical changes to the practice are not needed for winter operation.

Enhanced Grass Swale

Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff (also known as enhanced vegetated swales). Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. Simple grass channels or ditches have long been used for stormwater conveyance, particularly for roadway drainage. Enhanced grass swales incorporate design features such as modified geometry and check dams that improve the contaminant removal and runoff reduction functions of simple grass channel and roadside ditch designs.

A dry swale is a design variation that incorporates an engineered soil media bed and optional perforated pipe underdrain system. Enhanced grass swales are not capable of providing the same water balance and water quality benefits as dry swales, as they lack the engineered soil media and storage capacity of that best management practice.

Where development density, topography and depth to water table permit, enhanced grass swales are a preferred alternative to both curb and gutter and storm drains as a stormwater conveyance system. When incorporated into a site design, they can reduce impervious cover, accent natural landscape, and provide aesthetic benefits.

Dry Swales

A dry swale can be thought of as an enhanced grass swale that incorporates an engineered soil bed and optional perforated pipe underdrain or a bioretention cell configured as a linear open channel. They can also be referred to as infiltration swales or bio-swales. Dry swales are similar to enhanced grassed swales in terms of the design of their surface geometry, slope, check dams and pre-treatment devices. They are similar to bioretention cells in terms of the design of the filter media bed, gravel storage layer and optional underdrain components. In general, they are open channels designed to convey, treat and attenuate stormwater runoff. Vegetation or aggregate material on the surface of the swales slows the runoff water to allow sedimentation, filtration through the root zone and engineered soil bed, evapotranspiration, and infiltration into the underlying native soil. Dry swales may be planted with grasses or have more elaborate landscaping.

Perforated Pipe Systems

Perforated pipe systems can be thought of as long infiltration trenches or linear soakaway pits that are designed for both conveyance and infiltration of stormwater runoff. They are underground stormwater conveyance systems designed to attenuate runoff volume and reduce contaminant loads to receiving

waters. They are composed of perforated pipes installed in gently sloping granular stone beds that are lined with geotextile fabric that allow infiltration of runoff into the gravel bed and underlying native soil while it is being conveyed from source areas or other BMPs to an end-of pipe facility or receiving waterbody. Perforated pipe systems can be used in place of conventional storm sewer pipes, where topography, water table depth, and runoff quality conditions are suitable. They are suitable for treating runoff from roofs, walkways, parking lots and low to medium traffic roads, with adequate pre-treatment. A design variation can include perforated catchbasins, where the catchbasin sump is perforated to allow for runoff to infiltrate into the underlying native soil. Perforated pipe systems can also be referred to as pervious pipe systems, exfiltration systems, clean water collector systems and percolation drainage systems.

A full list of LID conveyance controls including design guidelines are described in detail in the *Low impact Development Stormwater Management Planning and Design Guide (TRCA/CVC, 2010)*.

9.5 General Stormwater Improvement Alternatives

The following alternatives represent a number of options, all of which can be implemented concurrently.

9.5.1 Alternative 13 – SWM System Design Rainfall to Account for Climate Change

Fluctuating weather patterns have been shown to change rainfall patterns. Climate change has the potential to increase the intensity, duration and frequency of storms. If it is not considered as part of the design of future SWM systems, climate change has the potential to jeopardize the water quantity and quality functions of existing and future SWM systems. In extreme circumstances, public safety could be at risk due to downstream flooding or erosion, pond berm failure etc. To account for climate change, the design of all future SWM systems in the Township should consider a 15% increase in rainfall depth and intensity for all design storms including the 2 – 100-year storm events. The expected result is more robust SWM facilities that are capable of functioning as designed for a wider range of runoff scenarios. The function of SWM facilities designed for increased rainfall depth and frequency is expected to result in more sustainable SWM systems.

A 15% increase in rainfall depth and intensity applied to all design storms has been used in other municipalities and has been shown to produce similar rainfall results to those that are produced using larger scale climate models. Adjustments to the 15% increase in rainfall depth and intensity can be reviewed in the future as more data becomes available.

9.5.2 Alternative 14 – Landscape Program Including Drought and Flood Tolerant Species

SWM facilities including: wet ponds, dry ponds, wetlands, bio swales, bioretention cells, etc. play a vital role in water quality treatment throughout a number of biological and physical mechanisms. Nutrient uptake by plants and sediment filtering by vegetation are incorporated into SWM facilities to

improve water quality and treatment of runoff. Landscape plans that consider native plant species able to tolerate extended wet and dry conditions are to be prepared with all proposed SWM systems. Selection of appropriate vegetation will ensure long term water quality treatment of runoff in all future SWM facilities. Efforts by the Township to replace unhealthy or dead vegetation in existing SWM facilities or along existing drainage paths etc. should be incorporated in the Township's operation and maintenance plans and should also consider proper selection of plants to encourage water quality treatment and to avoid the need for repeated re-planting.

9.5.3 Alternative 15 – Convert Roadside Ditches to Enhanced Grass Swales

As a vast majority of the runoff from the developed land in the Study Area is uncontrolled and this presents an opportunity to implement LID controls in appropriate areas to treat runoff from existing developments. A large portion of the roads in the Study area are a rural section and consist of open ditches. These ditches convey runoff from a variety of developments including residential, commercial and industrial. Converting these ditches to Enhanced Grass Swales provides an opportunity increase the quality of stormwater runoff, as well as promote infiltration. Enhanced Grass Swales are discussed in detail in the Toronto and Region and Credit Valley Conservation Authority's *Low Impact Development Stormwater Management Planning and Design Guide* (2010), and are summarized below.

Enhanced Grass Swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff. Check dams and vegetation in the swale slows the water to allow sedimentation, filtrating, evapotranspiration and infiltration. It is estimated that a volumetric runoff reduction of between 10-20% can be achieved by Enhanced Grass Swales, depending on soil type (20% for Type A or B, 10% for type C or D). It is also estimated that these swales can remove 76% of Total Suspended Solids, and have a 55% phosphorus reduction. Some design considerations to consider are listed below.

- Longitudinal swale slope should be between 0.5 and 4%. For slopes steeper than 3%, check dams should be used. Slopes less than 1% enhance the removal rate of pollutants.
- Bottom width of swales should be between 0.75 and 3.0 m.
- A maximum flow depth of 100 mm is recommended during a 4-hour, 25 mm Chicago storm event.
- Bottom of swale should be separated from the seasonally high water table or top of bedrock by at least 1 m or be supported by appropriate geotechnical design
- Grass swales can be applied on any type of soils, however increased soil infiltration rates (greater than 15 mm/hr) will enhance the removal of pollutants.
- Pre-treatment with vegetated filter strips or sediment forebays enhance the pollutant removal rate.

- A planting strategy for Enhanced Grass Swales is provided in the TRCA/ CVCA Guide. Salt tolerant species are preferred as road salt often enters ditch.

9.5.4 Alternative 16 – As-Constructed Drawings for All New SWM Facilities

In order to assess future sediment accumulation in SWM facilities, it is important to have an accurate as-built survey of each pond to confirm the original pond volumes that existed following initial construction.

The developer should be responsible for completing a pond cleanout and a post pond clean out topographic survey, confirming the pond has been constructed as designed and with the pond volumes intended. It is recommended that the post pond cleanout survey take place at the end of the maintenance period prior to assumption by the Township.

9.5.5 Alternative 17 – Low Impact Development Urban Road Section

Runoff from the majority of the developed areas in the Study Area, including all roadways is discharged uncontrolled to the receiving watercourses of Lake Simcoe. It is recommended that for all new development and redevelopment of roads, water quality treatment for runoff be considered whether existing quality SWM controls exist or not. This alternative would have the effect of continuing to improve the existing quality of runoff from roads that is directed to the receiving watercourses and Lake Simcoe. LID practices can be incorporated into standard road sections where the existing soil, groundwater and bedrock conditions allow.

9.5.6 Alternative 18 – Joint Public & Private Awareness Programs

Runoff from the majority of settlement areas within the Township discharges uncontrolled to a tributary watercourse or Lake Simcoe directly. To assist in reducing the impacts of runoff produced during frequent storms joint public/private programs are recommended to promote rainwater harvesting and greywater reuse. A program promoting the use of rain barrels is recommended for individual households whereby individual property owners located within the settlement boundary limits are encouraged to purchase a rain barrel(s) from the Township, at a subsidized rate, for rainwater harvesting and re-use, in order to reduce the storm runoff volume and peak flow rate on an individual site basis. As part of the rain barrel campaign, public education related to other at-source SWM opportunities are to be introduced to the public including reducing fertilizer usage, rain gardens, roof downspout directed to pervious areas etc. Stormwater initiatives aimed at individual property owners are not only effective on a site by site basis, but have been shown to promote public education and awareness having positive effects on the community.

9.5.7 Alternative 19 – Township SWM Operation and Maintenance Program

Existing certificates of approval (C of As) and Environmental Compliance Approvals (ECAs) issued under Section 53 of the Water Resources Act, require that the owners of all SWM facilities, including LID features, maintain the facilities to ensure they continue operating as originally designed over time.

After construction, the maintenance responsibilities of SWM facilities are often forgotten and when extensive maintenance is required financial resources are not available to complete the work. As indicated above, there are nine SWM facilities located in the Township that drain into Lake Simcoe. There is planned development located within the settlement boundaries, and inspection and maintenance of these facilities will be required. As a minimum, it is recommended that for all future SWM facilities and LID features, an operation and maintenance manual detailing the specific maintenance requirements, be submitted by the SWM facility designer prior to final approval of the SWM facility. The manuals are to identify the specific frequency of maintenance responsibilities and are to be kept on file by the operating authority for reference.

An annual Township SWM facility and maintenance program is also recommended for the purposes of documenting SWM facility operating characteristics on an annual basis. The maintenance program will include review of existing and future LID practices also. Detailed annual field assessments are recommended to record:

- Sediment accumulation depth;
- Signs of erosion;
- Excessive debris;
- Excessive vegetation which may be obstruction flow, access, blocking inlets or outlets etc.;
- Prolonged ponding; and
- Damage to either the inlet / outlet.

Photos are to be logged during each visit and kept on file to monitor SWM facility features from year to year.

A proper SWM maintenance plan, including annual records and ongoing analysis of data can be useful to assist with prioritizing SWM maintenance capital works projects (including outlet adjustments/retrofits, bank stabilization, sediment clean-outs etc.) and reduce liabilities and overall long term costs. An operation and maintenance plan can be used to determine the anticipated maintenance needs for each SWM facility based on past records and to allocate long range budget resources as part of the Township's 5, 10 and 15-year capital budgets.

9.5.8 Alternative 20 – Phosphorus Reduction Strategies in Agricultural Areas

Agricultural areas make up approximately 33% of the total Township area that drains into Lake Simcoe, and a majority of the overall existing and future phosphorus loading to Lake Simcoe. For this reason, it is appropriate to consider efforts on reducing phosphorus loadings outside of the settlement areas. There are a number of methods that can be used to reduced phosphorus loading from agricultural areas and which are described in the Lake Simcoe Climate Change Adaptation Strategy (Draft October 2013) including promoting the following:

- drainage and irrigation techniques to conserve water and minimize nutrient loss;
- promoting farmers to apply manure and other fertilizers in the spring after the spring freshet as opposed to the fall;
- sustainable management (i.e. crop rotation, low tillage, wind breaks, vegetated filter steps etc.); and
- environmental farm plans and plan updates.

The above techniques can be achieved through the implementation of pilot projects and programs such as the farm stewardship implementation program. Funding is available for rural retrofits and it is recommended that the Township support and promote these programs with the farming community.

9.6 Evaluation of Alternatives

The Alternatives described above have been evaluated in each of the settlement areas and screened with respect to their impact on the physical, natural, social, cultural and economic environments. Table 9-1 assesses the SWM Alternatives in context with the preliminary criteria.

9.7 Evaluation Criteria and Weighting

Evaluation criteria were developed according to the MCEA guidelines recognizing that a number of alternatives would be selected and that selection of one does not preclude the selection of another. The evaluation criteria for each alternative are summarized in the table overleaf:

Table 9-1: Alternative Screening Table

Preliminary Criteria	Do Nothing	SWM Improvement Alternatives																		
		SWM Alternatives With Focus on Existing Development			SWM Alternatives With Focus on Future Development (Quantity Control)						SWM Alternatives With Focus on Future Development (Quality Control)			General SWM Improvement Alternatives						
		Alternative 1 - Existing SWM Facility Retrofit Opportunities	Alternative 2 - Improve Existing Condition Stormwater Runoff Using LIDs	Alternative 3 - Improve Existing Condition Uncoltrolled Stormwater Using End of Pipe Controls	Alternative 4 - Standard Post to Pre Development Peak Flow Control	Alternative 5 - Peak Design Flow Targets	Alternative 6 - Centralized SWM Pond Locations	Alternative 7 - Extended Detention Over-Control	Alternative 8 - Water Balance and Infiltration Measures	Alternative 9 - Over-Control Infiltration Rates	Alternative 10 - MOE Enhanced Level Water Quality Control	Alternative 11 - LID At-Source Controls	Alternative 12 - LID Conveyance Controls	Alternative 13 - SWM System Design Rainfall to Account for Climate Change	Alternative 14 - Landscape Program Includign Drought and Flood Tolerant Plant Species	Alternative 15 - Convert Roadside Ditches to Enhances Grass Swales	Alternative 16 - As-Construted Drawings fro All New SWM Facilities	Alternative 17 - Low Impact Development Urban Road Section	Alternative 18 - Joint Public & Private Awareness Programs	Alternative 19 - Township SWM Operation and Maintenance Program	Alternative 20 - Phosphorus Reduction Strategies in Agricultural Areas
Land uses where strategy is to be applied	N/A	Existing SWM Facilities	Existing Development, Open Areas, Ditches etc.	Open Space Downstream of Existing Development	Future SWM Facility	Future SWM Facility	Future SWM Facility At Downstream Limit of Settlement Area	Future SWM Facilities	Future Development Lands	Future Development Lands	Future SWM Facilities	Future Development Lands	Future Development Lands	N/A	Existing & Future SWM Facilities, ditches etc.	Existing Ditches	New SWM Facilities	Existing and new Roads	Individual Property Owners (Private Property)	Existing SWM facilities	Agricultural Areas
Peak flows	Negative	Potential Positive	Potential Positive	Potential Positive	Positive	Positive	Positive	N/A	N/A	N/A	N/A	Positive	Positive	Positive	N/A	Positive	N/A	Positive	Positive	Potential Positive	N/A
Phosphorus Loading	Negative	Positive	Positive	Positive	N/A	N/A	N/A	N/A	Positive	Positive	Positive	Positive	Positive	N/A	Positive	Positive	N/A	Positive	Potential Positive	Potential Positive	Potential Positive
Infiltration	Negative	Potential Positive	Potential Positive	Potential Positive	N/A	N/A	N/A	N/A	Positive	Positive	N/A	Positive	Positive	N/A	Positive	Positive	N/A	Positive	Potential Positive	N/A	N/A
Erosion Potential	Negative	Positive	Positive	Positive	N/A	N/A	N/A	Positive	Positive	Positive	N/A	Positive	Positive	Positive	Positive	Positive	N/A	Positive	Positive	Potential Positive	N/A

Notes: Decrease and increase in peak flows is considered ‘positive’ and ‘negative’ respectively.

Decrease and increase in phosphorus loading is considered ‘positive’ and ‘negative’ respectively.

Decrease and increase in infiltration is considered ‘positive’ and ‘negative’ respectively.

Decrease and increase in erosion potential is considered ‘positive’ and ‘negative’ respectively.

Table 9-2: SWM Alternative Evaluation Criteria

Technical	Opportunity to reduce peak flows into Lake Simcoe
	Opportunities to decrease erosion of watercourses
	Opportunity to improve water quality
	Opportunity to reduce phosphorus loadings into Lake Simcoe
	Opportunities to mitigate changes in water balance
Natural Heritage Features	Provisions of direct and indirect fish habitat
	Potential to improve terrestrial habitats
	Impact to natural hazard features
Social Environment	Ability to improve public health and safety
	Impacts to private structures
	Impacts to public property
Cultural Environment	Impacts to built and cultural heritage landscape
	Impacts to archaeological resources
Economic Environment	Capital costs
	Operation and maintenance costs
	Risk management
	Impact on agricultural land use

The above evaluation criteria were applied to each proposed alternatives on an individual settlement area basis. This will help ensure the implementation of alternatives targets the specific constraints and opportunities of each area. The preferred alternatives are discussed in Section 10.

10 Preferred Alternative(s) (Step Eight)

The recommendations provided herein are the preferred alternatives of this Master Plan process. The preferred alternatives are intended to guide SWM related to future development that has been identified in the Township's Official Plan. The selection of the preferred alternatives for this CSWM-MP were developed following the detailed analysis completed in Sections 5 through 8. Input from the public and agencies were also considered through the PIC that was completed September 18, 2014. Relevant information re: open house comments and EA circulations is attached to this report in Appendix E. The preferred alternatives have been divided into two categories. A SWM plan has been developed for the Study Area as a whole and provides a general guideline for SWM practices for all future development in Oro-Medonte. Individual SWM Plans have also been prepared for each settlement area with respect to the list of alternatives which provide a more detailed SWM plan for each settlement area specifically.

10.1 Overall SWM Plan

The overall SWM Plan includes a broad range of SWM recommendations and applies to all areas of Oro-Medonte located in the Study Area and includes the following:

1. SWM plans related to all future development and re-development should consider a minimum 15% increase in rainfall depth and intensity for the design of all future SWM systems.

2. The SWM plans related to all future development and re-development are to provide post to pre development peak flow control at a minimum unless specified otherwise herein.

3. The SWM plan related to all future development and re-development is to provide MOE Enhanced Level water quality control including a minimum of 24 hour extended detention of the greater of: 40 m^3/ha of contributing area or the total runoff volume produced by the 25 mm 4-hr Chicago storm, unless specified otherwise herein. This applies to all development with a total area greater than 2 ha. Specific unit-flow rate requirements for select settlement areas have also been determined based on an erosion threshold analysis. The erosion control criteria that is more stringent is to be used.

4. The SWM plan related to all future development and re-development is to consider the use of LID practices where applicable, as stand-alone SWM systems or as part of a treatment train combined with other SWM practices. The conversion of existing roadside ditches into Enhanced Grass Swales is also recommended as a relatively low cost solution to improve the water quality of the runoff, including phosphorus reduction from existing developed areas.

5. All new roads and road reconstructions are to consider implementing LID road section. Adaptations of the road section for other types of road sections and right-of-way widths are

recommended and should be reviewed with the Township during the initial planning stages of a project.

6. All new development and redevelopment is to consider the use of flood and drought tolerant plant species. Landscape plans specifying the use of such plants are required as part of each future development application involving SWM.

7. As-built surveys are required as part of all newly constructed SWM facilities for the purposes of confirming that the design storage volumes exist and for determining sediment accumulation throughout the lifespan of the facility.

8. The Township is to develop a Township-wide operation and maintenance program for ongoing maintenance and monitoring of existing SWM facilities including SWM ponds, OGS, LIDs etc.

9. Joint public/private programs are to be advance by the Township to improve water quality, reduce erosion and to promote public education and awareness on issues related to SWM.

10. The phosphorus analysis included herein has focussed on the settlement areas. However actively farmed agricultural areas outside of settlement areas constitute a large portion of the existing and future phosphorus loading from the Township Area that drains into Lake Simcoe. For this reason, it is appropriate to implement efforts on reducing phosphorus loadings from these areas. A list of methods is included in Section 9.5.8 and can be realized through the implementation of pilot projects and programs such as the farm stewardship implementation program. Funding is available for rural retrofits and it is recommended that the Township support these programs in cooperation with the farming community.

10.2 Settlement Area Specific SWM Plans

10.2.1 East Oro

Existing Development Areas

The East Oro Settlement area including existing/future development areas is included as Figure 11-1.

Currently there are no SWM facilities in East Oro. The recommended approach to improve stormwater runoff quality in the uncontrolled developed areas is to implement LID measures into the existing developments as part of reconstruction projects or as stand-alone projects if warranted. The soil in East Oro has moderate to high infiltration capacity, which are good for LID practices. The Bluff's Creek tributary in the area of East Oro is also stable from an erosion perspective and not entrenched therefore additional erosion control beyond the 25 mm and 2 year is not required. The following is a list of recommendations:

- Where appropriate, reconstruction projects shall convert existing roadside ditches, swales and conveyance routes into enhanced grass swales to provide increased stormwater quality and infiltration; and

- Where appropriate, install check dams in existing roadside ditches, swales and conveyance routes in order to promote infiltration.

Future Development Areas

East Oro settlement is small and is planned to increase only modestly in developed area from approximately 45% to 62%. The following recommendations have been made for the future developments:

- Implement lot level (at-source) LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;

- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading;

- A treatment train of LID approaches should be provided to achieve the required water quality control;

- Where site conditions do not allow the implementation of LID measures to provide quality/quantity control and contributing drainage areas exceed 5 ha, standard wet ponds should be designed to provide both quality and quantity control. Standard post-to-pre water quantity controls are appropriate for future development given the size of the development area and receiving watercourse; and

- New development to control post-development peak flow rates to pre-development levels and to provide enhanced level quality control. An erosion control threshold flow target of 1.7 L/s/ha for the 25 mm and 2-year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha, is required for future development in Catchment 2071. 24 hour detention for run-off from the 25 mm 4-hour Chicago storm is required elsewhere.

Table 10-1 East Oro SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Post to pre development peak flow control to MOECC criteria
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Erosion control to 1.71 L/s/ha for the 25 mm and 2-year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 2071. Standard MOECC erosion control elsewhere.

10.2.2 Forest Home

Existing Development Areas

The Forest Home area with existing and future land uses is presented on Figure 11-2.

Similar to East Oro, there are no currently SWM facilities identified at Forest Home settlement area.

Recommendations to improve stormwater runoff quality for any developed and uncontrolled areas are to implement LID measures. The soil in Forest Home is generally sandy loam or silt loam, which provides good characteristics for infiltration practices. The following is a list of recommendations:

- Where appropriate, convert existing roadside ditches, swales and conveyance routes into enhanced grass swales to provide increased stormwater quality and infiltration;
- Where appropriate, install check dams in existing roadside ditches, swales and conveyance routes in order to promote infiltration;
- Where appropriate, install infiltration trenches/soakaway pits on Township land at downstream ends of storm pipes or conveyance channels to promote infiltration and provide increased water quality; and
- The Forest Home industrial/commercial area east of Hwy 11 is not currently in the settlement boundary but has been identified with drainage problems in the past and currently has no SWM quantity or quality controls in place. Outlet channel gradients are low in this area and beavers have been known to exacerbate this issue in the past. Retrofit and/or channel outlet (Bluff's Creek) improvement opportunities should be considered.

Future Development Areas

The Forest Home is mostly developed with a potential increase from approximately 79% to 99% from development. The future development will consist of residential development and local industrial, as designated in the OP. Development areas will drain into the tributaries of Bluffs Creek Subwatershed. The following recommendations have been made for the future developments:

- Implement lot level LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;
- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading;
- A treatment train of LID approaches should be provided to achieve the required water quality control;

- Where site conditions do not allow the implementation of LID measures to provide quality/quantity control, standard wet ponds should be designed to provide both quality and quantity control if contributing drainage areas exceed 5 ha; and

- New development to control post-development peak flow rates to pre-development levels and to provide enhanced level quality control. An erosion control threshold flow target of 7.8 L/s/ha for the 25 mm storm and 2-10-year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha, is required for future development in Catchment 2025. 24 hour detention for run-off from the 25 mm 4-hour Chicago storm is required elsewhere.

Table 10-2 Forest Home SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Unit flow rates (see Section Table 7-5)
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Erosion control to 7.84 L/s/ha for the 25 mm storm and 2-10-year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 2025. Standard MOECC erosion control elsewhere.

10.2.3 Guthrie

Existing Development Areas

The features of the Guthrie Area are presented on Figure 11-3.

Currently, Guthrie has approximately 59.8 ha of the developed land, among which 5.2 ha is controlled by Pond #3. The majority of stormwater runoff from Guthrie is uncontrolled.

Retrofit options to the existing dry pond #3 include converting the pond into wet pond, and installing check dams in existing roadside ditches, swales and conveyance routes to promote infiltration. This project should consider improvements to the creek downstream of the SWM pond to alleviate existing ponding/flooding concerns upstream of Hwy 11.

Pond #2, located outside of the settlement area, has a total of approximately 38.2 ha of contributing area. The retrofit of this facility could have a benefit for quality control to the NVCA watershed. The retrofit options recommended include converting the existing dry pond into hybrid wet pond/wetland. It is recommended that a detailed assessment of the pond be completed with ultimate goal of achieve the required MOE Enhanced Level water quality controls. As this is not part of the effort to reduce to phosphorus loading to Lake Simcoe, a specific recommendation is not provided in this report.

Recommendations to improve stormwater runoff quality for any developed and uncontrolled areas is to implement LID measures. The soil in Guthrie has generally good infiltration capacity which is favorable for LID practices, however, areas of high groundwater also exist. The following is a list of recommendations:

- Where appropriate, convert existing roadside ditches, swales and conveyance routes into enhanced grass swales to provide increased stormwater quality and infiltration;
- Where appropriate, install infiltration trenches/soakaway pits at downstream ends of storm pipes or conveyance channels to promote infiltration and provide increased water quality; and
- Promote the use of rain barrels (rainwater harvesting) for existing houses, and encourage roof-downspout disconnection into pervious areas.

Existing drainage issues within Guthrie

Residents of Guthrie have identified a long standing flood issue along the upper reach of Shelswells Creek (north of Hwy 11) within the settlement boundary. To a degree the problem stems from the fact that several of the rear yards in the area are too low and the existing channel does not have adequate size or gradient to convey the expected flow. Upon field reconnaissance, heavy vegetation along the drainage route has also been observed, which is reducing the channel conveyance capacity. Channel investigation and maintenance to increase the existing channel capacity is considered a preferred option at this stage. Retrofitting to Pond #3 would be another option to ease the flood issue. Increased runoff from the lands upstream of the Guthrie settlement, could also be a contributing factor of this deteriorating drainage issue and additional retention of upstream runoff would also be beneficial in terms of water quality and quantity control.

Future Development Areas

The developed area in Guthrie is planned to increase from approximately 61% to 96%. The future development will consist of residential, commercial and industrial, as designated in the OP. The following recommendations have been made for the future developments:

- Implement lot level LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;
- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading;
- A treatment train of LID approaches should be provided to achieve the required water quality control;
- Where site conditions do not allow the implementation of LID measures to provide quality control, standard wet ponds should be designed to provide both quality and quantity control; and

- New development to control post-development peak flow rates to pre-development levels and to provide enhanced level quality control. An erosion control threshold flow target of 3.4 L/s/ha for the 25 mm storm and 2-5-year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha is required for future development in Catchment 5141. 24 hour detention for run-off from the 25 mm 4-hour Chicago storm is required elsewhere.

Table 10-3 Guthrie SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Post to pre development peak flow control to MOECC criteria
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Erosion control to 3.40 L/s/ha for the 25 mm storm and 2-5 year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 5141. Standard MOECC erosion control elsewhere.

10.2.4 Hawkestone

Existing Development

Currently there are no SWM facilities in Hawkestone settlement. The settlement boundaries and land uses are depicted on Figure 11-4.

The recommended approach to improve stormwater runoff quality in the developed areas is to implement LID measures into the existing developments as opportunities arise. The soil in Hawkestone has moderate infiltration capacity, which is supports the use of LID practices in some areas. The following is a list of recommendations:

- Where appropriate, convert existing roadside ditches, swales and conveyance routes into enhanced grass swales to provide increased stormwater quality and infiltration;
- Where appropriate, install check dams in existing roadside ditches, swales and conveyance routes in order to promote infiltration; and
- Promote the use of rain barrels for existing houses, and encourage roof-downspout disconnection into pervious areas.

Future Development

Hawkestone is planned to increase in developed area from approximately 33% to 46%. Several large blocks of land exist in this settlement area that can warrant new SWM ponds with development. The following recommendations have been made for the future developments:

- Use of traditional SWM practices for new development (regional SWM facilities) in combination with non-infiltration based LID practices for surface runoff. Candidate SWM areas are identified on Figure 11-4;
- Implement lot level LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;
- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading; and
- New development to control post-development peak flow rates to pre-development levels and to provide enhanced level quality control. Erosion control threshold flow targets of 2.3 L/s/ha for the 25 mm storm and 2-year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha, is required for future development in Catchments 2207. Erosion control threshold flow targets of 1.53 L/s/ha for the 25 mm storm and 2-5-year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha, is required for future development in Catchments 2204. 24 hour detention for run-off from the 25 mm 4-hour Chicago storm is required elsewhere.

Table 10-4 Hawkestone SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Post to pre development peak flow control to MOECC criteria
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Erosion control to 2.27 L/s/ha for the 25 mm storm and 2-year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 2207. Erosion control to 1.53 L/s/ha for the 25 mm storm and the 2-5year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 2204. Standard MOECC erosion control elsewhere.

10.2.5 Oro Station

Existing Development

The Oro-Station Settlement area and land uses are depicted on Figure 11-5.

Currently there are no SWM facilities in Oro Station. The recommended approach to improve stormwater runoff quality in the uncontrolled developed areas is to implement LID measures into the existing developments. The soil in Oro Station has moderate or good infiltration capacity, which is good for LID practices. No significant watercourses or drainage features exist in the Oro Station Settlement area. All drainage is currently conveyed via roadside ditches. The following is a list of recommendations:

- Where appropriate, convert existing roadside ditches, swales and conveyance routes into enhanced grass swales to provide increased stormwater quality and infiltration;
- Where appropriate, install check dams in existing roadside ditches, swales and conveyance routes in order to promote infiltration; and
- Promote the use of rain barrels for existing houses, and encourage roof-downspout disconnection into pervious areas.

Future Development

Oro Station is planned to increase in developed area only modestly with small infill type development from approximately 62.7% to 72%, a large portion of which will be residential infill. The following recommendations have been made for the future developments:

- Implement lot level LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;
- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading;
- A treatment train of LID approaches should be provided to achieve the required water quality control; and
- Where site conditions do not allow the implementation of LID measures to provide quality/quantity control, standard wet ponds should be constructed. The capacity of the receiving drainage feature should be confirmed to verify that standard post-to-pre water quantity controls are appropriate for future development.
- New developments with a total area greater than 2.0 ha are to provide 24 hour detention for run-off from the 25 mm 4-hour Chicago storm.

Table 10-5 Oro Station SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Post to pre development peak flow control to MOECC criteria
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Standard MOECC erosion control

10.2.6 Rugby

Existing Development

The existing/future land uses in Rugby are illustrated on Figure 11-6.

Currently there are no SWM facilities in Rugby and the outlet for drainage is a headwater tributary of Bluff's Creek. Future development is predominantly infill residential. The recommended approach to improve stormwater runoff quality in the uncontrolled developed areas is to implement LID measures into the existing developments. The soil in Rugby has good infiltration capacity, which is ideal for LID practices. The following is a list of recommendations:

- Where appropriate, convert existing roadside ditches, swales and conveyance routes into enhanced grass swales to provide increased stormwater quality and infiltration;
- Where appropriate, install check dams in existing roadside ditches, swales and conveyance routes in order to promote infiltration; and
- Promote the use of rain barrels for existing houses, and encourage roof-downspout disconnection into pervious areas.

Future Development

Rugby is planned to increase only incrementally in developed area from approximately 54% to 58%. The majority of the settlement area will remain residential or agricultural. The following recommendations have been made for the future developments:

- Implement lot level LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;
- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading;

- A treatment train of LID approaches should be provided to achieve the required water quality control; and
- Where site conditions do not allow the implementation of LID measures to provide quality control, standard wet ponds should be designed to provide both quality and quantity control. Standard post-to-pre water quantity controls are appropriate for future development.
- New developments with a total area greater than 2.0 ha are to provide 24 hour detention for run-off from the 25 mm 4-hour Chicago storm.

Table 10-6 Rugby SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Post to pre development peak flow control to MOECC criteria
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Standard MOECC erosion control

10.2.7 Shanty Bay

Existing Development

Currently there are 113.5 ha of the development land, representing 64% of the total area. The remaining area includes agricultural and natural heritage. Figure 11-7 presents the Shanty Bay area and associated drainage features. As discussed in Section 5.9, there are four SWM facilities in Shanty Bay, with a total contributing area of about 49 ha, majority of which is residential land. Pond 4 is a wet pond, and the rest are dry ponds. It is considered beneficial to convert existing ponds to hybrid wet pond /wetland. The recommended approach to improve stormwater runoff quality in the controlled and uncontrolled developed areas is to implement LID measures into the existing developments where possible. The soil in Shanty Bay has generally moderate to moderately high infiltration capacity, which is good for LID practices. The tributaries of Shanty Bay are documented to be experiencing erosion. The implementation of retrofit or LID measures to better control flow to these tributaries should be considered a priority. The following is a list of recommendations:

- LID lot level and conveyance practices should be implemented for existing systems to improve water quality control, reduce erosion and promote infiltration; and
- Retrofit opportunities for Pond #6, #7 and #8 exist to convert dry ponds into wet ponds to help reduce phosphorus loading in combination with LID measures to help with erosion control for affected tributaries.

Future Development

Shanty Bay is planned to increase in developed area from approximately 64% to 76%. The following recommendations have been made for the future developments:

- Implement lot level LID measures such as downspout disconnection to pervious areas, porous pavement, and soakaway areas to improve water balance, reduce phosphorus loading, and reduce peak flows from the site;
- Provide conveyance LID measures such as enhanced grass swales, perforated pipe systems, vegetated filter strips to improve water quality and reduce phosphorus loading;
- A treatment train of LID approaches should be provided to achieve the required water quality control;
- Where site conditions do not allow the implementation of LID measures to provide quality control, standard wet ponds should be designed to provide both quality and quantity control; and
- New development to control post-development peak flow rates to pre-development levels and to provide enhanced level quality control. Erosion control threshold flow targets of 4.5 L/s/ha for the 25 mm storm and the 2-5 year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha, is required for future development in Catchments 5250. Erosion control threshold flow targets of 3.69 L/s/ha for the 25 mm storm and the 2-25 year storm events or 24 hour detention for run-off from the 25 mm 4-hour Chicago storm (whichever is more stringent) for new development with a total area greater than 2.0 ha, is required for future development in Catchments 5255. 24 hour detention for run-off from the 25 mm 4-hour Chicago storm is required elsewhere.

Table 10-7 Shanty Bay SWM Plan Summary Table

SWM Plan Criteria	Recommendation
Water Quality	Lot level and Conveyance LIDs (preferred) & standard MOECC water quality treatment
Water Quantity	Post to pre development peak flow control to MOECC criteria
Water Balance	Where possible match existing condition annual infiltration volume in future condition
Erosion Control	Erosion control to 4.50 L/s/ha for the 25 mm storm and 2-5-year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 5250. Erosion control to 3.69 L/s/ha for the 25 mm storm and 2-25 year storm events or standard MOECC erosion control (whichever is more stringent) for future development in Catchment 5255. Standard MOECC erosion control elsewhere.

11 Implementation Plan (Step Nine)

In order to ensure the preferred alternatives identified in the previous section are carried out, it is necessary to create a detailed implementation plan to outline implementation strategies, determine the responsibilities of various stakeholders, determine potential funding sources, and create a primary implementation schedule. The implementation plan places responsibility with the Township, as well as developers, residents and other government agencies.

The implementation of a portion of the preferred alternatives can be initiated immediately by the Township to improve existing SWM systems whereas the balance will be initiated as part of future development projects located in the settlement areas. These will be described in detail in the sections to follow:

11.1 Alternatives Available for Implementation Immediately

Each settle area has specific SWM plans which correspond to the existing condition as are described in Section 10.2. These SWM plans are available for implementation immediately subject to available funding. It is proposed that these SWM plans be implemented during construction/implementation of other planned works to maximize efficiency and cost effectiveness. At the present time, there are no capital projects planned that would coincide with any of the specific SWM plans presented. However, all future capital projects in the settlement areas are to consider the proposed SWM plans presented herein.

11.1.1 Township-wide SWM Operation and Maintenance Program

As indicated in Section 10.1.8, a Township wide operation and maintenance program is recommended to meet the goal of this CSWMMP and can also be useful to prioritize and budget for SWM maintenance capital works projects (including outlet adjustments/retrofits, bank stabilization, sediment clean-outs etc.) and reduce liabilities and overall long term costs.

The Township is in the process of preparing a Township-wide operation and maintenance program to meet the criteria described in Section 9.5.7. The operation and maintenance program will include the nine existing SWM facilities which are located in study area, in addition to the existing SWM facilities which are located outside of the Lake Simcoe watershed, and will be expanded to include future SWM facilities as development proceeds.

Other preferred alternatives available for implementation immediately by the Township are Alternatives 9 and 10 described in Section 10.1 including:

- Joint public/private programs to achieve SWM goals and raise awareness; and
- Programs aimed at reducing phosphorus loading on Lake Simcoe from agricultural areas.

The costs of preparing a comprehensive SWM Operation and Maintenance program will be borne by the Township. Alternate sources of funding which may be eligible are described in Section 11.1.3.

11.2 Alternatives Available for Implementation at Time of Future Development

Each settlement area has specific SWM plans which correspond to future development as are described in Section 10.2. These SWM plans are available for implementation at the time of future development where it is assumed that the cost for implementation is paid by the developer.

The preferred alternatives to be implemented as part of all future development in the Settlement Areas are Alternatives 1-7 described in Section 10.1 including:

- 15% increase in rainfall depth and intensity for the design of all future SWM systems;
- Post to pre development peak flow control unless specified otherwise herein;
- MOECC Enhanced Level water quality control including a minimum of 24 hour extended detention of the greater of: 40 m3/ha of contributing area or the total runoff volume produced by the 25 mm storm, unless specified otherwise herein;
- LID practices for all future development and re-development where applicable;
- Consider implementing the standardized LID road section included in Appendix F;
- Landscape plans specifying the use of flood and drought tolerant plant species;
- As-built surveys are required as part of all newly constructed SWM facilities; and

The above alternatives are to be considered for implementation at the preliminary design stage of all future development and redevelopment. On this basis, the cost implications of each will vary on a project by project basis and will be incorporated into the overall project costs and born by developer.

The above recommended alternatives are to be implemented in combination with all other applicable MOECC, LSRCA, Township and LSPP SWM standards guidelines. The unit rate criteria for future development located in Forest Home are presented in Section 7.1.2. Typical post to pre development peak flow control was determined to be sufficient in all other future development areas.

11.3 Sources of Funding

Funding is needed in order to implement the SWM recommendations described above. It is expected that the majority of the funds needed to implement the recommendations should be provided by the Township, however other sources should include:

- LSRCA;
- MOE;

- MTO (for roadside ditch enhancements);
- Provincial Government (grants for sustainability and asset management);
- Federal Government; and
- Private Sector/ Developers.

A handful of potential funding sources are discussed below.

11.3.1 Lake Simcoe/South-Eastern Georgian Bay Clean-Up Fund

The Lake Simcoe Clean-up Fund (LSGBCUF) is a program funded by Environment Canada, and was created in 2007. From 2001-2012 it was successful in accelerating the adoption of beneficial management practices in the watershed, reducing phosphorous loads from urban and rural sources, and improving information and monitoring for decision making. The Government of Canada renewed and expanded the program for 2012-2017 with a $29 million funding budget. The main objectives are:

- to improve environmental monitoring, assessment and scientific information required to measure the effectiveness of control strategies, and identify and assess alternative approaches to reducing phosphorous discharges;
- to conserve critical aquatic habitat and associated species through targeted aquatic habitat protection, restoration and creation projects;
- to reduce rural and urban non-point sources of phosphorous / nutrients, including implementation of BMPs for the management of soil, crops, livestock, and water use, septic systems and creating and rehabilitating wetlands and naturalizing watercourses to attenuate phosphorous discharges; and
- to reduce discharge of phosphorous from point sources including sewage, combined sewer overflows and urban stormwater systems including support to development and testing of innovative approaches to manage urban stormwater and wastewater.

The fund is open to applications from the following groups:

- Landowners;
- Environmental groups;
- Community groups (e.g. youth and seniors groups, community-based associations, service clubs);
- Small and medium sized business (e.g. developers, industries etc.);
- Aboriginal organizations (e.g. First Nations Councils, Métis Associations);
- Conservation Authorities;
- Stewardship Networks;

- Agriculture Associations;
- Non-governmental organizations;
- Educational institutions;
- Industry; and
- Provincial/territorial/municipal governments.

For more information on the program, refer to http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=85C54DAE-1#Purpose.

11.3.2 Landowner Environmental Assistance Program (LEAP)

LSRCA's Landowner Environmental Assistance Program (LEAP) provides landowners with funding and technical assistance for environmental projects on their land. LEAP is administered by the LSRCA and made possible by funding from municipal partners and the support of the York, Durham, and Simcoe chapters of the Ontario Federation of Agriculture. Examples of LEAP eligible projects related to potential SWM improvements include: improving streams, upgrading septic systems, managing manure, restricting livestock from watercourses, controlling cropland erosion etc. LSRCA stewardship technicians are available to answer questions regarding the funding available. For more information on the program, refer to http://www.lsrca.on.ca/leap/.

11.3.3 Ontario Soil and Crop Improvement Association (OSCIA)

The Ontario Soil and Crop Improvement Association offer cost-share programs for a wide variety of agricultural practices including environmental initiatives such as best management practices. At the present time, there are no related cost–share programs available however farmers are encouraged to contact OSCIA for information related to upcoming programs. OSCIA also offers frequent workshops and webinars for farmers including how to set up an Environmental Farm Plan, which is a volountary environmental education and awareness program, to promote sustainable farming practices.

11.3.4 Green Municipal Fund

The Green Municipal Fund (GMF) is an initiative program run by the Federation of Canadian Municipalities (FCM) with the goal of funding municipal environmental initiatives including Plans, Studies and Projects. The GMF funds a variety of project including works related to water conservation, stormwater management, wastewater systems and septic systems. For more information on the program, refer to http://www.fcm.ca/home/programs/green-municipal-fund/about-gmf.htm.

11.3.5 Enbridge Savings by Design

Created by Enbridge Gas Distribution with integrated design support from Sustainable Buildings Canada and their network of sustainable experts, the Savings by Design program was developed to facilitate an easier transition to green housing innovation. This program is available for both residential and commercial developments. Enbridge and their support team assist in LID designs, which incorporate LID SWM controls, as well as other various energy saving designs. This program is ideal for residential developers. For more information, refer to http://residential.savingsbydesign.ca/incentives.html for the residential program, and http://commercial.savingsbydesign.ca/programoverview.html for the commercial program.

11.3.6 LSRCA Phosphorous Offsetting Program

This is a program under development by the LSRCA to establish methods to control phosphorous loading to Lake Simcoe. It includes consideration of water quality trading opportunities. The program is under design by the LSRCA http://www.lsrca.on.ca/programs/lspop.php.

11.4 Policy Considerations

It is recommended that a number of additions/alterations be made to the Township's policies and guidelines in regards to stormwater management. The alterations/additions to these documents are as follows:

11.4.1 Township of Oro-Medonte Official Plan (March, 2007)

In recognizing that the Township's Official Plan will be up for renewal in the near future, it is recommended that the following be included in *Section C17.5 Stormwater Management*.

- In areas where soil/groundwater conditions permit, at source infiltration measures (LID) installed at the lot level are recommended. In these areas, roof leaders and yard drainage should be disconnected and directed towards lawns, side and rear yard swales, boulevards, parks and other open spaces throughout the development where possible to promote infiltration;
- Road infiltration trenches and perforated pipe systems should be installed where soil/groundwater conditions permit;
- Enhanced grass swales should be implemented as conveyance channels where soil/groundwater conditions permit; and
- End-of Pipe SWM facility infiltration and exfiltration systems should be installed where soil and groundwater conditions permit to promote infiltration and reduce thermal impacts of the proposed SWM Facilities.

11.4.2 Township of Oro-Medonte Engineering Design Criteria (May 2013)

Section 4.2.2 Storm Water Management describes the SWM requirements related to future development must adhere to existing Watershed Planning Studies and Master Drainage Plans. For clarity a direct reference to this CSWM MP should be incorporated into Section 4.2.2 related to the requirements for all future development located in the Study Area.

The preferred alternatives included herein were developed specifically for implementation within the Study Area however their use and effectiveness throughout the Township can be expected. For this reason, the Township may wish to amend the stormwater management criteria to incorporate the preferred alternatives of this CSWM MP as criteria to be applied throughout the entire Township.

12 Inspection and Maintenance of SWM Facilities (Step 10)

Intrinsic to meeting the objectives of the CSWM MP will be the implementation of an inspection and maintenance schedule that will ensure the existing and future SWM facilities and LID SWM features operate as designed to meet the objectives of the LSPP.

The Township is currently responsible for the operation and maintenance of nine SWM facilities in the Lake Simcoe watershed. However, implementation of the CSWM MP has the potential to increase the number of SWM facilities and LID practices to be maintained by the Township, assuming the majority of these will be operated and maintained by the Township.

As discussed in Section 9.5.7, it is recommended that for all future SWM facilities and LID features, an operation and maintenance manual detailing the specific maintenance requirements, be submitted by the SWM facility designer prior to final approval of the SWM facility. The manuals are to identify the specific frequency of maintenance responsibilities and are to be kept on file by the operating authority for reference. The majority of SWM ponds and LID practices are designed and constructed by developers and ownership is later transferred to the Municipality following development and the construction maintenance period. The liability and maintenance responsibilities contained in the O&M manual are also transferred at this time. Only SWM facilities for private developments are typically owned and maintained by the owner of the property.

Section 53 of the Ontario Water Resources Act states the owner of a SWM facility is responsible for maintaining it in proper working condition. Environmental Compliance Approvals (ECA) are issued by the MOE under section 53 of the Water Resources Act for new SWM facilities. Specifically, ECA's outline the legal requirements for operation and maintenance and include:

1. The owner must maintain the SWMF retention volumes at all times;

2. The owner shall inspect the SWMF at least once a year, and if necessary, clean and maintain the SWMF to prevent excessive build-up of sediment and/or vegetation; and

3. The owner shall maintain a logbook to record inspections and maintenance operations undertaken and shall keep the logbook at a readily accessible location for inspection by the Ministry.

As described in Section 9.5.7, Alternative 19, an annual Township SWM facility operation and maintenance program is recommended for documenting the operating characteristics of each SWM facility and LID practice on an annual basis. The operation and maintenance program will be implemented during the construction phase of each SWM facility and will be maintained throughout the intended life in the manner intended and in compliance with the O&M manual prepared by the SWM facility designer and in accordance with the existing C of A's and ECA's. A list of typical annual field assessment data to be recorded, for existing facilities without an O&M manual is described in Section 9.5.7. Other details to be included in the operation and maintenance schedule will be confirmed in consultation with the Township to ensure the data collected will assist with prioritizing SWM maintenance capital works projects (including outlet adjustments/retrofits, bank stabilization, sediment clean-outs etc.) and reduce liabilities and overall long term maintenance costs. The operation and maintenance schedule will be used to allocate long range budget resources as part of the Township's 5, 10 and 15 year capital budgets.

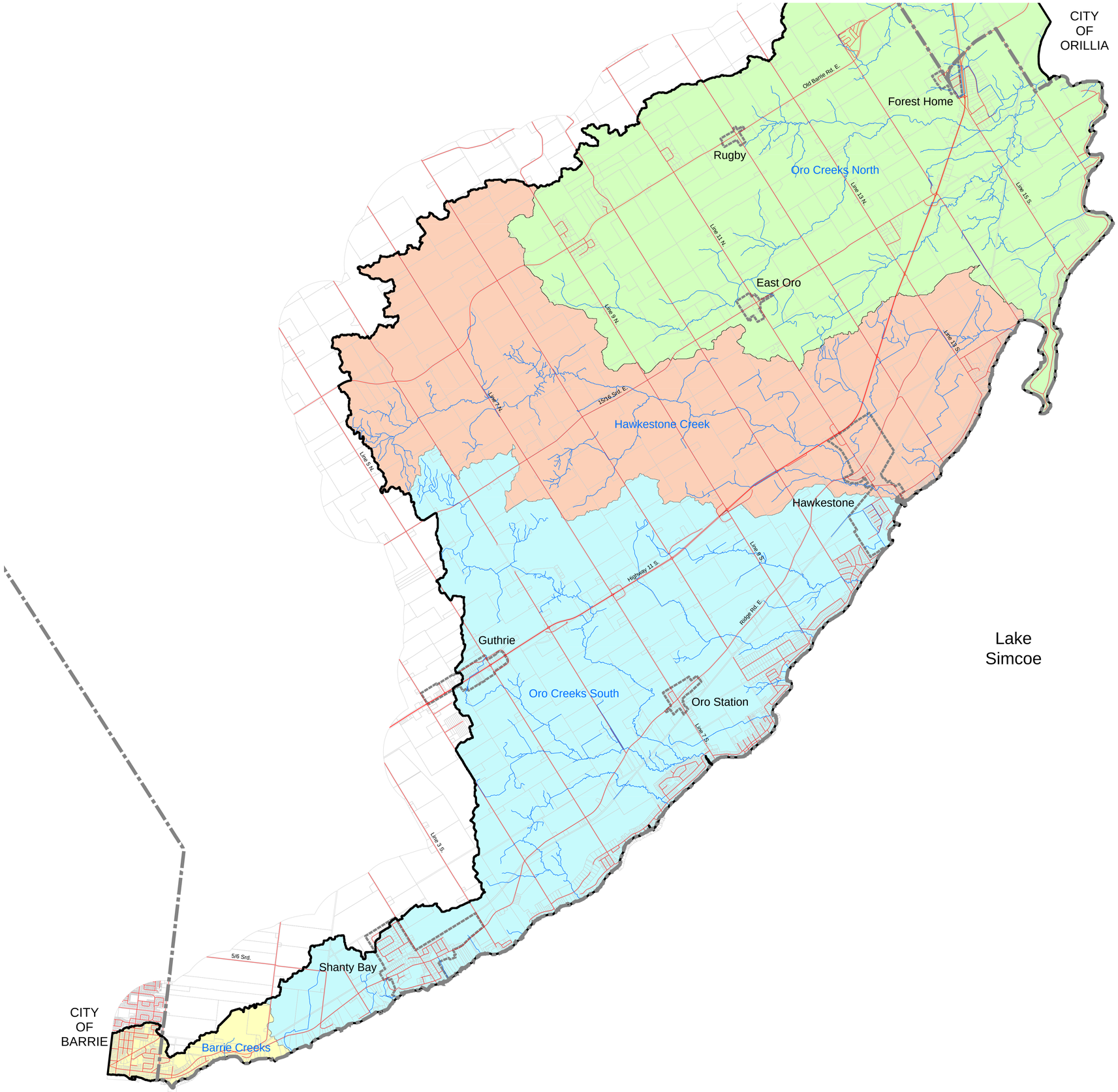
Authored by: Dan Hurley, B.A.Sc., P.Eng.
Vice President, Manager – Collingwood Branch

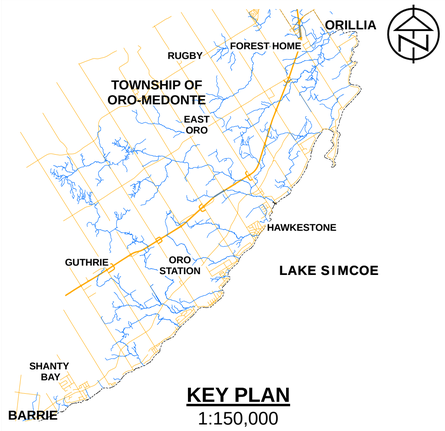
Reviewed by: Jeremy Ash, B.Sc.Eng., P.Eng.

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KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- **Watercourse**
- **Roads**
- Settlement Area Boundaries
- **Assessment Parcels**

WATERSHED

- Barrie Creeks
- Hawkestone Creek
- Oro Creeks North
- Oro Creeks South

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
LSRCA GIS Mapping

C.C. Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Study Area

FIGURE 1

DATE: SEPTEMBER 2014

CITY OF ORILLIA

Old Barrie Rd. E.

Forest Home

Rugby

Line 13 N.

Line 15 S.

Line 11 N.

1

5

Oro Creeks North

East Oro

Line 9 N.

Line 11 S.

Line 7 N.

15/16 Sdrd. E.

Hawkestone Creek

Line 5 N.

Hawkestone

Line 9 S.

Line 7 S.

Highway 11 S.

Oro Creeks South

Ridge Rd. E.

Guthrie

3

2

Oro Station

Line 7 S.

Lake Simcoe

Line 3 S.

9

8

4

7

6

5/6 Srd.

Shanty Bay

CITY OF BARRIE

ORILLIA

RUGBY

FOREST HOME

TOWNSHIP OF ORO-MEDONTE

EAST ORO

HAWKESTONE

GUTHRIE

ORO STATION

LAKE SIMCOE

SHANTY BAY

BARRIE

KEY PLAN
1:150,000

Legend

- MunicipalBorder
- Study Area
- Existing Stormwater Pond Locations
- VO3_delineations
- Watercourse
- Roads
- Settlements Areas

750 ha Catchment

- Barrie Creeks
- Hawkestone Creek
- Oro Creeks North
- Oro Creeks South

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
LSRCA GIS Mapping

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Township of Oro-Medonte
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SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Subwatershed and Existing SWM Facilities

FIGURE 2

DATE: OCTOBER 2014

CITY OF ORILLIA

Lake Simcoe

Rugby

Forest Home

East Oro

Hawkestone

Guthrie

Oro Station

Shanty Bay

CITY OF BARRIE

Old Barrie Rd. E

Line 13 N.

Line 11 N.

Line 9 N.

Line 7 N.

Line 5 N.

15/16 Sdrd. E.

Line 15 S.

Line 11 S.

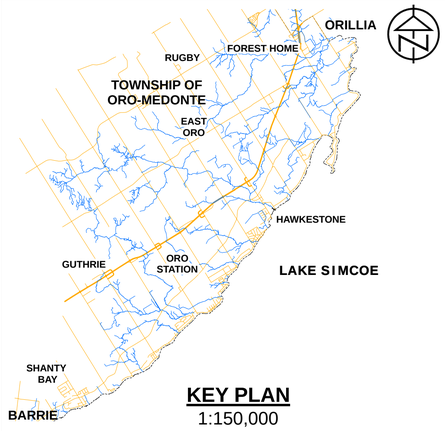
Highway 11 S.

Ridge Rd. E.

Line 7 S.

Line 3 S.

5/6 Srd.



KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- MunicipalBorder
- Study Area
- Existing Stormwater Pond Locations
- Watercourse
- Roads
- Settlements Areas
- 514 — Catchment Unit

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
LSRCA GIS Mapping

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Township of Oro-Medonte
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SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Hydrologic Model Setup

FIGURE 3

DATE: OCTOBER 2014

CITY OF ORILLIA

Rugby

Forest Home

East Oro

Hawkestone

Guthrie

Oro Station

Shanty Bay

CITY OF BARRIE

Lake Simcoe

Line 11 N.

Old Barrie Rd. E.

Line 9 N.

Line 7 N.

Line 5 N.

15/16 Srd. E.

Line 11 N.

Line 13 S.

Line 15 S.

Highway 11 S.

Line 9 S.

Line 7 S.

Ridge Rd. E.

Line 3 S.

5/6 Srd.

1

5

2

3

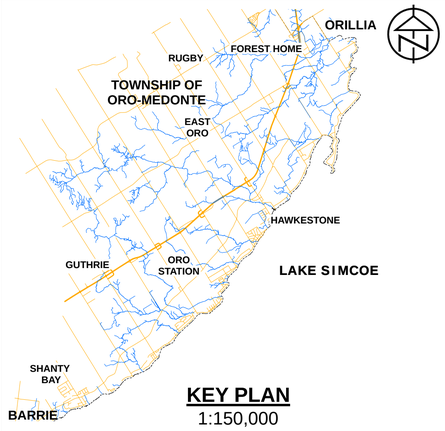
4

6

7

8

9



KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- **Existing Stormwater Pond Locations**
- Settlement Boundaries

POLICY

- Level 1
- Level 2
- Level 3
- Level 4
- **Watercourse**
- **Roads**

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
Natural Heritage System for the Lake Simcoe Watershed
Phase 1: Components and Policy Templates (LSRCA, July 2007)

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Township of Oro-Medonte
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SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

NATURAL HERITAGE

FIGURE 4

DATE: SEPTEMBER 2014

CITY OF ORILLIA

Rugby

Forest Home

Oro Creeks North

East Oro

Hawkestone Creek

Hawkestone

Guthrie

Oro Creeks South

Oro Station

Shanty Bay

CITY OF BARRIE

Barrie Creeks

Lake Simcoe

Old Barrie Rd. E.

Line 11 N.

Line 9 N.

15/16 Sdrd. E.

Line 7 N.

Line 5 N.

Line 13 N.

Line 15 S.

Line 13 S.

Line 9 S.

Highway 11 S.

Ridge Rd. E.

Line 7 S.

Line 3 S.

5/6 Srd.

1

5

3

2

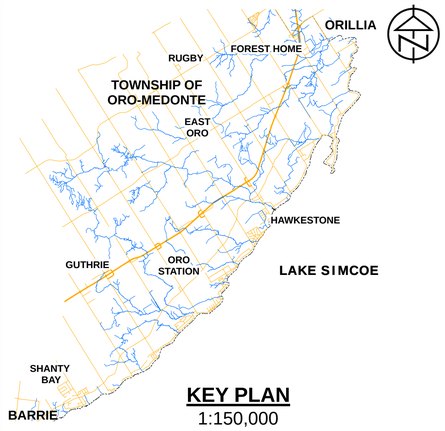
9

8

4

7

6



KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- **Stormwater Pond Locations**
- 750ha Watershed
- Settlement Boundaries
- **Watercourse**
- **Roads**

HSG

- **A**
- **AB**
- **B**
- **C**
- **CD**

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
Soil Map of Simcoe County (1962)

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Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:40,000

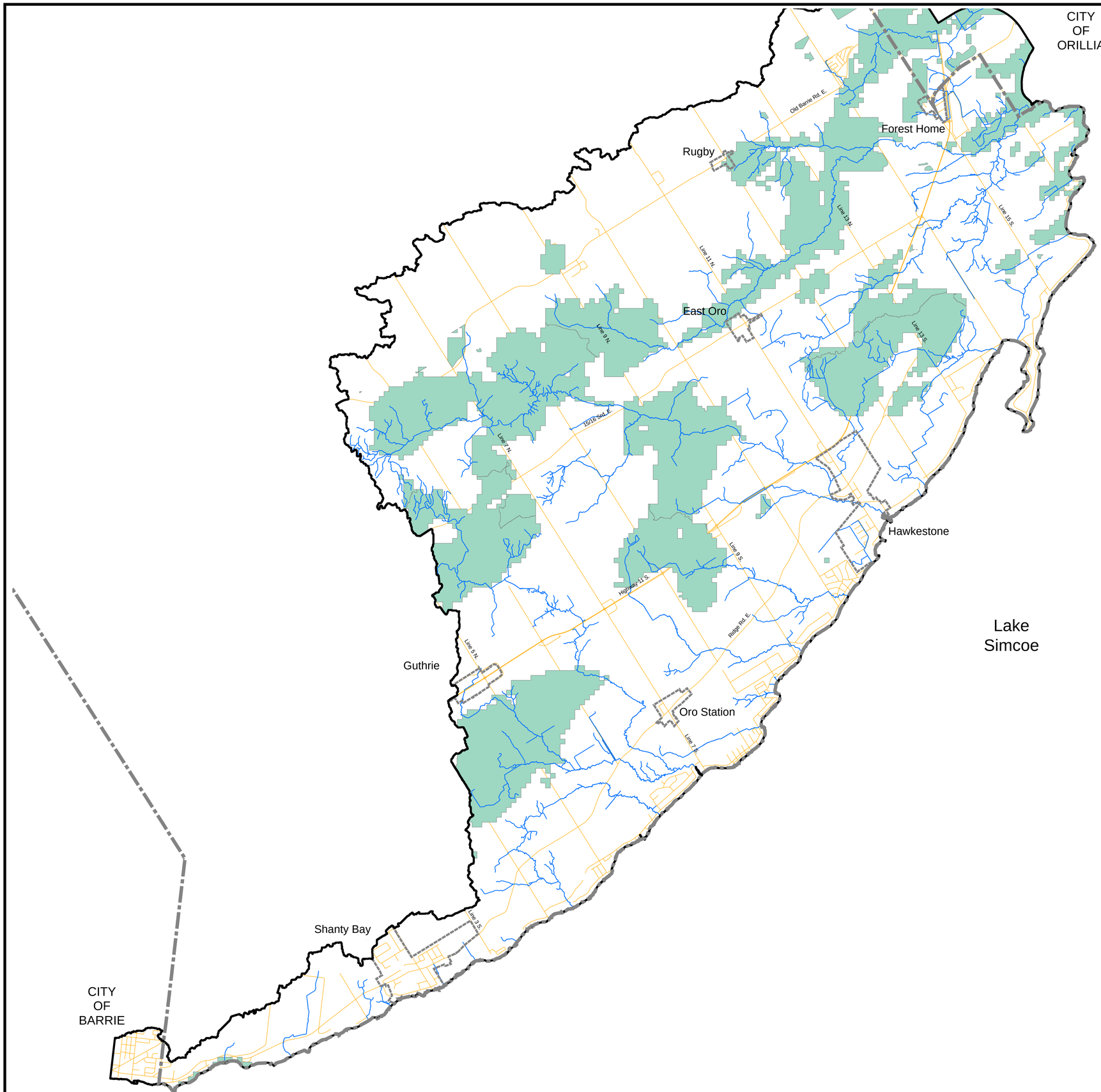
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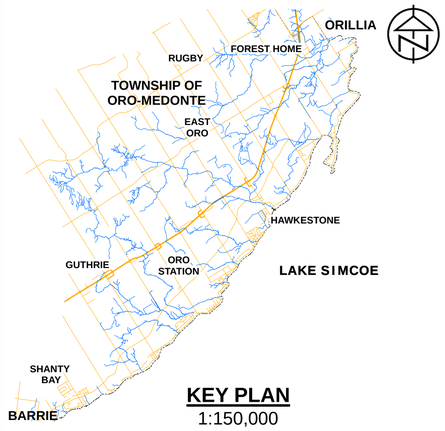
ORO-MEDONTE STORMWATER MASTER PLAN

Hydrologic Soil Groups

FIGURE 5

DATE: SEPTEMBER 2014





KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- Settlement Boundaries
- **Watercourse**
- Highly Vulnerable Aquifer
- **Roads**

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
Approved Assessment Report: Lakes Simcoe and Couchiching - Black River Source Protection Area, Part 1 Lake Simcoe Watershed (January 2015)

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Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Highly Vulnerable Aquifers

FIGURE 6

DATE: SEPTEMBER 2015

CITY OF ORILLIA

Forest Home

Rugby

East Oro

Hawkestone

Lake Simcoe

Guthrie

Oro Station

Shanty Bay

CITY OF BARRIE

Old Barne Rd. E.

Line 12 N.

Line 11 N.

15/16 Sdd. E.

Line 13 S.

Line 9 N.

Line 7 N.

Line 9 S.

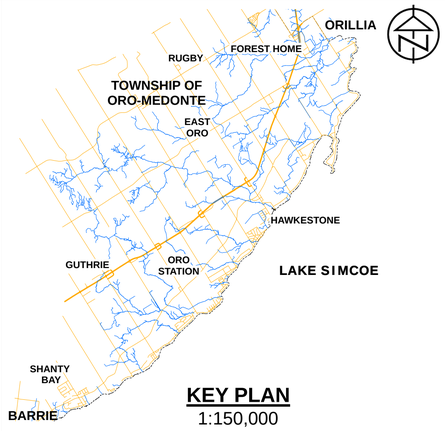
Highway 11 S.

Ridge Rd. E.

Line 5 N.

Line 7 S.

Line 3 S.



KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- Settlement Boundaries
- **Watercourse**
- Ecologically Significant Groundwater Recharge Areas
- **Roads**

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
Ecologically Significant Groundwater Recharge Area Assessment for the Oro North, Oro South and Hawkestone Creeks Subwatersheds Report (Earth fx, September 2013)

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Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Ecologically Significant Groundwater Recharge Areas

FIGURE 7

DATE: SEPTEMBER 2015

CITY OF ORILLIA

Forest Home

Rugby

East Oro

Hawkestone

Lake Simcoe

Guthrie

Oro Station

Shanty Bay

CITY OF BARRIE

Old Barrie Rd. E.

Line 11 N.

Line 9 N.

15/16 Sdr. E.

Line 7 N.

Line 5 N.

Line 13 N.

Line 15 S.

Line 13 S.

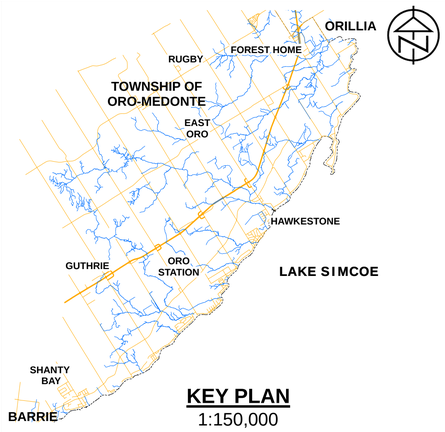
Highway 11 S.

Line 9 S.

Ridge Rd. E.

Line 5 S.

Line 3 S.



KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- Settlement Boundaries
- **Watercourse**
- Significant Discharge Areas
- **Roads**

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
LSRCA GIS Mapping

C.C. Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Groundwater Discharge Areas

FIGURE 8

DATE: SEPTEMBER 2015

CITY OF ORILLIA

Forest Home

Rugby

East Oro

Hawkestone

Guthrie

Oro Station

Shanty Bay

CITY OF BARRIE

Lake Simcoe

Old Barrie Rd. E.

Line 11 N.

Line 13 N.

Line 15 S.

Line 13 S.

15/16 Sdrd. E.

Line 9 N.

Line 7 N.

Line 5 N.

Line 9 S.

Highway 11 S.

Ridge Rd. E.

Line 7 S.

Line 3 S.

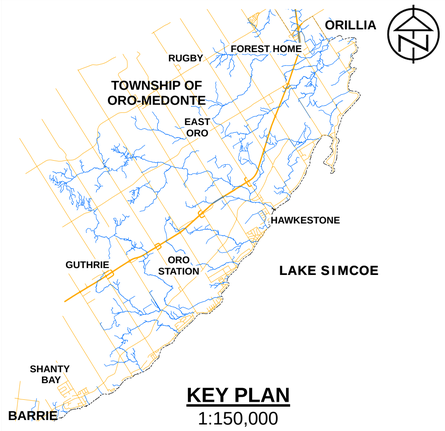
Maplewood Well Supply

Cedarbrook Well Supply

Canterbury Well Supply

Harbourwood Well Supply

Shanty Bay



KEY PLAN
1:150,000

Legend

- Township of Oro-Medonte Boundary
- Study Area
- Settlement Boundaries

Wellhead Protection Area

- WHPA-A (100m)
- WHPA-B (2 years time of travel)
- WHPA-C (5-10 years time of travel)
- WHPA-D (25 years time of travel)

Watercourse

Roads

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
Lakes Simcoe and Couchiching - Black River SPA, Part 1 Updated Assessment Report (January 2015)

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Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:40,000

0 625 1,250 2,500 3,750 5,000 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

Wellhead Protection Area

FIGURE 9

DATE: SEPTEMBER 2015

CITY OF ORILLIA

Rugby

Forest Home

East Oro

Hawkestone

Guthrie

Oro Station

Shanty Bay

CITY OF BARRIE

Lake Simcoe

Old Barrie Rd. E.

15/16 Sdrd. E.

Line 11 N.

Line 12 N.

Line 13 N.

Line 7 N.

Line 9 N.

Line 5 N.

Line 4 S.

Line 5 S.

Line 6 S.

Line 7 S.

Line 8 S.

Line 9 S.

Line 3 S.

Highway 11 S.

Bridge St. E.

5/6 Srd.

1

2

3

4

5

6

7

8

9

ORILLIA

FOREST HOME

RUGBY

TOWNSHIP OF ORO-MEDONTE

EAST ORO

HAWKESTONE

GUTHRIE

ORO STATION

LAKE SIMCOE

SHANTY BAY

BARRIE

KEY PLAN
1:150,000

Legend

- Study Area
- MunicipalBorder
- **Existing Stormwater Pond Locations**
- Settlement Area Boundaries
- **Watercourse**
- **Roads**

LANDUSE

- Active Aggregate
- Commercial
- Estate Residential
- Golf Course
- Industrial
- Institutional
- Intensive Agriculture
- Manicured Open Space
- Natural Heritage Feature
- Non-intensive Agriculture
- Road
- Rural Development
- Urban

Data used for map creation received from the County of Simcoe (January 2014) and from the Lake Simcoe Region Conservation Authority (February 2014 and September 2015).

Source of Data:
LSRCA GIS Mapping

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SCALE = 1:40,000

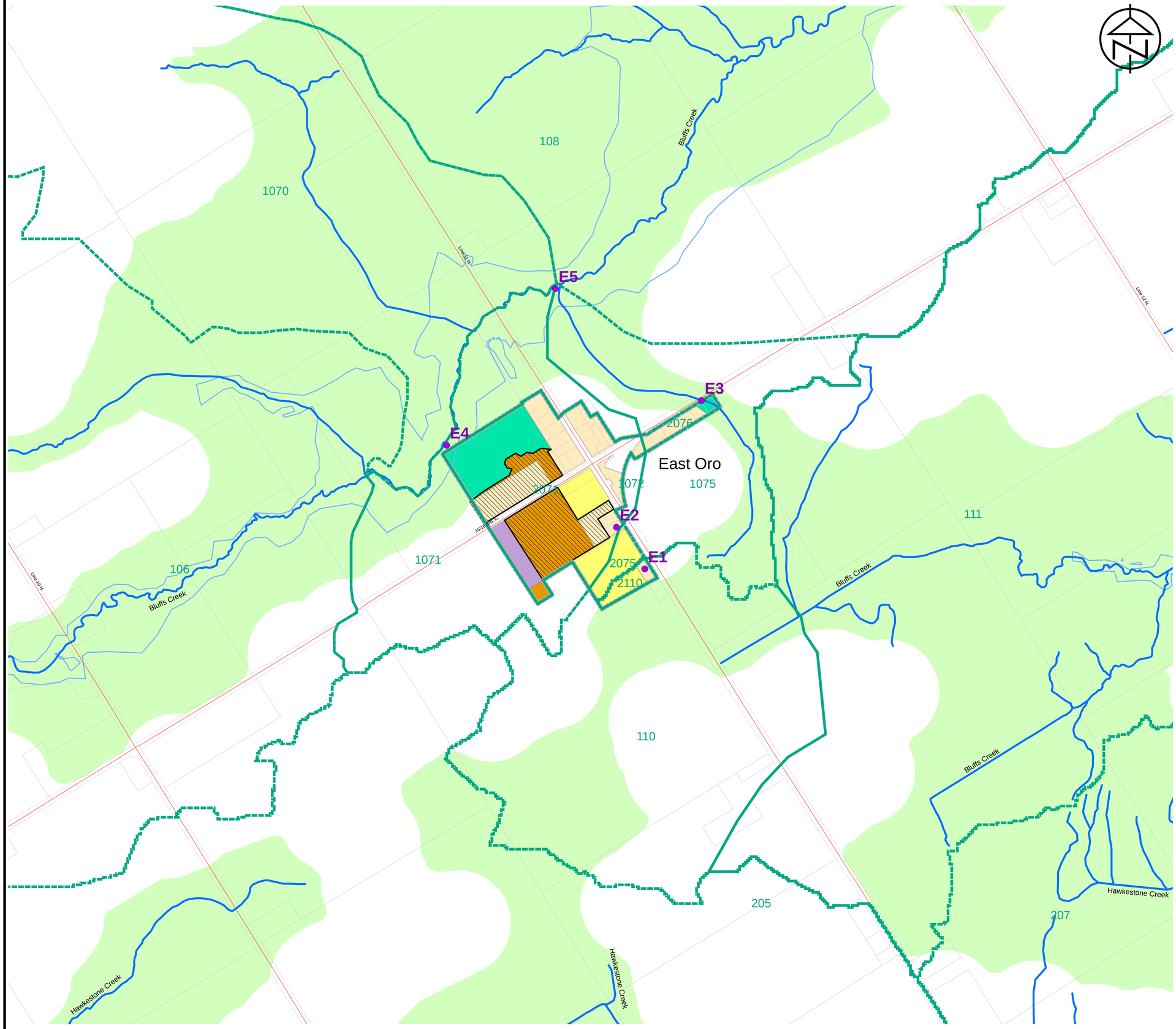
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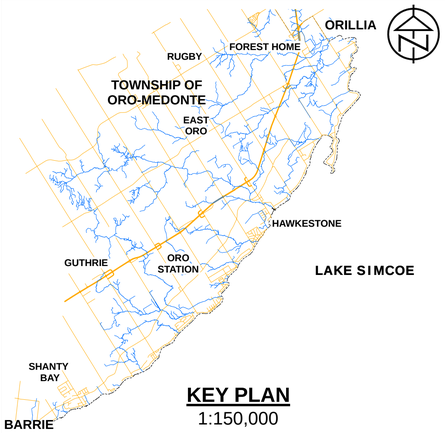
ORO-MEDONTE STORMWATER MASTER PLAN

Existing Land Use

FIGURE 10

DATE: SEPTEMBER 2014





KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- Watercourse
- Roads
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- **Assessment Parcels (Existing Zoning)**
- A/R1 Agriculture/Rural One
- A/RU Agriculture/Rural One
- ED Economic Development
- EP Environmental Protection
- GC General Commercial
- I Institutional
- LC Local Commercial
- OS Open Space
- PR Private Recreational
- R1 Residential One
- RLS Residential Limited Service
- RUR1 Rural Residential One
- RUR2 Rural Residential Two
- SR Shoreline Residential
- Greenlands (County of Simcoe Official Plan)

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Source of land use designation information shown is from the Township of Oro-Medonte Zoning Bylaw Schedule A.

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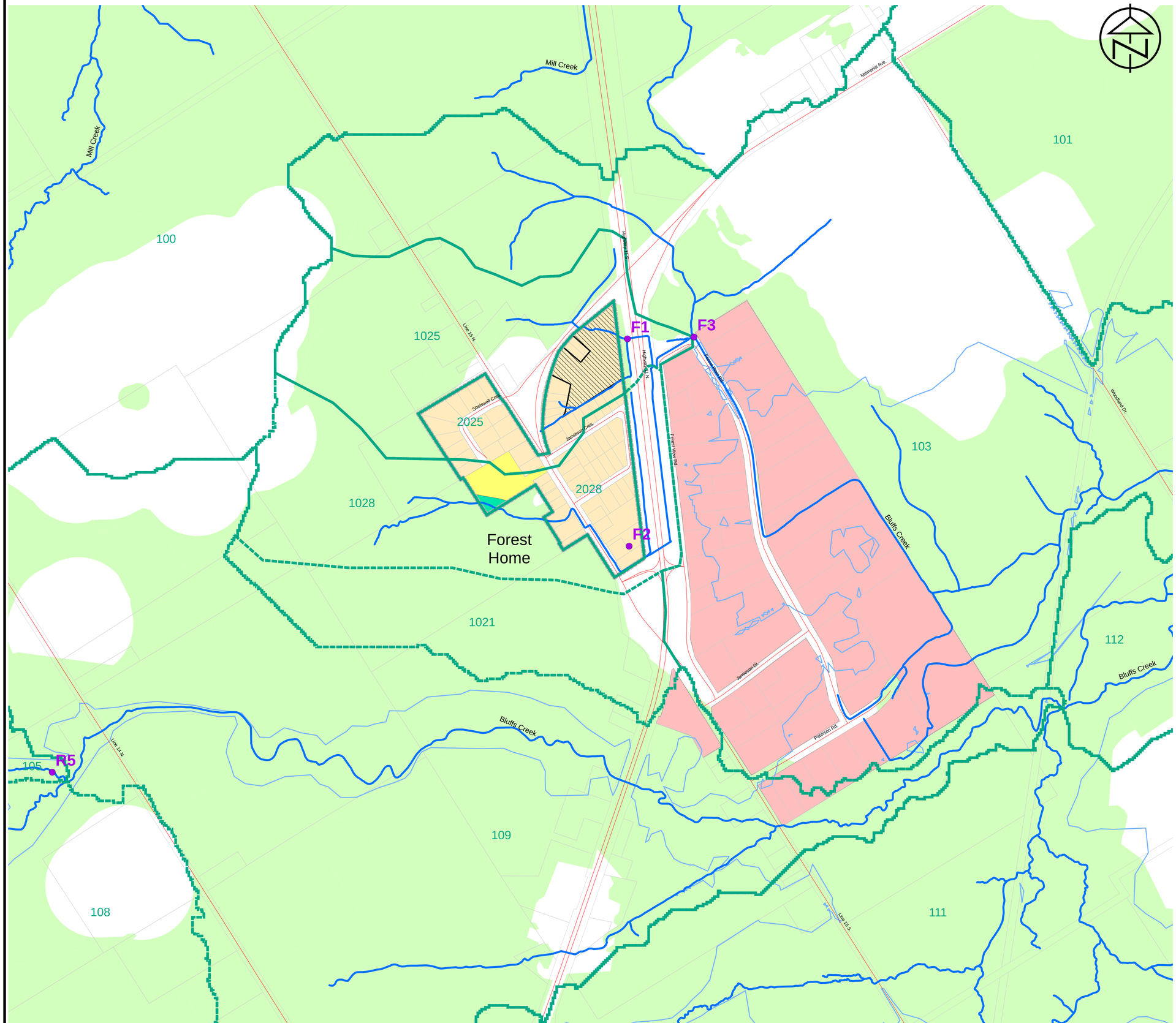
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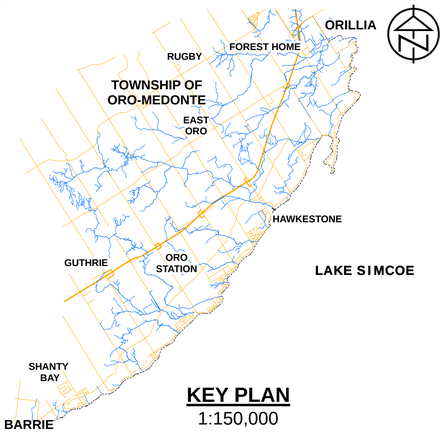
0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

SETTLEMENT AREAS
East Oro
FIGURE 11-1

DATE: SEPTEMBER 2014





KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- Watercourse
- Roads
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- Assessment Parcels (Existing Zoning)
  - A/R1 Agriculture/Rural One
  - A/RU Agriculture/Rural One
  - ED Economic Development
  - EP Environmental Protection
  - GC General Commercial
  - I Institutional
  - LC Local Commercial
  - OS Open Space
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  - RLS Residential Limited Service
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SCALE = 1:5,000

0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

SETTLEMENT AREAS
Forest Home
FIGURE 11-2

DATE: SEPTEMBER 2014

Nottawasaga River Watershed

Lake Simcoe Watershed

Guthrie

Shelswells Creek

Shelswells Creek

Shelswells Creek

Line 5 N

Line 4 N

Line 4 S

Line 5 S

Queen St.

Highway 11 N

Highway 11 S

Hoick Rd.

Wristar Rd.

313

5140

5145

3145

5141

3141

315

316

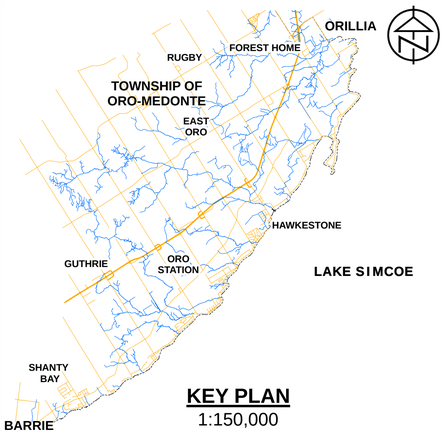
3

2

G1

G2

G3



KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- **Watercourse**
- **Roads**
- Study Area
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- **Assessment Parcels (Existing Zoning)**
- A/R1 Agriculture/Rural One
- A/RU Agriculture/Rural One
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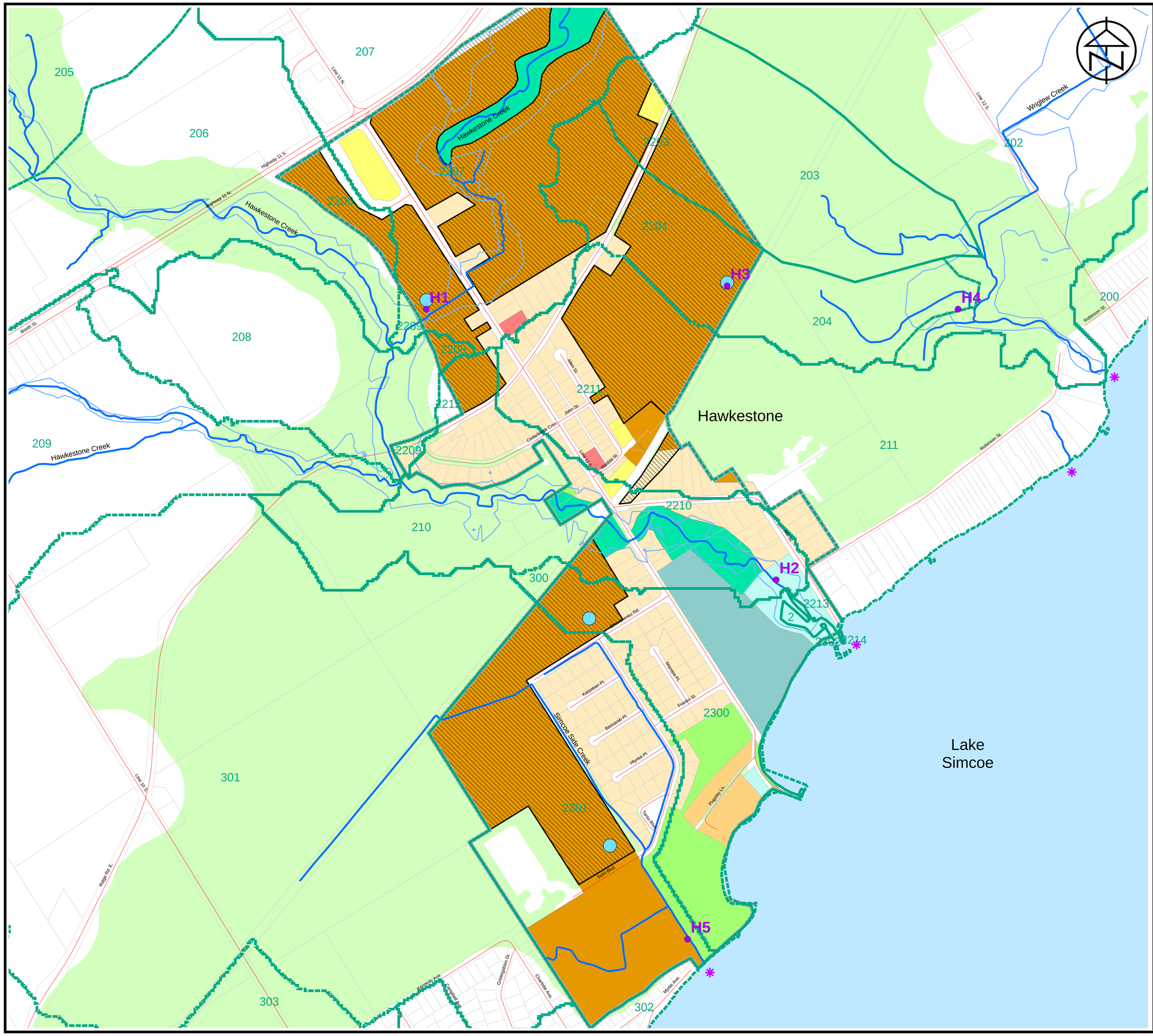
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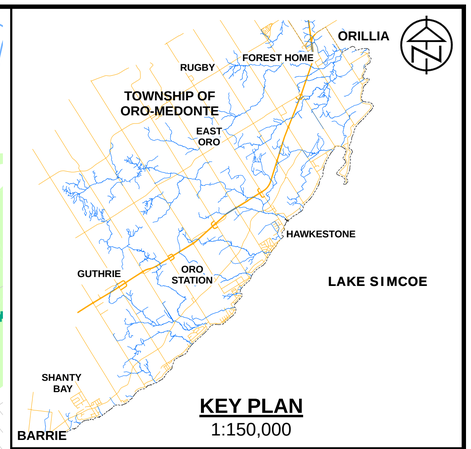
0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

SETTLEMENT AREAS
Guthrie
FIGURE 11-3

DATE: SEPTEMBER 2014





KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- Potential SWM Pond
- Drainage Outfall to Lake
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- Watercourse
- Roads
- Lake Simcoe
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- **Assessment Parcels (Existing Zoning)**
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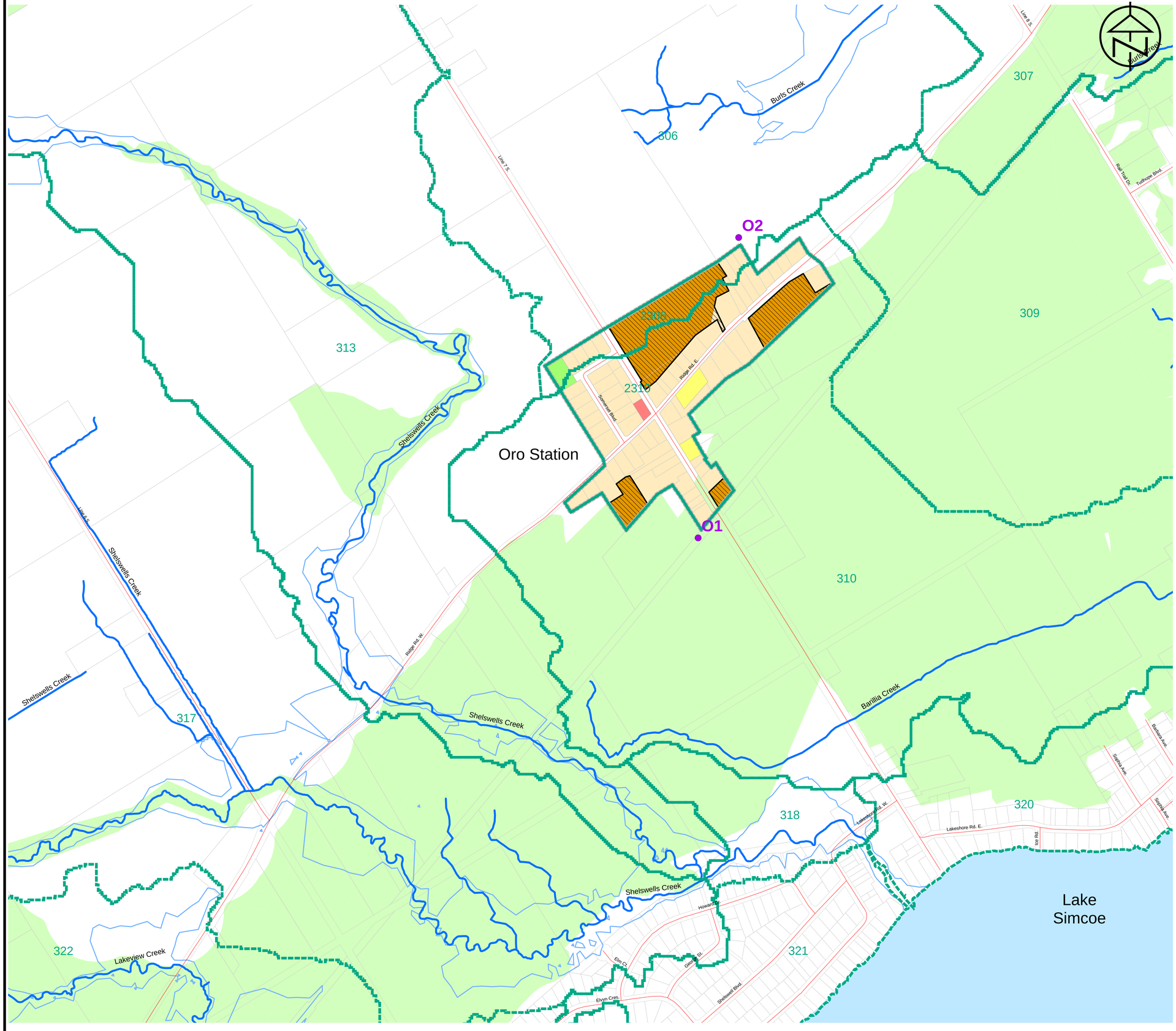
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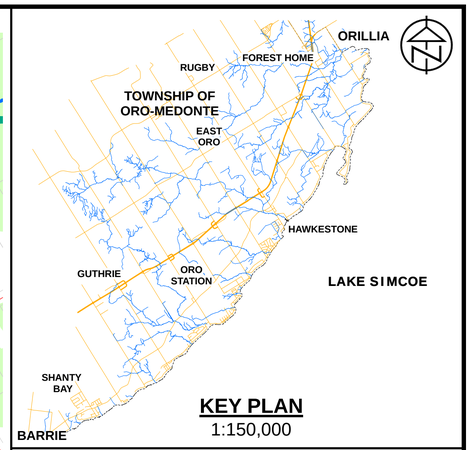
SCALE = 1:5,000

0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN
SETTLEMENT AREAS
Hawkestone
FIGURE 11-4

DATE: SEPTEMBER 2014





KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- Watercourse
- Roads
- Lake Simcoe
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- **Assessment Parcels (Existing Zoning)**
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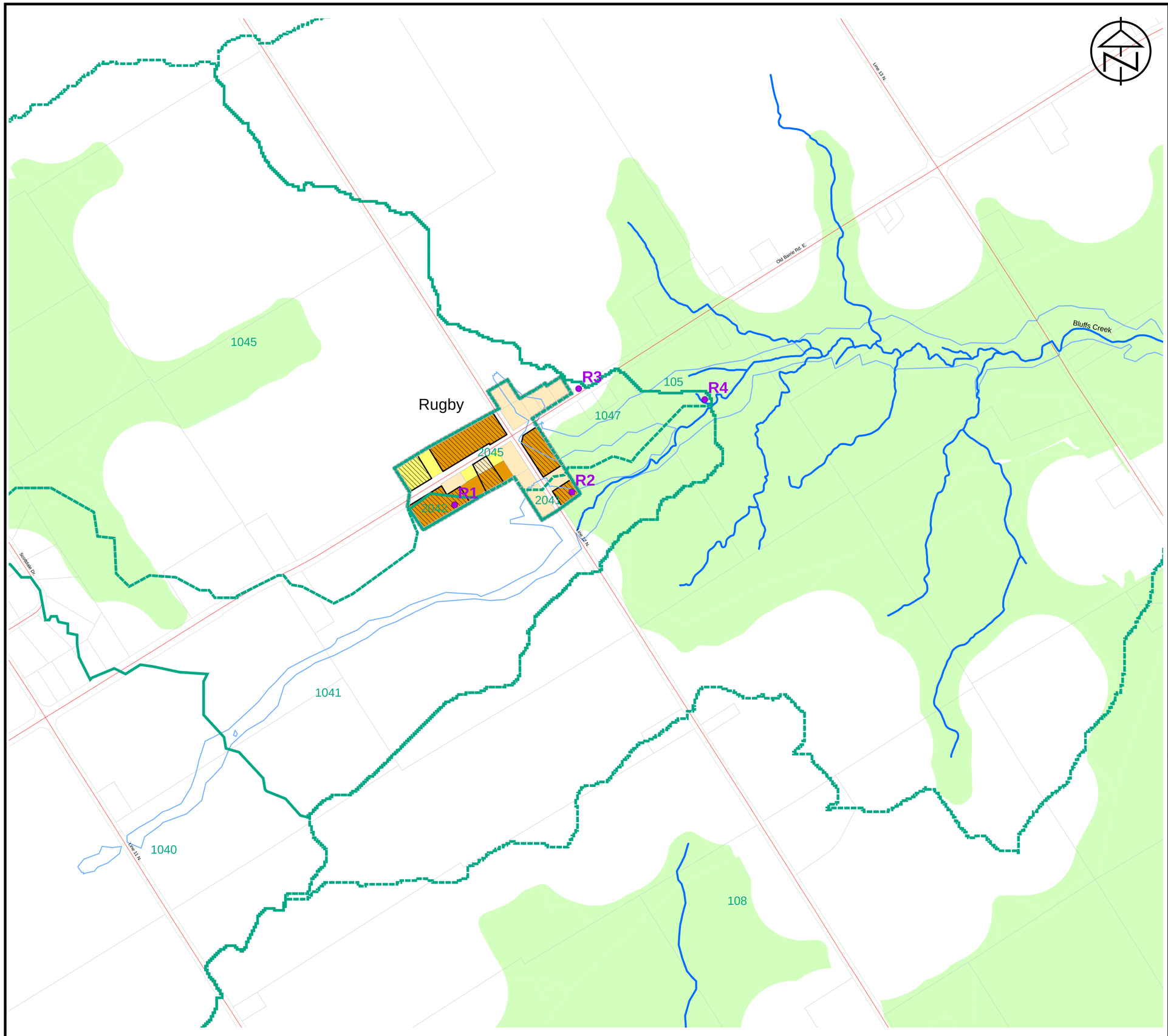
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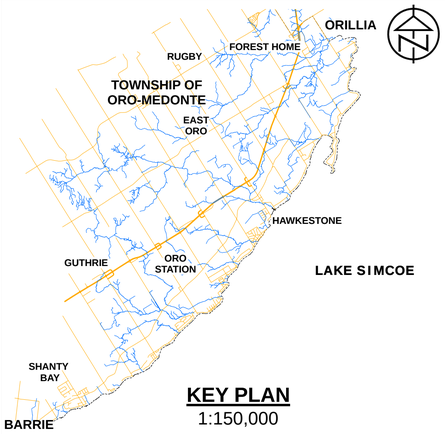
SCALE = 1:5,000

0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN
SETTLEMENT AREAS
Oro Station
FIGURE 11-5

DATE: SEPTEMBER 2014





KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- Watercourse
- Roads
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- **Assessment Parcels (Existing Zoning)**
- A/R1 Agriculture/Rural One
- A/RU Agriculture/Rural One
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- EP Environmental Protection
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- I Institutional
- LC Local Commercial
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Township of Oro-Medonte
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SCALE = 1:5,000

0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

SETTLEMENT AREAS
Rugby
FIGURE 11-6

DATE: SEPTEMBER 2014

Nottawasaga River Watershed

Lake Simcoe Watershed

Shanty Bay

Lake Simcoe

3255

3254

325

324

5250

5254

3250

5255

5260

5265

3265

3269

327

3256

5257

S1

S2

S3

1

4

6

7

8

Line 7 S.

Line 5 S.

Wallace Dr.

Basswood Cir.

Red Oak Cres.

Diane Ct.

Jenna Ct.

Rails St.

Melissa Cres.

Gowan Rd.

Shade Rd.

Graham St.

William St.

Simpson Cr.

Shanty Bay East Tributary

Marble Cres.

Kirkwood Cogue

Pelissier Cir.

Church St.

Bell Ln.

Owen St.

Brook St.

Brook Street Tributary

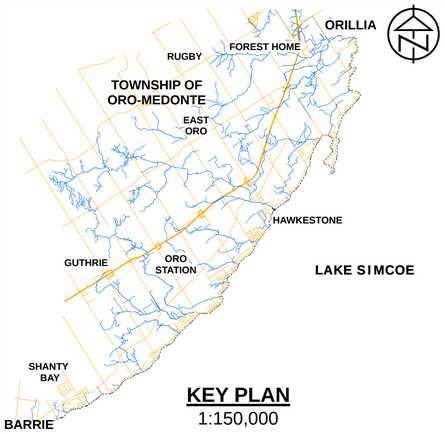
Bay St.

Shanty Bay West Tributary (Pemberton Creek)

Ridge Rd.

Ridge Rd. W.

Pemberton Ln.



KEY PLAN
1:150,000

Legend

- Hydrologic Reference Point (HRP)
- Potential SWM Pond
- Drainage Outfall
- **Existing Stormwater Pond Locations**
- 514 Catchment Area with VO2 number
- Watercourse
- Roads
- Study Area
- Lake Simcoe
- Settlement Area Boundaries
- Floodplain
- Area of Potential Infill Development (per Official Plan)
- **Assessment Parcels (Existing Zoning)**
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Township of Oro-Medonte
Proud Heritage, Exciting Future

SCALE = 1:5,000

0 50 100 200 300 400 500 Meters

ORO-MEDONTE STORMWATER MASTER PLAN

SETTLEMENT AREAS
Shanty Bay
FIGURE 11-7

DATE: SEPTEMBER 2014

APPENDIX A:
HYDROLOGIC MODELING

ELC Land Use

Landuse	TIMP	XIMP	CN Category	Curve Number (AMC II) Whole area Soil Group				Curve Number (AMC II) Pervious area Soil Group				Runoff Coefficient Soil Group				
				A	B	C	D	A	B	C	D	All	A	B	C	D
Active Aggregate	0	0	newly graded area	77	86	91	94	39	61	74	80	0.65	0.65	0.65	0.65	0.65
Commercial	50	50	Commercial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Estate Residential	15	10	Residential Half acre	48	67	78	83	39	61	74	80	0.33	0.33	0.33	0.33	0.33
Golf Course	0	0	Open Space- Good	39	61	74	80	39	61	74	80	0.18	0.18	0.18	0.18	0.18
Inactive Aggregate	0	0	newly graded area	77	86	91	94	39	61	74	80	0.65	0.65	0.65	0.65	0.65
Industrial	50	50	Industrial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Institutional	50	50	Commercial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Orchard	0	0	Straight row crops- good	67	78	85	89	67	78	85	89		0.22	0.35	0.42	0.55
row crop	0	0	Straight row crops- good	67	78	85	89	67	78	85	89		0.22	0.35	0.42	0.55
Market Garden	0	0	Straight row crops- good	67	78	85	89	67	78	85	89		0.22	0.35	0.42	0.55
Tree Farm	0	0	Straight row crops- good	67	78	85	89	67	78	85	89		0.22	0.35	0.42	0.55
Manicured Open Space	0	0	Open space-fair	49	69	79	84	39	61	74	80	0.18	0.18	0.18	0.18	0.18
Coniferous Forest	0	0	Wood fair	36	60	73	79	36	60	73	79		0.10	0.28	0.34	0.40
Coniferous Swamp	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Cultural Meadow	0	0	Meadow	30	58	71	78	30	58	71	78		0.10	0.28	0.34	0.40
Cultural Thicket	0	0	Brush- good	30	48	65	73	30	48	65	73		0.08	0.25	0.30	0.35
Cultural Woodland	0	0	Wood-Fair	43	65	76	82	43	65	76	82		0.08	0.25	0.30	0.35
Cultural Plantation	0	0	Brush- Fair	35	56	70	77	35	56	70	77		0.22	0.35	0.42	0.55
Deciduous Forest	0	0	Wood-Fair	43	65	76	82	43	65	76	82		0.08	0.25	0.30	0.35
Deciduous Swamp	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Meadow marsh	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Mixed Forest	0	0	Wood-Fair	43	65	76	82	43	65	76	82		0.08	0.25	0.30	0.35
Mixed Shallow Aquatic	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Mixed Swamp	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Open Water	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Open Fen	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Shrub Fen	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Shallow Marsh	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Thicket Swamp	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Submerged Shallow Aquatic	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Floating-leaved Shallow Aquatic	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
hay	0	0	Meadow	30	58	71	78	30	58	71	78	0.40	0.10	0.28	0.34	0.40
Pasture	0	0	Pasture- Fair	49	69	79	84	49	69	79	84	0.40	0.10	0.28	0.34	0.40
Rail	30	30	Roads-gravel	76	85	89	91	76	85	89	91	0.28	0.28	0.28	0.28	0.28
Road	75	75	Road-Paved (inlcuding ROW)	83	89	92	93	39	61	74	80	0.88	0.88	0.88	0.88	0.88
Rural Development	15	10	Residential Half acre	48	67	78	83	39	61	74	80	0.33	0.33	0.33	0.33	0.33
Urban	45	35	Residential 1/4 acre	66	78	85	88	39	61	74	80	0.40	0.40	0.40	0.40	0.40

References

CN- Whole Area
- TR-55 Curve Number Table 2.2a
- MTO Design Chart 1.09
- Composite CN based of TIMP (CN=98), remainder = Open Space

CN- Pervious Area
- tr-55 Open Space good condition
- TR-55 Curve Number Table 2.2a
- MTO Design Chart 1.09

TIMP/XIMP
- TR-55 Average % Imp
- Township Zoning - Direct Category
- Township Zoning - Assumed Category
- Assumed
- LSRCA SWM Guidelines XIMP/TIMP Table Appendix C

Runoff Coefficient
- Adapted from MTO Table 1.07
- Adapted from Township RC Table

OP Land Use

Landuse	TIMP	XIMP	CN Category	Curve Number Whole area				Curve Number Pervious area				Runoff Coefficient				
				Soil Group				Soil Group				Soil Group				
				A	B	C	D	A	B	C	D	All	A	B	C	D
				1	3	5	7	1	3	5	7		1	3	5	7
Agriculture-Rural Area	0	0	Straight Row Crops- good	67	78	85	89	67	78	85	89		0.22	0.35	0.42	0.55
Agriculture-Special Rural Area	0	0	Straight Row Crops- good	67	78	85	89	67	78	85	89		0.22	0.35	0.42	0.55
Business Park	85	85	Commercial and Business	89	92	94	95	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Convenience	50	50	Commercial and Business	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Core	85	85	Commercial and Business	89	92	94	95	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Highway	30	30	Commercial and Business	57	72	81	85	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Neighbourhood	50	50	Commercial and Business	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Neighbourhood/ Mixed Use	50	50	Commercial and Business	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Shoreline	30	30	Commercial and Business	57	72	81	85	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial-Village	50	50	Commercial and Business	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Commercial	50	50	Commercial and Business	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Community Service	55	55	Commercial and Business	71	81	87	90	39	61	74	80	0.65	0.65	0.65	0.65	0.65
Estate Residential	15	10	Residential Half acre	48	67	78	83	39	61	74	80	0.33	0.33	0.33	0.33	0.33
Residential-Estate	15	10	Residential Half acre	48	67	78	83	39	61	74	80	0.33	0.33	0.33	0.33	0.33
Industrial-Extractive	50	50	Industrial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Industrial	50	50	Industrial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Industrial-General	50	50	Industrial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Landfill	0	0	Open space-fair	49	69	79	84	39	61	74	80	0.20	0.20	0.20	0.20	0.20
Landfill-Closed	0	0	Open space-fair	49	69	79	84	39	61	74	80	0.20	0.20	0.20	0.20	0.20
Institutional	50	50	Commercial	69	80	86	89	39	61	74	80	0.75	0.75	0.75	0.75	0.75
Natural Environmental Area	0	0	Brush- fair	35	56	70	77	35	56	70	77	0.20	0.20	0.20	0.20	0.20
Market Garden	0	0	Straight row crops- good	67	78	85	89	67	78	85	89	0.55	0.22	0.35	0.42	0.55
row crop	0	0	Straight row crops- good	67	78	85	89	67	78	85	89	0.55	0.22	0.35	0.42	0.55
Tree Farm	0	0	Straight row crops- good	67	78	85	89	67	78	85	89	0.55	0.22	0.35	0.42	0.55
Inactive Aggregate	0	0	newly graded area	77	86	91	94	39	61	74	80	0.65	0.65	0.65	0.65	0.65
Orchard	0	0	Straight row crops- good	67	78	85	89	67	78	85	89	0.55	0.22	0.35	0.42	0.55
hay	0	0	Meadow	30	58	71	78	30	58	71	78	0.40	0.10	0.28	0.34	0.40
Pasture	0	0	Pasture- Fair	49	69	79	84	49	69	79	84	0.40	0.10	0.28	0.34	0.40
Manicured Open Space	0	0	Open space-fair	49	69	79	84	39	61	74	80	0.18	0.18	0.18	0.18	0.18
Neighbourhood Park	5	3	Open Space-fair	49	69	79	84	39	61	74	80	0.18	0.18	0.18	0.18	0.18
Parks And Open Space	5	3	Open Space- Good	39	61	74	80	39	61	74	80	0.18	0.18	0.18	0.18	0.18
Parks and Open Space-Neighbourhood Park	5	3	Open Space- Good	39	61	74	80	39	61	74	80	0.18	0.18	0.18	0.18	0.18
Residential-Village	45	35	Residential 1/3 acre	66	78	85	88	39	61	74	80	0.40	0.40	0.40	0.40	0.40
Residential-Low Density	35	20	Residential 1/3 acre	60	74	82	86	39	61	74	80	0.40	0.40	0.40	0.40	0.40
Residential-Low Density 1	35	20	Residential 1/3 acre	60	74	82	86	39	61	74	80	0.40	0.40	0.40	0.40	0.40
Residential-Low Density 2	35	20	Residential 1/3 acre	60	74	82	86	39	61	74	80	0.40	0.40	0.40	0.40	0.40
Residential-Medium Density	55	35	Residential 1/4 acre	71	81	87	90	39	61	74	80	0.50	0.50	0.50	0.50	0.50
Residential-Retirement	60	40	Residential 1/8 acre or less	74	83	88	91	39	61	74	80	0.68	0.68	0.68	0.68	0.68
Residential-Shoreline	35	20	Residential 1/3 acre	60	74	82	86	39	61	74	80	0.50	0.50	0.50	0.50	0.50
Rural Development	15	10	Residential Half acre	48	67	78	83	39	61	74	80	0.33	0.33	0.33	0.33	0.33
Stormwater Management	0	0	Lakes and Wetlands	50	50	50	50	50	50	50	50	0.05	0.05	0.05	0.05	0.05
Urban	45	35	Residential 1/4 acre or less	66	78	85	88	39	61	74	80	0.40	0.40	0.40	0.40	0.40
Rail	30	30	Roads-gravel	76	85	89	91	76	85	89	91	0.28	0.28	0.28	0.28	0.28
Road	75	75	Road-Paved (inlcuding ROW)	83	89	92	93	39	61	74	80	0.88	0.88	0.88	0.88	0.88

References

CN- Whole Area
- TR-55 Curve Number Table 2.2a
- MTO Design Chart 1.09
- Composite CN based of TIMP (CN=98), remainder = Open Space

CN- Pervious Area
- TR-55 Open Space good condition
- TR-55 Curve Number Table 2.2a
- MTO Design Chart 1.09

TIMP/XIMP
- TR-55 Average % Imp
- TOI Zoning - Direct Category
- TOI Zoning - Assumed Category
- Assumed
- LSRCA SWM Guidelines XIMP/TIMP Table Appendix C
- Assumed from City of Barrie SWM Guidelines
- Calculated from Aerial Photography

Runoff Coefficient
- Adapted from MTO Table 1.07
- Adapted from Township Rc Table

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
SOIL GROUP BREAKDOWN

Soil Group	East Oro	Forest Home	Guthrie	Hawkestone	Oro Station	Rugby	Shanty Bay	Overall
A	0%	60%	0%	0%	0%	100%	0%	17%
AB	95%	36%	91%	0%	79%	0%	58%	48%
B	5%	4%	9%	100%	21%	0%	42%	34%
C	0%	0%	0%	0%	0%	0%	0%	1%
CD	0%	0%	0%	0%	0%	0%	0%	0%
Grand Total	100%	100%	100%	100%	100%	100%	100%	100%

Source:
Soil Survey of Simcoe County (Report 23 of the Ontario Soil Survey, Research Branch Canada Department of Agriculture and Ontario Agricultural College, 1950)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING INPUT
RAINFALL INTENSITY
BARRIE WPCC

Barrie WPCC Rainfall Intensity (mm/hr)						
Duration (min)	Return Period					
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
5	100.8	130.8	150	175.2	194.4	212.4
10	70.8	93.6	109.2	128.4	142.2	156.6
15	58.4	78	91.2	107.6	119.6	131.6
30	37.4	49	56.6	66.2	73.2	80.4
60	22	28.5	32.7	38.1	42.1	46.1
120	13.5	19.1	22.7	27.3	30.8	34.2
360	6.1	8.6	10.3	12.4	13.9	15.4
720	3.4	4.7	5.5	6.6	7.4	8.2
1440	2	2.8	3.3	3.9	4.4	4.8
6-hour P Total (mm)	36.8	51.7	61.6	74.1	83.4	92.6
12-hour P Total (mm)	40.6	55.9	66.1	78.9	88.4	97.8
24-hour P Total (mm)	47.8	66.1	78.2	93.5	104.9	116.2

Environment Canada IDF at Barrie WPCC (ON 6110557)

EXISTING CONDITIONS VO2 PARAMETERS

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWN OF ORO MEDONTE
HYDROLOGIC MODEL VO2 PARAMETERS FOR EXISTING CONDITONS

VO2 ID	Area (ha)	CN	CN(pervious)	Ia (mm)	Timp (%)	Ximp (%)	slope	Rc	airport Tp	B-W Tp	select Tp (hr)	Ntype select	Note
100	835.70	57.85	54.44	7.05	2.71	2.21	1.01	0.23	2.64	2.27	2.64	Nash	
101	96.09	69.17	64.80	6.28	11.20	10.19	3.18	0.33	0.61	0.33	0.61	Nash	
103	223.30	62.20	56.82	6.27	13.03	12.94	0.93	0.31	1.71	1.28	1.71	Nash	
105	509.25	53.66	48.08	6.85	1.04	0.91	1.67	0.22	1.81	1.38	1.81	Nash	
106	814.51	51.78	51.23	7.18	1.18	1.02	1.06	0.19	2.69	2.22	2.69	Nash	
108	673.15	54.71	54.06	7.58	1.49	1.26	0.68	0.20	3.22	2.68	3.22	Nash	
109	228.84	45.44	43.61	8.03	3.38	3.21	1.27	0.17	2.06	1.54	2.06	Nash	
110	58.53	55.89	55.57	7.50	0.76	0.74	1.37	0.20	0.94	0.41	0.94	Nash	
111	1152.01	56.80	55.64	7.47	2.73	2.61	0.65	0.23	3.59	3.30	3.59	Nash	
112	32.04	49.92	49.56	6.54	0.67	0.64	1.04	0.11	1.20	0.51	1.20	Nash	
113	23.58	52.03	51.70	7.72	0.71	0.68	1.92	0.12	0.95	0.44	0.95	Nash	
114	193.26	61.28	59.18	7.59	5.40	4.35	1.37	0.24	1.20	0.64	1.20	Nash	
115	170.62	69.27	68.83	7.79	1.43	1.17	1.34	0.29	1.46	1.07	1.46	Nash	
116	289.79	63.55	58.78	6.72	12.15	9.67	0.55	0.25	2.01	1.17	2.01	Nash	
200	89.02	70.01	62.34	6.31	21.49	16.93	5.51	0.33	0.35	0.14	0.35	standhyd	
201	255.45	63.16	62.74	7.68	1.13	0.96	1.11	0.24	2.09	1.74	2.09	Nash	
202	307.29	61.03	60.43	8.00	1.49	1.28	1.09	0.24	2.08	1.68	2.08	Nash	
203	30.53	61.50	61.33	8.50	0.32	0.32	2.64	0.22	0.82	0.46	0.82	Nash	
204	13.66	55.46	55.40	6.89	0.00	0.00	1.03	0.31	0.79	0.38	0.79	Nash	
205	3159.99	52.29	50.69	7.25	0.98	0.87	0.38	0.17	5.93	5.66	5.93	Nash	
206	73.80	61.63	59.22	6.42	6.19	5.05	0.96	0.28	1.10	0.56	1.10	Nash	
207	315.33	62.74	62.07	7.06	1.83	1.78	0.53	0.26	2.20	1.39	2.20	Nash	
208	33.63	65.85	64.82	7.03	3.11	2.93	1.70	0.27	0.91	0.52	0.91	Nash	
209	295.05	53.89	52.54	7.28	2.97	2.90	1.24	0.21	2.11	1.70	2.11	Nash	
210	18.83	60.77	59.17	7.25	2.97	2.10	1.33	0.23	1.09	0.64	1.09	Nash	
211	50.58	65.56	61.32	6.74	11.49	9.06	1.10	0.32	0.94	0.50	0.94	Nash	
300	0.88	60.67	60.00	8.58	0.00	0.00	3.64	0.25	0.18	0.04	0.18	Nash	
301	186.26	63.88	63.03	7.60	2.36	2.01	1.93	0.24	1.03	0.56	1.03	Nash	
302	20.91	77.90	61.21	3.19	45.33	36.21	2.99	0.42	0.42	0.23	0.23	standhyd	
303	611.79	57.24	55.94	7.55	2.80	2.40	1.10	0.21	2.51	2.11	2.51	Nash	
304	46.90	70.58	61.42	5.65	25.03	19.83	2.27	0.33	0.58	0.27	0.58	standhyd	
305	309.29	57.76	56.09	7.11	1.66	1.47	0.81	0.20	2.55	2.01	2.55	Nash	
306	155.62	64.29	64.02	7.38	0.77	0.74	1.39	0.25	1.32	0.82	1.32	Nash	
307	165.22	56.84	55.63	7.65	2.49	2.09	1.24	0.21	1.56	1.00	1.56	Nash	
308	44.53	72.02	62.35	5.42	25.33	20.31	2.08	0.34	0.58	0.27	0.58	standhyd	
309	157.12	62.97	59.29	7.09	9.44	7.56	1.94	0.24	1.14	0.69	1.14	Nash	
310	162.43	59.58	57.77	7.64	4.43	3.52	1.22	0.21	1.74	1.23	1.74	Nash	
311	536.71	58.40	57.52	7.03	1.29	1.21	0.42	0.20	2.91	1.82	2.91	Nash	
312	28.89	60.52	60.52	6.98	0.00	0.00	1.73	0.18	0.87	0.40	0.87	Nash	
313	607.44	52.94	51.69	7.16	2.08	1.99	0.70	0.21	3.38	3.09	3.38	Nash	
315	123.44	57.83	57.33	7.58	1.12	0.83	1.03	0.23	1.44	0.83	1.44	Nash	
316	211.32	57.02	56.54	7.71	1.17	0.91	0.92	0.21	2.14	1.56	2.14	Nash	
317	278.29	58.67	57.63	7.31	2.13	1.76	0.92	0.23	2.45	2.10	2.45	Nash	
318	12.69	58.23	53.81	6.94	9.99	7.81	0.82	0.27	0.79	0.31	0.79	Nash	
320	46.41	72.05	59.85	4.89	31.97	25.37	1.96	0.36	0.41	0.14	0.41	standhyd	
321	34.71	75.73	59.93	3.51	40.64	32.47	2.15	0.41	0.40	0.16	0.16	standhyd	
322	207.40	58.12	56.80	7.62	3.04	2.42	0.96	0.21	2.28	1.84	2.28	Nash	
323	236.30	63.41	60.36	7.60	8.04	6.43	2.36	0.27	0.88	0.47	0.88	Nash	
324	303.00	62.29	62.01	7.70	0.74	0.68	1.27	0.24	1.74	1.23	1.74	Nash	
325	156.62	64.35	62.35	7.74	5.58	4.47	3.38	0.28	0.69	0.36	0.69	Nash	
327	198.82	60.41	60.10	7.30	0.74	0.73	0.64	0.22	2.01	1.21	2.01	Nash	
328	171.14	59.68	57.27	7.43	5.88	4.78	2.49	0.25	0.81	0.39	0.81	Nash	
329	117.37	74.20	55.15	3.39	43.91	36.96	1.50	0.46	0.72	0.46	0.46	standhyd	
1021	26.87	48.53	46.54	9.05	3.87	3.78	2.99	0.16	0.82	0.44	0.82	Nash	
1025	35.23	59.01	55.18	8.02	7.79	6.97	4.67	0.26	0.60	0.35	0.60	Nash	
1028	32.85	56.37	54.39	9.25	4.54	4.51	3.63	0.22	0.78	0.48	0.78	Nash	
1040	452.51	47.70	47.09	8.44	1.18	1.00	1.72	0.15	1.59	0.93	1.59	Nash	
1041	76.98	41.62	40.78	7.93	1.47	1.20	2.72	0.11	1.40	1.00	1.40	Nash	
1045	188.03	45.58	39.87	7.65	0.36	0.33	3.15	0.18	0.98	0.56	0.98	Nash	
1047	6.75	50.32	48.03	5.57	4.59	3.63	2.18	0.12	0.59	0.21	0.59	Nash	
1070	137.82	56.12	55.91	7.89	0.50	0.48	1.93	0.19	1.26	0.77	1.26	Nash	
1071	28.72	51.41	50.11	6.51	2.71	2.39	2.87	0.17	0.73	0.34	0.73	Nash	
1072	0.71	47.56	44.48	6.57	5.75	5.60	4.30	0.25	0.13	0.02	0.13	Nash	
1075	28.08	49.53	48.84	6.91	1.40	1.34	1.98	0.18	0.87	0.42	0.87	Nash	
2001	19.92	62.19	58.42	7.45	9.51	7.77	4.18	0.27	0.42	0.18	0.42	Nash	
2025	10.24	65.38	47.70	4.44	35.17	27.89	1.73	0.36	0.64	0.36	0.64	standhyd	
2028	9.83	64.37	43.12	4.03	38.74	30.95	1.58	0.37	0.60	0.32	0.60	standhyd	

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWN OF ORO MEDONTE
HYDROLOGIC MODEL VO2 PARAMETERS FOR EXISTING CONDITONS

VO2 ID	Area (ha)	CN	CN(pervious)	Ia (mm)	Timp (%)	Ximp (%)	slope	Rc	airport Tp	B-W Tp	select Tp (hr)	Ntype select	Note
2041	0.96	50.17	43.82	4.80	11.74	8.92	1.01	0.24	0.31	0.06	0.31	Nash	
2042	0.87	44.11	44.11	7.00	0.00	0.00	6.09	0.10	0.20	0.04	0.20	Nash	
2045	8.17	45.22	38.16	5.16	11.81	9.10	4.52	0.26	0.34	0.13	0.34	Nash	
2071	16.86	55.63	47.51	5.63	15.15	12.82	3.22	0.29	0.46	0.20	0.46	Nash	
2075	1.10	73.96	50.04	3.01	49.88	49.88	1.12	0.75	0.16	0.11	0.11	standhyd	
2076	0.92	57.21	50.00	4.00	15.02	10.02	2.31	0.33	0.34	0.14	0.34	Nash	
2110	0.78	73.46	50.23	3.19	48.62	48.62	1.88	0.73	0.08	0.03	0.03	standhyd	
2203	6.70	63.47	61.87	8.18	4.42	4.42	3.03	0.30	0.38	0.15	0.38	Nash	
2204	15.92	61.55	61.04	8.37	1.37	1.16	3.51	0.27	0.51	0.25	0.51	Nash	
2206	3.51	63.53	62.77	7.99	2.15	2.02	2.77	0.29	0.25	0.07	0.25	Nash	
2207	44.56	58.63	56.77	6.80	4.51	3.66	0.91	0.26	1.19	0.63	1.19	Nash	
2208	0.69	49.01	49.01	9.00	0.00	0.00	2.81	0.25	0.23	0.06	0.23	Nash	
2209	0.57	65.41	56.43	6.26	21.55	18.77	0.00	0.36	-	-	0.25	standhyd	
2210	23.61	68.36	58.53	5.26	24.27	19.45	3.85	0.32	0.51	0.28	0.51	standhyd	
2211	27.27	67.59	58.75	5.88	21.13	16.94	4.51	0.34	0.35	0.15	0.35	standhyd	
2212	0.55	53.11	51.18	7.62	4.13	2.76	1.47	0.27	0.22	0.04	0.22	Nash	
2213	0.88	71.86	60.97	3.69	29.30	24.44	6.96	0.43	0.12	0.04	0.04	standhyd	
2269	0.84	60.43	59.53	8.04	2.34	1.56	1.67	0.27	0.28	0.07	0.28	Nash	
2300	30.27	69.21	61.43	5.71	18.22	14.35	2.12	0.31	0.63	0.31	0.63	Nash	
2301	49.24	67.42	61.86	6.80	14.82	11.69	1.36	0.31	0.89	0.47	0.89	Nash	
2306	4.18	54.84	45.66	5.48	17.54	13.94	0.48	0.28	0.77	0.26	0.77	Nash	
2310	22.21	67.21	53.19	4.86	31.29	25.02	3.94	0.35	0.39	0.18	0.39	standhyd	
3141	85.39	52.28	51.88	7.87	0.86	0.74	0.71	0.18	1.60	0.79	1.60	Nash	
3145	132.54	52.12	51.08	7.30	2.15	2.06	0.95	0.19	1.46	0.74	1.46	Nash	
3250	43.70	64.84	62.74	6.99	5.86	4.58	5.48	0.28	0.45	0.21	0.45	Nash	
3254	13.91	74.08	73.91	6.97	0.20	0.16	2.41	0.31	0.42	0.15	0.42	Nash	
3255	53.36	58.39	57.72	7.21	1.58	1.31	1.62	0.28	0.72	0.31	0.72	Nash	
3256	13.61	65.81	62.96	7.15	8.10	6.06	4.14	0.30	0.37	0.15	0.37	Nash	
3265	26.53	55.66	54.47	7.46	2.68	2.02	3.87	0.19	0.57	0.26	0.57	Nash	
3269	124.61	57.34	55.09	7.16	5.17	4.09	2.22	0.25	0.78	0.36	0.78	Nash	
5140	119.44	57.25	57.00	7.31	0.62	0.57	1.03	0.21	1.33	0.68	1.33	Nash	
5141	29.18	70.04	52.01	4.10	38.12	34.09	0.58	0.48	0.79	0.44	0.44	standhyd	
5142	5.20	76.43	57.75	3.00	46.37	36.83	-	0.42	-	-	-	standhyd	Pond 3
5145	3.56	73.18	49.64	3.16	48.68	46.10	3.30	0.65	0.16	0.09	0.09	standhyd	
5250	20.10	53.97	53.10	6.85	1.96	1.52	0.99	0.25	0.69	0.24	0.69	Nash	
5254	11.03	62.90	57.73	5.97	12.82	10.11	6.75	0.31	0.28	0.12	0.28	Nash	
5255	25.03	72.05	53.76	3.73	39.85	32.94	1.71	0.42	0.44	0.19	0.19	standhyd	
5257	10.19	74.24	61.13	3.50	35.54	27.76	4.82	0.39	0.34	0.18	0.34	standhyd	
5260	54.55	63.83	51.46	6.44	13.10	11.18	3.63	0.32	0.58	0.33	0.58	Nash	
5261	37.50	69.94	52.96	3.24	37.68	28.90	-	0.38	#N/A	#N/A	-	standhyd	Pond 4
5262	7.50	69.94	52.96	3.24	37.68	28.90	-	0.38	#N/A	#N/A	-	standhyd	Pond 6
5263	2.35	69.94	52.96	3.24	37.68	28.90	-	0.38	#N/A	#N/A	-	standhyd	Pond 7

FUTURE CONDITIONS VO2 PARAMETERS

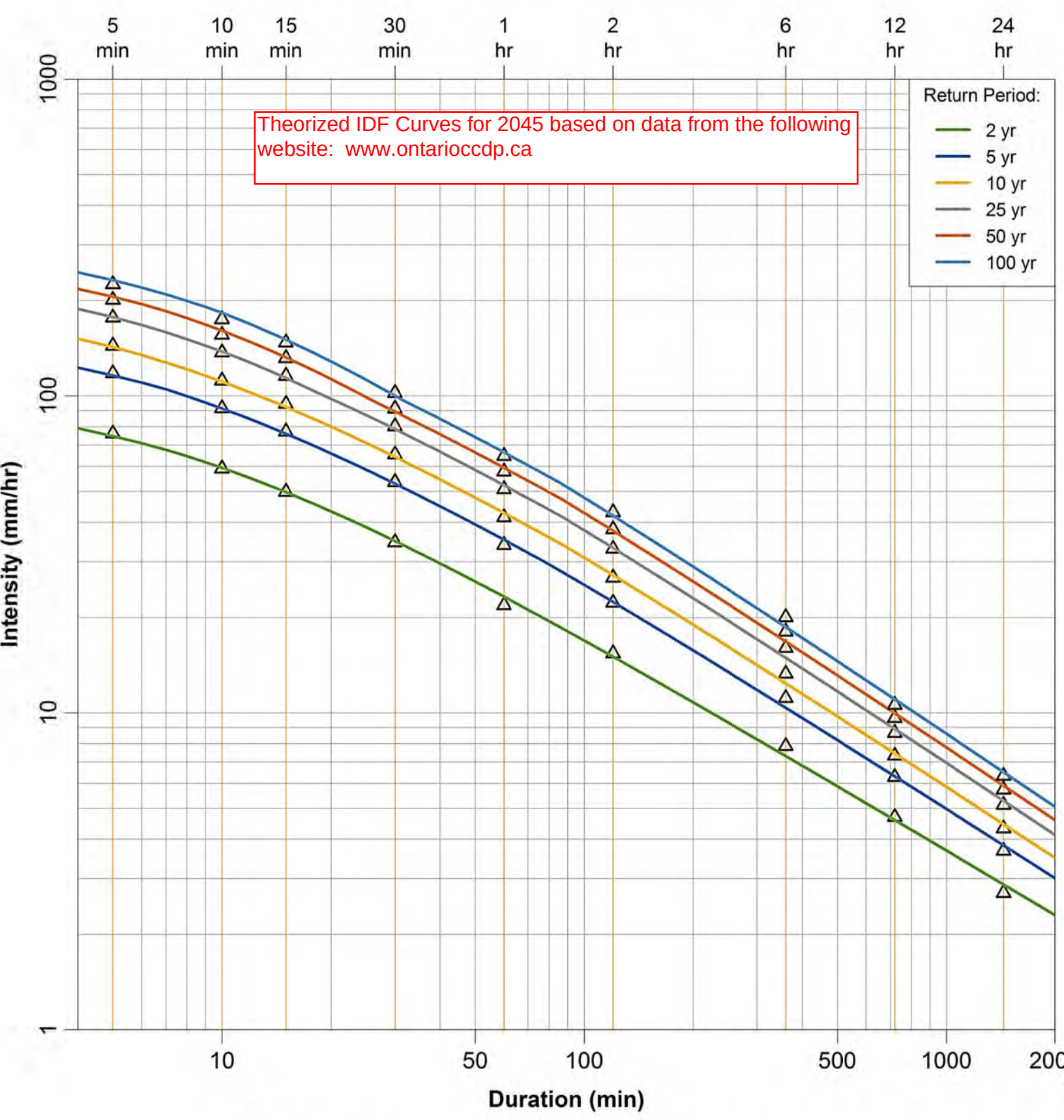
COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWN OF ORO MEDONTE
HYDROLOGIC MODEL VO2 PARAMETERS FOR FUTURE CONDITONS

vo3id2	area (ha)	CN	CN(pervious)	Ia (mm)	Timp (%)	Ximp (%)	slope	Rc	airport Tp	B-W Tp	select Tp (hr)	Ntype select	Note
100	835.70	57.85	54.44	7.05	2.71	2.21	1.01	0.23	2.64	2.27	2.64	Nash	
101	96.09	69.17	64.80	6.28	11.20	10.19	3.18	0.33	0.61	0.33	0.61	Nash	
103	223.30	62.20	56.82	6.27	13.03	12.94	0.93	0.31	1.71	1.28	1.71	Nash	
105	509.25	53.66	48.08	6.85	1.04	0.91	1.67	0.22	1.81	1.38	1.81	Nash	
106	814.51	51.78	51.23	7.18	1.18	1.02	1.06	0.19	2.69	2.22	2.69	Nash	
108	673.15	54.71	54.06	7.58	1.49	1.26	0.68	0.20	3.22	2.68	3.22	Nash	
109	228.84	45.44	43.61	8.03	3.38	3.21	1.27	0.17	2.06	1.54	2.06	Nash	
110	58.53	55.89	55.57	7.50	0.76	0.74	1.37	0.20	0.94	0.41	0.94	Nash	
111	1152.01	56.80	55.64	7.47	2.73	2.61	0.65	0.23	3.59	3.30	3.59	Nash	
112	32.04	49.92	49.56	6.54	0.67	0.64	1.04	0.11	1.20	0.51	1.20	Nash	
113	23.58	52.03	51.70	7.72	0.71	0.68	1.92	0.12	0.95	0.44	0.95	Nash	
114	193.26	61.28	59.18	7.59	5.40	4.35	1.37	0.24	1.20	0.64	1.20	Nash	
115	170.62	69.27	68.83	7.79	1.43	1.17	1.34	0.29	1.46	1.07	1.46	Nash	
116	289.79	63.55	58.78	6.72	12.15	9.67	0.55	0.25	2.01	1.17	2.01	Nash	
200	89.02	70.01	62.34	6.31	21.49	16.93	5.51	0.33	0.35	0.14	0.35	standhyd	
201	255.45	63.16	62.74	7.68	1.13	0.96	1.11	0.24	2.09	1.74	2.09	Nash	
202	307.29	61.03	60.43	8.00	1.49	1.28	1.09	0.24	2.08	1.68	2.08	Nash	
203	30.53	61.50	61.33	8.50	0.32	0.32	2.64	0.22	0.82	0.46	0.82	Nash	
204	13.66	55.46	55.40	6.89	0.00	0.00	1.03	0.31	0.79	0.38	0.79	Nash	
205	3159.99	52.29	50.69	7.25	0.98	0.87	0.38	0.17	5.93	5.66	5.93	Nash	
206	73.80	61.63	59.22	6.42	6.19	5.05	0.96	0.28	1.10	0.56	1.10	Nash	
207	315.33	62.74	62.07	7.06	1.83	1.78	0.53	0.26	2.20	1.39	2.20	Nash	
208	33.63	65.85	64.82	7.03	3.11	2.93	1.70	0.27	0.91	0.52	0.91	Nash	
209	295.05	53.89	52.54	7.28	2.97	2.90	1.24	0.21	2.11	1.70	2.11	Nash	
210	18.83	60.77	59.17	7.25	2.97	2.10	1.33	0.23	1.09	0.64	1.09	Nash	
211	50.58	65.56	61.32	6.74	11.49	9.06	1.10	0.32	0.94	0.50	0.94	Nash	
300	0.88	60.67	60.00	8.58	0.00	0.00	3.64	0.25	0.18	0.04	0.18	Nash	
301	186.26	63.88	63.03	7.60	2.36	2.01	1.93	0.24	1.03	0.56	1.03	Nash	
302	20.91	77.90	61.21	3.19	45.33	36.21	2.99	0.42	0.42	0.23	0.23	standhyd	
303	611.79	57.24	55.94	7.55	2.80	2.40	1.10	0.21	2.51	2.11	2.51	Nash	
304	46.90	70.58	61.42	5.65	25.03	19.83	2.27	0.33	0.58	0.27	0.58	standhyd	
305	309.29	57.76	56.09	7.11	1.66	1.47	0.81	0.20	2.55	2.01	2.55	Nash	
306	155.62	64.29	64.02	7.38	0.77	0.74	1.39	0.25	1.32	0.82	1.32	Nash	
307	165.22	56.84	55.63	7.65	2.49	2.09	1.24	0.21	1.56	1.00	1.56	Nash	
308	44.53	72.02	62.35	5.42	25.33	20.31	2.08	0.34	0.58	0.27	0.58	standhyd	
309	157.12	62.97	59.29	7.09	9.44	7.56	1.94	0.24	1.14	0.69	1.14	Nash	
310	162.43	59.58	57.77	7.64	4.43	3.52	1.22	0.21	1.74	1.23	1.74	Nash	
311	536.71	58.40	57.52	7.03	1.29	1.21	0.42	0.20	2.91	1.82	2.91	Nash	
312	28.89	60.52	60.52	6.98	0.00	0.00	1.73	0.18	0.87	0.40	0.87	Nash	
313	607.44	52.94	51.69	7.16	2.08	1.99	0.70	0.21	3.38	3.09	3.38	Nash	
315	123.44	57.83	57.33	7.58	1.12	0.83	1.03	0.23	1.44	0.83	1.44	Nash	
316	211.32	57.02	56.54	7.71	1.17	0.91	0.92	0.21	2.14	1.56	2.14	Nash	
317	278.29	58.67	57.63	7.31	2.13	1.76	0.92	0.23	2.45	2.10	2.45	Nash	
318	12.69	58.23	53.81	6.94	9.99	7.81	0.82	0.27	0.79	0.31	0.79	Nash	
320	46.41	72.05	59.85	4.89	31.97	25.37	1.96	0.36	0.41	0.14	0.41	standhyd	
321	34.71	75.73	59.93	3.51	40.64	32.47	2.15	0.41	0.40	0.16	0.16	standhyd	
322	207.40	58.12	56.80	7.62	3.04	2.42	0.96	0.21	2.28	1.84	2.28	Nash	
323	236.30	63.41	60.36	7.60	8.04	6.43	2.36	0.27	0.88	0.47	0.88	Nash	
324	303.00	62.29	62.01	7.70	0.74	0.68	1.27	0.24	1.74	1.23	1.74	Nash	
325	156.62	64.35	62.35	7.74	5.58	4.47	3.38	0.28	0.69	0.36	0.69	Nash	
327	198.82	60.41	60.10	7.30	0.74	0.73	0.64	0.22	2.01	1.21	2.01	Nash	
328	171.14	59.68	57.27	7.43	5.88	4.78	2.49	0.25	0.81	0.39	0.81	Nash	
329	117.37	74.20	55.15	3.39	43.91	36.96	1.50	0.46	0.72	0.46	0.46	standhyd	
1021	26.87	48.53	46.54	9.05	3.87	3.78	2.99	0.16	0.82	0.44	0.82	Nash	
1025	35.23	59.01	55.18	8.02	7.79	6.97	4.67	0.26	0.60	0.35	0.60	Nash	
1028	32.85	56.37	54.39	9.25	4.54	4.51	3.63	0.22	0.78	0.48	0.78	Nash	
1040	452.51	47.70	47.09	8.44	1.18	1.00	1.72	0.15	1.59	0.93	1.59	Nash	

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWN OF ORO MEDONTE
HYDROLOGIC MODEL VO2 PARAMETERS FOR FUTURE CONDITONS

vo3id2	area (ha)	CN	CN(pervious)	Ia (mm)	Timp (%)	Ximp (%)	slope	Rc	airport Tp	B-W Tp	select Tp (hr)	Ntype select	Note
1041	76.98	41.62	40.78	7.93	1.47	1.20	2.72	0.11	1.40	1.00	1.40	Nash	
1045	188.03	45.58	39.87	7.65	0.36	0.33	3.15	0.18	0.98	0.56	0.98	Nash	
1047	6.75	50.32	48.03	5.57	4.59	3.63	2.18	0.12	0.59	0.21	0.59	Nash	
1070	137.82	56.12	55.91	7.89	0.50	0.48	1.93	0.19	1.26	0.77	1.26	Nash	
1071	28.72	51.41	50.11	6.51	2.71	2.39	2.87	0.17	0.73	0.34	0.73	Nash	
1072	0.71	47.56	44.48	6.57	5.75	5.60	4.30	0.25	0.13	0.02	0.13	Nash	
1075	28.08	49.53	48.84	6.91	1.40	1.34	1.98	0.18	0.87	0.42	0.87	Nash	
2001	19.92	62.19	58.42	7.45	9.51	7.77	4.18	0.27	0.42	0.18	0.42	Nash	
2025	10.24	68.47	46.78	3.26	43.55	33.03	1.73	0.42	0.58	0.36	0.36	standhyd	
2028	9.83	66.87	43.03	3.33	43.96	35.58	1.58	0.46	0.53	0.32	0.32	standhyd	
2041	0.96	58.83	45.27	4.49	25.84	16.48	1.01	0.36	0.26	0.06	0.26	standhyd	
2042	0.87	57.43	53.00	5.50	7.50	5.00	6.09	0.27	0.16	0.04	0.16	Nash	
2045	8.17	58.82	45.21	4.36	26.08	19.67	4.52	0.40	0.28	0.13	0.13	standhyd	
2071	16.86	63.91	53.02	4.70	24.04	19.25	3.22	0.38	0.40	0.20	0.40	standhyd	
2075	1.10	74.00	50.02	3.00	50.00	50.00	1.12	0.75	0.16	0.11	0.11	standhyd	
2076	0.92	64.75	50.00	4.00	30.72	17.87	2.31	0.38	0.32	0.14	0.32	standhyd	
2110	0.78	74.00	50.12	3.00	50.00	50.00	1.88	0.75	0.08	0.03	0.03	standhyd	
2203	6.70	72.78	68.80	5.36	11.75	9.58	3.03	0.38	0.35	0.15	0.35	Nash	
2204	15.92	72.26	69.16	5.47	8.73	6.01	3.51	0.34	0.46	0.25	0.46	Nash	
2206	3.51	70.51	67.58	5.83	8.07	5.97	2.77	0.34	0.24	0.07	0.24	Nash	
2207	44.56	70.31	66.12	5.35	12.15	9.30	0.91	0.35	1.06	0.63	1.06	Nash	
2208	0.69	72.28	69.50	5.50	7.50	5.00	2.81	0.34	0.20	0.06	0.20	Nash	
2209	0.57	69.51	57.18	5.23	30.16	23.68	0.00	0.40	-	-	0.25	standhyd	
2210	23.61	72.47	61.97	4.19	28.77	22.35	3.85	0.37	0.48	0.28	0.48	standhyd	
2211	27.27	74.91	65.59	4.26	27.58	21.45	4.51	0.39	0.33	0.15	0.33	standhyd	
2212	0.55	53.11	51.18	7.62	4.13	2.76	1.47	0.27	0.22	0.04	0.22	Nash	
2213	0.88	71.89	61.00	3.69	29.33	24.46	6.96	0.43	0.12	0.04	0.04	standhyd	
2269	0.84	60.43	59.53	8.04	2.34	1.56	1.67	0.27	0.28	0.07	0.28	Nash	
2300	30.27	71.39	62.87	4.11	21.75	16.64	2.12	0.34	0.61	0.31	0.61	standhyd	
2301	49.24	73.13	66.92	4.88	19.12	14.48	1.36	0.36	0.84	0.47	0.84	Nash	
2306	4.18	67.19	57.81	4.58	22.16	16.99	0.48	0.35	0.70	0.26	0.70	standhyd	
2310	22.21	71.54	56.65	3.73	36.53	28.58	3.94	0.41	0.36	0.18	0.18	standhyd	
3141	85.39	52.28	51.88	7.87	0.86	0.74	0.71	0.18	1.60	0.79	1.60	Nash	
3145	132.54	52.12	51.08	7.30	2.15	2.06	0.95	0.19	1.46	0.74	1.46	Nash	
3250	43.70	64.84	62.74	6.99	5.86	4.58	5.48	0.28	0.45	0.21	0.45	Nash	
3254	13.91	74.08	73.91	6.97	0.20	0.16	2.41	0.31	0.42	0.15	0.42	Nash	
3255	53.36	58.39	57.72	7.21	1.58	1.31	1.62	0.28	0.72	0.31	0.72	Nash	
3256	13.61	65.81	62.96	7.15	8.10	6.06	4.14	0.30	0.37	0.15	0.37	Nash	
3265	26.53	55.66	54.47	7.46	2.68	2.02	3.87	0.19	0.57	0.26	0.57	Nash	
3269	124.61	57.34	55.09	7.16	5.17	4.09	2.22	0.25	0.78	0.36	0.78	Nash	
5140	119.44	57.25	57.00	7.31	0.62	0.57	1.03	0.21	1.33	0.68	1.33	Nash	
5141	29.18	72.94	52.03	3.25	44.68	39.43	0.58	0.56	0.69	0.44	0.44	standhyd	
5142	5.20	76.43	57.75	3.00	46.37	36.83	-	0.42	-	-	-	standhyd	Pond 3
5145	3.56	74.84	50.00	3.00	51.75	51.24	3.30	0.74	0.13	0.09	0.09	standhyd	
5250	20.10	69.77	66.17	5.39	9.21	6.35	0.99	0.33	0.63	0.24	0.63	Nash	
5254	11.03	73.13	67.02	4.78	18.63	13.93	6.75	0.36	0.27	0.12	0.27	Nash	
5255	25.03	73.46	54.65	3.31	42.38	35.16	1.71	0.45	0.42	0.19	0.19	standhyd	
5257	10.19	74.91	61.10	3.38	37.57	28.83	4.82	0.40	0.33	0.18	0.33	standhyd	
5260	54.55	71.08	58.09	4.47	25.98	18.72	3.63	0.40	0.52	0.33	0.33	standhyd	
5261	37.50	69.94	52.96	3.24	37.68	28.90	-	0.38	#N/A	#N/A	-	standhyd	Pond 4
5262	7.50	69.94	52.96	3.24	37.68	28.90	-	0.38	#N/A	#N/A	-	standhyd	Pond 6
5263	2.35	69.94	52.96	3.24	37.68	28.90	-	0.38	#N/A	#N/A	-	standhyd	Pond 7

IDF Curves for [44.5651, 280.4123]: 2015-2045, 50%



This graph was produced by Xander Wang on April 15, 2014.
More IDF curves are available at: http://www.ontarioccdp.ca
For any queries please email to: xander.wang@ontarioccdp.ca

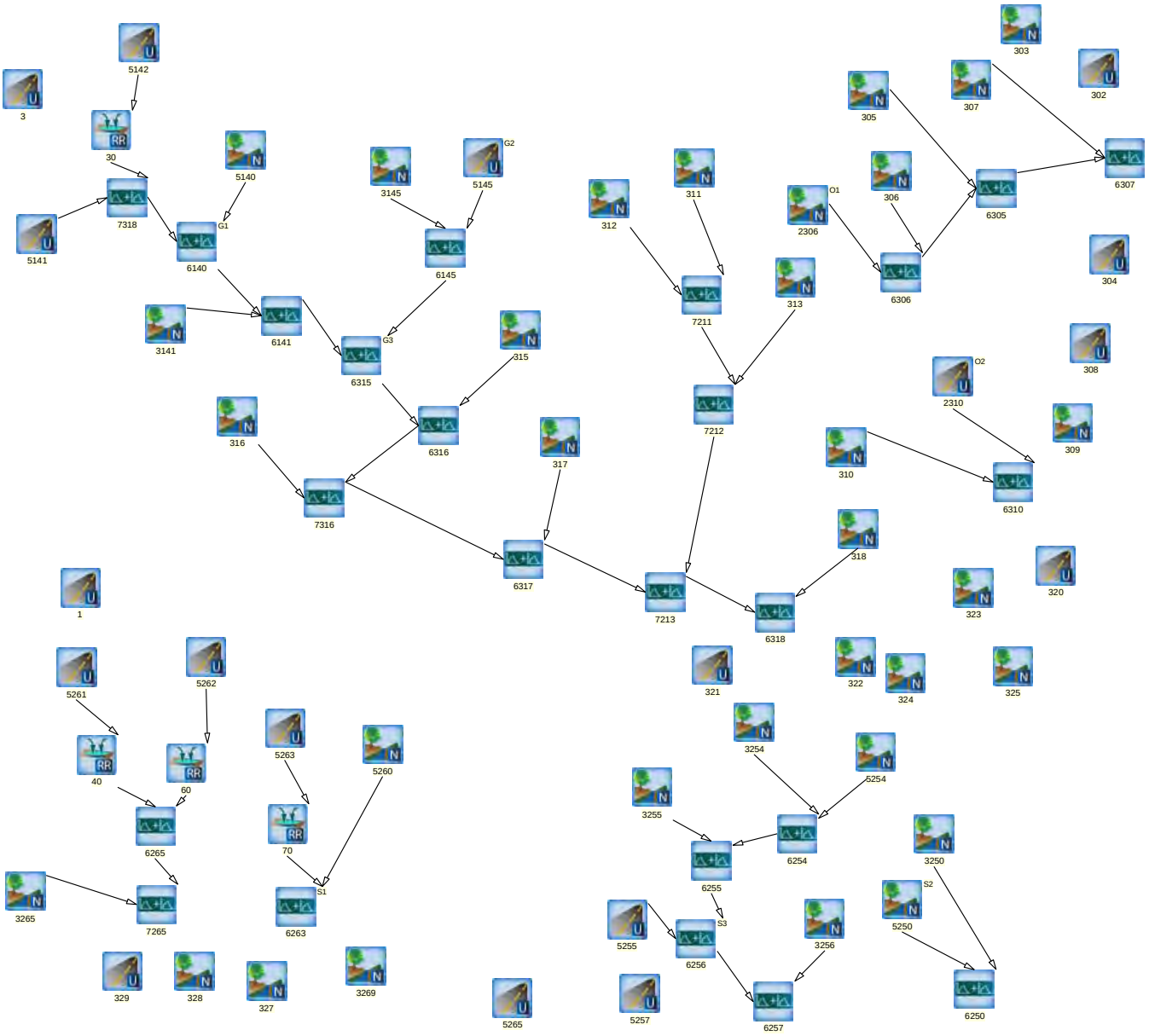
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EXISTING & FUTURE CONDITIONS VO2 SCHEMATICS

C.C. Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Project:	Oro-Medonte
Date:	August, 2015
File No.:	113238
Designed By:	TY
Checked By:	JA
Subject:	Hydrologic Model Schematic

HYDROLOGIC MODEL SCHEMATIC: ORO-SOUTH-EXISTING

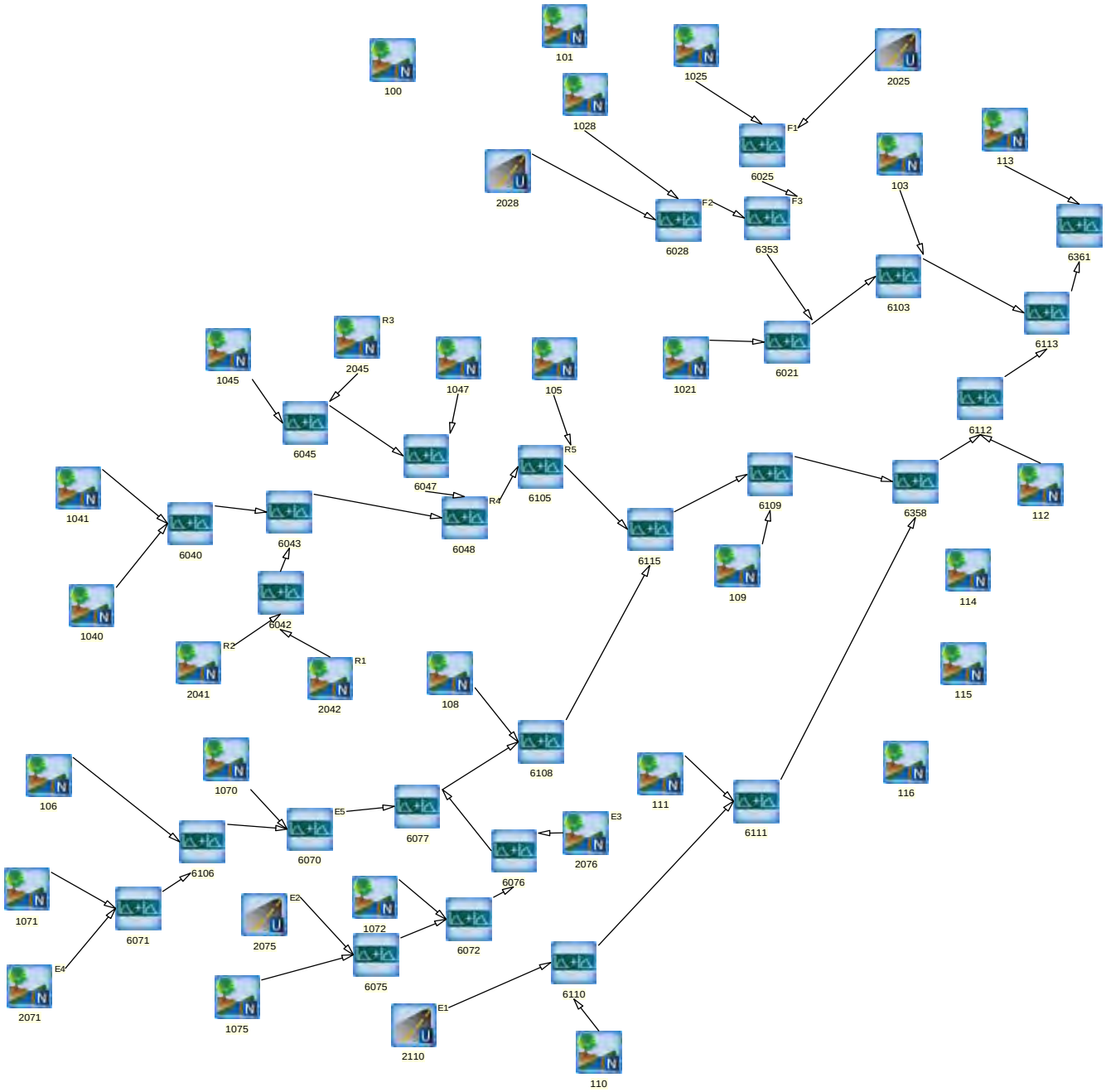


Nashyd		Route Pipe		Duhyd	
Standhyd		Route Channel		Diverthyd	
Addhyd		Route Reservoir	S1	HRP	

C.C.Tatham & Associates Ltd.
Consulting Engineers
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HYDROLOGIC MODEL SCHEMATIC: ORO-NORTH-EXISTING

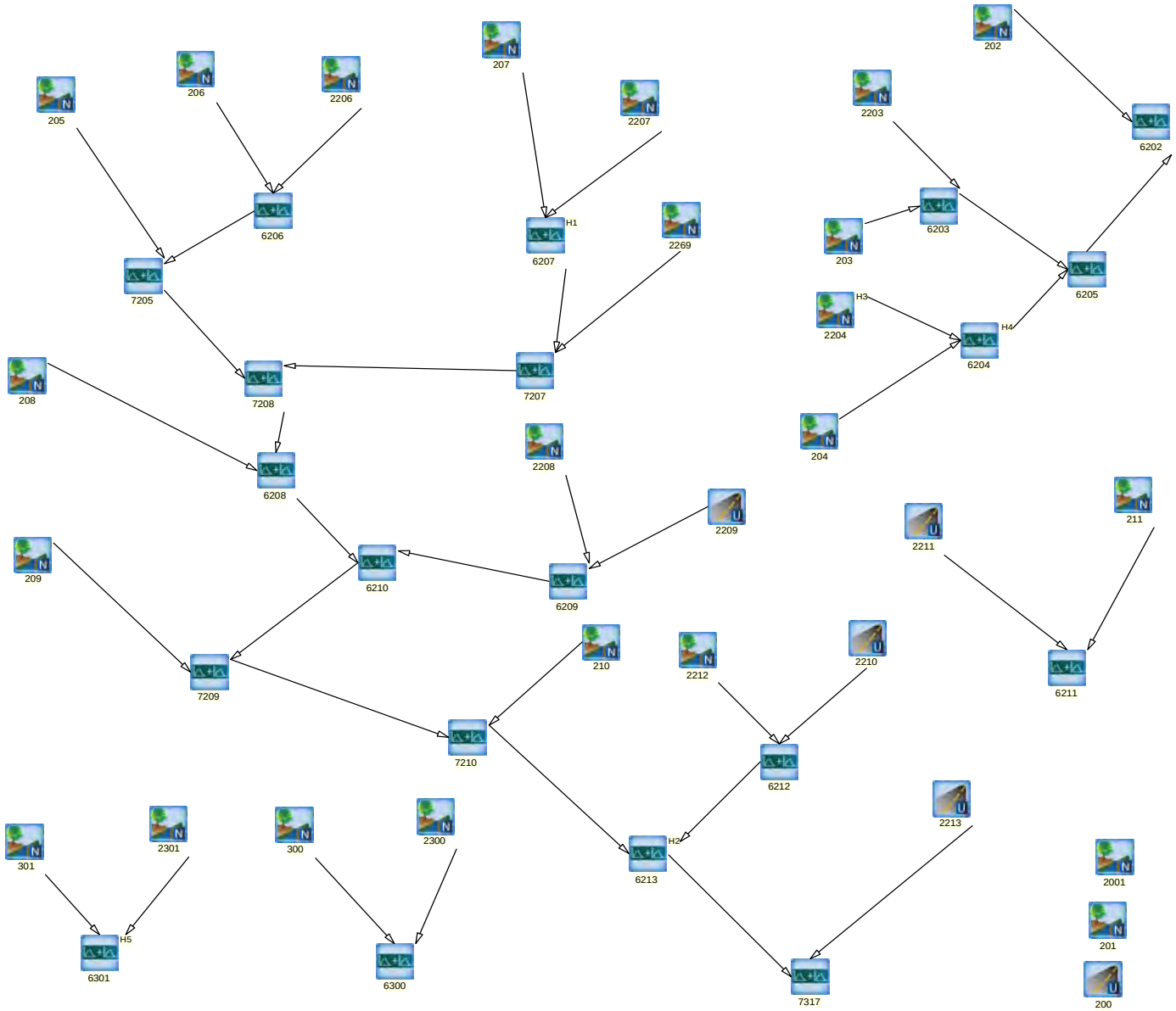


Nashyd		Route Pipe		Duhyd	
Standhyd		Route Channel		Diverthyd	
Addhyd		Route Reservoir	F1	HRP	

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HYDROLOGIC MODEL SCHEMATIC: HAWKESTONE-EXISTING

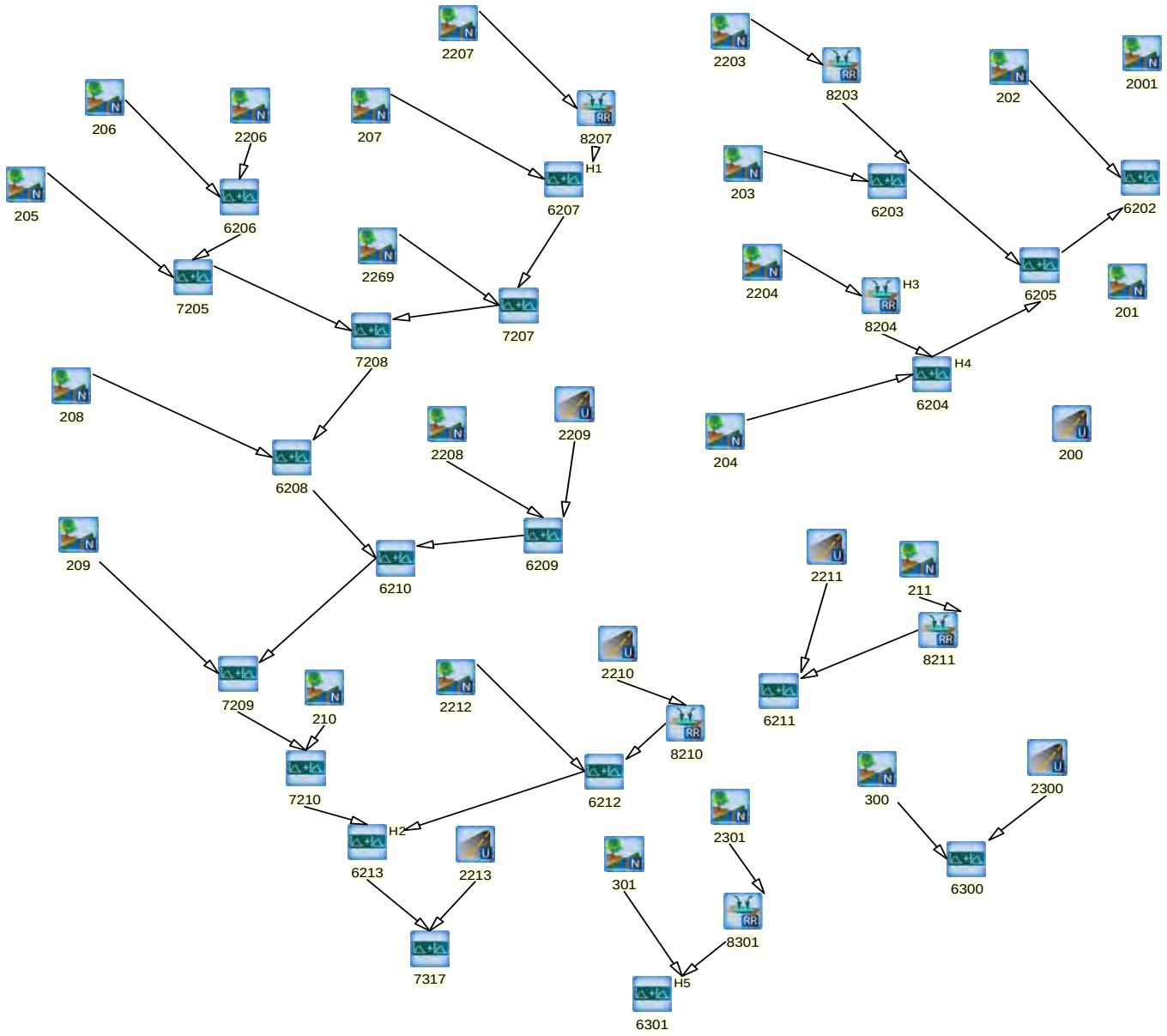


Nashyd		Route Pipe		Duhyd	
Standhyd		Route Channel		Diverthyd	
Addhyd		Route Reservoir	H1	HRP	

C.C.Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

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HYDROLOGIC MODEL SCHEMATIC: HAWKESTONE-PROPOSED

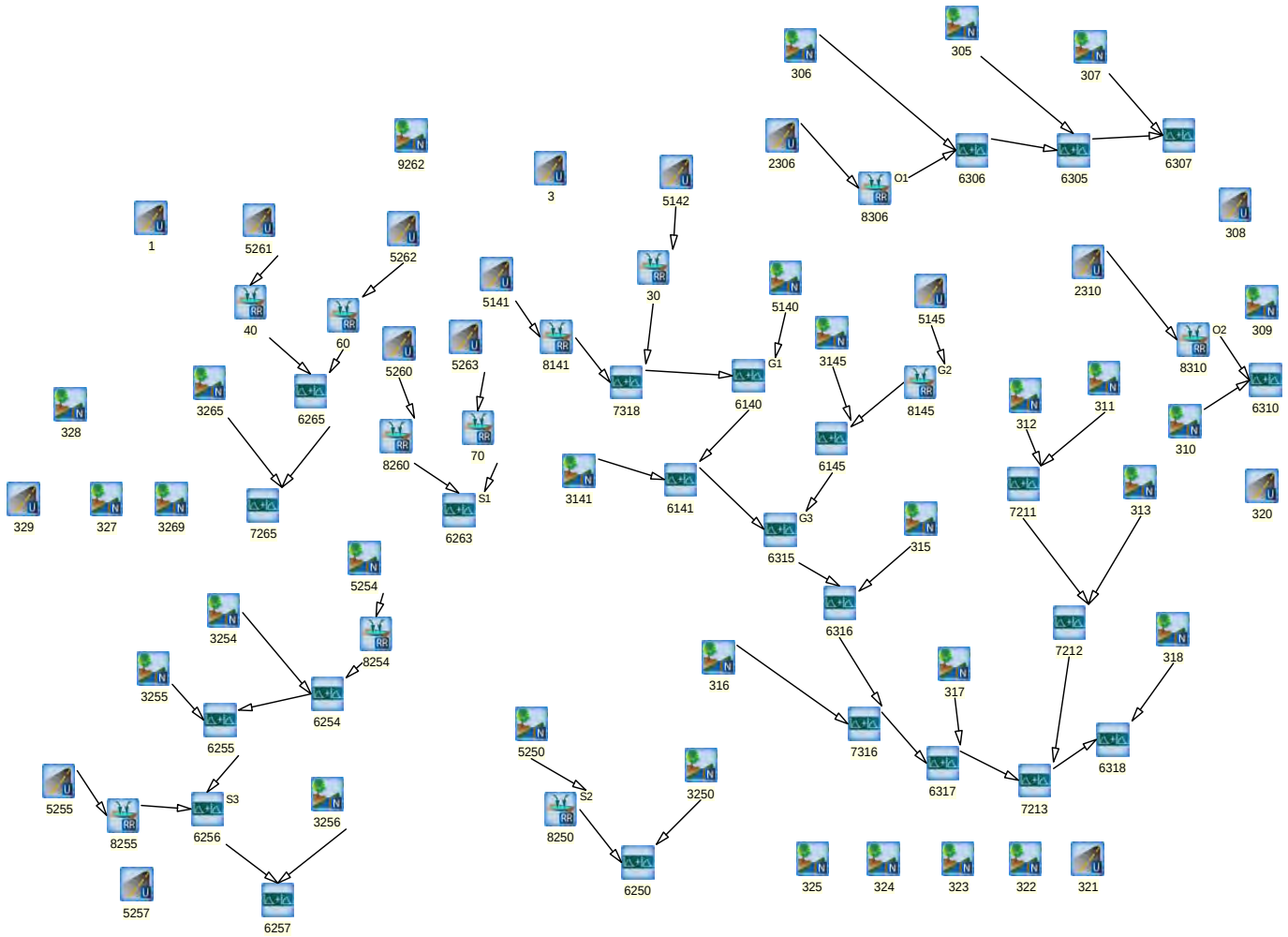


Nashyd		Route Pipe		Duhyd	
Standhyd		Route Channel		Diverthyd	
Addhyd		Route Reservoir	H1	HRP	

C.C. Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Project:	Oro-Medonte
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Subject:	Hydrologic Model Schematic

HYDROLOGIC MODEL SCHEMATIC: ORO-SOUTH-PROPOSED

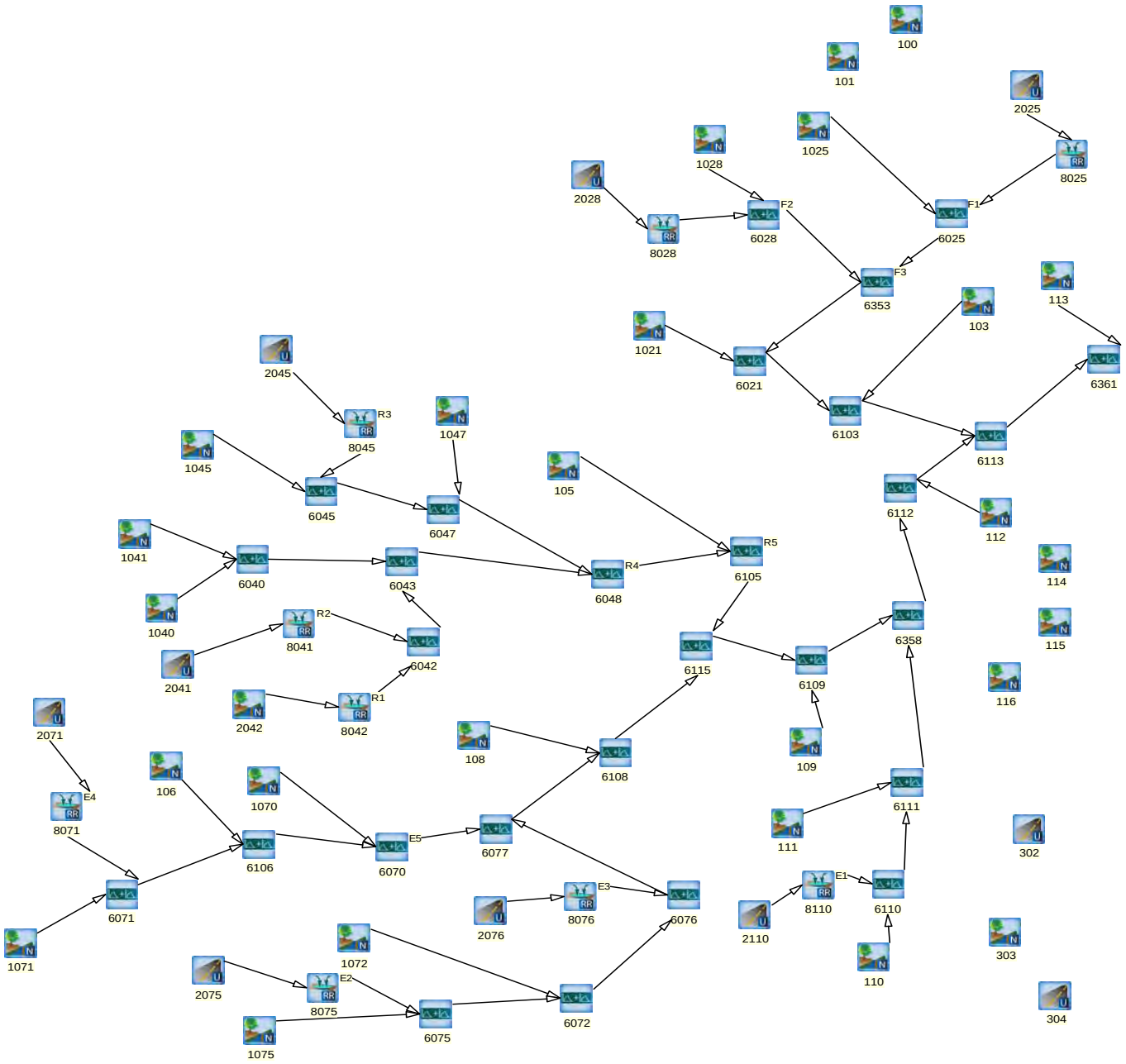


Nashyd		Route Pipe		Duhyd	
Standhyd		Route Channel		Diverthyd	
Addhyd		Route Reservoir	S1	HRP	

C.C. Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

Project:	Oro-Medonte
Date:	August, 2015
File No.:	113238
Designed By:	TY
Checked By:	JA
Subject:	Hydrologic Model Schematic

HYDROLOGIC MODEL SCHEMATIC: ORO-NORTH-PROPOSED



1	Nashyd	1	Route Pipe	1	Duhyd
1	Standhyd	1	Route Channel	1	Diverthyd
1	Addhyd	1	Route Reservoir	F1	HRP

VO2 RESULTS

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 results for SCS 12 hour storm
Existing condition
Aug-15

Flownode	Settlement	VO2ID	Area	2year	5year	10year	25 year	50 year	100 year
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	997.91	1.74	3.56	5.06	7.23	9.02	10.93
F3	Forest Home	6353	88.15	0.83	1.29	1.67	2.2	2.61	3.11
G1	Guthrie	6140	153.82	1.22	1.84	2.29	3	3.51	4.04
H1	Hawkestone	6207	359.89	1.06	2.13	2.98	4.2	5.19	6.23
H4	Hawkestone	6204	29.58	0.18	0.38	0.54	0.77	0.96	1.16
H5	Hawkestone	6301	235.5	1.31	2.65	3.73	5.26	6.5	7.8
R3	Rugby	2045	8.17	0.06	0.11	0.16	0.22	0.28	0.34
R4	Rugby	6048	734.27	1.52	3.23	4.67	6.78	8.55	10.46
S2	Shanty Bay	5250	20.1	0.1	0.21	0.3	0.43	0.54	0.65
S3	Shanty Bay	6256	103.33	1.34	2.1	2.79	3.72	4.47	5.42

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

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
         V V    I      SS   U   U A   A  L
          VV    I    SSSSS  UUUUU A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                    *****  S U M M A R Y   O U T P U T  *****


  Input   filename: C:\Program Files\Visual OTTHYMO 2.2.4\voin.dat

  Output  filename: C:\Users\jash\Desktop\Project Files\113238 - Oro-Medonte SWM Master Plan\CSWMM Report UPDATE - May
2015\2nd submission\O
  Summary filename: C:\Users\jash\Desktop\Project Files\113238 - Oro-Medonte SWM Master Plan\CSWMM Report UPDATE - May
2015\2nd submission\O


DATE: 10/26/2015                          TIME: 11:58:57 AM

USER:


COMMENTS: _____________________________________________________


  ****************************
  ** SIMULATION NUMBER:   1 ** 2 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha      cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                 5.0
      [ Ptot= 40.53 mm ]
*
  **  CALIB NASHYD       0100  1  5.0  835.70    1.82  9.33   5.13  .13    .000
      [CN=57.8         ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD       0101  1  5.0   96.09     .98  6.67   7.96  .20    .000
      [CN=69.2         ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD       0114  1  5.0  193.26     .82  7.42   5.61  .14    .000
      [CN=61.3         ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD       0115  1  5.0  170.62     .83  7.75   7.37  .18    .000
      [CN=69.3         ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD       0116  1  5.0  289.79     .96  8.50   6.37  .16    .000
      [CN=63.5         ]
      [ N = 3.0:Tp 2.01]
*
   *  CALIB STANDHYD     0200  1  5.0   89.02    1.82  6.17  12.24  .30    .000
      [I%=17.0:S%= 2.00]
*
   *  CALIB NASHYD       0201  1  5.0  255.45     .77  8.67   5.96  .15    .000
      [CN=63.2         ]
      [ N = 3.0:Tp 2.09]
*
   *  CALIB STANDHYD     0302  1  5.0   20.91     .98  6.08  19.50  .48    .000
      [I%=36.2:S%= 2.00]
*
   *  CALIB NASHYD       0303  1  5.0  611.79    1.31  9.17   4.88  .12    .000
      [CN=57.2         ]
      [ N = 3.0:Tp 2.51]
*
   *  CALIB STANDHYD     0304  1  5.0   46.90    1.18  6.08  13.24  .33    .000
      [I%=19.8:S%= 2.00]
*
   *  CALIB STANDHYD     0308  1  5.0   44.53    1.15  6.08  13.62  .34    .000
      [I%=20.3:S%= 2.00]
*
   *  CALIB STANDHYD     0320  1  5.0   46.41    1.44  6.08  15.10  .37    .000
      [I%=25.4:S%= 2.00]
*
   *  CALIB STANDHYD     0003  1  5.0   21.92     .74  6.08  14.48  .36    .000
      [I%=26.8:S%= 2.00]
*
   *  CALIB STANDHYD     0321  1  5.0   34.71    1.39  6.08  17.91  .44    .000
      [I%=32.5:S%= 2.00]
*
   *  CALIB NASHYD       0322  1  5.0  207.40     .49  8.92   5.02  .12    .000
      [CN=58.1         ]
      [ N = 3.0:Tp 2.28]
*
   *  CALIB NASHYD       0323  1  5.0  236.30    1.36  7.00   6.04  .15    .000
      [CN=63.4         ]
      [ N = 3.0:Tp  .88]
*
   *  CALIB NASHYD       0324  1  5.0  303.00    1.01  8.17   5.78  .14    .000
      [CN=62.3         ]
      [ N = 3.0:Tp 1.74]
*
   *  CALIB NASHYD       0325  1  5.0  156.62    1.03  6.83   5.78  .14    .000
      [CN=62.3         ]
      [ N = 3.0:Tp  .69]
*
   *  CALIB STANDHYD     5257  1  5.0   10.19     .39  6.00  16.54  .41    .000
      [I%=27.8:S%= 2.00]
*
   *  CALIB STANDHYD     0001  1  5.0    9.26     .28  6.00  12.28  .30    .000
      [I%=22.2:S%= 2.00]
*
   *  CALIB NASHYD       3269  1  5.0  124.61     .65  6.92   5.01  .12    .000
      [CN=57.3         ]
      [ N = 3.0:Tp  .78]
*
   *  CALIB NASHYD       0327  1  5.0  198.82     .57  8.50   5.53  .14    .000
      [CN=60.4         ]
      [ N = 3.0:Tp 2.01]
*
   *  CALIB NASHYD       0328  1  5.0  171.14     .93  6.92   5.35  .13    .000
      [CN=59.7         ]
      [ N = 3.0:Tp  .81]
*
   *  CALIB STANDHYD     0329  1  5.0  117.37    4.49  6.17  18.62  .46    .000
      [I%=37.0:S%= 2.00]
*
   *  CALIB NASHYD       3256  1  5.0   13.61     .16  6.33   6.74  .17    .000
      [CN=65.8         ]
      [ N = 3.0:Tp  .37]
*
   *  CALIB NASHYD       5254  1  5.0   11.03     .15  6.25   6.48  .16    .000
      [CN=62.9         ]
      [ N = 3.0:Tp  .28]
*
   *  CALIB NASHYD       3254  1  5.0   13.91     .22  6.42   9.20  .23    .000
      [CN=74.1         ]
      [ N = 3.0:Tp  .41]
*
   *  CALIB NASHYD       3255  1  5.0   53.36     .30  6.83   5.18  .13    .000
      [CN=58.4         ]
      [ N = 3.0:Tp  .75]
*
   *  CALIB STANDHYD     5255  1  5.0   25.03    1.01  6.08  17.00  .42    .000
      [I%=32.9:S%= 2.00]
*
   *  CALIB NASHYD       3250  1  5.0   43.70     .45  6.50   6.57  .16    .000
      [CN=64.8         ]
      [ N = 3.0:Tp  .45]
*
   *  CALIB NASHYD       5250  1  5.0   20.10     .10  6.83   4.53  .11    .000
      [CN=54.0         ]
      [ N = 3.0:Tp  .69]
*
   *  CALIB NASHYD       2306  1  5.0    4.18     .02  6.83   5.03  .12    .000
      [CN=54.8         ]
      [ N = 3.0:Tp  .77]
*
   *  CALIB NASHYD       0306  1  5.0  155.62     .69  7.58   6.31  .16    .000
      [CN=64.3         ]
      [ N = 3.0:Tp 1.32]
*
   *  CALIB NASHYD       0305  1  5.0  309.29     .68  9.25   5.10  .13    .000
      [CN=57.8         ]
      [ N = 3.0:Tp 2.55]
*
   *  CALIB NASHYD       0307  1  5.0  165.22     .49  7.92   4.79  .12    .000
      [CN=56.8         ]
      [ N = 3.0:Tp 1.56]
*
   *  CALIB STANDHYD     2310  1  5.0   22.21     .70  6.08  13.94  .34    .000
      [I%=25.0:S%= 2.00]
*
   *  CALIB NASHYD       0310  1  5.0  162.43     .49  8.17   5.27  .13    .000
      [CN=59.6         ]
      [ N = 3.0:Tp 1.74]
*
```

```
*   CALIB NASHYD      0301  1  5.0  186.26     .97  7.25   6.14  .15    .000
     [CN=63.9        ]
     [ N = 3.0:Tp 1.03]
*
*   CALIB NASHYD      2301  1  5.0   49.24     .35  7.00   7.27  .18    .000
     [CN=67.4        ]
     [ N = 3.0:Tp  .89]
*
*   CALIB NASHYD      2203  1  5.0    6.70     .07  6.42   5.86  .14    .000
     [CN=63.5        ]
     [ N = 3.0:Tp  .38]
*
*   CALIB NASHYD      0203  1  5.0   30.53     .16  7.00   5.37  .13    .000
     [CN=61.5        ]
     [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD      2204  1  5.0   15.92     .12  6.58   5.42  .13    .000
     [CN=61.5        ]
     [ N = 3.0:Tp  .51]
*
*   CALIB NASHYD      0204  1  5.0   13.66     .07  6.92   4.76  .12    .000
     [CN=55.5        ]
     [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD      0202  1  5.0  307.29     .84  8.67   5.44  .13    .000
     [CN=61.0        ]
     [ N = 3.0:Tp 2.08]
*
*   CALIB STANDHYD    2211  1  5.0   27.27     .61  6.08  11.67  .29    .000
     [I%=17.0:S%= 2.00]
*
*   CALIB NASHYD      0211  1  5.0   50.58     .32  7.08   6.83  .17    .000
     [CN=65.6        ]
     [ N = 3.0:Tp  .94]
*
*   CALIB NASHYD      0300  1  5.0     .88     .01  6.17   5.18  .13    .000
     [CN=60.7        ]
     [ N = 3.0:Tp  .18]
*
*   CALIB NASHYD      2300  1  5.0   30.27     .31  6.67   8.20  .20    .000
     [CN=69.2        ]
     [ N = 3.0:Tp  .63]
*
*   CALIB NASHYD      0103  1  5.0  223.30     .82  8.08   6.22  .15    .000
     [CN=62.2        ]
     [ N = 3.0:Tp 1.71]
*
*   CALIB STANDHYD    2025  1  5.0   10.24     .38  6.00  14.40  .36    .000
     [I%=28.0:S%= 2.00]
*
*   CALIB NASHYD      1025  1  5.0   35.23     .22  6.67   5.06  .12    .000
     [CN=59.0        ]
     [ N = 3.0:Tp  .60]
*
*   CALIB NASHYD      1028  1  5.0   32.85     .14  6.92   4.29  .11    .000
     [CN=56.4        ]
     [ N = 3.0:Tp  .78]
*
*   CALIB STANDHYD    2028  1  5.0    9.83     .40  6.00  15.08  .37    .000
     [I%=31.0:S%= 2.00]
*
*   CALIB NASHYD      1021  1  5.0   26.87     .09  7.00   3.29  .08    .000
     [CN=48.5        ]
     [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD      0105  1  5.0  509.25    1.28  8.25   4.48  .11    .000
     [CN=53.7        ]
     [ N = 3.0:Tp 1.81]
*
*   CALIB NASHYD      1045  1  5.0  188.03     .52  7.17   3.22  .08    .000
     [CN=45.6        ]
     [ N = 3.0:Tp  .98]
*
*   CALIB NASHYD      2045  1  5.0    8.17     .06  6.33   3.65  .09    .000
     [CN=45.2        ]
     [ N = 3.0:Tp  .34]
*
*   CALIB NASHYD      1047  1  5.0    6.75     .04  6.67   4.28  .11    .000
     [CN=50.3        ]
     [ N = 3.0:Tp  .59]
*
*   CALIB NASHYD      2041  1  5.0     .96     .01  6.33   4.43  .11    .000
     [CN=50.2        ]
     [ N = 3.0:Tp  .31]
*
*   CALIB NASHYD      2042  1  5.0     .87     .01  6.17   3.16  .08    .000
     [CN=44.1        ]
     [ N = 3.0:Tp  .20]
*
*   CALIB NASHYD      1040  1  5.0  452.51     .90  8.00   3.32  .08    .000
     [CN=47.7        ]
     [ N = 3.0:Tp 1.59]
*
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*   CALIB NASHYD      1041  1  5.0   76.98     .14  7.75   2.73  .07    .000
     [CN=41.6        ]
     [ N = 3.0:Tp 1.40]
*
*   CALIB NASHYD      0108  1  5.0  673.15    1.10 10.25   4.46  .11    .000
     [CN=54.7        ]
     [ N = 3.0:Tp 3.22]
*
*   CALIB NASHYD      1070  1  5.0  137.82     .46  7.50   4.61  .11    .000
     [CN=56.1        ]
     [ N = 3.0:Tp 1.26]
*
*   CALIB NASHYD      0106  1  5.0  814.51    1.40  9.42   4.12  .10    .000
     [CN=51.8        ]
     [ N = 3.0:Tp 2.69]
*
*   CALIB NASHYD      2071  1  5.0   16.86     .13  6.50   5.13  .13    .000
     [CN=55.6        ]
     [ N = 3.0:Tp  .46]
*
*   CALIB NASHYD      1071  1  5.0   28.72     .13  6.83   4.22  .10    .000
     [CN=51.4        ]
     [ N = 3.0:Tp  .73]
*
*   CALIB NASHYD      2076  1  5.0     .92     .01  6.33   5.89  .15    .000
     [CN=57.2        ]
     [ N = 3.0:Tp  .34]
*
*   CALIB NASHYD      1072  1  5.0     .71     .01  6.08   3.64  .09    .000
     [CN=47.6        ]
     [ N = 3.0:Tp  .13]
*
*   CALIB STANDHYD    2075  1  5.0    1.10     .08  6.00  22.17  .55    .000
     [I%=50.0:S%= 2.00]
*
*   CALIB NASHYD      1075  1  5.0   28.08     .10  7.00   3.87  .10    .000
     [CN=49.5        ]
     [ N = 3.0:Tp  .87]
*
*   CALIB NASHYD      0109  1  5.0  228.84     .36  8.67   3.13  .08    .000
     [CN=45.4        ]
     [ N = 3.0:Tp 2.06]
*
*   CALIB NASHYD      0111  1  5.0 1152.01    1.88 10.67   4.83  .12    .000
     [CN=56.8        ]
     [ N = 3.0:Tp 3.59]
*
*   CALIB STANDHYD    2110  1  5.0     .78     .05  6.00  21.46  .53    .000
     [I%=48.0:S%= 2.00]
*
*   CALIB NASHYD      0110  1  5.0   58.53     .25  7.08   4.67  .12    .000
     [CN=55.9        ]
     [ N = 3.0:Tp  .94]
*
*   CALIB NASHYD      0112  1  5.0   32.04     .10  7.42   4.00  .10    .000
     [CN=49.9        ]
     [ N = 3.0:Tp 1.20]
*
*   CALIB NASHYD      0113  1  5.0   23.58     .08  7.17   4.03  .10    .000
     [CN=52.0        ]
     [ N = 3.0:Tp  .95]
*
*   CALIB NASHYD      0318  1  5.0   12.69     .07  6.92   5.23  .13    .000
     [CN=58.2        ]
     [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD      0311  1  5.0  536.71    1.11  9.75   5.23  .13    .000
     [CN=58.4        ]
     [ N = 3.0:Tp 2.91]
*
*   CALIB NASHYD      0312  1  5.0   28.89     .16  7.00   5.65  .14    .000
     [CN=60.5        ]
     [ N = 3.0:Tp  .87]
*
*   CALIB NASHYD      0313  1  5.0  607.44     .92 10.42   4.30  .11    .000
     [CN=52.9        ]
     [ N = 3.0:Tp 3.38]
*
*   CALIB NASHYD      0317  1  5.0  278.29     .65  9.08   5.20  .13    .000
     [CN=58.7        ]
     [ N = 3.0:Tp 2.45]
*
*   CALIB NASHYD      0316  1  5.0  211.32     .50  8.75   4.80  .12    .000
     [CN=57.0        ]
     [ N = 3.0:Tp 2.14]
*
*   CALIB STANDHYD    5145  1  5.0    3.56     .23  6.00  20.90  .52    .000
     [I%=46.1:S%= 2.00]
*
*   CALIB NASHYD      3145  1  5.0  132.54     .36  7.83   4.14  .10    .000
     [CN=52.1        ]
     [ N = 3.0:Tp 1.46]
*
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   *   CALIB STANDHYD     5142  1  5.0    5.20     .26  6.00  18.64  .46    .000
       [I%=35.0:S%= 2.00]
   *
   *   CALIB STANDHYD     5141  1  5.0   29.18    1.18  6.08  16.93  .42    .000
       [I%=34.1:S%= 2.00]
   *
   *   CALIB NASHYD       5140  1  5.0  119.44     .42  7.58   4.99  .12    .000
       [CN=57.3        ]
       [ N = 3.0:Tp 1.33]
   *
   *   CALIB NASHYD       3141  1  5.0   85.39     .21  8.00   4.03  .10    .000
       [CN=52.3        ]
       [ N = 3.0:Tp 1.60]
   *
   *   CALIB NASHYD       0315  1  5.0  123.44     .40  7.75   4.98  .12    .000
       [CN=57.8        ]
       [ N = 3.0:Tp 1.44]
   *
   *   CALIB STANDHYD     2213  1  5.0     .88     .03  6.00  15.14  .37    .000
       [I%=24.4:S%= 2.00]
   *
   *   CALIB NASHYD       2212  1  5.0     .55     .01  6.17   4.85  .12    .000
       [CN=53.1        ]
       [ N = 3.0:Tp  .22]
   *
   *   CALIB STANDHYD     2210  1  5.0   23.61     .61  6.08  12.67  .31    .000
       [I%=19.5:S%= 2.00]
   *
   *   CALIB NASHYD       0205  1  5.0 3159.99    3.06 13.42   4.18  .10    .000
       [CN=52.3        ]
       [ N = 3.0:Tp 5.93]
   *
   *   CALIB NASHYD       0206  1  5.0   73.80     .37  7.25   6.05  .15    .000
       [CN=61.6        ]
       [ N = 3.0:Tp 1.10]
   *
   *   CALIB NASHYD       2206  1  5.0    3.51     .05  6.25   5.93  .15    .000
       [CN=63.5        ]
       [ N = 3.0:Tp  .25]
   *
   *   CALIB NASHYD       0207  1  5.0  315.33     .93  8.75   6.08  .15    .000
       [CN=62.7        ]
       [ N = 3.0:Tp 2.20]
   *
   *   CALIB NASHYD       2207  1  5.0   44.56     .18  7.42   5.34  .13    .000
       [CN=58.6        ]
       [ N = 3.0:Tp 1.19]
   *
   *   CALIB NASHYD       2269  1  5.0     .84     .01  6.25   5.31  .13    .000
       [CN=60.4        ]
       [ N = 3.0:Tp  .28]
   *
   *   CALIB NASHYD       0208  1  5.0   33.63     .22  7.08   6.79  .17    .000
       [CN=65.8        ]
       [ N = 3.0:Tp  .91]
   *
   *   CALIB NASHYD       2208  1  5.0     .69     .01  6.25   3.36  .08    .000
       [CN=49.0        ]
       [ N = 3.0:Tp  .23]
   *
   *   CALIB STANDHYD     2209  1  5.0     .57     .02  6.00  11.72  .29    .000
       [I%=18.8:S%= 2.00]
   *
   *   CALIB NASHYD       0209  1  5.0  295.05     .65  8.67   4.41  .11    .000
       [CN=53.9        ]
       [ N = 3.0:Tp 2.11]
   *
   *   CALIB NASHYD       0210  1  5.0   18.83     .09  7.25   5.62  .14    .000
       [CN=60.8        ]
       [ N = 3.0:Tp 1.09]
   *
   *   CALIB NASHYD       9262  1  5.0    7.50     .06  6.42   4.65  .11    .000
       [CN=55.7        ]
       [ N = 3.0:Tp  .40]
   *
   *   CALIB NASHYD       9263  1  5.0    2.35     .02  6.25   4.64  .11    .000
       [CN=55.7        ]
       [ N = 3.0:Tp  .25]
   *
   *   CALIB STANDHYD     5261  1  5.0   37.50    1.56  6.08  17.94  .44    .000
       [I%=35.0:S%= 2.00]
   *
   *   CALIB STANDHYD     5262  1  5.0    7.50     .36  6.00  17.93  .44    .000
       [I%=35.0:S%= 2.00]
   *
   *   CALIB NASHYD       3265  1  5.0   26.53     .16  6.67   4.65  .11    .000
       [CN=55.7        ]
       [ N = 3.0:Tp  .57]
   *
   *   CALIB STANDHYD     5263  1  5.0    2.35     .12  6.00  17.93  .44    .000
       [I%=35.0:S%= 2.00]
   *
   *   CALIB NASHYD       5260  1  5.0   54.55     .47  6.67   6.53  .16    .000
       [CN=63.8        ]
       [ N = 3.0:Tp  .58]
   *
   *   CALIB NASHYD       2001  1  5.0   19.92     .19  6.42   5.84  .14    .000
       [CN=62.2        ]
       [ N = 3.0:Tp  .42]
   *
   *   CALIB NASHYD       0309  1  5.0  157.12     .73  7.33   5.93  .15    .000
       [CN=63.0        ]
       [ N = 3.0:Tp 1.14]
   *
       ADD [5254 + 3254]  6254  3  5.0   24.94     .36  6.33   7.99  n/a    .000
   *
       ADD [6254 + 3255]  6255  3  5.0   78.30     .58  6.50   6.08  n/a    .000
   *
       ADD [6255 + 5255]  6256  3  5.0  103.33    1.34  6.17   8.72  n/a    .000
   *
       ADD [3250 + 5250]  6250  3  5.0   63.80     .54  6.50   5.93  n/a    .000
   *
       ADD [2306 + 0306]  6306  3  5.0  159.80     .71  7.58   6.27  n/a    .000
   *
       ADD [6306 + 0305]  6305  3  5.0  469.09    1.25  8.17   5.50  n/a    .000
   *
       ADD [6305 + 0307]  6307  3  5.0  634.31    1.74  8.08   5.31  n/a    .000
   *
       ADD [2310 + 0310]  6310  3  5.0  184.64     .73  6.08   6.31  n/a    .000
   *
       ADD [0301 + 2301]  6301  3  5.0  235.50    1.31  7.17   6.38  n/a    .000
   *
       ADD [2203 + 0203]  6203  3  5.0   37.23     .21  6.75   5.46  n/a    .000
   *
       ADD [2204 + 0204]  6204  3  5.0   29.58     .18  6.67   5.12  n/a    .000
   *
       ADD [2211 + 0211]  6211  3  5.0   77.85     .68  6.17   8.52  n/a    .000
   *
       ADD [0300 + 2300]  6300  3  5.0   31.15     .32  6.67   8.12  n/a    .000
   *
       ADD [2025 + 1025]  6025  3  5.0   45.47     .42  6.08   7.16  n/a    .000
   *
       ADD [1028 + 2028]  6028  3  5.0   42.68     .41  6.00   6.78  n/a    .000
   *
       ADD [1045 + 2045]  6045  3  5.0  196.20     .54  7.17   3.23  n/a    .000
   *
       ADD [6045 + 1047]  6047  3  5.0  202.95     .57  7.08   3.27  n/a    .000
   *
       ADD [2041 + 2042]  6042  3  5.0    1.83     .02  6.25   3.83  n/a    .000
   *
       ADD [1040 + 1041]  6040  3  5.0  529.49    1.04  8.00   3.23  n/a    .000
   *
       ADD [2071 + 1071]  6071  3  5.0   45.58     .25  6.67   4.56  n/a    .000
   *
       ADD [2075 + 1075]  6075  3  5.0   29.18     .11  7.00   4.56  n/a    .000
   *
       ADD [2110 + 0110]  6110  3  5.0   59.31     .25  7.08   4.89  n/a    .000
   *
       ADD [0311 + 0312]  7211  3  5.0  565.60    1.15  9.67   5.26  n/a    .000
   *
       ADD [7211 + 0313]  7212  3  5.0 1173.04    2.06 10.00   4.76  n/a    .000
   *
       ADD [5145 + 3145]  6145  3  5.0  136.10     .37  7.75   4.58  n/a    .000
   *
       RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .00 12.08   9.73  n/a    .000
       {ST=   .09 ha.m }
   *
       ADD [0030 + 5141]  7318  3  5.0   34.38    1.18  6.08  15.84  n/a    .000
   *
       ADD [7318 + 5140]  6140  3  5.0  153.82    1.22  6.08   7.42  n/a    .000
   *
       ADD [6140 + 3141]  6141  3  5.0  239.21    1.23  6.08   6.21  n/a    .000
   *
       ADD [2212 + 2210]  6212  3  5.0   24.16     .61  6.08  12.49  n/a    .000
   *
       ADD [0206 + 2206]  6206  3  5.0   77.31     .37  7.25   6.05  n/a    .000
   *
       ADD [0207 + 2207]  6207  3  5.0  359.89    1.06  8.50   5.99  n/a    .000
   *
       ADD [6207 + 2269]  7207  3  5.0  360.73    1.06  8.50   5.99  n/a    .000
   *
       ADD [2208 + 2209]  6209  3  5.0    1.26     .02  6.00   7.14  n/a    .000
   *
       RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .02 12.33   5.00  n/a    .000
       {ST=   .64 ha.m }
   *
       RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .08  6.67  17.91  n/a    .000
       {ST=   .06 ha.m }
   *
       RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .02  6.67  17.84  n/a    .000
       {ST=   .02 ha.m }
   *
       ADD [0070 + 5260]  6263  3  5.0   56.90     .49  6.67   7.00  n/a    .000
   *
       ADD [3256 + 6256]  6257  3  5.0  116.94    1.47  6.17   8.49  n/a    .000
   *
```

```
*     ADD [6203 + 6204]  6205  3  5.0   66.81     .39  6.75   5.31  n/a    .000
*     ADD [6025 + 6028]  6353  3  5.0   88.15     .83  6.00   6.98  n/a    .000
*     ADD [6042 + 6040]  6043  3  5.0  531.32    1.04  8.00   3.23  n/a    .000
*     ADD [0106 + 6071]  6106  3  5.0  860.09    1.45  9.42   4.14  n/a    .000
*     ADD [1072 + 6075]  6072  3  5.0   29.89     .11  7.00   4.53  n/a    .000
*     ADD [0111 + 6110]  6111  3  5.0 1211.32    1.94 10.58   4.83  n/a    .000
*     ADD [6145 + 6141]  6315  3  5.0  375.31    1.45  6.08   5.62  n/a    .000
*     ADD [0205 + 6206]  7205  3  5.0 3237.30    3.09 13.25   4.22  n/a    .000
*     ADD [7205 + 7207]  7208  3  5.0 3598.03    3.54 12.33   4.40  n/a    .000
*     ADD [0040 + 0060]  6265  3  5.0   45.00     .08  6.67   7.15  n/a    .000
*     ADD [6205 + 0202]  6202  3  5.0  374.10     .98  8.25   5.41  n/a    .000
*     ADD [6353 + 1021]  6021  3  5.0  115.02     .83  6.00   6.12  n/a    .000
*     ADD [6047 + 6043]  6048  3  5.0  734.27    1.52  7.58   3.24  n/a    .000
*     ADD [1070 + 6106]  6070  3  5.0  997.91    1.74  8.83   4.21  n/a    .000
*     ADD [2076 + 6072]  6076  3  5.0   30.81     .12  6.92   4.57  n/a    .000
*     ADD [6315 + 0315]  6316  3  5.0  498.75    1.52  7.67   5.46  n/a    .000
*     ADD [7208 + 0208]  6208  3  5.0 3631.66    3.57 12.25   4.42  n/a    .000
*     ADD [6265 + 3265]  7265  3  5.0   71.53     .24  6.67   6.22  n/a    .000
*     ADD [0103 + 6021]  6103  3  5.0  338.32    1.15  7.42   6.19  n/a    .000
*     ADD [0105 + 6048]  6105  3  5.0 1243.52    2.73  7.92   3.75  n/a    .000
*     ADD [6070 + 6076]  6077  3  5.0 1028.72    1.79  8.67   4.22  n/a    .000
*     ADD [0316 + 6316]  7316  3  5.0  710.07    1.95  7.92   5.26  n/a    .000
*     ADD [6208 + 6209]  6210  3  5.0 3632.92    3.57 12.25   4.42  n/a    .000
*     ADD [0108 + 6077]  6108  3  5.0 1701.87    2.80  9.33   4.32  n/a    .000
*     ADD [0317 + 7316]  6317  3  5.0  988.36    2.51  8.08   5.25  n/a    .000
*     ADD [6210 + 0209]  7209  3  5.0 3927.97    3.92 11.50   4.42  n/a    .000
*     ADD [6105 + 6108]  6115  3  5.0 2945.39    5.27  8.42   4.08  n/a    .000
*     ADD [7212 + 6317]  7213  3  5.0 2161.40    4.24  8.75   4.98  n/a    .000
*     ADD [7209 + 0210]  7210  3  5.0 3946.80    3.94 11.42   4.43  n/a    .000
*     ADD [6115 + 0109]  6109  3  5.0 3174.23    5.63  8.42   4.01  n/a    .000
*     ADD [0318 + 7213]  6318  3  5.0 2174.09    4.26  8.75   4.98  n/a    .000
*     ADD [6212 + 7210]  6213  3  5.0 3970.96    3.97 11.42   4.48  n/a    .000
*     ADD [6109 + 6111]  6358  3  5.0 4385.55    7.20  8.75   4.24  n/a    .000
*     ADD [2213 + 6213]  7317  3  5.0 3971.84    3.97 11.42   4.48  n/a    .000
*     ADD [6358 + 0112]  6112  3  5.0 4417.59    7.26  8.75   4.24  n/a    .000
*     ADD [6103 + 6112]  6113  3  5.0 4755.91    8.24  8.58   4.37  n/a    .000
*     ADD [6113 + 0113]  6361  3  5.0 4779.49    8.28  8.50   4.37  n/a    .000
  ****************************
  ** SIMULATION NUMBER:   2 ** 5 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                5.0
      [ Ptot= 55.81 mm ]
*
  **  CALIB NASHYD      0100  1  5.0  835.70    3.66  9.25  10.17  .18    .000
      [CN=57.8        ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD      0101  1  5.0   96.09    1.90  6.67  15.07  .27    .000
      [CN=69.2        ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD      0114  1  5.0  193.26    1.68  7.42  11.14  .20    .000
      [CN=61.3        ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD      0115  1  5.0  170.62    1.66  7.75  14.35  .26    .000
      [CN=69.3        ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD      0116  1  5.0  289.79    1.91  8.42  12.37  .22    .000
      [CN=63.5        ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD    0200  1  5.0   89.02    3.27  6.17  19.89  .36    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD      0201  1  5.0  255.45    1.55  8.58  11.80  .21    .000
      [CN=63.2        ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD    0302  1  5.0   20.91    1.48  6.00  29.25  .52    .000
      [I%=36.2:S%= 2.00]
*
  *   CALIB NASHYD      0303  1  5.0  611.79    2.67  9.08   9.78  .18    .000
      [CN=57.2        ]
      [ N = 3.0:Tp 2.51]
*
  *   CALIB STANDHYD    0304  1  5.0   46.90    1.95  6.17  21.11  .38    .000
      [I%=19.8:S%= 2.00]
*
  *   CALIB STANDHYD    0308  1  5.0   44.53    1.91  6.17  21.68  .39    .000
      [I%=20.3:S%= 2.00]
*
  *   CALIB STANDHYD    0320  1  5.0   46.41    2.27  6.08  23.43  .42    .000
      [I%=25.4:S%= 2.00]
*
  *   CALIB STANDHYD    0003  1  5.0   21.92    1.11  6.00  21.98  .39    .000
      [I%=26.8:S%= 2.00]
*
  *   CALIB STANDHYD    0321  1  5.0   34.71    2.13  6.08  27.09  .49    .000
      [I%=32.5:S%= 2.00]
*
  *   CALIB NASHYD      0322  1  5.0  207.40    1.00  8.83  10.04  .18    .000
      [CN=58.1        ]
      [ N = 3.0:Tp 2.28]
*
  *   CALIB NASHYD      0323  1  5.0  236.30    2.79  7.00  11.93  .21    .000
      [CN=63.4        ]
      [ N = 3.0:Tp  .88]
*
  *   CALIB NASHYD      0324  1  5.0  303.00    2.05  8.08  11.46  .21    .000
      [CN=62.3        ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD      0325  1  5.0  156.62    2.12  6.75  11.47  .21    .000
      [CN=62.3        ]
      [ N = 3.0:Tp  .69]
*
  *   CALIB STANDHYD    5257  1  5.0   10.19     .61  6.00  25.40  .46    .000
      [I%=27.8:S%= 2.00]
*
  *   CALIB STANDHYD    0001  1  5.0    9.26     .41  6.00  18.93  .34    .000
      [I%=22.2:S%= 2.00]
*
  *   CALIB NASHYD      3269  1  5.0  124.61    1.33  6.83   9.96  .18    .000
      [CN=57.3        ]
      [ N = 3.0:Tp  .78]
*
  *   CALIB NASHYD      0327  1  5.0  198.82    1.15  8.42  10.95  .20    .000
      [CN=60.4        ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB NASHYD      0328  1  5.0  171.14    1.91  6.92  10.64  .19    .000
      [CN=59.7        ]
      [ N = 3.0:Tp  .81]
*
  *   CALIB STANDHYD    0329  1  5.0  117.37    6.86  6.08  27.68  .50    .000
      [I%=37.0:S%= 2.00]
*
  *   CALIB NASHYD      3256  1  5.0   13.61     .33  6.33  13.11  .23    .000
      [CN=65.8        ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB NASHYD      5254  1  5.0   11.03     .30  6.25  12.43  .22    .000
      [CN=62.9        ]
      [ N = 3.0:Tp  .28]
*
  *   CALIB NASHYD      3254  1  5.0   13.91     .42  6.42  17.32  .31    .000
      [CN=74.1        ]
      [ N = 3.0:Tp  .41]
*
  *   CALIB NASHYD      3255  1  5.0   53.36     .61  6.83  10.29  .18    .000
      [CN=58.4        ]
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```
     [ N = 3.0:Tp  .75]
*
  *  CALIB STANDHYD     5255  1  5.0   25.03    1.52  6.00  25.48  .46    .000
     [I%=32.9:S%= 2.00]
*
  *  CALIB NASHYD       3250  1  5.0   43.70     .90  6.42  12.77  .23    .000
     [CN=64.8       ]
     [ N = 3.0:Tp  .45]
*
  *  CALIB NASHYD       5250  1  5.0   20.10     .21  6.75   9.02  .16    .000
     [CN=54.0       ]
     [ N = 3.0:Tp  .69]
*
  *  CALIB NASHYD       2306  1  5.0    4.18     .04  6.83   9.76  .17    .000
     [CN=54.8       ]
     [ N = 3.0:Tp  .77]
*
  *  CALIB NASHYD       0306  1  5.0  155.62    1.40  7.50  12.37  .22    .000
     [CN=64.3       ]
     [ N = 3.0:Tp 1.32]
*
  *  CALIB NASHYD       0305  1  5.0  309.29    1.38  9.17  10.11  .18    .000
     [CN=57.8       ]
     [ N = 3.0:Tp 2.55]
*
  *  CALIB NASHYD       0307  1  5.0  165.22    1.01  7.83   9.62  .17    .000
     [CN=56.8       ]
     [ N = 3.0:Tp 1.56]
*
  *  CALIB STANDHYD     2310  1  5.0   22.21    1.06  6.00  21.43  .38    .000
     [I%=25.0:S%= 2.00]
*
  *  CALIB NASHYD       0310  1  5.0  162.43    1.00  8.08  10.52  .19    .000
     [CN=59.6       ]
     [ N = 3.0:Tp 1.74]
*
  *  CALIB NASHYD       0301  1  5.0  186.26    1.98  7.17  12.11  .22    .000
     [CN=63.9       ]
     [ N = 3.0:Tp 1.03]
*
  *  CALIB NASHYD       2301  1  5.0   49.24     .69  7.00  13.98  .25    .000
     [CN=67.4       ]
     [ N = 3.0:Tp  .89]
*
  *  CALIB NASHYD       2203  1  5.0    6.70     .14  6.42  11.70  .21    .000
     [CN=63.5       ]
     [ N = 3.0:Tp  .38]
*
  *  CALIB NASHYD       0203  1  5.0   30.53     .34  6.92  10.85  .19    .000
     [CN=61.5       ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD       2204  1  5.0   15.92     .25  6.58  10.92  .20    .000
     [CN=61.5       ]
     [ N = 3.0:Tp  .51]
*
  *  CALIB NASHYD       0204  1  5.0   13.66     .14  6.92   9.46  .17    .000
     [CN=55.5       ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD       0202  1  5.0  307.29    1.72  8.58  10.88  .20    .000
     [CN=61.0       ]
     [ N = 3.0:Tp 2.08]
*
  *  CALIB STANDHYD     2211  1  5.0   27.27     .98  6.08  18.83  .34    .000
     [I%=17.0:S%= 2.00]
*
  *  CALIB NASHYD       0211  1  5.0   50.58     .63  7.08  13.19  .24    .000
     [CN=65.6       ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD       0300  1  5.0    .88     .03  6.17  10.50  .19    .000
     [CN=69.7       ]
     [ N = 3.0:Tp  .18]
*
  *  CALIB NASHYD       2300  1  5.0   30.27     .60  6.67  15.39  .28    .000
     [CN=69.2       ]
     [ N = 3.0:Tp  .63]
*
  *  CALIB NASHYD       0103  1  5.0  223.30    1.62  8.00  12.03  .22    .000
     [CN=62.2       ]
     [ N = 3.0:Tp 1.71]
*
  *  CALIB STANDHYD     2025  1  5.0   10.24     .56  6.00  21.72  .39    .000
     [I%=28.0:S%= 2.00]
*
  *  CALIB NASHYD       1025  1  5.0   35.23     .47  6.67  10.18  .18    .000
     [CN=59.0       ]
     [ N = 3.0:Tp  .60]
*
  *  CALIB NASHYD       1028  1  5.0   32.85     .31  6.92   8.91  .16    .000
     [CN=56.4       ]
     [ N = 3.0:Tp  .78]
```

```
*
  *  CALIB STANDHYD     2028  1  5.0    9.83     .58  6.00  22.38  .40    .000
     [I%=31.0:S%= 2.00]
*
  *  CALIB NASHYD       1021  1  5.0   26.87     .19  6.92   6.92  .12    .000
     [CN=48.5       ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD       0105  1  5.0  509.25    2.59  8.17   8.93  .16    .000
     [CN=53.7       ]
     [ N = 3.0:Tp 1.81]
*
  *  CALIB NASHYD       1045  1  5.0  188.03    1.10  7.17   6.60  .12    .000
     [CN=45.6       ]
     [ N = 3.0:Tp  .98]
*
  *  CALIB NASHYD       2045  1  5.0    8.17     .11  6.33   7.16  .13    .000
     [CN=45.2       ]
     [ N = 3.0:Tp  .34]
*
  *  CALIB NASHYD       1047  1  5.0    6.75     .07  6.67   8.38  .15    .000
     [CN=50.3       ]
     [ N = 3.0:Tp  .59]
*
  *  CALIB NASHYD       2041  1  5.0     .96     .02  6.25   8.57  .15    .000
     [CN=50.2       ]
     [ N = 3.0:Tp  .31]
*
  *  CALIB NASHYD       2042  1  5.0     .87     .01  6.17   6.41  .11    .000
     [CN=44.1       ]
     [ N = 3.0:Tp  .20]
*
  *  CALIB NASHYD       1040  1  5.0  452.51    1.93  7.92   6.89  .12    .000
     [CN=47.7       ]
     [ N = 3.0:Tp 1.59]
*
  *  CALIB NASHYD       1041  1  5.0   76.98     .30  7.67   5.67  .10    .000
     [CN=41.6       ]
     [ N = 3.0:Tp 1.40]
*
  *  CALIB NASHYD       0108  1  5.0  673.15    2.24 10.08   9.00  .16    .000
     [CN=54.7       ]
     [ N = 3.0:Tp 3.22]
*
  *  CALIB NASHYD       1070  1  5.0  137.82     .96  7.50   9.31  .17    .000
     [CN=56.1       ]
     [ N = 3.0:Tp 1.26]
*
  *  CALIB NASHYD       0106  1  5.0  814.51    2.85  9.33   8.29  .15    .000
     [CN=51.8       ]
     [ N = 3.0:Tp 2.69]
*
  *  CALIB NASHYD       2071  1  5.0   16.86     .26  6.50   9.96  .18    .000
     [CN=55.6       ]
     [ N = 3.0:Tp  .46]
*
  *  CALIB NASHYD       1071  1  5.0   28.72     .27  6.83   8.40  .15    .000
     [CN=51.4       ]
     [ N = 3.0:Tp  .73]
*
  *  CALIB NASHYD       2076  1  5.0     .92     .02  6.33  11.10  .20    .000
     [CN=57.2       ]
     [ N = 3.0:Tp  .34]
*
  *  CALIB NASHYD       1072  1  5.0     .71     .02  6.08   7.29  .13    .000
     [CN=47.6       ]
     [ N = 3.0:Tp  .13]
*
  *  CALIB STANDHYD     2075  1  5.0    1.10     .11  6.00  31.94  .57    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD       1075  1  5.0   28.08     .22  7.00   7.77  .14    .000
     [CN=49.5       ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD       0109  1  5.0  228.84     .76  8.58   6.47  .12    .000
     [CN=45.4       ]
     [ N = 3.0:Tp 2.06]
*
  *  CALIB NASHYD       0111  1  5.0 1152.01    3.81 10.58   9.67  .17    .000
     [CN=56.8       ]
     [ N = 3.0:Tp 3.59]
*
  *  CALIB STANDHYD     2110  1  5.0     .78     .08  6.00  31.02  .56    .000
     [I%=48.0:S%= 2.00]
*
  *  CALIB NASHYD       0110  1  5.0   58.53     .51  7.08   9.38  .17    .000
     [CN=55.9       ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD       0112  1  5.0   32.04     .20  7.42   7.98  .14    .000
     [CN=49.9       ]
     [ N = 3.0:Tp 1.20]
```

```
*
*   CALIB NASHYD       0113  1  5.0   23.58     .18  7.08   8.19  .15    .000
    [CN=52.0        ]
    [ N = 3.0:Tp  .95]
*
*   CALIB NASHYD       0318  1  5.0   12.69     .14  6.92  10.33  .19    .000
    [CN=58.2        ]
    [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD       0311  1  5.0  536.71    2.22  9.58  10.36  .19    .000
    [CN=58.4        ]
    [ N = 3.0:Tp 2.91]
*
*   CALIB NASHYD       0312  1  5.0   28.89     .32  7.00  11.11  .20    .000
    [CN=60.5        ]
    [ N = 3.0:Tp  .87]
*
*   CALIB NASHYD       0313  1  5.0  607.44    1.87 10.33   8.62  .15    .000
    [CN=52.9        ]
    [ N = 3.0:Tp 3.38]
*
*   CALIB NASHYD       0317  1  5.0  278.29    1.31  9.00  10.34  .19    .000
    [CN=58.7        ]
    [ N = 3.0:Tp 2.45]
*
*   CALIB NASHYD       0316  1  5.0  211.32    1.03  8.67   9.66  .17    .000
    [CN=57.0        ]
    [ N = 3.0:Tp 2.14]
*
*   CALIB STANDHYD     5145  1  5.0    3.56     .32  6.00  30.30  .54    .000
    [I%=46.1:S%= 2.00]
*
*   CALIB NASHYD       3145  1  5.0  132.54     .74  7.75   8.35  .15    .000
    [CN=52.1        ]
    [ N = 3.0:Tp 1.46]
*
*   CALIB STANDHYD     5142  1  5.0    5.20     .38  6.00  27.94  .50    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD     5141  1  5.0   29.18    1.78  6.00  25.23  .45    .000
    [I%=34.1:S%= 2.00]
*
*   CALIB NASHYD       5140  1  5.0  119.44     .85  7.58   9.93  .18    .000
    [CN=57.3        ]
    [ N = 3.0:Tp 1.33]
*
*   CALIB NASHYD       3141  1  5.0   85.39     .44  7.92   8.21  .15    .000
    [CN=52.3        ]
    [ N = 3.0:Tp 1.60]
*
*   CALIB NASHYD       0315  1  5.0  123.44     .83  7.67   9.96  .18    .000
    [CN=57.8        ]
    [ N = 3.0:Tp 1.44]
*
*   CALIB STANDHYD     2213  1  5.0     .88     .05  6.00  23.51  .42    .000
    [I%=24.4:S%= 2.00]
*
*   CALIB NASHYD       2212  1  5.0     .55     .01  6.17   9.37  .17    .000
    [CN=53.1        ]
    [ N = 3.0:Tp  .22]
*
*   CALIB STANDHYD     2210  1  5.0   23.61     .95  6.08  20.13  .36    .000
    [I%=19.5:S%= 2.00]
*
*   CALIB NASHYD       0205  1  5.0 3159.99    6.17 13.33   8.41  .15    .000
    [CN=52.3        ]
    [ N = 3.0:Tp 5.93]
*
*   CALIB NASHYD       0206  1  5.0   73.80     .73  7.25  11.75  .21    .000
    [CN=61.6        ]
    [ N = 3.0:Tp 1.10]
*
*   CALIB NASHYD       2206  1  5.0    3.51     .10  6.25  11.80  .21    .000
    [CN=63.5        ]
    [ N = 3.0:Tp  .25]
*
*   CALIB NASHYD       0207  1  5.0  315.33    1.86  8.67  11.91  .21    .000
    [CN=62.7        ]
    [ N = 3.0:Tp 2.20]
*
*   CALIB NASHYD       2207  1  5.0   44.56     .37  7.33  10.52  .19    .000
    [CN=58.6        ]
    [ N = 3.0:Tp 1.19]
*
*   CALIB NASHYD       2269  1  5.0     .84     .02  6.25  10.65  .19    .000
    [CN=60.4        ]
    [ N = 3.0:Tp  .28]
*
*   CALIB NASHYD       0208  1  5.0   33.63     .43  7.00  13.18  .24    .000
    [CN=65.8        ]
    [ N = 3.0:Tp  .91]
*
*   CALIB NASHYD       2208  1  5.0     .69     .01  6.25   7.03  .13    .000
    [CN=49.0        ]
    [ N = 3.0:Tp  .23]
*
*   CALIB STANDHYD     2209  1  5.0     .57     .03  6.00  18.69  .33    .000
    [I%=18.8:S%= 2.00]
*
*   CALIB NASHYD       0209  1  5.0  295.05    1.32  8.58   8.86  .16    .000
    [CN=53.9        ]
    [ N = 3.0:Tp 2.11]
*
*   CALIB NASHYD       0210  1  5.0   18.83     .18  7.25  11.09  .20    .000
    [CN=60.8        ]
    [ N = 3.0:Tp 1.09]
*
*   CALIB NASHYD       9262  1  5.0    7.50     .12  6.42   9.32  .17    .000
    [CN=55.7        ]
    [ N = 3.0:Tp  .40]
*
*   CALIB NASHYD       9263  1  5.0    2.35     .05  6.25   9.32  .17    .000
    [CN=55.7        ]
    [ N = 3.0:Tp  .25]
*
*   CALIB STANDHYD     5261  1  5.0   37.50    2.36  6.08  26.74  .48    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD     5262  1  5.0    7.50     .53  6.00  26.73  .48    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD       3265  1  5.0   26.53     .33  6.67   9.32  .17    .000
    [CN=55.7        ]
    [ N = 3.0:Tp  .57]
*
*   CALIB STANDHYD     5263  1  5.0    2.35     .18  6.00  26.73  .48    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD       5260  1  5.0   54.55     .92  6.67  12.61  .23    .000
    [CN=63.8        ]
    [ N = 3.0:Tp  .58]
*
*   CALIB NASHYD       2001  1  5.0   19.92     .38  6.42  11.53  .21    .000
    [CN=62.2        ]
    [ N = 3.0:Tp  .42]
*
*   CALIB NASHYD       0309  1  5.0  157.12    1.50  7.33  11.74  .21    .000
    [CN=63.0        ]
    [ N = 3.0:Tp 1.14]
*
    ADD [5254 + 3254]  6254  3  5.0   24.94     .70  6.33  15.16  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30    1.15  6.50  11.84  n/a    .000
*
    ADD [6255 + 5255]  6256  3  5.0  103.33    2.10  6.08  15.14  n/a    .000
*
    ADD [3250 + 5250]  6250  3  5.0   63.80    1.09  6.50  11.59  n/a    .000
*
    ADD [2306 + 0306]  6306  3  5.0  159.80    1.44  7.50  12.31  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    2.52  8.08  10.86  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31    3.53  8.00  10.54  n/a    .000
*
    ADD [2310 + 0310]  6310  3  5.0  184.64    1.12  6.08  11.83  n/a    .000
*
    ADD [0301 + 2301]  6301  3  5.0  235.50    2.65  7.17  12.51  n/a    .000
*
    ADD [2203 + 0203]  6203  3  5.0   37.23     .43  6.75  11.00  n/a    .000
*
    ADD [2204 + 0204]  6204  3  5.0   29.58     .38  6.67  10.24  n/a    .000
*
    ADD [2211 + 0211]  6211  3  5.0   77.85    1.11  6.08  15.17  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15     .61  6.67  15.25  n/a    .000
*
    ADD [2025 + 1025]  6025  3  5.0   45.47     .68  6.08  12.78  n/a    .000
*
    ADD [1028 + 2028]  6028  3  5.0   42.68     .62  6.00  12.02  n/a    .000
*
    ADD [1045 + 2045]  6045  3  5.0  196.20    1.14  7.08   6.62  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95    1.20  7.08   6.68  n/a    .000
*
    ADD [2041 + 2042]  6042  3  5.0    1.83     .03  6.25   7.55  n/a    .000
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    2.22  7.92   6.71  n/a    .000
*
    ADD [2071 + 1071]  6071  3  5.0   45.58     .51  6.58   8.98  n/a    .000
*
    ADD [2075 + 1075]  6075  3  5.0   29.18     .23  7.00   8.68  n/a    .000
*
    ADD [2110 + 0110]  6110  3  5.0   59.31     .52  7.08   9.66  n/a    .000
*
    ADD [0311 + 0312]  7211  3  5.0  565.60    2.30  9.50  10.40  n/a    .000
*
```

	ADD [7211 + 0313]	7212	3	5.0	1173.04	4.14	9.83	9.48	n/a	.000
*	ADD [5145 + 3145]	6145	3	5.0	136.10	.76	7.75	8.92	n/a	.000
*	RESRVR [2 : 5142] {ST= .11 ha.m }	0030	1	5.0	5.20	.02	8.50	18.85	n/a	.000
*	ADD [0030 + 5141]	7318	3	5.0	34.38	1.78	6.00	24.26	n/a	.000
*	ADD [7318 + 5140]	6140	3	5.0	153.82	1.84	6.00	13.13	n/a	.000
*	ADD [6140 + 3141]	6141	3	5.0	239.21	1.88	6.08	11.38	n/a	.000
*	ADD [2212 + 2210]	6212	3	5.0	24.16	.96	6.08	19.88	n/a	.000
*	ADD [0206 + 2206]	6206	3	5.0	77.31	.75	7.25	11.76	n/a	.000
*	ADD [0207 + 2207]	6207	3	5.0	359.89	2.13	8.42	11.73	n/a	.000
*	ADD [6207 + 2269]	7207	3	5.0	360.73	2.13	8.42	11.73	n/a	.000
*	ADD [2208 + 2209]	6209	3	5.0	1.26	.03	6.08	12.31	n/a	.000
*	RESRVR [2 : 5261] {ST= .96 ha.m }	0040	1	5.0	37.50	.02	12.42	13.80	n/a	.000
*	RESRVR [2 : 5262] {ST= .09 ha.m }	0060	1	5.0	7.50	.16	6.50	26.71	n/a	.000
*	RESRVR [2 : 5263] {ST= .03 ha.m }	0070	1	5.0	2.35	.05	6.58	26.64	n/a	.000
*	ADD [0070 + 5260]	6263	3	5.0	56.90	.97	6.67	13.19	n/a	.000
*	ADD [3256 + 6256]	6257	3	5.0	116.94	2.35	6.17	14.91	n/a	.000
*	ADD [6203 + 6204]	6205	3	5.0	66.81	.81	6.67	10.67	n/a	.000
*	ADD [6025 + 6028]	6353	3	5.0	88.15	1.29	6.08	12.41	n/a	.000
*	ADD [6042 + 6040]	6043	3	5.0	531.32	2.22	7.92	6.71	n/a	.000
*	ADD [0106 + 6071]	6106	3	5.0	860.09	2.94	9.25	8.33	n/a	.000
*	ADD [1072 + 6075]	6072	3	5.0	29.89	.23	6.92	8.65	n/a	.000
*	ADD [0111 + 6110]	6111	3	5.0	1211.32	3.92	10.50	9.67	n/a	.000
*	ADD [6145 + 6141]	6315	3	5.0	375.31	2.24	6.00	10.49	n/a	.000
*	ADD [0205 + 6206]	7205	3	5.0	3237.30	6.23	13.08	8.49	n/a	.000
*	ADD [7205 + 7207]	7208	3	5.0	3598.03	7.10	12.25	8.82	n/a	.000
*	ADD [0040 + 0060]	6265	3	5.0	45.00	.18	6.58	15.95	n/a	.000
*	ADD [6205 + 0202]	6202	3	5.0	374.10	2.01	8.17	10.84	n/a	.000
*	ADD [6353 + 1021]	6021	3	5.0	115.02	1.33	6.08	11.13	n/a	.000
*	ADD [6047 + 6043]	6048	3	5.0	734.27	3.23	7.58	6.70	n/a	.000
*	ADD [1070 + 6106]	6070	3	5.0	997.91	3.56	8.67	8.46	n/a	.000
*	ADD [2076 + 6072]	6076	3	5.0	30.81	.24	6.92	8.72	n/a	.000
*	ADD [6315 + 0315]	6316	3	5.0	498.75	3.06	7.67	10.36	n/a	.000
*	ADD [7208 + 0208]	6208	3	5.0	3631.66	7.15	12.17	8.86	n/a	.000
*	ADD [6265 + 3265]	7265	3	5.0	71.53	.51	6.58	13.49	n/a	.000
*	ADD [0103 + 6021]	6103	3	5.0	338.32	2.29	7.33	11.73	n/a	.000
*	ADD [0105 + 6048]	6105	3	5.0	1243.52	5.70	7.83	7.62	n/a	.000
*	ADD [6070 + 6076]	6077	3	5.0	1028.72	3.66	8.58	8.47	n/a	.000
*	ADD [0316 + 6316]	7316	3	5.0	710.07	3.96	7.83	10.15	n/a	.000
*	ADD [6208 + 6209]	6210	3	5.0	3632.92	7.15	12.17	8.86	n/a	.000
*	ADD [0108 + 6077]	6108	3	5.0	1701.87	5.70	9.17	8.68	n/a	.000
*	ADD [0317 + 7316]	6317	3	5.0	988.36	5.09	8.00	10.20	n/a	.000
*	ADD [6210 + 0209]	7209	3	5.0	3927.97	7.85	11.33	8.86	n/a	.000
*	ADD [6105 + 6108]	6115	3	5.0	2945.39	10.88	8.33	8.23	n/a	.000
*	ADD [7212 + 6317]	7213	3	5.0	2161.40	8.59	8.67	9.81	n/a	.000
*	ADD [7209 + 0210]	7210	3	5.0	3946.80	7.89	11.25	8.87	n/a	.000
*	ADD [6115 + 0109]	6109	3	5.0	3174.23	11.63	8.33	8.10	n/a	.000
*	ADD [0318 + 7213]	6318	3	5.0	2174.09	8.64	8.67	9.81	n/a	.000
*	ADD [6212 + 7210]	6213	3	5.0	3970.96	7.93	11.25	8.94	n/a	.000
*	ADD [6109 + 6111]	6358	3	5.0	4385.55	14.78	8.67	8.54	n/a	.000
*	ADD [2213 + 6213]	7317	3	5.0	3971.84	7.93	11.25	8.94	n/a	.000
*	ADD [6358 + 0112]	6112	3	5.0	4417.59	14.92	8.67	8.53	n/a	.000
*	ADD [6103 + 6112]	6113	3	5.0	4755.91	16.85	8.42	8.76	n/a	.000
*	ADD [6113 + 0113]	6361	3	5.0	4779.49	16.95	8.42	8.76	n/a	.000

****
** SIMULATION NUMBER: 3 ** 10 yr 12 hr SCS
****

W/E	COMMAND	HYD ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs								

	MASS STORM		5.0						
	[Ptot= 65.99 mm]								
**	CALIB NASHYD [CN=57.8] [N = 3.0:Tp 2.64]	0100 1	5.0	835.70	5.15	9.25	14.24	.22	.000
**	CALIB NASHYD [CN=69.2] [N = 3.0:Tp .61]	0101 1	5.0	96.09	2.63	6.67	20.62	.31	.000
**	CALIB NASHYD [CN=61.3] [N = 3.0:Tp 1.20]	0114 1	5.0	193.26	2.39	7.33	15.58	.24	.000
**	CALIB NASHYD [CN=69.3] [N = 3.0:Tp 1.46]	0115 1	5.0	170.62	2.33	7.67	19.82	.30	.000
**	CALIB NASHYD [CN=63.5] [N = 3.0:Tp 2.01]	0116 1	5.0	289.79	2.66	8.42	17.14	.26	.000
*	CALIB STANDHYD [I%=17.0:S%= 2.00]	0200 1	5.0	89.02	4.28	6.17	25.62	.39	.000
*	CALIB NASHYD [CN=63.2] [N = 3.0:Tp 2.09]	0201 1	5.0	255.45	2.18	8.50	16.47	.25	.000
*	CALIB STANDHYD [I%=36.2:S%= 2.00]	0302 1	5.0	20.91	1.83	6.00	36.22	.55	.000
*	CALIB NASHYD [CN=57.2] [N = 3.0:Tp 2.51]	0303 1	5.0	611.79	3.79	9.08	13.76	.21	.000
*	CALIB STANDHYD [I%=19.8:S%= 2.00]	0304 1	5.0	46.90	2.51	6.17	26.96	.41	.000
*	CALIB STANDHYD [I%=20.3:S%= 2.00]	0308 1	5.0	44.53	2.46	6.17	27.65	.42	.000
*	CALIB STANDHYD [I%=25.4:S%= 2.00]	0320 1	5.0	46.41	2.86	6.08	29.52	.45	.000
*	CALIB STANDHYD [I%=26.8:S%= 2.00]	0003 1	5.0	21.92	1.40	6.00	27.44	.42	.000
*	CALIB STANDHYD [I%=32.5:S%= 2.00]	0321 1	5.0	34.71	2.70	6.08	33.70	.51	.000
*	CALIB NASHYD [CN=58.1] [N = 3.0:Tp 2.28]	0322 1	5.0	207.40	1.41	8.75	14.11	.21	.000
*	CALIB NASHYD [CN=63.4] [N = 3.0:Tp .88]	0323 1	5.0	236.30	3.94	7.00	16.63	.25	.000
*	CALIB NASHYD [CN=62.3] [N = 3.0:Tp 1.74]	0324 1	5.0	303.00	2.90	8.08	16.02	.24	.000
*	CALIB NASHYD [CN=62.3] [N = 3.0:Tp .69]	0325 1	5.0	156.62	3.00	6.75	16.03	.24	.000

```
*
*   CALIB STANDHYD     5257  1  5.0   10.19     .75  6.00  31.83  .48    .000
    [I%=27.8:S%= 2.00]
*
*   CALIB STANDHYD     0001  1  5.0    9.26     .52  6.00  23.83  .36    .000
    [I%=22.2:S%= 2.00]
*
*   CALIB NASHYD       3269  1  5.0  124.61    1.89  6.83  13.97  .21    .000
    [CN=57.3       ]
    [ N = 3.0:Tp  .78]
*
*   CALIB NASHYD       0327  1  5.0  198.82    1.62  8.42  15.30  .23    .000
    [CN=60.4       ]
    [ N = 3.0:Tp 2.01]
*
*   CALIB NASHYD       0328  1  5.0  171.14    2.71  6.92  14.90  .23    .000
    [CN=59.7       ]
    [ N = 3.0:Tp  .81]
*
*   CALIB STANDHYD     0329  1  5.0  117.37    8.68  6.08  34.15  .52    .000
    [I%=37.0:S%= 2.00]
*
*   CALIB NASHYD       3256  1  5.0   13.61     .46  6.33  18.14  .27    .000
    [CN=65.8       ]
    [ N = 3.0:Tp  .37]
*
*   CALIB NASHYD       5254  1  5.0   11.03     .42  6.25  17.16  .26    .000
    [CN=62.9       ]
    [ N = 3.0:Tp  .28]
*
*   CALIB NASHYD       3254  1  5.0   13.91     .58  6.42  23.55  .36    .000
    [CN=74.1       ]
    [ N = 3.0:Tp  .41]
*
*   CALIB NASHYD       3255  1  5.0   53.36     .86  6.83  14.41  .22    .000
    [CN=58.4       ]
    [ N = 3.0:Tp  .75]
*
*   CALIB STANDHYD     5255  1  5.0   25.03    1.91  6.00  31.58  .48    .000
    [I%=32.9:S%= 2.00]
*
*   CALIB NASHYD       3250  1  5.0   43.70    1.26  6.42  17.69  .27    .000
    [CN=64.8       ]
    [ N = 3.0:Tp  .45]
*
*   CALIB NASHYD       5250  1  5.0   20.10     .30  6.75  12.68  .19    .000
    [CN=54.0       ]
    [ N = 3.0:Tp  .69]
*
*   CALIB NASHYD       2306  1  5.0    4.18     .06  6.83  13.58  .21    .000
    [CN=54.8       ]
    [ N = 3.0:Tp  .77]
*
*   CALIB NASHYD       0306  1  5.0  155.62    1.97  7.50  17.20  .26    .000
    [CN=64.3       ]
    [ N = 3.0:Tp 1.32]
*
*   CALIB NASHYD       0305  1  5.0  309.29    1.95  9.08  14.17  .21    .000
    [CN=57.8       ]
    [ N = 3.0:Tp 2.55]
*
*   CALIB NASHYD       0307  1  5.0  165.22    1.44  7.83  13.55  .21    .000
    [CN=56.8       ]
    [ N = 3.0:Tp 1.56]
*
*   CALIB STANDHYD     2310  1  5.0   22.21    1.35  6.08  26.92  .41    .000
    [I%=25.0:S%= 2.00]
*
*   CALIB NASHYD       0310  1  5.0  162.43    1.42  8.08  14.76  .22    .000
    [CN=59.6       ]
    [ N = 3.0:Tp 1.74]
*
*   CALIB NASHYD       0301  1  5.0  186.26    2.80  7.17  16.88  .26    .000
    [CN=63.9       ]
    [ N = 3.0:Tp 1.03]
*
*   CALIB NASHYD       2301  1  5.0   49.24     .95  7.00  19.26  .29    .000
    [CN=67.4       ]
    [ N = 3.0:Tp  .89]
*
*   CALIB NASHYD       2203  1  5.0    6.70     .20  6.33  16.38  .25    .000
    [CN=63.5       ]
    [ N = 3.0:Tp  .38]
*
*   CALIB NASHYD       0203  1  5.0   30.53     .49  6.92  15.27  .23    .000
    [CN=61.5       ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD       2204  1  5.0   15.92     .36  6.50  15.35  .23    .000
    [CN=61.5       ]
    [ N = 3.0:Tp  .51]
*
*   CALIB NASHYD       0204  1  5.0   13.66     .20  6.83  13.28  .20    .000
    [CN=55.5       ]
    [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD       0202  1  5.0  307.29    2.43  8.50  15.27  .23    .000
    [CN=61.0       ]
    [ N = 3.0:Tp 2.08]
*
*   CALIB STANDHYD     2211  1  5.0   27.27    1.34  6.08  24.20  .37    .000
    [I%=17.0:S%= 2.00]
*
*   CALIB NASHYD       0211  1  5.0   50.58     .88  7.08  18.22  .28    .000
    [CN=65.6       ]
    [ N = 3.0:Tp  .94]
*
*   CALIB NASHYD       0300  1  5.0     .88     .04  6.17  14.80  .22    .000
    [CN=60.7       ]
    [ N = 3.0:Tp  .18]
*
*   CALIB NASHYD       2300  1  5.0   30.27     .83  6.67  20.97  .32    .000
    [CN=69.2       ]
    [ N = 3.0:Tp  .63]
*
*   CALIB NASHYD       0103  1  5.0  223.30    2.26  8.00  16.66  .25    .000
    [CN=62.2       ]
    [ N = 3.0:Tp 1.71]
*
*   CALIB STANDHYD     2025  1  5.0   10.24     .70  6.00  27.02  .41    .000
    [I%=28.0:S%= 2.00]
*
*   CALIB NASHYD       1025  1  5.0   35.23     .66  6.67  14.34  .22    .000
    [CN=59.0       ]
    [ N = 3.0:Tp  .60]
*
*   CALIB NASHYD       1028  1  5.0   32.85     .45  6.92  12.71  .19    .000
    [CN=56.4       ]
    [ N = 3.0:Tp  .78]
*
*   CALIB STANDHYD     2028  1  5.0    9.83     .71  6.00  27.63  .42    .000
    [I%=31.0:S%= 2.00]
*
*   CALIB NASHYD       1021  1  5.0   26.87     .27  6.92   9.94  .15    .000
    [CN=48.5       ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD       0105  1  5.0  509.25    3.68  8.17  12.56  .19    .000
    [CN=53.7       ]
    [ N = 3.0:Tp 1.81]
*
*   CALIB NASHYD       1045  1  5.0  188.03    1.59  7.08   9.41  .14    .000
    [CN=45.6       ]
    [ N = 3.0:Tp  .98]
*
*   CALIB NASHYD       2045  1  5.0    8.17     .16  6.33  10.04  .15    .000
    [CN=45.2       ]
    [ N = 3.0:Tp  .34]
*
*   CALIB NASHYD       1047  1  5.0    6.75     .10  6.67  11.73  .18    .000
    [CN=50.3       ]
    [ N = 3.0:Tp  .59]
*
*   CALIB NASHYD       2041  1  5.0     .96     .02  6.25  11.94  .18    .000
    [CN=50.2       ]
    [ N = 3.0:Tp  .31]
*
*   CALIB NASHYD       2042  1  5.0     .87     .02  6.17   9.12  .14    .000
    [CN=44.1       ]
    [ N = 3.0:Tp  .20]
*
*   CALIB NASHYD       1040  1  5.0  452.51    2.79  7.92   9.86  .15    .000
    [CN=47.7       ]
    [ N = 3.0:Tp 1.59]
*
*   CALIB NASHYD       1041  1  5.0   76.98     .43  7.67   8.14  .12    .000
    [CN=41.6       ]
    [ N = 3.0:Tp 1.40]
*
*   CALIB NASHYD       0108  1  5.0  673.15    3.17 10.00  12.70  .19    .000
    [CN=54.7       ]
    [ N = 3.0:Tp 3.22]
*
*   CALIB NASHYD       1070  1  5.0  137.82    1.37  7.42  13.15  .20    .000
    [CN=56.1       ]
    [ N = 3.0:Tp 1.26]
*
*   CALIB NASHYD       0106  1  5.0  814.51    4.05  9.33  11.71  .18    .000
    [CN=51.8       ]
    [ N = 3.0:Tp 2.69]
*
*   CALIB NASHYD       2071  1  5.0   16.86     .37  6.50  13.85  .21    .000
    [CN=55.6       ]
    [ N = 3.0:Tp  .46]
*
*   CALIB NASHYD       1071  1  5.0   28.72     .38  6.83  11.81  .18    .000
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     [CN=51.4          ]
     [ N = 3.0:Tp  .73]
*
   *  CALIB NASHYD       2076  1  5.0     .92     .03  6.33  15.25  .23    .000
     [CN=57.2          ]
     [ N = 3.0:Tp  .34]
*
   *  CALIB NASHYD       1072  1  5.0     .71     .02  6.08  10.30  .16    .000
     [CN=47.6          ]
     [ N = 3.0:Tp  .13]
*
   *  CALIB STANDHYD     2075  1  5.0    1.10     .14  6.00  38.75  .59    .000
     [I%=50.0:S%= 2.00]
*
   *  CALIB NASHYD       1075  1  5.0   28.08     .31  7.00  10.98  .17    .000
     [CN=49.5          ]
     [ N = 3.0:Tp  .87]
*
   *  CALIB NASHYD       0109  1  5.0  228.84    1.09  8.50   9.26  .14    .000
     [CN=45.4          ]
     [ N = 3.0:Tp 2.06]
*
   *  CALIB NASHYD       0111  1  5.0 1152.01    5.37 10.50  13.61  .21    .000
     [CN=56.8          ]
     [ N = 3.0:Tp 3.59]
*
   *  CALIB STANDHYD     2110  1  5.0     .78     .09  6.00  37.70  .57    .000
     [I%=48.0:S%= 2.00]
*
   *  CALIB NASHYD       0110  1  5.0   58.53     .73  7.08  13.21  .20    .000
     [CN=55.9          ]
     [ N = 3.0:Tp  .94]
*
   *  CALIB NASHYD       0112  1  5.0   32.04     .28  7.33  11.25  .17    .000
     [CN=49.9          ]
     [ N = 3.0:Tp 1.20]
*
   *  CALIB NASHYD       0113  1  5.0   23.58     .26  7.08  11.61  .18    .000
     [CN=52.0          ]
     [ N = 3.0:Tp  .95]
*
   *  CALIB NASHYD       0318  1  5.0   12.69     .20  6.83  14.45  .22    .000
     [CN=58.2          ]
     [ N = 3.0:Tp  .79]
*
   *  CALIB NASHYD       0311  1  5.0  536.71    3.13  9.58  14.49  .22    .000
     [CN=58.4          ]
     [ N = 3.0:Tp 2.91]
*
   *  CALIB NASHYD       0312  1  5.0   28.89     .45  7.00  15.50  .23    .000
     [CN=60.5          ]
     [ N = 3.0:Tp  .87]
*
   *  CALIB NASHYD       0313  1  5.0  607.44    2.64 10.25  12.16  .18    .000
     [CN=52.9          ]
     [ N = 3.0:Tp 3.38]
*
   *  CALIB NASHYD       0317  1  5.0  278.29    1.85  9.00  14.49  .22    .000
     [CN=58.7          ]
     [ N = 3.0:Tp 2.45]
*
   *  CALIB NASHYD       0316  1  5.0  211.32    1.46  8.58  13.60  .21    .000
     [CN=57.0          ]
     [ N = 3.0:Tp 2.14]
*
   *  CALIB STANDHYD     5145  1  5.0    3.56     .39  6.00  36.89  .56    .000
     [I%=46.1:S%= 2.00]
*
   *  CALIB NASHYD       3145  1  5.0  132.54    1.05  7.67  11.80  .18    .000
     [CN=52.1          ]
     [ N = 3.0:Tp 1.46]
*
   *  CALIB STANDHYD     5142  1  5.0    5.20     .47  6.00  34.60  .52    .000
     [I%=35.0:S%= 2.00]
*
   *  CALIB STANDHYD     5141  1  5.0   29.18    2.18  6.00  31.18  .47    .000
     [I%=34.1:S%= 2.00]
*
   *  CALIB NASHYD       5140  1  5.0  119.44    1.21  7.50  13.93  .21    .000
     [CN=57.3          ]
     [ N = 3.0:Tp 1.33]
*
   *  CALIB NASHYD       3141  1  5.0   85.39     .62  7.92  11.65  .18    .000
     [CN=52.3          ]
     [ N = 3.0:Tp 1.60]
*
   *  CALIB NASHYD       0315  1  5.0  123.44    1.18  7.67  14.00  .21    .000
     [CN=57.8          ]
     [ N = 3.0:Tp 1.44]
*
   *  CALIB STANDHYD     2213  1  5.0     .88     .07  6.00  29.64  .45    .000
     [I%=24.4:S%= 2.00]
*
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   *  CALIB NASHYD       2212  1  5.0     .55     .02  6.17  13.02  .20    .000
     [CN=53.1          ]
     [ N = 3.0:Tp  .22]
*
   *  CALIB STANDHYD     2210  1  5.0   23.61    1.28  6.08  25.68  .39    .000
     [I%=19.5:S%= 2.00]
*
   *  CALIB NASHYD       0205  1  5.0 3159.99    8.72 13.25  11.88  .18    .000
     [CN=52.3          ]
     [ N = 3.0:Tp 5.93]
*
   *  CALIB NASHYD       0206  1  5.0   73.80    1.02  7.25  16.30  .25    .000
     [CN=61.6          ]
     [ N = 3.0:Tp 1.10]
*
   *  CALIB NASHYD       2206  1  5.0    3.51     .14  6.25  16.49  .25    .000
     [CN=63.5          ]
     [ N = 3.0:Tp  .25]
*
   *  CALIB NASHYD       0207  1  5.0  315.33    2.61  8.67  16.55  .25    .000
     [CN=62.7          ]
     [ N = 3.0:Tp 2.20]
*
   *  CALIB NASHYD       2207  1  5.0   44.56     .52  7.33  14.69  .22    .000
     [CN=58.6          ]
     [ N = 3.0:Tp 1.19]
*
   *  CALIB NASHYD       2269  1  5.0     .84     .03  6.25  14.97  .23    .000
     [CN=60.4          ]
     [ N = 3.0:Tp  .28]
*
   *  CALIB NASHYD       0208  1  5.0   33.63     .61  7.00  18.23  .28    .000
     [CN=65.8          ]
     [ N = 3.0:Tp  .91]
*
   *  CALIB NASHYD       2208  1  5.0     .69     .02  6.25  10.10  .15    .000
     [CN=49.0          ]
     [ N = 3.0:Tp  .23]
*
   *  CALIB STANDHYD     2209  1  5.0     .57     .03  6.00  23.90  .36    .000
     [I%=18.8:S%= 2.00]
*
   *  CALIB NASHYD       0209  1  5.0  295.05    1.88  8.58  12.49  .19    .000
     [CN=53.9          ]
     [ N = 3.0:Tp 2.11]
*
   *  CALIB NASHYD       0210  1  5.0   18.83     .25  7.25  15.49  .23    .000
     [CN=60.8          ]
     [ N = 3.0:Tp 1.09]
*
   *  CALIB NASHYD       9262  1  5.0    7.50     .17  6.42  13.13  .20    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .40]
*
   *  CALIB NASHYD       9263  1  5.0    2.35     .07  6.25  13.12  .20    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .25]
*
   *  CALIB STANDHYD     5261  1  5.0   37.50    2.94  6.08  33.03  .50    .000
     [I%=35.0:S%= 2.00]
*
   *  CALIB STANDHYD     5262  1  5.0    7.50     .65  6.00  33.03  .50    .000
     [I%=35.0:S%= 2.00]
*
   *  CALIB NASHYD       3265  1  5.0   26.53     .47  6.58  13.13  .20    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .57]
*
   *  CALIB STANDHYD     5263  1  5.0    2.35     .21  6.00  33.03  .50    .000
     [I%=35.0:S%= 2.00]
*
   *  CALIB NASHYD       5260  1  5.0   54.55    1.29  6.58  17.43  .26    .000
     [CN=63.8          ]
     [ N = 3.0:Tp  .58]
*
   *  CALIB NASHYD       2001  1  5.0   19.92     .54  6.42  16.09  .24    .000
     [CN=62.2          ]
     [ N = 3.0:Tp  .42]
*
   *  CALIB NASHYD       0309  1  5.0  157.12    2.12  7.33  16.39  .25    .000
     [CN=63.0          ]
     [ N = 3.0:Tp 1.14]
*
     ADD [5254 + 3254]  6254  3  5.0   24.94     .97  6.33  20.72  n/a    .000
*
     ADD [6254 + 3255]  6255  3  5.0   78.30    1.61  6.50  16.42  n/a    .000
*
     ADD [6255 + 5255]  6256  3  5.0  103.33    2.79  6.17  20.09  n/a    .000
*
     ADD [3250 + 5250]  6250  3  5.0   63.80    1.53  6.50  16.11  n/a    .000
*
     ADD [2306 + 0306]  6306  3  5.0  159.80    2.02  7.50  17.11  n/a    .000
*
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*    ADD [6306 + 0305]  6305  3  5.0  469.09    3.56  8.08  15.17  n/a    .000
*    ADD [6305 + 0307]  6307  3  5.0  634.31    4.98  8.00  14.75  n/a    .000
*    ADD [2310 + 0310]  6310  3  5.0  184.64    1.56  8.00  16.22  n/a    .000
*    ADD [0301 + 2301]  6301  3  5.0  235.50    3.73  7.08  17.37  n/a    .000
*    ADD [2203 + 0203]  6203  3  5.0   37.23     .62  6.75  15.47  n/a    .000
*    ADD [2204 + 0204]  6204  3  5.0   29.58     .54  6.67  14.39  n/a    .000
*    ADD [2211 + 0211]  6211  3  5.0   77.85    1.57  6.17  20.31  n/a    .000
*    ADD [0300 + 2300]  6300  3  5.0   31.15     .84  6.67  20.80  n/a    .000
*    ADD [2025 + 1025]  6025  3  5.0   45.47     .90  6.08  17.19  n/a    .000
*    ADD [1028 + 2028]  6028  3  5.0   42.68     .78  6.00  16.15  n/a    .000
*    ADD [1045 + 2045]  6045  3  5.0  196.20    1.65  7.08   9.44  n/a    .000
*    ADD [6045 + 1047]  6047  3  5.0  202.95    1.73  7.00   9.51  n/a    .000
*    ADD [2041 + 2042]  6042  3  5.0    1.83     .04  6.25  10.60  n/a    .000
*    ADD [1040 + 1041]  6040  3  5.0  529.49    3.21  7.83   9.61  n/a    .000
*    ADD [2071 + 1071]  6071  3  5.0   45.58     .72  6.58  12.57  n/a    .000
*    ADD [2075 + 1075]  6075  3  5.0   29.18     .32  6.92  12.03  n/a    .000
*    ADD [2110 + 0110]  6110  3  5.0   59.31     .74  7.08  13.53  n/a    .000
*    ADD [0311 + 0312]  7211  3  5.0  565.60    3.24  9.42  14.54  n/a    .000
*    ADD [7211 + 0313]  7212  3  5.0 1173.04    5.83  9.83  13.31  n/a    .000
*    ADD [5145 + 3145]  6145  3  5.0  136.10    1.08  7.67  12.45  n/a    .000
     RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .03  8.25  25.44  n/a    .000
     {ST=   .14 ha.m }
*    ADD [0030 + 5141]  7318  3  5.0   34.38    2.18  6.00  30.31  n/a    .000
*    ADD [7318 + 5140]  6140  3  5.0  153.82    2.29  6.08  17.59  n/a    .000
*    ADD [6140 + 3141]  6141  3  5.0  239.21    2.35  6.08  15.47  n/a    .000
*    ADD [2212 + 2210]  6212  3  5.0   24.16    1.29  6.08  25.39  n/a    .000
*    ADD [0206 + 2206]  6206  3  5.0   77.31    1.04  7.25  16.31  n/a    .000
*    ADD [0207 + 2207]  6207  3  5.0  359.89    2.98  8.42  16.32  n/a    .000
*    ADD [6207 + 2269]  7207  3  5.0  360.73    2.99  8.42  16.32  n/a    .000
*    ADD [2208 + 2209]  6209  3  5.0    1.26     .04  6.08  16.34  n/a    .000
     RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .05 12.17  20.09  n/a    .000
     {ST=  1.15 ha.m }
     RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .22  6.50  33.01  n/a    .000
     {ST=   .10 ha.m }
     RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .06  6.50  32.94  n/a    .000
     {ST=   .03 ha.m }
*    ADD [0070 + 5260]  6263  3  5.0   56.90    1.35  6.58  18.07  n/a    .000
*    ADD [3256 + 6256]  6257  3  5.0  116.94    3.17  6.17  19.87  n/a    .000
*    ADD [6203 + 6204]  6205  3  5.0   66.81    1.16  6.67  14.99  n/a    .000
*    ADD [6025 + 6028]  6353  3  5.0   88.15    1.67  6.08  16.69  n/a    .000
*    ADD [6042 + 6040]  6043  3  5.0  531.32    3.22  7.83   9.61  n/a    .000
*    ADD [0106 + 6071]  6106  3  5.0  860.09    4.18  9.25  11.76  n/a    .000
*    ADD [1072 + 6075]  6072  3  5.0   29.89     .32  6.92  11.99  n/a    .000
*    ADD [0111 + 6110]  6111  3  5.0 1211.32    5.53 10.42  13.60  n/a    .000
*    ADD [6145 + 6141]  6315  3  5.0  375.31    3.14  7.58  14.37  n/a    .000
*    ADD [0205 + 6206]  7205  3  5.0 3237.30    8.81 13.08  11.98  n/a    .000
*    ADD [7205 + 7207]  7208  3  5.0 3598.03   10.00 12.25  12.42  n/a    .000
*    ADD [0040 + 0060]  6265  3  5.0   45.00     .24  6.50  22.25  n/a    .000
*    ADD [6205 + 0202]  6202  3  5.0  374.10    2.85  8.17  15.22  n/a    .000
```

```
*
*    ADD [6353 + 1021]  6021  3  5.0  115.02    1.73  6.08  15.11  n/a    .000
*    ADD [6047 + 6043]  6048  3  5.0  734.27    4.67  7.50   9.58  n/a    .000
*    ADD [1070 + 6106]  6070  3  5.0  997.91    5.06  8.67  11.95  n/a    .000
*    ADD [2076 + 6072]  6076  3  5.0   30.81     .34  6.92  12.08  n/a    .000
*    ADD [6315 + 0315]  6316  3  5.0  498.75    4.31  7.67  14.28  n/a    .000
*    ADD [7208 + 0208]  6208  3  5.0 3631.66   10.07 12.17  12.47  n/a    .000
*    ADD [6265 + 3265]  7265  3  5.0   71.53     .70  6.58  18.87  n/a    .000
*    ADD [0103 + 6021]  6103  3  5.0  338.32    3.21  7.25  16.13  n/a    .000
*    ADD [0105 + 6048]  6105  3  5.0 1243.52    8.16  7.83  10.80  n/a    .000
*    ADD [6070 + 6076]  6077  3  5.0 1028.72    5.20  8.50  11.95  n/a    .000
*    ADD [0316 + 6316]  7316  3  5.0  710.07    5.60  7.83  14.08  n/a    .000
*    ADD [6208 + 6209]  6210  3  5.0 3632.92   10.07 12.17  12.47  n/a    .000
*    ADD [0108 + 6077]  6108  3  5.0 1701.87    8.10  9.17  12.25  n/a    .000
*    ADD [0317 + 7316]  6317  3  5.0  988.36    7.20  8.00  14.20  n/a    .000
*    ADD [6210 + 0209]  7209  3  5.0 3927.97   11.06 11.25  12.47  n/a    .000
*    ADD [6105 + 6108]  6115  3  5.0 2945.39   15.52  8.25  11.64  n/a    .000
*    ADD [7212 + 6317]  7213  3  5.0 2161.40   12.14  8.67  13.71  n/a    .000
*    ADD [7209 + 0210]  7210  3  5.0 3946.80   11.11 11.17  12.49  n/a    .000
*    ADD [6115 + 0109]  6109  3  5.0 3174.23   16.60  8.25  11.47  n/a    .000
*    ADD [0318 + 7213]  6318  3  5.0 2174.09   12.21  8.58  13.72  n/a    .000
*    ADD [6212 + 7210]  6213  3  5.0 3970.96   11.16 11.17  12.57  n/a    .000
*    ADD [6109 + 6111]  6358  3  5.0 4385.55   21.05  8.58  12.06  n/a    .000
*    ADD [2213 + 6213]  7317  3  5.0 3971.84   11.16 11.17  12.57  n/a    .000
*    ADD [6358 + 0112]  6112  3  5.0 4417.59   21.25  8.58  12.05  n/a    .000
*    ADD [6103 + 6112]  6113  3  5.0 4755.91   23.95  8.42  12.34  n/a    .000
*    ADD [6113 + 0113]  6361  3  5.0 4779.49   24.09  8.42  12.34  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   4 ** 25 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     MASS STORM                   5.0
     [ Ptot= 78.77 mm ]
*
  **  CALIB NASHYD       0100  1  5.0  835.70    7.29  9.17  20.03  .25    .000
      [CN=57.8          ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD       0101  1  5.0   96.09    3.64  6.67  28.30  .36    .000
      [CN=69.2          ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD       0114  1  5.0  193.26    3.39  7.33  21.87  .28    .000
      [CN=61.3          ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD       0115  1  5.0  170.62    3.25  7.67  27.43  .35    .000
      [CN=69.3          ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD       0116  1  5.0  289.79    3.73  8.33  23.84  .30    .000
      [CN=63.5          ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD     0200  1  5.0   89.02    5.68  6.17  33.41  .42    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD       0201  1  5.0  255.45    3.08  8.50  23.05  .29    .000
      [CN=63.2          ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD     0302  1  5.0   20.91    2.29  6.00  45.39  .58    .000
```

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     [I%=36.2:S%= 2.00]
*
  *  CALIB NASHYD      0303  1  5.0  611.79    5.38  9.00  19.44  .25    .000
     [CN=57.2          ]
     [ N = 3.0:Tp 2.51]
*
  *  CALIB STANDHYD    0304  1  5.0   46.90    3.38  6.08  34.86  .44    .000
     [I%=19.8:S%= 2.00]
*
  *  CALIB STANDHYD    0308  1  5.0   44.53    3.30  6.08  35.70  .45    .000
     [I%=20.3:S%= 2.00]
*
  *  CALIB STANDHYD    0320  1  5.0   46.41    3.81  6.08  37.68  .48    .000
     [I%=25.4:S%= 2.00]
*
  *  CALIB STANDHYD    0003  1  5.0   21.92    1.76  6.00  34.74  .44    .000
     [I%=26.8:S%= 2.00]
*
  *  CALIB STANDHYD    0321  1  5.0   34.71    3.41  6.08  42.45  .54    .000
     [I%=32.5:S%= 2.00]
*
  *  CALIB NASHYD      0322  1  5.0  207.40    2.01  8.75  19.92  .25    .000
     [CN=58.1          ]
     [ N = 3.0:Tp 2.28]
*
  *  CALIB NASHYD      0323  1  5.0  236.30    5.57  7.00  23.26  .30    .000
     [CN=63.4          ]
     [ N = 3.0:Tp  .88]
*
  *  CALIB NASHYD      0324  1  5.0  303.00    4.10  8.00  22.46  .29    .000
     [CN=62.3          ]
     [ N = 3.0:Tp 1.74]
*
  *  CALIB NASHYD      0325  1  5.0  156.62    4.26  6.75  22.48  .29    .000
     [CN=62.3          ]
     [ N = 3.0:Tp  .69]
*
  *  CALIB STANDHYD    5257  1  5.0   10.19     .95  6.00  40.40  .51    .000
     [I%=27.8:S%= 2.00]
*
  *  CALIB STANDHYD    0001  1  5.0    9.26     .66  6.00  30.45  .39    .000
     [I%=22.2:S%= 2.00]
*
  *  CALIB NASHYD      3269  1  5.0  124.61    2.69  6.83  19.68  .25    .000
     [CN=57.3          ]
     [ N = 3.0:Tp  .78]
*
  *  CALIB NASHYD      0327  1  5.0  198.82    2.30  8.42  21.47  .27    .000
     [CN=60.4          ]
     [ N = 3.0:Tp 2.01]
*
  *  CALIB NASHYD      0328  1  5.0  171.14    3.85  6.92  20.95  .27    .000
     [CN=59.7          ]
     [ N = 3.0:Tp  .81]
*
  *  CALIB STANDHYD    0329  1  5.0  117.37   10.92  6.08  42.68  .54    .000
     [I%=37.0:S%= 2.00]
*
  *  CALIB NASHYD      3256  1  5.0   13.61     .65  6.33  25.19  .32    .000
     [CN=65.8          ]
     [ N = 3.0:Tp  .37]
*
  *  CALIB NASHYD      5254  1  5.0   11.03     .58  6.25  23.79  .30    .000
     [CN=62.9          ]
     [ N = 3.0:Tp  .28]
*
  *  CALIB NASHYD      3254  1  5.0   13.91     .79  6.42  32.08  .41    .000
     [CN=74.1          ]
     [ N = 3.0:Tp  .41]
*
  *  CALIB NASHYD      3255  1  5.0   53.36    1.22  6.83  20.27  .26    .000
     [CN=58.4          ]
     [ N = 3.0:Tp  .75]
*
  *  CALIB STANDHYD    5255  1  5.0   25.03    2.38  6.00  39.67  .50    .000
     [I%=32.9:S%= 2.00]
*
  *  CALIB NASHYD      3250  1  5.0   43.70    1.77  6.42  24.59  .31    .000
     [CN=64.8          ]
     [ N = 3.0:Tp  .45]
*
  *  CALIB NASHYD      5250  1  5.0   20.10     .43  6.75  17.92  .23    .000
     [CN=54.0          ]
     [ N = 3.0:Tp  .69]
*
  *  CALIB NASHYD      2306  1  5.0    4.18     .09  6.83  19.02  .24    .000
     [CN=54.8          ]
     [ N = 3.0:Tp  .77]
*
  *  CALIB NASHYD      0306  1  5.0  155.62    2.78  7.50  23.99  .30    .000
     [CN=64.3          ]
     [ N = 3.0:Tp 1.32]
*
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  *  CALIB NASHYD      0305  1  5.0  309.29    2.76  9.08  19.95  .25    .000
     [CN=57.8          ]
     [ N = 3.0:Tp 2.55]
*
  *  CALIB NASHYD      0307  1  5.0  165.22    2.05  7.83  19.16  .24    .000
     [CN=56.8          ]
     [ N = 3.0:Tp 1.56]
*
  *  CALIB STANDHYD    2310  1  5.0   22.21    1.72  6.08  34.29  .44    .000
     [I%=25.0:S%= 2.00]
*
  *  CALIB NASHYD      0310  1  5.0  162.43    2.02  8.08  20.78  .26    .000
     [CN=59.6          ]
     [ N = 3.0:Tp 1.74]
*
  *  CALIB NASHYD      0301  1  5.0  186.26    3.95  7.17  23.58  .30    .000
     [CN=63.9          ]
     [ N = 3.0:Tp 1.03]
*
  *  CALIB NASHYD      2301  1  5.0   49.24    1.33  7.00  26.60  .34    .000
     [CN=67.4          ]
     [ N = 3.0:Tp  .89]
*
  *  CALIB NASHYD      2203  1  5.0    6.70     .28  6.33  22.98  .29    .000
     [CN=63.5          ]
     [ N = 3.0:Tp  .38]
*
  *  CALIB NASHYD      0203  1  5.0   30.53     .70  6.92  21.54  .27    .000
     [CN=61.5          ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD      2204  1  5.0   15.92     .52  6.50  21.63  .27    .000
     [CN=61.5          ]
     [ N = 3.0:Tp  .51]
*
  *  CALIB NASHYD      0204  1  5.0   13.66     .28  6.83  18.73  .24    .000
     [CN=55.5          ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD      0202  1  5.0  307.29    3.46  8.50  21.50  .27    .000
     [CN=61.0          ]
     [ N = 3.0:Tp 2.08]
*
  *  CALIB STANDHYD    2211  1  5.0   27.27    1.76  6.08  31.51  .40    .000
     [I%=17.0:S%= 2.00]
*
  *  CALIB NASHYD      0211  1  5.0   50.58    1.24  7.00  25.25  .32    .000
     [CN=65.6          ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD      0300  1  5.0     .88     .05  6.17  20.92  .27    .000
     [CN=60.7          ]
     [ N = 3.0:Tp  .18]
*
  *  CALIB NASHYD      2300  1  5.0   30.27    1.14  6.67  28.69  .36    .000
     [CN=69.2          ]
     [ N = 3.0:Tp  .63]
*
  *  CALIB NASHYD      0103  1  5.0  223.30    3.16  8.00  23.17  .29    .000
     [CN=62.2          ]
     [ N = 3.0:Tp 1.71]
*
  *  CALIB STANDHYD    2025  1  5.0   10.24     .87  6.00  34.11  .43    .000
     [I%=28.0:S%= 2.00]
*
  *  CALIB NASHYD      1025  1  5.0   35.23     .95  6.67  20.25  .26    .000
     [CN=59.0          ]
     [ N = 3.0:Tp  .60]
*
  *  CALIB NASHYD      1028  1  5.0   32.85     .65  6.83  18.16  .23    .000
     [CN=56.4          ]
     [ N = 3.0:Tp  .78]
*
  *  CALIB STANDHYD    2028  1  5.0    9.83     .89  6.00  34.60  .44    .000
     [I%=31.0:S%= 2.00]
*
  *  CALIB NASHYD      1021  1  5.0   26.87     .40  6.92  14.33  .18    .000
     [CN=48.5          ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD      0105  1  5.0  509.25    5.24  8.17  17.76  .23    .000
     [CN=53.7          ]
     [ N = 3.0:Tp 1.81]
*
  *  CALIB NASHYD      1045  1  5.0  188.03    2.31  7.08  13.51  .17    .000
     [CN=45.6          ]
     [ N = 3.0:Tp  .98]
*
  *  CALIB NASHYD      2045  1  5.0    8.17     .22  6.33  14.21  .18    .000
     [CN=45.2          ]
     [ N = 3.0:Tp  .34]
*
  *  CALIB NASHYD      1047  1  5.0    6.75     .15  6.58  16.54  .21    .000
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      [CN=50.3         ]
      [ N = 3.0:Tp  .59]
*
  *   CALIB NASHYD      2041  1  5.0     .96     .03  6.25  16.76  .21    .000
      [CN=50.2         ]
      [ N = 3.0:Tp  .31]
*
  *   CALIB NASHYD      2042  1  5.0     .87     .03  6.17  13.06  .17    .000
      [CN=44.1         ]
      [ N = 3.0:Tp  .20]
*
  *   CALIB NASHYD      1040  1  5.0  452.51    4.05  7.92  14.18  .18    .000
      [CN=47.7         ]
      [ N = 3.0:Tp 1.59]
*
  *   CALIB NASHYD      1041  1  5.0   76.98     .63  7.67  11.75  .15    .000
      [CN=41.6         ]
      [ N = 3.0:Tp 1.40]
*
  *   CALIB NASHYD      0108  1  5.0  673.15    4.52 10.00  18.01  .23    .000
      [CN=54.7         ]
      [ N = 3.0:Tp 3.22]
*
  *   CALIB NASHYD      1070  1  5.0  137.82    1.96  7.42  18.64  .24    .000
      [CN=56.1         ]
      [ N = 3.0:Tp 1.26]
*
  *   CALIB NASHYD      0106  1  5.0  814.51    5.79  9.25  16.63  .21    .000
      [CN=51.8         ]
      [ N = 3.0:Tp 2.69]
*
  *   CALIB NASHYD      2071  1  5.0   16.86     .52  6.42  19.40  .25    .000
      [CN=55.6         ]
      [ N = 3.0:Tp  .46]
*
  *   CALIB NASHYD      1071  1  5.0   28.72     .55  6.83  16.72  .21    .000
      [CN=51.4         ]
      [ N = 3.0:Tp  .73]
*
  *   CALIB NASHYD      2076  1  5.0     .92     .04  6.33  21.11  .27    .000
      [CN=57.2         ]
      [ N = 3.0:Tp  .34]
*
  *   CALIB NASHYD      1072  1  5.0     .71     .03  6.08  14.65  .19    .000
      [CN=47.6         ]
      [ N = 3.0:Tp  .13]
*
  *   CALIB STANDHYD    2075  1  5.0    1.10     .16  6.00  47.59  .60    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB NASHYD      1075  1  5.0   28.08     .44  6.92  15.62  .20    .000
      [CN=49.5         ]
      [ N = 3.0:Tp  .87]
*
  *   CALIB NASHYD      0109  1  5.0  228.84    1.59  8.50  13.32  .17    .000
      [CN=45.4         ]
      [ N = 3.0:Tp 2.06]
*
  *   CALIB NASHYD      0111  1  5.0 1152.01    7.62 10.42  19.22  .24    .000
      [CN=56.8         ]
      [ N = 3.0:Tp 3.59]
*
  *   CALIB STANDHYD    2110  1  5.0     .78     .11  6.00  46.39  .59    .000
      [I%=48.0:S%= 2.00]
*
  *   CALIB NASHYD      0110  1  5.0   58.53    1.04  7.00  18.69  .24    .000
      [CN=55.9         ]
      [ N = 3.0:Tp  .94]
*
  *   CALIB NASHYD      0112  1  5.0   32.04     .40  7.33  15.95  .20    .000
      [CN=49.9         ]
      [ N = 3.0:Tp 1.20]
*
  *   CALIB NASHYD      0113  1  5.0   23.58     .37  7.08  16.54  .21    .000
      [CN=52.0         ]
      [ N = 3.0:Tp  .95]
*
  *   CALIB NASHYD      0318  1  5.0   12.69     .28  6.83  20.31  .26    .000
      [CN=58.2         ]
      [ N = 3.0:Tp  .79]
*
  *   CALIB NASHYD      0311  1  5.0  536.71    4.42  9.50  20.37  .26    .000
      [CN=58.4         ]
      [ N = 3.0:Tp 2.91]
*
  *   CALIB NASHYD      0312  1  5.0   28.89     .64  6.92  21.70  .28    .000
      [CN=60.5         ]
      [ N = 3.0:Tp  .87]
*
  *   CALIB NASHYD      0313  1  5.0  607.44    3.76 10.17  17.24  .22    .000
      [CN=52.9         ]
      [ N = 3.0:Tp 3.38]
*
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  *   CALIB NASHYD      0317  1  5.0  278.29    2.62  8.92  20.39  .26    .000
      [CN=58.7         ]
      [ N = 3.0:Tp 2.45]
*
  *   CALIB NASHYD      0316  1  5.0  211.32    2.08  8.58  19.23  .24    .000
      [CN=57.0         ]
      [ N = 3.0:Tp 2.14]
*
  *   CALIB STANDHYD    5145  1  5.0    3.56     .48  6.00  45.48  .58    .000
      [I%=46.1:S%= 2.00]
*
  *   CALIB NASHYD      3145  1  5.0  132.54    1.51  7.67  16.76  .21    .000
      [CN=52.1         ]
      [ N = 3.0:Tp 1.46]
*
  *   CALIB STANDHYD    5142  1  5.0    5.20     .61  6.00  43.40  .55    .000
      [I%=35.0:S%= 2.00]
*
  *   CALIB STANDHYD    5141  1  5.0   29.18    2.77  6.00  39.05  .50    .000
      [I%=34.1:S%= 2.00]
*
  *   CALIB NASHYD      5140  1  5.0  119.44    1.72  7.50  19.63  .25    .000
      [CN=57.3         ]
      [ N = 3.0:Tp 1.33]
*
  *   CALIB NASHYD      3141  1  5.0   85.39     .90  7.83  16.60  .21    .000
      [CN=52.3         ]
      [ N = 3.0:Tp 1.60]
*
  *   CALIB NASHYD      0315  1  5.0  123.44    1.68  7.67  19.76  .25    .000
      [CN=57.8         ]
      [ N = 3.0:Tp 1.44]
*
  *   CALIB STANDHYD    2213  1  5.0     .88     .09  6.00  37.84  .48    .000
      [I%=24.4:S%= 2.00]
*
  *   CALIB NASHYD      2212  1  5.0     .55     .03  6.17  18.23  .23    .000
      [CN=53.1         ]
      [ N = 3.0:Tp  .22]
*
  *   CALIB STANDHYD    2210  1  5.0   23.61    1.66  6.08  33.19  .42    .000
      [I%=19.5:S%= 2.00]
*
  *   CALIB NASHYD      0205  1  5.0 3159.99   12.39 13.17  16.87  .21    .000
      [CN=52.3         ]
      [ N = 3.0:Tp 5.93]
*
  *   CALIB NASHYD      0206  1  5.0   73.80    1.43  7.25  22.71  .29    .000
      [CN=61.6         ]
      [ N = 3.0:Tp 1.10]
*
  *   CALIB NASHYD      2206  1  5.0    3.51     .19  6.25  23.11  .29    .000
      [CN=63.5         ]
      [ N = 3.0:Tp  .25]
*
  *   CALIB NASHYD      0207  1  5.0  315.33    3.67  8.58  23.10  .29    .000
      [CN=62.7         ]
      [ N = 3.0:Tp 2.20]
*
  *   CALIB NASHYD      2207  1  5.0   44.56     .74  7.33  20.62  .26    .000
      [CN=58.6         ]
      [ N = 3.0:Tp 1.19]
*
  *   CALIB NASHYD      2269  1  5.0     .84     .04  6.25  21.09  .27    .000
      [CN=60.4         ]
      [ N = 3.0:Tp  .28]
*
  *   CALIB NASHYD      0208  1  5.0   33.63     .85  7.00  25.29  .32    .000
      [CN=65.8         ]
      [ N = 3.0:Tp  .91]
*
  *   CALIB NASHYD      2208  1  5.0     .69     .02  6.17  14.55  .18    .000
      [CN=49.0         ]
      [ N = 3.0:Tp  .23]
*
  *   CALIB STANDHYD    2209  1  5.0     .57     .04  6.00  30.98  .39    .000
      [I%=18.8:S%= 2.00]
*
  *   CALIB NASHYD      0209  1  5.0  295.05    2.69  8.50  17.69  .22    .000
      [CN=53.9         ]
      [ N = 3.0:Tp 2.11]
*
  *   CALIB NASHYD      0210  1  5.0   18.83     .35  7.25  21.72  .28    .000
      [CN=60.8         ]
      [ N = 3.0:Tp 1.09]
*
  *   CALIB NASHYD      9262  1  5.0    7.50     .24  6.42  18.58  .24    .000
      [CN=55.7         ]
      [ N = 3.0:Tp  .40]
*
  *   CALIB NASHYD      9263  1  5.0    2.35     .10  6.25  18.57  .24    .000
      [CN=55.7         ]
      [ N = 3.0:Tp  .25]
```

```
*
*   CALIB STANDHYD     5261  1  5.0   37.50    3.68  6.08  41.36  .53    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD     5262  1  5.0    7.50     .81  6.00  41.36  .53    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD       3265  1  5.0   26.53     .67  6.58  18.58  .24    .000
    [CN=55.7          ]
    [ N = 3.0:Tp  .57]
*
*   CALIB STANDHYD     5263  1  5.0    2.35     .27  6.00  41.36  .53    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD       5260  1  5.0   54.55    1.80  6.58  24.19  .31    .000
    [CN=63.8          ]
    [ N = 3.0:Tp  .58]
*
*   CALIB NASHYD       2001  1  5.0   19.92     .77  6.42  22.53  .29    .000
    [CN=62.2          ]
    [ N = 3.0:Tp  .42]
*
*   CALIB NASHYD       0309  1  5.0  157.12    3.00  7.25  22.94  .29    .000
    [CN=63.0          ]
    [ N = 3.0:Tp 1.14]
*
    ADD [5254 + 3254]  6254  3  5.0   24.94    1.34  6.33  28.42  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30    2.26  6.50  22.87  n/a    .000
*
    ADD [6255 + 5255]  6256  3  5.0  103.33    3.72  6.17  26.94  n/a    .000
*
    ADD [3250 + 5250]  6250  3  5.0   63.80    2.15  6.50  22.49  n/a    .000
*
    ADD [2306 + 0306]  6306  3  5.0  159.80    2.85  7.50  23.86  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    5.02  8.00  21.28  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31    7.06  7.92  20.73  n/a    .000
*
    ADD [2310 + 0310]  6310  3  5.0  184.64    2.19  8.00  22.41  n/a    .000
*
    ADD [0301 + 2301]  6301  3  5.0  235.50    5.26  7.08  24.21  n/a    .000
*
    ADD [2203 + 0203]  6203  3  5.0   37.23     .88  6.75  21.80  n/a    .000
*
    ADD [2204 + 0204]  6204  3  5.0   29.58     .77  6.58  20.29  n/a    .000
*
    ADD [2211 + 0211]  6211  3  5.0   77.85    2.14  6.17  27.44  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15    1.16  6.67  28.47  n/a    .000
*
    ADD [2025 + 1025]  6025  3  5.0   45.47    1.23  6.50  23.37  n/a    .000
*
    ADD [1028 + 2028]  6028  3  5.0   42.68    1.01  6.00  21.95  n/a    .000
*
    ADD [1045 + 2045]  6045  3  5.0  196.20    2.39  7.08  13.54  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95    2.50  7.00  13.64  n/a    .000
*
    ADD [2041 + 2042]  6042  3  5.0    1.83     .06  6.25  15.00  n/a    .000
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    4.67  7.83  13.83  n/a    .000
*
    ADD [2071 + 1071]  6071  3  5.0   45.58    1.02  6.58  17.71  n/a    .000
*
    ADD [2075 + 1075]  6075  3  5.0   29.18     .46  6.92  16.82  n/a    .000
*
    ADD [2110 + 0110]  6110  3  5.0   59.31    1.06  7.00  19.06  n/a    .000
*
    ADD [0311 + 0312]  7211  3  5.0  565.60    4.57  9.42  20.44  n/a    .000
*
    ADD [7211 + 0313]  7212  3  5.0 1173.04    8.27  9.75  18.78  n/a    .000
*
    ADD [5145 + 3145]  6145  3  5.0  136.10    1.54  7.67  17.51  n/a    .000
*
    RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .04  8.25  34.13  n/a    .000
    {ST=   .17 ha.m }
*
    ADD [0030 + 5141]  7318  3  5.0   34.38    2.77  6.00  38.31  n/a    .000
*
    ADD [7318 + 5140]  6140  3  5.0  153.82    3.00  6.08  23.80  n/a    .000
*
    ADD [6140 + 3141]  6141  3  5.0  239.21    3.10  6.08  21.23  n/a    .000
*
    ADD [2212 + 2210]  6212  3  5.0   24.16    1.68  6.08  32.85  n/a    .000
*
    ADD [0206 + 2206]  6206  3  5.0   77.31    1.47  7.17  22.73  n/a    .000
*
    ADD [0207 + 2207]  6207  3  5.0  359.89    4.20  8.33  22.80  n/a    .000
*
    ADD [6207 + 2269]  7207  3  5.0  360.73    4.20  8.33  22.79  n/a    .000
*
    ADD [2208 + 2209]  6209  3  5.0    1.26     .06  6.08  21.99  n/a    .000
*
    RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .15 10.33  28.42  n/a    .000
    {ST=  1.32 ha.m }
*
    RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .29  6.50  41.33  n/a    .000
    {ST=   .13 ha.m }
*
    RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .09  6.42  41.27  n/a    .000
    {ST=   .04 ha.m }
*
    ADD [0070 + 5260]  6263  3  5.0   56.90    1.89  6.58  24.89  n/a    .000
*
    ADD [3256 + 6256]  6257  3  5.0  116.94    4.26  6.17  26.74  n/a    .000
*
    ADD [6203 + 6204]  6205  3  5.0   66.81    1.65  6.67  21.13  n/a    .000
*
    ADD [6025 + 6028]  6353  3  5.0   88.15    2.20  6.08  22.68  n/a    .000
*
    ADD [6042 + 6040]  6043  3  5.0  531.32    4.67  7.83  13.83  n/a    .000
*
    ADD [0106 + 6071]  6106  3  5.0  860.09    5.96  9.17  16.69  n/a    .000
*
    ADD [1072 + 6075]  6072  3  5.0   29.89     .46  6.92  16.77  n/a    .000
*
    ADD [0111 + 6110]  6111  3  5.0 1211.32    7.84 10.33  19.21  n/a    .000
*
    ADD [6145 + 6141]  6315  3  5.0  375.31    4.43  7.58  19.88  n/a    .000
*
    ADD [0205 + 6206]  7205  3  5.0 3237.30   12.51 13.00  17.01  n/a    .000
*
    ADD [7205 + 7207]  7208  3  5.0 3598.03   14.16 12.17  17.59  n/a    .000
*
    ADD [0040 + 0060]  6265  3  5.0   45.00     .32  6.58  30.57  n/a    .000
*
    ADD [6205 + 0202]  6202  3  5.0  374.10    4.04  8.08  21.43  n/a    .000
*
    ADD [6353 + 1021]  6021  3  5.0  115.02    2.40  6.58  20.73  n/a    .000
*
    ADD [6047 + 6043]  6048  3  5.0  734.27    6.78  7.50  13.78  n/a    .000
*
    ADD [1070 + 6106]  6070  3  5.0  997.91    7.23  8.58  16.96  n/a    .000
*
    ADD [2076 + 6072]  6076  3  5.0   30.81     .48  6.92  16.90  n/a    .000
*
    ADD [6315 + 0315]  6316  3  5.0  498.75    6.11  7.58  19.85  n/a    .000
*
    ADD [7208 + 0208]  6208  3  5.0 3631.66   14.25 12.17  17.66  n/a    .000
*
    ADD [6265 + 3265]  7265  3  5.0   71.53     .99  6.58  26.12  n/a    .000
*
    ADD [0103 + 6021]  6103  3  5.0  338.32    4.52  7.25  22.34  n/a    .000
*
    ADD [0105 + 6048]  6105  3  5.0 1243.52   11.76  7.75  15.41  n/a    .000
*
    ADD [6070 + 6076]  6077  3  5.0 1028.72    7.43  8.50  16.96  n/a    .000
*
    ADD [0316 + 6316]  7316  3  5.0  710.07    7.95  7.83  19.67  n/a    .000
*
    ADD [6208 + 6209]  6210  3  5.0 3632.92   14.25 12.17  17.66  n/a    .000
*
    ADD [0108 + 6077]  6108  3  5.0 1701.87   11.55  9.08  17.37  n/a    .000
*
    ADD [0317 + 7316]  6317  3  5.0  988.36   10.23  8.00  19.87  n/a    .000
*
    ADD [6210 + 0209]  7209  3  5.0 3927.97   15.66 11.17  17.66  n/a    .000
*
    ADD [6105 + 6108]  6115  3  5.0 2945.39   22.24  8.25  16.54  n/a    .000
*
    ADD [7212 + 6317]  7213  3  5.0 2161.40   17.24  8.58  19.28  n/a    .000
*
    ADD [7209 + 0210]  7210  3  5.0 3946.80   15.73 11.08  17.68  n/a    .000
*
    ADD [6115 + 0109]  6109  3  5.0 3174.23   23.81  8.25  16.31  n/a    .000
*
    ADD [0318 + 7213]  6318  3  5.0 2174.09   17.33  8.58  19.29  n/a    .000
*
    ADD [6212 + 7210]  6213  3  5.0 3970.96   15.79 11.08  17.77  n/a    .000
*
    ADD [6109 + 6111]  6358  3  5.0 4385.55   30.12  8.58  17.11  n/a    .000
*
    ADD [2213 + 6213]  7317  3  5.0 3971.84   15.80 11.08  17.78  n/a    .000
*
    ADD [6358 + 0112]  6112  3  5.0 4417.59   30.40  8.50  17.10  n/a    .000
*
    ADD [6103 + 6112]  6113  3  5.0 4755.91   34.20  8.33  17.48  n/a    .000
*
    ADD [6113 + 0113]  6361  3  5.0 4779.49   34.41  8.33  17.47  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   5 ** 50 yr 12 hr SCS
  ****************************
```

```
  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     MASS STORM               5.0
     [ Ptot= 88.25 mm ]
*
  ** CALIB NASHYD       0100  1  5.0  835.70    9.05  9.17  24.76  .28    .000
     [CN=57.8        ]
     [ N = 3.0:Tp 2.64]
*
  ** CALIB NASHYD       0101  1  5.0   96.09    4.45  6.67  34.43  .39    .000
     [CN=69.2        ]
     [ N = 3.0:Tp  .61]
*
  ** CALIB NASHYD       0114  1  5.0  193.26    4.20  7.33  26.98  .31    .000
     [CN=61.3        ]
     [ N = 3.0:Tp 1.20]
*
  ** CALIB NASHYD       0115  1  5.0  170.62    4.00  7.67  33.52  .38    .000
     [CN=69.3        ]
     [ N = 3.0:Tp 1.46]
*
  ** CALIB NASHYD       0116  1  5.0  289.79    4.60  8.33  29.26  .33    .000
     [CN=63.5        ]
     [ N = 3.0:Tp 2.01]
*
   * CALIB STANDHYD     0200  1  5.0   89.02    7.52  6.17  39.54  .45    .000
     [I%=17.0:S%= 2.00]
*
   * CALIB NASHYD       0201  1  5.0  255.45    3.81  8.50  28.38  .32    .000
     [CN=63.2        ]
     [ N = 3.0:Tp 2.09]
*
   * CALIB STANDHYD     0302  1  5.0   20.91    2.79  6.08  52.47  .59    .000
     [I%=36.2:S%= 2.00]
*
   * CALIB NASHYD       0303  1  5.0  611.79    6.70  9.00  24.08  .27    .000
     [CN=57.2        ]
     [ N = 3.0:Tp 2.51]
*
   * CALIB STANDHYD     0304  1  5.0   46.90    4.03  6.08  41.07  .47    .000
     [I%=19.8:S%= 2.00]
*
   * CALIB STANDHYD     0308  1  5.0   44.53    3.94  6.08  42.02  .48    .000
     [I%=20.3:S%= 2.00]
*
   * CALIB STANDHYD     0320  1  5.0   46.41    4.50  6.08  44.05  .50    .000
     [I%=25.4:S%= 2.00]
*
   * CALIB STANDHYD     0003  1  5.0   21.92    2.04  6.00  40.46  .46    .000
     [I%=26.8:S%= 2.00]
*
   * CALIB STANDHYD     0321  1  5.0   34.71    3.98  6.08  49.22  .56    .000
     [I%=32.5:S%= 2.00]
*
   * CALIB NASHYD       0322  1  5.0  207.40    2.50  8.75  24.66  .28    .000
     [CN=58.1        ]
     [ N = 3.0:Tp 2.28]
*
   * CALIB NASHYD       0323  1  5.0  236.30    6.89  6.92  28.63  .32    .000
     [CN=63.4        ]
     [ N = 3.0:Tp  .88]
*
   * CALIB NASHYD       0324  1  5.0  303.00    5.08  8.00  27.69  .31    .000
     [CN=62.3        ]
     [ N = 3.0:Tp 1.74]
*
   * CALIB NASHYD       0325  1  5.0  156.62    5.28  6.75  27.71  .31    .000
     [CN=62.3        ]
     [ N = 3.0:Tp  .69]
*
   * CALIB STANDHYD     5257  1  5.0   10.19    1.20  6.08  47.06  .53    .000
     [I%=27.8:S%= 2.00]
*
   * CALIB STANDHYD     0001  1  5.0    9.26     .76  6.00  35.67  .40    .000
     [I%=22.2:S%= 2.00]
*
   * CALIB NASHYD       3269  1  5.0  124.61    3.35  6.83  24.35  .28    .000
     [CN=57.3        ]
     [ N = 3.0:Tp  .78]
*
   * CALIB NASHYD       0327  1  5.0  198.82    2.85  8.33  26.49  .30    .000
     [CN=60.4        ]
     [ N = 3.0:Tp 2.01]
*
   * CALIB NASHYD       0328  1  5.0  171.14    4.79  6.83  25.88  .29    .000
     [CN=59.7        ]
     [ N = 3.0:Tp  .81]
*
   * CALIB STANDHYD     0329  1  5.0  117.37   13.16  6.08  49.27  .56    .000
     [I%=37.0:S%= 2.00]
*
   * CALIB NASHYD       3256  1  5.0   13.61     .80  6.33  30.87  .35    .000
     [CN=65.8        ]
     [ N = 3.0:Tp  .37]
*
   * CALIB NASHYD       5254  1  5.0   11.03     .72  6.25  29.16  .33    .000
     [CN=62.9        ]
     [ N = 3.0:Tp  .28]
*
   * CALIB NASHYD       3254  1  5.0   13.91     .96  6.42  38.82  .44    .000
     [CN=74.1        ]
     [ N = 3.0:Tp  .41]
*
   * CALIB NASHYD       3255  1  5.0   53.36    1.52  6.83  25.06  .28    .000
     [CN=58.4        ]
     [ N = 3.0:Tp  .75]
*
   * CALIB STANDHYD     5255  1  5.0   25.03    2.75  6.00  45.95  .52    .000
     [I%=32.9:S%= 2.00]
*
   * CALIB NASHYD       3250  1  5.0   43.70    2.19  6.42  30.15  .34    .000
     [CN=64.8        ]
     [ N = 3.0:Tp  .45]
*
   * CALIB NASHYD       5250  1  5.0   20.10     .54  6.75  22.23  .25    .000
     [CN=54.0        ]
     [ N = 3.0:Tp  .69]
*
   * CALIB NASHYD       2306  1  5.0    4.18     .11  6.83  23.47  .27    .000
     [CN=54.8        ]
     [ N = 3.0:Tp  .77]
*
   * CALIB NASHYD       0306  1  5.0  155.62    3.44  7.50  29.47  .33    .000
     [CN=64.3        ]
     [ N = 3.0:Tp 1.32]
*
   * CALIB NASHYD       0305  1  5.0  309.29    3.42  9.00  24.67  .28    .000
     [CN=57.8        ]
     [ N = 3.0:Tp 2.55]
*
   * CALIB NASHYD       0307  1  5.0  165.22    2.56  7.83  23.76  .27    .000
     [CN=56.8        ]
     [ N = 3.0:Tp 1.56]
*
   * CALIB STANDHYD     2310  1  5.0   22.21    2.01  6.08  40.07  .45    .000
     [I%=25.0:S%= 2.00]
*
   * CALIB NASHYD       0310  1  5.0  162.43    2.51  8.00  25.69  .29    .000
     [CN=59.6        ]
     [ N = 3.0:Tp 1.74]
*
   * CALIB NASHYD       0301  1  5.0  186.26    4.89  7.17  29.00  .33    .000
     [CN=63.9        ]
     [ N = 3.0:Tp 1.03]
*
   * CALIB NASHYD       2301  1  5.0   49.24    1.64  6.92  32.49  .37    .000
     [CN=67.4        ]
     [ N = 3.0:Tp  .89]
*
   * CALIB NASHYD       2203  1  5.0    6.70     .35  6.33  28.33  .32    .000
     [CN=63.5        ]
     [ N = 3.0:Tp  .38]
*
   * CALIB NASHYD       0203  1  5.0   30.53     .87  6.92  26.64  .30    .000
     [CN=61.5        ]
     [ N = 3.0:Tp  .82]
*
   * CALIB NASHYD       2204  1  5.0   15.92     .64  6.50  26.75  .30    .000
     [CN=61.5        ]
     [ N = 3.0:Tp  .51]
*
   * CALIB NASHYD       0204  1  5.0   13.66     .35  6.83  23.20  .26    .000
     [CN=55.5        ]
     [ N = 3.0:Tp  .79]
*
   * CALIB NASHYD       0202  1  5.0  307.29    4.29  8.50  26.57  .30    .000
     [CN=61.0        ]
     [ N = 3.0:Tp 2.08]
*
   * CALIB STANDHYD     2211  1  5.0   27.27    2.10  6.08  37.30  .42    .000
     [I%=17.0:S%= 2.00]
*
   * CALIB NASHYD       0211  1  5.0   50.58    1.52  7.00  30.91  .35    .000
     [CN=65.6        ]
     [ N = 3.0:Tp  .94]
*
   * CALIB NASHYD       0300  1  5.0     .88     .06  6.17  25.91  .29    .000
     [CN=60.7        ]
     [ N = 3.0:Tp  .18]
*
   * CALIB NASHYD       2300  1  5.0   30.27    1.39  6.67  34.84  .39    .000
     [CN=69.2        ]
     [ N = 3.0:Tp  .63]
```

```
*
*   CALIB NASHYD      0103  1  5.0  223.30    3.90  8.00  28.44  .32    .000
    [CN=62.2        ]
    [ N = 3.0:Tp 1.71]
*
*   CALIB STANDHYD    2025  1  5.0   10.24    1.00  6.00  39.65  .45    .000
    [I%=28.0:S%= 2.00]
*
*   CALIB NASHYD      1025  1  5.0   35.23    1.18  6.67  25.08  .28    .000
    [CN=59.0        ]
    [ N = 3.0:Tp  .60]
*
*   CALIB NASHYD      1028  1  5.0   32.85     .82  6.83  22.65  .26    .000
    [CN=56.4        ]
    [ N = 3.0:Tp  .78]
*
*   CALIB STANDHYD    2028  1  5.0    9.83    1.03  6.00  40.02  .45    .000
    [I%=31.0:S%= 2.00]
*
*   CALIB NASHYD      1021  1  5.0   26.87     .51  6.92  18.00  .20    .000
    [CN=48.5        ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD      0105  1  5.0  509.25    6.52  8.08  22.03  .25    .000
    [CN=53.7        ]
    [ N = 3.0:Tp 1.81]
*
*   CALIB NASHYD      1045  1  5.0  188.03    2.91  7.08  16.92  .19    .000
    [CN=45.6        ]
    [ N = 3.0:Tp  .98]
*
*   CALIB NASHYD      2045  1  5.0    8.17     .28  6.33  17.66  .20    .000
    [CN=45.2        ]
    [ N = 3.0:Tp  .34]
*
*   CALIB NASHYD      1047  1  5.0    6.75     .19  6.58  20.50  .23    .000
    [CN=50.3        ]
    [ N = 3.0:Tp  .59]
*
*   CALIB NASHYD      2041  1  5.0     .96     .04  6.25  20.74  .23    .000
    [CN=50.2        ]
    [ N = 3.0:Tp  .31]
*
*   CALIB NASHYD      2042  1  5.0     .87     .04  6.17  16.35  .19    .000
    [CN=44.1        ]
    [ N = 3.0:Tp  .20]
*
*   CALIB NASHYD      1040  1  5.0  452.51    5.10  7.83  17.78  .20    .000
    [CN=47.7        ]
    [ N = 3.0:Tp 1.59]
*
*   CALIB NASHYD      1041  1  5.0   76.98     .79  7.58  14.78  .17    .000
    [CN=41.6        ]
    [ N = 3.0:Tp 1.40]
*
*   CALIB NASHYD      0108  1  5.0  673.15    5.63  9.92  22.37  .25    .000
    [CN=54.7        ]
    [ N = 3.0:Tp 3.22]
*
*   CALIB NASHYD      1070  1  5.0  137.82    2.45  7.42  23.15  .26    .000
    [CN=56.1        ]
    [ N = 3.0:Tp 1.26]
*
*   CALIB NASHYD      0106  1  5.0  814.51    7.23  9.25  20.69  .23    .000
    [CN=51.8        ]
    [ N = 3.0:Tp 2.69]
*
*   CALIB NASHYD      2071  1  5.0   16.86     .64  6.42  23.93  .27    .000
    [CN=55.6        ]
    [ N = 3.0:Tp  .46]
*
*   CALIB NASHYD      1071  1  5.0   28.72     .69  6.75  20.76  .24    .000
    [CN=51.4        ]
    [ N = 3.0:Tp  .73]
*
*   CALIB NASHYD      2076  1  5.0     .92     .05  6.33  25.88  .29    .000
    [CN=57.2        ]
    [ N = 3.0:Tp  .34]
*
*   CALIB NASHYD      1072  1  5.0     .71     .04  6.08  18.26  .21    .000
    [CN=47.6        ]
    [ N = 3.0:Tp  .13]
*
*   CALIB STANDHYD    2075  1  5.0    1.10     .19  6.00  54.34  .62    .000
    [I%=50.0:S%= 2.00]
*
*   CALIB NASHYD      1075  1  5.0   28.08     .55  6.92  19.45  .22    .000
    [CN=49.5        ]
    [ N = 3.0:Tp  .87]
*
*   CALIB NASHYD      0109  1  5.0  228.84    2.00  8.50  16.71  .19    .000
    [CN=45.4        ]
    [ N = 3.0:Tp 2.06]
```

```
*
*   CALIB NASHYD      0111  1  5.0 1152.01    9.46 10.42  23.82  .27    .000
    [CN=56.8        ]
    [ N = 3.0:Tp 3.59]
*
*   CALIB STANDHYD    2110  1  5.0     .78     .13  6.00  53.04  .60    .000
    [I%=48.0:S%= 2.00]
*
*   CALIB NASHYD      0110  1  5.0   58.53    1.30  7.00  23.19  .26    .000
    [CN=55.9        ]
    [ N = 3.0:Tp  .94]
*
*   CALIB NASHYD      0112  1  5.0   32.04     .50  7.33  19.84  .22    .000
    [CN=49.9        ]
    [ N = 3.0:Tp 1.20]
*
*   CALIB NASHYD      0113  1  5.0   23.58     .46  7.08  20.61  .23    .000
    [CN=52.0        ]
    [ N = 3.0:Tp  .95]
*
*   CALIB NASHYD      0318  1  5.0   12.69     .35  6.83  25.09  .28    .000
    [CN=58.2        ]
    [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD      0311  1  5.0  536.71    5.48  9.50  25.16  .29    .000
    [CN=58.4        ]
    [ N = 3.0:Tp 2.91]
*
*   CALIB NASHYD      0312  1  5.0   28.89     .79  6.92  26.75  .30    .000
    [CN=60.5        ]
    [ N = 3.0:Tp  .87]
*
*   CALIB NASHYD      0313  1  5.0  607.44    4.69 10.17  21.43  .24    .000
    [CN=52.9        ]
    [ N = 3.0:Tp 3.38]
*
*   CALIB NASHYD      0317  1  5.0  278.29    3.25  8.92  25.21  .29    .000
    [CN=58.7        ]
    [ N = 3.0:Tp 2.45]
*
*   CALIB NASHYD      0316  1  5.0  211.32    2.59  8.50  23.85  .27    .000
    [CN=57.0        ]
    [ N = 3.0:Tp 2.14]
*
*   CALIB STANDHYD    5145  1  5.0    3.56     .56  6.00  52.07  .59    .000
    [I%=46.1:S%= 2.00]
*
*   CALIB NASHYD      3145  1  5.0  132.54    1.89  7.67  20.85  .24    .000
    [CN=52.1        ]
    [ N = 3.0:Tp 1.46]
*
*   CALIB STANDHYD    5142  1  5.0    5.20     .71  6.00  50.19  .57    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD    5141  1  5.0   29.18    3.20  6.00  45.17  .51    .000
    [I%=34.1:S%= 2.00]
*
*   CALIB NASHYD      5140  1  5.0  119.44    2.14  7.50  24.29  .28    .000
    [CN=57.3        ]
    [ N = 3.0:Tp 1.33]
*
*   CALIB NASHYD      3141  1  5.0   85.39    1.13  7.83  20.69  .23    .000
    [CN=52.3        ]
    [ N = 3.0:Tp 1.60]
*
*   CALIB NASHYD      0315  1  5.0  123.44    2.09  7.67  24.48  .28    .000
    [CN=57.8        ]
    [ N = 3.0:Tp 1.44]
*
*   CALIB STANDHYD    2213  1  5.0     .88     .10  6.00  44.25  .50    .000
    [I%=24.4:S%= 2.00]
*
*   CALIB NASHYD      2212  1  5.0     .55     .03  6.17  22.51  .26    .000
    [CN=53.1        ]
    [ N = 3.0:Tp  .22]
*
*   CALIB STANDHYD    2210  1  5.0   23.61    1.97  6.08  39.11  .44    .000
    [I%=19.5:S%= 2.00]
*
*   CALIB NASHYD      0205  1  5.0 3159.99   15.41 13.17  20.98  .24    .000
    [CN=52.3        ]
    [ N = 3.0:Tp 5.93]
*
*   CALIB NASHYD      0206  1  5.0   73.80    1.77  7.25  27.91  .32    .000
    [CN=61.6        ]
    [ N = 3.0:Tp 1.10]
*
*   CALIB NASHYD      2206  1  5.0    3.51     .24  6.25  28.47  .32    .000
    [CN=63.5        ]
    [ N = 3.0:Tp  .25]
*
*   CALIB NASHYD      0207  1  5.0  315.33    4.54  8.58  28.41  .32    .000
    [CN=62.7        ]
```

```
     [ N = 3.0:Tp 2.20]
*
  *  CALIB NASHYD      2207  1  5.0   44.56     .91  7.33  25.45  .29    .000
     [CN=58.6          ]
     [ N = 3.0:Tp 1.19]
*
  *  CALIB NASHYD      2269  1  5.0     .84     .05  6.25  26.08  .30    .000
     [CN=60.4          ]
     [ N = 3.0:Tp  .28]
*
  *  CALIB NASHYD      0208  1  5.0   33.63    1.05  7.00  30.98  .35    .000
     [CN=65.8          ]
     [ N = 3.0:Tp  .91]
*
  *  CALIB NASHYD      2208  1  5.0     .69     .03  6.17  18.26  .21    .000
     [CN=49.0          ]
     [ N = 3.0:Tp  .23]
*
  *  CALIB STANDHYD    2209  1  5.0     .57     .05  6.00  36.59  .41    .000
     [I%=18.8:S%= 2.00]
*
  *  CALIB NASHYD      0209  1  5.0  295.05    3.35  8.50  21.98  .25    .000
     [CN=53.9          ]
     [ N = 3.0:Tp 2.11]
*
  *  CALIB NASHYD      0210  1  5.0   18.83     .44  7.17  26.78  .30    .000
     [CN=60.8          ]
     [ N = 3.0:Tp 1.09]
*
  *  CALIB NASHYD      9262  1  5.0    7.50     .30  6.42  23.05  .26    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .40]
*
  *  CALIB NASHYD      9263  1  5.0    2.35     .13  6.25  23.04  .26    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .25]
*
  *  CALIB STANDHYD    5261  1  5.0   37.50    4.27  6.08  47.80  .54    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD    5262  1  5.0    7.50     .97  6.00  47.80  .54    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      3265  1  5.0   26.53     .84  6.58  23.05  .26    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .57]
*
  *  CALIB STANDHYD    5263  1  5.0    2.35     .32  6.00  47.80  .54    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      5260  1  5.0   54.55    2.22  6.58  29.65  .34    .000
     [CN=63.8          ]
     [ N = 3.0:Tp  .58]
*
  *  CALIB NASHYD      2001  1  5.0   19.92     .95  6.42  27.75  .31    .000
     [CN=62.2          ]
     [ N = 3.0:Tp  .42]
*
  *  CALIB NASHYD      0309  1  5.0  157.12    3.72  7.25  28.25  .32    .000
     [CN=63.0          ]
     [ N = 3.0:Tp 1.14]
*
     ADD [5254 + 3254]  6254  3  5.0   24.94    1.64  6.33  34.55  n/a    .000
*
     ADD [6254 + 3255]  6255  3  5.0   78.30    2.79  6.50  28.08  n/a    .000
*
     ADD [6255 + 5255]  6256  3  5.0  103.33    4.47  6.17  32.41  n/a    .000
*
     ADD [3250 + 5250]  6250  3  5.0   63.80    2.66  6.50  27.66  n/a    .000
*
     ADD [2306 + 0306]  6306  3  5.0  159.80    3.52  7.42  29.31  n/a    .000
*
     ADD [6306 + 0305]  6305  3  5.0  469.09    6.22  8.00  26.25  n/a    .000
*
     ADD [6305 + 0307]  6307  3  5.0  634.31    8.76  7.92  25.60  n/a    .000
*
     ADD [2310 + 0310]  6310  3  5.0  184.64    2.71  8.00  27.42  n/a    .000
*
     ADD [0301 + 2301]  6301  3  5.0  235.50    6.50  7.08  29.73  n/a    .000
*
     ADD [2203 + 0203]  6203  3  5.0   37.23    1.10  6.67  26.94  n/a    .000
*
     ADD [2204 + 0204]  6204  3  5.0   29.58     .96  6.58  25.11  n/a    .000
*
     ADD [2211 + 0211]  6211  3  5.0   77.85    2.61  6.17  33.15  n/a    .000
*
     ADD [0300 + 2300]  6300  3  5.0   31.15    1.41  6.67  34.59  n/a    .000
*
     ADD [2025 + 1025]  6025  3  5.0   45.47    1.52  6.50  28.36  n/a    .000
*
     ADD [1028 + 2028]  6028  3  5.0   42.68    1.18  6.08  26.65  n/a    .000
*
     ADD [1045 + 2045]  6045  3  5.0  196.20    3.00  7.08  16.96  n/a    .000
```

```
*
*
     ADD [6045 + 1047]  6047  3  5.0  202.95    3.15  7.00  17.07  n/a    .000
*
     ADD [2041 + 2042]  6042  3  5.0    1.83     .08  6.25  18.65  n/a    .000
*
     ADD [1040 + 1041]  6040  3  5.0  529.49    5.89  7.83  17.34  n/a    .000
*
     ADD [2071 + 1071]  6071  3  5.0   45.58    1.27  6.58  21.94  n/a    .000
*
     ADD [2075 + 1075]  6075  3  5.0   29.18     .57  6.92  20.77  n/a    .000
*
     ADD [2110 + 0110]  6110  3  5.0   59.31    1.32  7.00  23.58  n/a    .000
*
     ADD [0311 + 0312]  7211  3  5.0  565.60    5.67  9.33  25.25  n/a    .000
*
     ADD [7211 + 0313]  7212  3  5.0 1173.04   10.27  9.75  23.27  n/a    .000
*
     ADD [5145 + 3145]  6145  3  5.0  136.10    1.92  7.67  21.67  n/a    .000
*
     RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .04  8.25  40.86  n/a    .000
     {ST=   .19 ha.m }
*
     ADD [0030 + 5141]  7318  3  5.0   34.38    3.21  6.00  44.51  n/a    .000
*
     ADD [7318 + 5140]  6140  3  5.0  153.82    3.51  6.08  28.81  n/a    .000
*
     ADD [6140 + 3141]  6141  3  5.0  239.21    3.64  6.08  25.91  n/a    .000
*
     ADD [2212 + 2210]  6212  3  5.0   24.16    1.99  6.08  38.73  n/a    .000
*
     ADD [0206 + 2206]  6206  3  5.0   77.31    1.81  7.17  27.93  n/a    .000
*
     ADD [0207 + 2207]  6207  3  5.0  359.89    5.19  8.33  28.04  n/a    .000
*
     ADD [6207 + 2269]  7207  3  5.0  360.73    5.19  8.33  28.04  n/a    .000
*
     ADD [2208 + 2209]  6209  3  5.0    1.26     .08  6.08  26.55  n/a    .000
*
     RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .21 10.08  34.86  n/a    .000
     {ST=  1.44 ha.m }
*
     RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .37  6.42  47.77  n/a    .000
     {ST=   .14 ha.m }
*
     RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .12  6.33  47.71  n/a    .000
     {ST=   .05 ha.m }
*
     ADD [0070 + 5260]  6263  3  5.0   56.90    2.33  6.58  30.39  n/a    .000
*
     ADD [3256 + 6256]  6257  3  5.0  116.94    5.14  6.17  32.23  n/a    .000
*
     ADD [6203 + 6204]  6205  3  5.0   66.81    2.05  6.67  26.13  n/a    .000
*
     ADD [6025 + 6028]  6353  3  5.0   88.15    2.61  6.08  27.53  n/a    .000
*
     ADD [6042 + 6040]  6043  3  5.0  531.32    5.90  7.83  17.35  n/a    .000
*
     ADD [0106 + 6071]  6106  3  5.0  860.09    7.44  9.17  20.76  n/a    .000
*
     ADD [1072 + 6075]  6072  3  5.0   29.89     .58  6.92  20.71  n/a    .000
*
     ADD [0111 + 6110]  6111  3  5.0 1211.32    9.73 10.33  23.81  n/a    .000
*
     ADD [6145 + 6141]  6315  3  5.0  375.31    5.50  7.58  24.37  n/a    .000
*
     ADD [0205 + 6206]  7205  3  5.0 3237.30   15.56 13.00  21.15  n/a    .000
*
     ADD [7205 + 7207]  7208  3  5.0 3598.03   17.58 12.17  21.84  n/a    .000
*
     ADD [0040 + 0060]  6265  3  5.0   45.00     .43  6.67  37.01  n/a    .000
*
     ADD [6205 + 0202]  6202  3  5.0  374.10    5.02  8.08  26.49  n/a    .000
*
     ADD [6353 + 1021]  6021  3  5.0  115.02    2.98  6.58  25.30  n/a    .000
*
     ADD [6047 + 6043]  6048  3  5.0  734.27    8.55  7.50  17.27  n/a    .000
*
     ADD [1070 + 6106]  6070  3  5.0  997.91    9.02  8.58  21.09  n/a    .000
*
     ADD [2076 + 6072]  6076  3  5.0   30.81     .60  6.92  20.86  n/a    .000
*
     ADD [6315 + 0315]  6316  3  5.0  498.75    7.59  7.58  24.40  n/a    .000
*
     ADD [7208 + 0208]  6208  3  5.0 3631.66   17.69 12.17  21.92  n/a    .000
*
     ADD [6265 + 3265]  7265  3  5.0   71.53    1.26  6.67  31.84  n/a    .000
*
     ADD [0103 + 6021]  6103  3  5.0  338.32    5.60  7.25  27.37  n/a    .000
*
     ADD [0105 + 6048]  6105  3  5.0 1243.52   14.75  7.75  19.22  n/a    .000
*
     ADD [6070 + 6076]  6077  3  5.0 1028.72    9.27  8.50  21.08  n/a    .000
*
```

```
      ADD [0316 + 6316]  7316  3  5.0  710.07    9.89  7.83  24.24  n/a    .000
*
      ADD [6208 + 6209]  6210  3  5.0 3632.92   17.69 12.17  21.92  n/a    .000
*
      ADD [0108 + 6077]  6108  3  5.0 1701.87   14.40  9.08  21.59  n/a    .000
*
      ADD [0317 + 7316]  6317  3  5.0  988.36   12.72  8.00  24.51  n/a    .000
*
      ADD [6210 + 0209]  7209  3  5.0 3927.97   19.44 11.08  21.93  n/a    .000
*
      ADD [6105 + 6108]  6115  3  5.0 2945.39   27.82  8.17  20.59  n/a    .000
*
      ADD [7212 + 6317]  7213  3  5.0 2161.40   21.43  8.58  23.84  n/a    .000
*
      ADD [7209 + 0210]  7210  3  5.0 3946.80   19.52 11.08  21.95  n/a    .000
*
      ADD [6115 + 0109]  6109  3  5.0 3174.23   29.80  8.25  20.31  n/a    .000
*
      ADD [0318 + 7213]  6318  3  5.0 2174.09   21.55  8.58  23.84  n/a    .000
*
      ADD [6212 + 7210]  6213  3  5.0 3970.96   19.60 11.08  22.05  n/a    .000
*
      ADD [6109 + 6111]  6358  3  5.0 4385.55   37.64  8.50  21.28  n/a    .000
*
      ADD [2213 + 6213]  7317  3  5.0 3971.84   19.60 11.08  22.06  n/a    .000
*
      ADD [6358 + 0112]  6112  3  5.0 4417.59   38.00  8.50  21.27  n/a    .000
*
      ADD [6103 + 6112]  6113  3  5.0 4755.91   42.70  8.33  21.70  n/a    .000
*
      ADD [6113 + 0113]  6361  3  5.0 4779.49   42.96  8.33  21.70  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   6 ** 100 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha     cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                  5.0
      [ Ptot= 97.64 mm ]
*
  **  CALIB NASHYD       0100  1  5.0  835.70   10.91  9.17  29.77  .30    .000
      [CN=57.8         ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD       0101  1  5.0   96.09    5.29  6.67  40.80  .42    .000
      [CN=69.2         ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD       0114  1  5.0  193.26    5.07  7.33  32.36  .33    .000
      [CN=61.3         ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD       0115  1  5.0  170.62    4.78  7.67  39.86  .41    .000
      [CN=69.3         ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD       0116  1  5.0  289.79    5.51  8.33  34.94  .36    .000
      [CN=63.5         ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD     0200  1  5.0   89.02    8.87  6.17  45.88  .47    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD       0201  1  5.0  255.45    4.58  8.42  33.99  .35    .000
      [CN=63.2         ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD     0302  1  5.0   20.91    3.20  6.08  59.67  .61    .000
      [I%=36.2:S%= 2.00]
*
  *   CALIB NASHYD       0303  1  5.0  611.79    8.09  9.00  29.00  .30    .000
      [CN=57.2         ]
      [ N = 3.0:Tp 2.51]
*
  *   CALIB STANDHYD     0304  1  5.0   46.90    4.70  6.08  47.47  .49    .000
      [I%=19.8:S%= 2.00]
*
  *   CALIB STANDHYD     0308  1  5.0   44.53    4.59  6.08  48.52  .50    .000
      [I%=20.3:S%= 2.00]
*
  *   CALIB STANDHYD     0320  1  5.0   46.41    5.19  6.08  50.59  .52    .000
      [I%=25.4:S%= 2.00]
*
  *   CALIB STANDHYD     0003  1  5.0   21.92    2.35  6.08  46.33  .47    .000
      [I%=26.8:S%= 2.00]
*
  *   CALIB STANDHYD     0321  1  5.0   34.71    4.86  6.08  56.14  .57    .000
      [I%=32.5:S%= 2.00]
*
  *   CALIB NASHYD       0322  1  5.0  207.40    3.02  8.67  29.68  .30    .000
      [CN=58.1         ]
      [ N = 3.0:Tp 2.28]
*
  *   CALIB NASHYD       0323  1  5.0  236.30    8.30  6.92  34.26  .35    .000
      [CN=63.4         ]
      [ N = 3.0:Tp  .88]
*
  *   CALIB NASHYD       0324  1  5.0  303.00    6.11  8.00  33.19  .34    .000
      [CN=62.3         ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD       0325  1  5.0  156.62    6.36  6.75  33.22  .34    .000
      [CN=62.3         ]
      [ N = 3.0:Tp  .69]
*
  *   CALIB STANDHYD     5257  1  5.0   10.19    1.38  6.08  53.87  .55    .000
      [I%=27.8:S%= 2.00]
*
  *   CALIB STANDHYD     0001  1  5.0    9.26     .92  6.00  41.07  .42    .000
      [I%=22.2:S%= 2.00]
*
  *   CALIB NASHYD       3269  1  5.0  124.61    4.05  6.83  29.29  .30    .000
      [CN=57.3         ]
      [ N = 3.0:Tp  .78]
*
  *   CALIB NASHYD       0327  1  5.0  198.82    3.43  8.33  31.78  .33    .000
      [CN=60.4         ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB NASHYD       0328  1  5.0  171.14    5.78  6.83  31.08  .32    .000
      [CN=59.7         ]
      [ N = 3.0:Tp  .81]
*
  *   CALIB STANDHYD     0329  1  5.0  117.37   15.10  6.08  55.99  .57    .000
      [I%=37.0:S%= 2.00]
*
  *   CALIB NASHYD       3256  1  5.0   13.61     .96  6.33  36.80  .38    .000
      [CN=65.8         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB NASHYD       5254  1  5.0   11.03     .86  6.25  34.78  .36    .000
      [CN=62.9         ]
      [ N = 3.0:Tp  .28]
*
  *   CALIB NASHYD       3254  1  5.0   13.91    1.14  6.42  45.78  .47    .000
      [CN=74.1         ]
      [ N = 3.0:Tp  .41]
*
  *   CALIB NASHYD       3255  1  5.0   53.36    1.83  6.83  30.13  .31    .000
      [CN=58.4         ]
      [ N = 3.0:Tp  .75]
*
  *   CALIB STANDHYD     5255  1  5.0   25.03    3.31  6.08  52.37  .54    .000
      [I%=32.9:S%= 2.00]
*
  *   CALIB NASHYD       3250  1  5.0   43.70    2.62  6.42  35.98  .37    .000
      [CN=64.8         ]
      [ N = 3.0:Tp  .45]
*
  *   CALIB NASHYD       5250  1  5.0   20.10     .65  6.75  26.81  .27    .000
      [CN=54.0         ]
      [ N = 3.0:Tp  .69]
*
  *   CALIB NASHYD       2306  1  5.0    4.18     .13  6.83  28.18  .29    .000
      [CN=54.8         ]
      [ N = 3.0:Tp  .77]
*
  *   CALIB NASHYD       0306  1  5.0  155.62    4.13  7.50  35.21  .36    .000
      [CN=64.3         ]
      [ N = 3.0:Tp 1.32]
*
  *   CALIB NASHYD       0305  1  5.0  309.29    4.13  9.00  29.66  .30    .000
      [CN=57.8         ]
      [ N = 3.0:Tp 2.55]
*
  *   CALIB NASHYD       0307  1  5.0  165.22    3.09  7.75  28.63  .29    .000
      [CN=56.8         ]
      [ N = 3.0:Tp 1.56]
*
  *   CALIB STANDHYD     2310  1  5.0   22.21    2.32  6.08  46.02  .47    .000
      [I%=25.0:S%= 2.00]
*
  *   CALIB NASHYD       0310  1  5.0  162.43    3.03  8.00  30.88  .32    .000
      [CN=59.6         ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD       0301  1  5.0  186.26    5.87  7.17  34.69  .36    .000
      [CN=63.9         ]
      [ N = 3.0:Tp 1.03]
*
  *   CALIB NASHYD       2301  1  5.0   49.24    1.96  6.92  38.63  .40    .000
      [CN=67.4         ]
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     [ N = 3.0:Tp  .89]
*
  *  CALIB NASHYD      2203  1  5.0    6.70     .42  6.33  33.95  .35    .000
     [CN=63.5        ]
     [ N = 3.0:Tp  .38]
*
  *  CALIB NASHYD      0203  1  5.0   30.53    1.05  6.92  32.02  .33    .000
     [CN=61.5        ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD      2204  1  5.0   15.92     .78  6.50  32.14  .33    .000
     [CN=61.5        ]
     [ N = 3.0:Tp  .51]
*
  *  CALIB NASHYD      0204  1  5.0   13.66     .42  6.83  27.94  .29    .000
     [CN=55.5        ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD      0202  1  5.0  307.29    5.17  8.42  31.91  .33    .000
     [CN=61.0        ]
     [ N = 3.0:Tp 2.08]
*
  *  CALIB STANDHYD    2211  1  5.0   27.27    2.47  6.08  43.29  .44    .000
     [I%=17.0:S%= 2.00]
*
  *  CALIB NASHYD      0211  1  5.0   50.58    1.82  7.00  36.83  .38    .000
     [CN=65.6        ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD      0300  1  5.0     .88     .08  6.17  31.17  .32    .000
     [CN=60.7        ]
     [ N = 3.0:Tp  .18]
*
  *  CALIB NASHYD      2300  1  5.0   30.27    1.66  6.67  41.24  .42    .000
     [CN=69.2        ]
     [ N = 3.0:Tp  .63]
*
  *  CALIB NASHYD      0103  1  5.0  223.30    4.68  7.92  33.97  .35    .000
     [CN=62.2        ]
     [ N = 3.0:Tp 1.71]
*
  *  CALIB STANDHYD    2025  1  5.0   10.24    1.20  6.00  45.35  .46    .000
     [I%=28.0:S%= 2.00]
*
  *  CALIB NASHYD      1025  1  5.0   35.23    1.43  6.67  30.19  .31    .000
     [CN=59.0        ]
     [ N = 3.0:Tp  .60]
*
  *  CALIB NASHYD      1028  1  5.0   32.85     .99  6.83  27.41  .28    .000
     [CN=56.4        ]
     [ N = 3.0:Tp  .78]
*
  *  CALIB STANDHYD    2028  1  5.0    9.83    1.16  6.00  45.58  .47    .000
     [I%=31.0:S%= 2.00]
*
  *  CALIB NASHYD      1021  1  5.0   26.87     .62  6.92  21.92  .22    .000
     [CN=48.5        ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD      0105  1  5.0  509.25    7.90  8.08  26.58  .27    .000
     [CN=53.7        ]
     [ N = 3.0:Tp 1.81]
*
  *  CALIB NASHYD      1045  1  5.0  188.03    3.56  7.08  20.59  .21    .000
     [CN=45.6        ]
     [ N = 3.0:Tp  .98]
*
  *  CALIB NASHYD      2045  1  5.0    8.17     .34  6.33  21.37  .22    .000
     [CN=45.2        ]
     [ N = 3.0:Tp  .34]
*
  *  CALIB NASHYD      1047  1  5.0    6.75     .22  6.58  24.72  .25    .000
     [CN=50.3        ]
     [ N = 3.0:Tp  .59]
*
  *  CALIB NASHYD      2041  1  5.0     .96     .05  6.25  24.96  .26    .000
     [CN=50.2        ]
     [ N = 3.0:Tp  .31]
*
  *  CALIB NASHYD      2042  1  5.0     .87     .05  6.17  19.88  .20    .000
     [CN=44.1        ]
     [ N = 3.0:Tp  .20]
*
  *  CALIB NASHYD      1040  1  5.0  452.51    6.24  7.83  21.64  .22    .000
     [CN=47.7        ]
     [ N = 3.0:Tp 1.59]
*
  *  CALIB NASHYD      1041  1  5.0   76.98     .97  7.58  18.04  .18    .000
     [CN=41.6        ]
     [ N = 3.0:Tp 1.40]
*
  *  CALIB NASHYD      0108  1  5.0  673.15    6.81  9.92  27.01  .28    .000
     [CN=54.7        ]
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     [ N = 3.0:Tp 3.22]
*
  *  CALIB NASHYD      1070  1  5.0  137.82    2.97  7.42  27.93  .29    .000
     [CN=56.1        ]
     [ N = 3.0:Tp 1.26]
*
  *  CALIB NASHYD      0106  1  5.0  814.51    8.76  9.25  25.02  .26    .000
     [CN=51.8        ]
     [ N = 3.0:Tp 2.69]
*
  *  CALIB NASHYD      2071  1  5.0   16.86     .78  6.42  28.73  .29    .000
     [CN=55.6        ]
     [ N = 3.0:Tp  .46]
*
  *  CALIB NASHYD      1071  1  5.0   28.72     .83  6.75  25.07  .26    .000
     [CN=51.4        ]
     [ N = 3.0:Tp  .73]
*
  *  CALIB NASHYD      2076  1  5.0     .92     .06  6.33  30.91  .32    .000
     [CN=57.2        ]
     [ N = 3.0:Tp  .34]
*
  *  CALIB NASHYD      1072  1  5.0     .71     .05  6.08  22.12  .23    .000
     [CN=47.6        ]
     [ N = 3.0:Tp  .13]
*
  *  CALIB STANDHYD    2075  1  5.0    1.10     .21  6.00  61.17  .63    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      1075  1  5.0   28.08     .67  6.92  23.55  .24    .000
     [CN=49.5        ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0109  1  5.0  228.84    2.44  8.50  20.35  .21    .000
     [CN=45.4        ]
     [ N = 3.0:Tp 2.06]
*
  *  CALIB NASHYD      0111  1  5.0 1152.01   11.42 10.42  28.69  .29    .000
     [CN=56.8        ]
     [ N = 3.0:Tp 3.59]
*
  *  CALIB STANDHYD    2110  1  5.0     .78     .15  6.00  59.78  .61    .000
     [I%=48.0:S%= 2.00]
*
  *  CALIB NASHYD      0110  1  5.0   58.53    1.58  7.00  27.96  .29    .000
     [CN=55.9        ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD      0112  1  5.0   32.04     .61  7.33  23.99  .25    .000
     [CN=49.9        ]
     [ N = 3.0:Tp 1.20]
*
  *  CALIB NASHYD      0113  1  5.0   23.58     .56  7.00  24.95  .26    .000
     [CN=52.0        ]
     [ N = 3.0:Tp  .95]
*
  *  CALIB NASHYD      0318  1  5.0   12.69     .42  6.83  30.14  .31    .000
     [CN=58.2        ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD      0311  1  5.0  536.71    6.60  9.50  30.23  .31    .000
     [CN=58.4        ]
     [ N = 3.0:Tp 2.91]
*
  *  CALIB NASHYD      0312  1  5.0   28.89     .95  6.92  32.06  .33    .000
     [CN=60.5        ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0313  1  5.0  607.44    5.67 10.17  25.88  .27    .000
     [CN=52.9        ]
     [ N = 3.0:Tp 3.38]
*
  *  CALIB NASHYD      0317  1  5.0  278.29    3.92  8.92  30.30  .31    .000
     [CN=58.7        ]
     [ N = 3.0:Tp 2.45]
*
  *  CALIB NASHYD      0316  1  5.0  211.32    3.13  8.50  28.74  .29    .000
     [CN=57.0        ]
     [ N = 3.0:Tp 2.14]
*
  *  CALIB STANDHYD    5145  1  5.0    3.56     .63  6.00  58.74  .60    .000
     [I%=46.1:S%= 2.00]
*
  *  CALIB NASHYD      3145  1  5.0  132.54    2.29  7.67  25.21  .26    .000
     [CN=52.1        ]
     [ N = 3.0:Tp 1.46]
*
  *  CALIB STANDHYD    5142  1  5.0    5.20     .81  6.00  57.12  .58    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD    5141  1  5.0   29.18    3.64  6.00  51.42  .53    .000
     [I%=34.1:S%= 2.00]
*
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*   CALIB NASHYD      5140  1  5.0  119.44    2.59  7.50  29.22  .30    .000
    [CN=57.3         ]
    [ N = 3.0:Tp 1.33]
*
*   CALIB NASHYD      3141  1  5.0   85.39    1.37  7.83  25.06  .26    .000
    [CN=52.3         ]
    [ N = 3.0:Tp 1.60]
*
*   CALIB NASHYD      0315  1  5.0  123.44    2.53  7.67  29.46  .30    .000
    [CN=57.8         ]
    [ N = 3.0:Tp 1.44]
*
*   CALIB STANDHYD    2213  1  5.0     .88     .12  6.00  50.82  .52    .000
    [I%=24.4:S%= 2.00]
*
*   CALIB NASHYD      2212  1  5.0     .55     .04  6.17  27.04  .28    .000
    [CN=53.1         ]
    [ N = 3.0:Tp  .22]
*
*   CALIB STANDHYD    2210  1  5.0   23.61    2.53  6.08  45.22  .46    .000
    [I%=19.5:S%= 2.00]
*
*   CALIB NASHYD      0205  1  5.0 3159.99   18.64 13.17  25.36  .26    .000
    [CN=52.3         ]
    [ N = 3.0:Tp 5.93]
*
*   CALIB NASHYD      0206  1  5.0   73.80    2.13  7.17  33.37  .34    .000
    [CN=61.6         ]
    [ N = 3.0:Tp 1.10]
*
*   CALIB NASHYD      2206  1  5.0    3.51     .29  6.25  34.11  .35    .000
    [CN=63.5         ]
    [ N = 3.0:Tp  .25]
*
*   CALIB NASHYD      0207  1  5.0  315.33    5.45  8.58  33.98  .35    .000
    [CN=62.7         ]
    [ N = 3.0:Tp 2.20]
*
*   CALIB NASHYD      2207  1  5.0   44.56    1.10  7.33  30.55  .31    .000
    [CN=58.6         ]
    [ N = 3.0:Tp 1.19]
*
*   CALIB NASHYD      2269  1  5.0     .84     .06  6.25  31.35  .32    .000
    [CN=60.4         ]
    [ N = 3.0:Tp  .28]
*
*   CALIB NASHYD      0208  1  5.0   33.63    1.25  7.00  36.92  .38    .000
    [CN=65.8         ]
    [ N = 3.0:Tp  .91]
*
*   CALIB NASHYD      2208  1  5.0     .69     .04  6.17  22.24  .23    .000
    [CN=49.0         ]
    [ N = 3.0:Tp  .23]
*
*   CALIB STANDHYD    2209  1  5.0     .57     .06  6.00  42.39  .43    .000
    [I%=18.8:S%= 2.00]
*
*   CALIB NASHYD      0209  1  5.0  295.05    4.06  8.50  26.53  .27    .000
    [CN=53.9         ]
    [ N = 3.0:Tp 2.11]
*
*   CALIB NASHYD      0210  1  5.0   18.83     .53  7.17  32.12  .33    .000
    [CN=60.8         ]
    [ N = 3.0:Tp 1.09]
*
*   CALIB NASHYD      9262  1  5.0    7.50     .37  6.42  27.80  .28    .000
    [CN=55.7         ]
    [ N = 3.0:Tp  .40]
*
*   CALIB NASHYD      9263  1  5.0    2.35     .15  6.25  27.78  .28    .000
    [CN=55.7         ]
    [ N = 3.0:Tp  .25]
*
*   CALIB STANDHYD    5261  1  5.0   37.50    4.86  6.08  54.38  .56    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD    5262  1  5.0    7.50    1.11  6.00  54.38  .56    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD      3265  1  5.0   26.53    1.02  6.58  27.80  .28    .000
    [CN=55.7         ]
    [ N = 3.0:Tp  .57]
*
*   CALIB STANDHYD    5263  1  5.0    2.35     .36  6.00  54.37  .56    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD      5260  1  5.0   54.55    2.67  6.58  35.37  .36    .000
    [CN=63.8         ]
    [ N = 3.0:Tp  .58]
*
*   CALIB NASHYD      2001  1  5.0   19.92    1.15  6.42  33.25  .34    .000
    [CN=62.2         ]
    [ N = 3.0:Tp  .42]
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*
*   CALIB NASHYD      0309  1  5.0  157.12    4.47  7.25  33.83  .35    .000
    [CN=63.0         ]
    [ N = 3.0:Tp 1.14]
*
    ADD [5254 + 3254]  6254  3  5.0   24.94    1.95  6.33  40.92  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30    3.35  6.50  33.56  n/a    .000
*
    ADD [6255 + 5255]  6256  3  5.0  103.33    5.42  6.17  38.12  n/a    .000
*
    ADD [3250 + 5250]  6250  3  5.0   63.80    3.19  6.50  33.09  n/a    .000
*
    ADD [2306 + 0306]  6306  3  5.0  159.80    4.22  7.42  35.03  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    7.49  8.00  31.49  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31   10.56  7.92  30.75  n/a    .000
*
    ADD [2310 + 0310]  6310  3  5.0  184.64    3.26  8.00  32.70  n/a    .000
*
    ADD [0301 + 2301]  6301  3  5.0  235.50    7.80  7.08  35.52  n/a    .000
*
    ADD [2203 + 0203]  6203  3  5.0   37.23    1.33  6.67  32.37  n/a    .000
*
    ADD [2204 + 0204]  6204  3  5.0   29.58    1.16  6.58  30.20  n/a    .000
*
    ADD [2211 + 0211]  6211  3  5.0   77.85    3.12  6.17  39.09  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15    1.68  6.67  40.95  n/a    .000
*
    ADD [2025 + 1025]  6025  3  5.0   45.47    1.80  6.50  33.60  n/a    .000
*
    ADD [1028 + 2028]  6028  3  5.0   42.68    1.37  6.08  31.60  n/a    .000
*
    ADD [1045 + 2045]  6045  3  5.0  196.20    3.67  7.08  20.62  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95    3.85  7.00  20.76  n/a    .000
*
    ADD [2041 + 2042]  6042  3  5.0    1.83     .09  6.25  22.55  n/a    .000
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    7.20  7.83  21.12  n/a    .000
*
    ADD [2071 + 1071]  6071  3  5.0   45.58    1.54  6.58  26.43  n/a    .000
*
    ADD [2075 + 1075]  6075  3  5.0   29.18     .69  6.92  24.97  n/a    .000
*
    ADD [2110 + 0110]  6110  3  5.0   59.31    1.59  7.00  28.38  n/a    .000
*
    ADD [0311 + 0312]  7211  3  5.0  565.60    6.83  9.33  30.33  n/a    .000
*
    ADD [7211 + 0313]  7212  3  5.0 1173.04   12.39  9.67  28.03  n/a    .000
*
    ADD [5145 + 3145]  6145  3  5.0  136.10    2.33  7.67  26.09  n/a    .000
*
    RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .05  8.25  47.71  n/a    .000
    {ST=   .22 ha.m }
*
    ADD [0030 + 5141]  7318  3  5.0   34.38    3.65  6.00  50.86  n/a    .000
*
    ADD [7318 + 5140]  6140  3  5.0  153.82    4.04  6.08  34.06  n/a    .000
*
    ADD [6140 + 3141]  6141  3  5.0  239.21    4.31  7.50  30.84  n/a    .000
*
    ADD [2212 + 2210]  6212  3  5.0   24.16    2.56  6.08  44.81  n/a    .000
*
    ADD [0206 + 2206]  6206  3  5.0   77.31    2.18  7.17  33.40  n/a    .000
*
    ADD [0207 + 2207]  6207  3  5.0  359.89    6.23  8.33  33.56  n/a    .000
*
    ADD [6207 + 2269]  7207  3  5.0  360.73    6.24  8.33  33.55  n/a    .000
*
    ADD [2208 + 2209]  6209  3  5.0    1.26     .09  6.17  31.35  n/a    .000
*
    RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .28  8.50  41.44  n/a    .000
    {ST=  1.58 ha.m }
*
    RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .43  6.33  54.35  n/a    .000
    {ST=   .16 ha.m }
*
    RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .14  6.33  54.29  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [0070 + 5260]  6263  3  5.0   56.90    2.80  6.58  36.15  n/a    .000
*
    ADD [3256 + 6256]  6257  3  5.0  116.94    6.23  6.17  37.97  n/a    .000
*
    ADD [6203 + 6204]  6205  3  5.0   66.81    2.48  6.67  31.41  n/a    .000
*
    ADD [6025 + 6028]  6353  3  5.0   88.15    3.11  6.08  32.63  n/a    .000
*
    ADD [6042 + 6040]  6043  3  5.0  531.32    7.21  7.83  21.12  n/a    .000
*
```

```
*     ADD [0106 + 6071]  6106  3  5.0  860.09    9.02  9.17  25.10  n/a    .000
*     ADD [1072 + 6075]  6072  3  5.0   29.89     .70  6.92  24.90  n/a    .000
*     ADD [0111 + 6110]  6111  3  5.0 1211.32   11.74 10.33  28.68  n/a    .000
*     ADD [6145 + 6141]  6315  3  5.0  375.31    6.64  7.58  29.12  n/a    .000
*     ADD [0205 + 6206]  7205  3  5.0 3237.30   18.82 13.00  25.55  n/a    .000
*     ADD [7205 + 7207]  7208  3  5.0 3598.03   21.21 12.17  26.36  n/a    .000
*     ADD [0040 + 0060]  6265  3  5.0   45.00     .58  6.67  43.59  n/a    .000
*     ADD [6205 + 0202]  6202  3  5.0  374.10    6.05  8.08  31.82  n/a    .000
*     ADD [6353 + 1021]  6021  3  5.0  115.02    3.57  6.58  30.13  n/a    .000
*     ADD [6047 + 6043]  6048  3  5.0  734.27   10.46  7.50  21.02  n/a    .000
*     ADD [1070 + 6106]  6070  3  5.0  997.91   10.93  8.58  25.49  n/a    .000
*     ADD [2076 + 6072]  6076  3  5.0   30.81     .72  6.92  25.08  n/a    .000
*     ADD [6315 + 0315]  6316  3  5.0  498.75    9.17  7.58  29.20  n/a    .000
*     ADD [7208 + 0208]  6208  3  5.0 3631.66   21.35 12.08  26.45  n/a    .000
*     ADD [6265 + 3265]  7265  3  5.0   71.53    1.59  6.67  37.73  n/a    .000
*     ADD [0103 + 6021]  6103  3  5.0  338.32    6.73  7.25  32.67  n/a    .000
*     ADD [0105 + 6048]  6105  3  5.0 1243.52   17.97  7.75  23.30  n/a    .000
*     ADD [6070 + 6076]  6077  3  5.0 1028.72   11.24  8.42  25.48  n/a    .000
*     ADD [0316 + 6316]  7316  3  5.0  710.07   11.95  7.75  29.07  n/a    .000
*     ADD [6208 + 6209]  6210  3  5.0 3632.92   21.35 12.08  26.45  n/a    .000
*     ADD [0108 + 6077]  6108  3  5.0 1701.87   17.45  9.08  26.08  n/a    .000
*     ADD [0317 + 7316]  6317  3  5.0  988.36   15.36  8.00  29.41  n/a    .000
*     ADD [6210 + 0209]  7209  3  5.0 3927.97   23.46 11.08  26.46  n/a    .000
*     ADD [6105 + 6108]  6115  3  5.0 2945.39   33.80  8.17  24.91  n/a    .000
*     ADD [7212 + 6317]  7213  3  5.0 2161.40   25.88  8.58  28.66  n/a    .000
*     ADD [7209 + 0210]  7210  3  5.0 3946.80   23.56 11.00  26.49  n/a    .000
*     ADD [6115 + 0109]  6109  3  5.0 3174.23   36.21  8.17  24.58  n/a    .000
*     ADD [0318 + 7213]  6318  3  5.0 2174.09   26.03  8.50  28.67  n/a    .000
*     ADD [6212 + 7210]  6213  3  5.0 3970.96   23.64 11.00  26.60  n/a    .000
*     ADD [6109 + 6111]  6358  3  5.0 4385.55   45.67  8.50  25.71  n/a    .000
*     ADD [2213 + 6213]  7317  3  5.0 3971.84   23.65 11.00  26.60  n/a    .000
*     ADD [6358 + 0112]  6112  3  5.0 4417.59   46.11  8.50  25.70  n/a    .000
*     ADD [6103 + 6112]  6113  3  5.0 4755.91   51.75  8.33  26.19  n/a    .000
*     ADD [6113 + 0113]  6361  3  5.0 4779.49   52.07  8.33  26.19  n/a    .000
 FINISH
================================================================================================================
```

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 results for 4 hour Chicago and Regional storm
Existing condition
Aug-15

Flownode	Settlement	VO2ID	Area	2year	5year	10year	25 year	50 year	100 year	Regional
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	997.91	1.85	5.76	7.54	9.49	10.12	12.33	56.82
F3	Forest Home	6353	88.15	0.96	1.56	1.96	2.27	2.53	3.00	8.87
G1	Guthrie	6140	153.82	1.44	2.26	2.79	3.24	3.64	4.17	12.88
H1	Hawkestone	6207	359.89	1.13	3.35	4.34	5.41	5.76	6.96	25.27
H4	Hawkestone	6204	29.58	0.15	0.44	0.60	0.79	0.87	1.07	3.07
H5	Hawkestone	6301	235.5	1.21	3.51	4.66	6.00	6.47	7.85	23.16
R3	Rugby	2045	8.17	0.04	0.11	0.16	0.20	0.23	0.29	0.87
R4	Rugby	6048	734.27	1.56	5.04	6.65	8.51	9.14	11.23	52.94
S2	Shanty Bay	5250	20.1	0.09	0.25	0.35	0.46	0.50	0.62	2.00
S3	Shanty Bay	6256	103.33	1.33	2.32	2.96	3.47	3.88	4.84	10.91

Note: Regional Storm event (Hazel) is with all reservior routing removed and CN(II) converted to CN(III) for Nashhyd, and CNPA(II) to CNPA(III) for all stan

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 results for SCS 12 hour storm
Future condition
Aug-15

Flownode	Settlement	VO2ID	Area	2year	5year	10year	25 year	50 year	100 year
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	997.91	1.79	3.61	5.12	7.30	9.10	11.02
F3	Forest Home	6353	88.15	0.90	1.45	1.89	2.47	2.95	3.51
G1	Guthrie	6140	153.82	1.21	1.83	2.27	2.96	3.47	3.99
H1	Hawkestone	6207	359.89	1.10	2.21	3.10	4.37	5.41	6.53
H4	Hawkestone	6204	29.58	0.17	0.37	0.54	0.76	0.97	1.19
H5	Hawkestone	6301	235.5	1.25	2.55	3.61	5.12	6.38	7.72
R3	Rugby	8045	8.17	0.04	0.10	0.13	0.21	0.27	0.34
R4	Rugby	6048	734.27	1.54	3.29	4.75	6.86	8.65	10.57
S2	Shanty Bay	8250	20.1	0.10	0.19	0.27	0.41	0.53	0.65
S3	Shanty Bay	6256	103.33	1.34	2.15	2.86	3.81	4.56	5.50

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 result comparison for SCS 12 hour and Regional storm
Aug-15

Flownode	Settlement	VO2ID	Scenario	Area	2year	5year	10year	25 year	50 year	100 year	Regional
				(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	Ex.	997.91	1.74	3.56	5.06	7.23	9.02	10.93	56.82
		6070	Future Unc.	997.91	1.75	3.57	5.06	7.22	9.01	10.92	56.69
		6070	Future Cont.	997.91	1.79	3.61	5.12	7.30	9.10	11.02	
			% inc./decr.		2.9%	1.4%	1.2%	1.0%	0.9%	0.8%	-0.2%
F3	Forest Home	6353	Ex.	88.15	0.83	1.29	1.67	2.2	2.61	3.11	8.87
		6353	Future Unc.	88.15	0.97	1.51	1.96	2.54	3	3.56	8.90
		6353	Future Cont.	88.15	0.90	1.45	1.89	2.47	2.95	3.51	
			% inc./decr.		8.4%	12.4%	13.2%	12.3%	13.0%	12.9%	0.3%
G1	Guthrie	6140	Ex.	153.82	1.22	1.84	2.29	3	3.51	4.04	12.88
		6140	Future Unc.	153.82	1.42	2.12	2.63	3.4	3.96	4.55	13.01
		6140	Future Cont.	153.82	1.21	1.83	2.27	2.96	3.47	3.99	
			% inc./decr.		-1.1%	-0.5%	-0.9%	-1.3%	-1.1%	-1.2%	1.0%
H1	Hawkestone	6207	Ex.	359.89	1.06	2.13	2.98	4.2	5.19	6.23	25.27
		6207	Future Unc.	359.89	1.14	2.25	3.14	4.4	5.43	6.5	25.41
		6207	Future Cont.	359.89	1.10	2.21	3.10	4.37	5.41	6.53	
			% inc./decr.		3.8%	3.8%	4.0%	4.0%	4.2%	4.8%	0.6%
H4	Hawkestone	6204	Ex.	29.58	0.18	0.38	0.54	0.77	0.96	1.16	3.07
		6204	Future Unc.	29.58	0.29	0.55	0.76	1.05	1.28	1.52	3.20
		6204	Future Cont.	29.58	0.17	0.37	0.54	0.76	0.97	1.19	
			% inc./decr.		-6.1%	-2.6%	0.0%	-1.3%	1.0%	2.6%	4.2%
H5	Hawkestone	6301	Ex.	235.5	1.31	2.65	3.73	5.26	6.5	7.8	23.16
		6301	Future Unc.	235.5	1.45	2.88	4.02	5.62	6.91	8.26	23.325
		6301	Future Cont.	235.5	1.25	2.55	3.61	5.12	6.38	7.72	
			% inc./decr.		-4.6%	-3.8%	-3.2%	-2.7%	-1.8%	-1.0%	0.7%
R3	Rugby	2045	Ex.	8.17	0.06	0.11	0.16	0.22	0.28	0.34	0.87
		8045	Future Unc.	8.17	0.22	0.33	0.40	0.52	0.61	0.70	0.97
		8045	Future Cont.	8.17	0.04	0.10	0.13	0.21	0.27	0.34	
			% inc./decr.		-33.3%	-9.1%	-18.8%	-4.5%	-3.6%	0.0%	10.6%
R4	Rugby	6048	Ex.	734.27	1.52	3.23	4.67	6.78	8.55	10.46	52.94
		6048	Future Unc.	734.27	1.53	3.25	4.69	6.79	8.56	10.46	52.86
		6048	Future Cont.	734.27	1.54	3.29	4.75	6.86	8.65	10.57	
			% inc./decr.		1.3%	1.9%	1.7%	1.2%	1.2%	1.1%	-0.2%
S2	Shanty Bay	5250	Ex.	20.1	0.1	0.21	0.3	0.43	0.54	0.65	2.00
		8250	Future Unc.	20.1	0.22	0.41	0.56	0.77	0.94	1.11	2.29
		8250	Future Cont.	20.1	0.10	0.19	0.27	0.41	0.53	0.65	
			% inc./decr.		0.0%	-9.5%	-10.0%	-4.7%	-1.9%	0.0%	14.6%
S3	Shanty Bay	6256	Ex.	103.33	1.34	2.1	2.79	3.72	4.47	5.42	10.91
		6256	Future Unc.	103.33	1.54	2.44	3.21	4.26	5.09	6.14	11.06
		6256	Future Cont.	103.33	1.34	2.15	2.86	3.81	4.56	5.50	
			% inc./decr.		0.0%	2.4%	2.5%	2.4%	2.0%	1.5%	1.4%

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

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
         V V    I      SS   U   U A   A  L
          VV    I    SSSSS  UUUUU A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                    *****  S U M M A R Y   O U T P U T  *****


  Input   filename: C:\Program Files\Visual OTTHYMO 2.2.4\voin.dat

  Output  filename: C:\Users\jash\Desktop\Project Files\113238 - Oro-Medonte SWM Master Plan\CSWMM Report UPDATE - May
2015\2nd submission\O
  Summary filename: C:\Users\jash\Desktop\Project Files\113238 - Oro-Medonte SWM Master Plan\CSWMM Report UPDATE - May
2015\2nd submission\O


DATE: 10/26/2015                          TIME: 12:02:42 PM

USER:


COMMENTS: _____________________________________________________


  ****************************
  ** SIMULATION NUMBER:   1 ** 2 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha      cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                5.0
      [ Ptot= 40.53 mm ]
*
  **  CALIB NASHYD      0100  1  5.0  835.70    1.82  9.33   5.13  .13    .000
      [CN=57.8        ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD      0101  1  5.0   96.09     .98  6.67   7.96  .20    .000
      [CN=69.2        ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD      0114  1  5.0  193.26     .82  7.42   5.61  .14    .000
      [CN=61.3        ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD      0115  1  5.0  170.62     .83  7.75   7.37  .18    .000
      [CN=69.3        ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD      0116  1  5.0  289.79     .96  8.50   6.37  .16    .000
      [CN=63.5        ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD    0200  1  5.0   89.02    1.82  6.17  12.24  .30    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD      0201  1  5.0  255.45     .77  8.67   5.96  .15    .000
      [CN=63.2        ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD    0302  1  5.0   20.91     .98  6.08  19.50  .48    .000
      [I%=36.2:S%= 2.00]
*
  *   CALIB NASHYD      0303  1  5.0  611.79    1.31  9.17   4.88  .12    .000
      [CN=57.2        ]
      [ N = 3.0:Tp 2.51]
*
  *   CALIB STANDHYD    0304  1  5.0   46.90    1.18  6.08  13.24  .33    .000
      [I%=19.8:S%= 2.00]
*
  *   CALIB STANDHYD    0308  1  5.0   44.53    1.15  6.08  13.62  .34    .000
      [I%=20.3:S%= 2.00]
*
  *   CALIB STANDHYD    0320  1  5.0   46.41    1.44  6.08  15.10  .37    .000
      [I%=25.4:S%= 2.00]
*
  *   CALIB STANDHYD    0003  1  5.0   21.92     .74  6.08  14.48  .36    .000
      [I%=26.8:S%= 2.00]
*
  *   CALIB STANDHYD    0321  1  5.0   34.71    1.39  6.08  17.91  .44    .000
      [I%=32.5:S%= 2.00]
*
  *   CALIB NASHYD      0322  1  5.0  207.40     .49  8.92   5.02  .12    .000
      [CN=58.1        ]
      [ N = 3.0:Tp 2.28]
*
  *   CALIB NASHYD      0323  1  5.0  236.30    1.36  7.00   6.04  .15    .000
      [CN=63.4        ]
      [ N = 3.0:Tp  .88]
*
  *   CALIB NASHYD      0324  1  5.0  303.00    1.01  8.17   5.78  .14    .000
      [CN=62.3        ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD      0325  1  5.0  156.62    1.03  6.83   5.78  .14    .000
      [CN=62.3        ]
      [ N = 3.0:Tp  .69]
*
  *   CALIB STANDHYD    5257  1  5.0   10.19     .41  6.00  17.00  .42    .000
      [I%=28.8:S%= 2.00]
*
  *   CALIB STANDHYD    0001  1  5.0    9.26     .28  6.00  12.28  .30    .000
      [I%=22.2:S%= 2.00]
*
  *   CALIB NASHYD      3269  1  5.0  124.61     .65  6.92   5.01  .12    .000
      [CN=57.3        ]
      [ N = 3.0:Tp  .78]
*
  *   CALIB NASHYD      0327  1  5.0  198.82     .57  8.50   5.53  .14    .000
      [CN=60.4        ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB NASHYD      0328  1  5.0  171.14     .93  6.92   5.35  .13    .000
      [CN=59.7        ]
      [ N = 3.0:Tp  .81]
*
  *   CALIB STANDHYD    0329  1  5.0  117.37    4.49  6.17  18.62  .46    .000
      [I%=37.0:S%= 2.00]
*
  *   CALIB NASHYD      3256  1  5.0   13.61     .16  6.33   6.74  .17    .000
      [CN=65.8        ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD    5255  1  5.0   25.03    1.08  6.08  17.97  .44    .000
      [I%=35.2:S%= 2.00]
*
  *   CALIB NASHYD      5254  1  5.0   11.03     .25  6.25   9.90  .24    .000
      [CN=73.1        ]
      [ N = 3.0:Tp  .27]
*
  *   CALIB NASHYD      3254  1  5.0   13.91     .22  6.42   9.20  .23    .000
      [CN=74.1        ]
      [ N = 3.0:Tp  .41]
*
  *   CALIB NASHYD      3255  1  5.0   53.36     .30  6.83   5.18  .13    .000
      [CN=58.4        ]
      [ N = 3.0:Tp  .75]
*
  *   CALIB NASHYD      5250  1  5.0   20.10     .22  6.67   8.51  .21    .000
      [CN=69.8        ]
      [ N = 3.0:Tp  .63]
*
  *   CALIB NASHYD      3250  1  5.0   43.70     .45  6.50   6.57  .16    .000
      [CN=64.8        ]
      [ N = 3.0:Tp  .45]
*
  *   CALIB STANDHYD    2306  1  5.0    4.18     .11  6.00  11.91  .29    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD      0306  1  5.0  155.62     .69  7.58   6.31  .16    .000
      [CN=64.3        ]
      [ N = 3.0:Tp 1.32]
*
  *   CALIB NASHYD      0305  1  5.0  309.29     .68  9.25   5.10  .13    .000
      [CN=57.8        ]
      [ N = 3.0:Tp 2.55]
*
  *   CALIB NASHYD      0307  1  5.0  165.22     .49  7.92   4.79  .12    .000
      [CN=56.8        ]
      [ N = 3.0:Tp 1.56]
*
  *   CALIB STANDHYD    2310  1  5.0   22.21     .81  6.08  16.01  .39    .000
      [I%=28.6:S%= 2.00]
*
  *   CALIB NASHYD      0310  1  5.0  162.43     .49  8.17   5.27  .13    .000
      [CN=59.6        ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD      2301  1  5.0   49.24     .50  6.92   9.85  .24    .000
```

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      [CN=73.1        ]
      [ N = 3.0:Tp  .84]
*
   *  CALIB NASHYD      0301  1  5.0  186.26     .97  7.25   6.14  .15    .000
      [CN=63.9        ]
      [ N = 3.0:Tp 1.03]
*
   *  CALIB NASHYD      2203  1  5.0    6.70     .12  6.33   9.50  .23    .000
      [CN=72.8        ]
      [ N = 3.0:Tp  .35]
*
   *  CALIB NASHYD      0203  1  5.0   30.53     .16  7.00   5.37  .13    .000
      [CN=61.5        ]
      [ N = 3.0:Tp  .82]
*
   *  CALIB NASHYD      2204  1  5.0   15.92     .23  6.50   9.27  .23    .000
      [CN=72.3        ]
      [ N = 3.0:Tp  .47]
*
   *  CALIB NASHYD      0204  1  5.0   13.66     .07  6.92   4.76  .12    .000
      [CN=55.5        ]
      [ N = 3.0:Tp  .79]
*
   *  CALIB NASHYD      0202  1  5.0  307.29     .84  8.67   5.44  .13    .000
      [CN=61.0        ]
      [ N = 3.0:Tp 2.08]
*
   *  CALIB STANDHYD    2211  1  5.0   27.27     .80  6.08  15.08  .37    .000
      [I%=21.4:S%= 2.00]
*
   *  CALIB NASHYD      0211  1  5.0   50.58     .32  7.08   6.83  .17    .000
      [CN=65.6        ]
      [ N = 3.0:Tp  .94]
*
   *  CALIB NASHYD      0300  1  5.0     .88     .01  6.17   5.18  .13    .000
      [CN=60.7        ]
      [ N = 3.0:Tp  .18]
*
   *  CALIB STANDHYD    2300  1  5.0   30.27     .71  6.08  12.89  .32    .000
      [I%=16.6:S%= 2.00]
*
   *  CALIB NASHYD      0103  1  5.0  223.30     .82  8.08   6.22  .15    .000
      [CN=62.2        ]
      [ N = 3.0:Tp 1.71]
*
   *  CALIB STANDHYD    2025  1  5.0   10.24     .45  6.00  16.45  .41    .000
      [I%=33.0:S%= 2.00]
*
   *  CALIB NASHYD      1025  1  5.0   35.23     .22  6.67   5.06  .12    .000
      [CN=59.0        ]
      [ N = 3.0:Tp  .60]
*
   *  CALIB STANDHYD    2028  1  5.0    9.83     .46  6.00  16.83  .42    .000
      [I%=35.6:S%= 2.00]
*
   *  CALIB NASHYD      1028  1  5.0   32.85     .14  6.92   4.29  .11    .000
      [CN=56.4        ]
      [ N = 3.0:Tp  .78]
*
   *  CALIB NASHYD      1021  1  5.0   26.87     .09  7.00   3.29  .08    .000
      [CN=48.5        ]
      [ N = 3.0:Tp  .82]
*
   *  CALIB NASHYD      0105  1  5.0  509.25    1.28  8.25   4.48  .11    .000
      [CN=53.7        ]
      [ N = 3.0:Tp 1.81]
*
   *  CALIB STANDHYD    2045  1  5.0    8.17     .22  6.00  11.12  .27    .000
      [I%=19.7:S%= 2.00]
*
   *  CALIB NASHYD      1045  1  5.0  188.03     .52  7.17   3.22  .08    .000
      [CN=45.6        ]
      [ N = 3.0:Tp  .98]
*
   *  CALIB NASHYD      1047  1  5.0    6.75     .04  6.67   4.28  .11    .000
      [CN=50.3        ]
      [ N = 3.0:Tp  .59]
*
   *  CALIB NASHYD      2042  1  5.0     .87     .01  6.17   5.47  .14    .000
      [CN=57.4        ]
      [ N = 3.0:Tp  .16]
*
   *  CALIB STANDHYD    2041  1  5.0     .96     .02  6.00  10.11  .25    .000
      [I%=16.5:S%= 2.00]
*
   *  CALIB NASHYD      1040  1  5.0  452.51     .90  8.00   3.32  .08    .000
      [CN=47.7        ]
      [ N = 3.0:Tp 1.59]
*
   *  CALIB NASHYD      1041  1  5.0   76.98     .14  7.75   2.73  .07    .000
      [CN=41.6        ]
      [ N = 3.0:Tp 1.40]
*
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   *  CALIB NASHYD      0108  1  5.0  673.15    1.10 10.25   4.46  .11    .000
      [CN=54.7        ]
      [ N = 3.0:Tp 3.22]
*
   *  CALIB NASHYD      1070  1  5.0  137.82     .46  7.50   4.61  .11    .000
      [CN=56.1        ]
      [ N = 3.0:Tp 1.26]
*
   *  CALIB NASHYD      0106  1  5.0  814.51    1.40  9.42   4.12  .10    .000
      [CN=51.8        ]
      [ N = 3.0:Tp 2.69]
*
   *  CALIB STANDHYD    2071  1  5.0   16.86     .43  6.00  11.86  .29    .000
      [I%=19.3:S%= 2.00]
*
   *  CALIB NASHYD      1071  1  5.0   28.72     .13  6.83   4.22  .10    .000
      [CN=51.4        ]
      [ N = 3.0:Tp  .73]
*
   *  CALIB STANDHYD    2076  1  5.0     .92     .03  6.00  11.56  .29    .000
      [I%=17.9:S%= 2.00]
*
   *  CALIB NASHYD      1072  1  5.0     .71     .01  6.08   3.64  .09    .000
      [CN=47.6        ]
      [ N = 3.0:Tp  .13]
*
   *  CALIB STANDHYD    2075  1  5.0    1.10     .08  6.00  22.17  .55    .000
      [I%=50.0:S%= 2.00]
*
   *  CALIB NASHYD      1075  1  5.0   28.08     .10  7.00   3.87  .10    .000
      [CN=49.5        ]
      [ N = 3.0:Tp  .87]
*
   *  CALIB NASHYD      0109  1  5.0  228.84     .36  8.67   3.13  .08    .000
      [CN=45.4        ]
      [ N = 3.0:Tp 2.06]
*
   *  CALIB NASHYD      0111  1  5.0 1152.01    1.88 10.67   4.83  .12    .000
      [CN=56.8        ]
      [ N = 3.0:Tp 3.59]
*
   *  CALIB STANDHYD    2110  1  5.0     .78     .06  6.00  22.17  .55    .000
      [I%=50.0:S%= 2.00]
*
   *  CALIB NASHYD      0110  1  5.0   58.53     .25  7.08   4.67  .12    .000
      [CN=55.9        ]
      [ N = 3.0:Tp  .94]
*
   *  CALIB NASHYD      0112  1  5.0   32.04     .10  7.42   4.00  .10    .000
      [CN=49.9        ]
      [ N = 3.0:Tp 1.20]
*
   *  CALIB NASHYD      0113  1  5.0   23.58     .08  7.17   4.03  .10    .000
      [CN=52.0        ]
      [ N = 3.0:Tp  .95]
*
   *  CALIB NASHYD      0318  1  5.0   12.69     .07  6.92   5.23  .13    .000
      [CN=58.2        ]
      [ N = 3.0:Tp  .79]
*
   *  CALIB NASHYD      0311  1  5.0  536.71    1.11  9.75   5.23  .13    .000
      [CN=58.4        ]
      [ N = 3.0:Tp 2.91]
*
   *  CALIB NASHYD      0312  1  5.0   28.89     .16  7.00   5.65  .14    .000
      [CN=60.5        ]
      [ N = 3.0:Tp  .87]
*
   *  CALIB NASHYD      0313  1  5.0  607.44     .92 10.42   4.30  .11    .000
      [CN=52.9        ]
      [ N = 3.0:Tp 3.38]
*
   *  CALIB NASHYD      0317  1  5.0  278.29     .65  9.08   5.20  .13    .000
      [CN=58.7        ]
      [ N = 3.0:Tp 2.45]
*
   *  CALIB NASHYD      0316  1  5.0  211.32     .50  8.75   4.80  .12    .000
      [CN=57.0        ]
      [ N = 3.0:Tp 2.14]
*
   *  CALIB STANDHYD    5145  1  5.0    3.56     .25  6.00  22.63  .56    .000
      [I%=51.2:S%= 2.00]
*
   *  CALIB NASHYD      3145  1  5.0  132.54     .36  7.83   4.14  .10    .000
      [CN=52.1        ]
      [ N = 3.0:Tp 1.46]
*
   *  CALIB STANDHYD    5141  1  5.0   29.18    1.17  6.08  16.72  .41    .000
      [I%=33.8:S%= 2.00]
*
   *  CALIB STANDHYD    5142  1  5.0    5.20     .26  6.00  18.64  .46    .000
      [I%=35.0:S%= 2.00]
*
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*   CALIB NASHYD      5140  1  5.0  119.44     .42  7.58   4.99  .12    .000
      [CN=57.3        ]
      [ N = 3.0:Tp 1.33]
*
*   CALIB NASHYD      3141  1  5.0   85.39     .21  8.00   4.03  .10    .000
      [CN=52.3        ]
      [ N = 3.0:Tp 1.60]
*
*   CALIB NASHYD      0315  1  5.0  123.44     .40  7.75   4.98  .12    .000
      [CN=57.8        ]
      [ N = 3.0:Tp 1.44]
*
*   CALIB STANDHYD    2213  1  5.0     .88     .03  6.00  15.14  .37    .000
      [I%=24.4:S%= 2.00]
*
*   CALIB STANDHYD    2210  1  5.0   23.61     .71  6.08  14.65  .36    .000
      [I%=22.4:S%= 2.00]
*
*   CALIB NASHYD      2212  1  5.0     .55     .01  6.17   4.85  .12    .000
      [CN=53.1        ]
      [ N = 3.0:Tp  .22]
*
*   CALIB NASHYD      0205  1  5.0 3159.99    3.06 13.42   4.18  .10    .000
      [CN=52.3        ]
      [ N = 3.0:Tp 5.93]
*
*   CALIB NASHYD      0206  1  5.0   73.80     .37  7.25   6.05  .15    .000
      [CN=61.6        ]
      [ N = 3.0:Tp 1.10]
*
*   CALIB NASHYD      2206  1  5.0    3.51     .07  6.25   8.54  .21    .000
      [CN=70.5        ]
      [ N = 3.0:Tp  .24]
*
*   CALIB NASHYD      2207  1  5.0   44.56     .33  7.25   8.69  .21    .000
      [CN=70.3        ]
      [ N = 3.0:Tp 1.06]
*
*   CALIB NASHYD      0207  1  5.0  315.33     .93  8.75   6.08  .15    .000
      [CN=62.7        ]
      [ N = 3.0:Tp 2.20]
*
*   CALIB NASHYD      2269  1  5.0     .84     .01  6.25   5.31  .13    .000
      [CN=60.4        ]
      [ N = 3.0:Tp  .28]
*
*   CALIB NASHYD      0208  1  5.0   33.63     .22  7.08   6.79  .17    .000
      [CN=65.8        ]
      [ N = 3.0:Tp  .91]
*
*   CALIB NASHYD      2208  1  5.0     .69     .02  6.17   9.25  .23    .000
      [CN=72.3        ]
      [ N = 3.0:Tp  .20]
*
*   CALIB STANDHYD    2209  1  5.0     .57     .02  6.00  13.99  .35    .000
      [I%=23.7:S%= 2.00]
*
*   CALIB NASHYD      0209  1  5.0  295.05     .65  8.67   4.41  .11    .000
      [CN=53.9        ]
      [ N = 3.0:Tp 2.11]
*
*   CALIB NASHYD      0210  1  5.0   18.83     .09  7.25   5.62  .14    .000
      [CN=60.8        ]
      [ N = 3.0:Tp 1.09]
*
*   CALIB NASHYD      9262  1  5.0    7.50     .06  6.42   4.65  .11    .000
      [CN=55.7        ]
      [ N = 3.0:Tp  .40]
*
*   CALIB NASHYD      9263  1  5.0    2.35     .02  6.25   4.64  .11    .000
      [CN=55.7        ]
      [ N = 3.0:Tp  .25]
*
*   CALIB STANDHYD    5261  1  5.0   37.50    1.56  6.08  17.94  .44    .000
      [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD    5262  1  5.0    7.50     .36  6.00  17.93  .44    .000
      [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD      3265  1  5.0   26.53     .16  6.67   4.65  .11    .000
      [CN=55.7        ]
      [ N = 3.0:Tp  .57]
*
*   CALIB STANDHYD    5260  1  5.0   54.55    1.29  6.08  12.71  .31    .000
      [I%=18.7:S%= 2.00]
*
*   CALIB STANDHYD    5263  1  5.0    2.35     .12  6.00  17.93  .44    .000
      [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD    9264  1  5.0   10.24     .38  6.00  14.40  .36    .000
      [I%=28.0:S%= 2.00]
*
*   CALIB NASHYD      2001  1  5.0   19.92     .19  6.42   5.84  .14    .000
      [CN=62.2        ]
      [ N = 3.0:Tp  .42]
*
*   CALIB NASHYD      0309  1 10.0  157.12     .73  7.33   5.93  .15    .000
      [CN=63.0        ]
      [ N = 3.0:Tp 1.14]
*
    RESRVR [ 2 : 5255] 8255  1  5.0   25.03    1.01  6.17  17.97  n/a    .000
    {ST=   .03 ha.m }
*
    RESRVR [ 2 : 5254] 8254  1  5.0   11.03     .14  6.67   9.89  n/a    .000
    {ST=   .03 ha.m }
*
    ADD [8254 + 3254]  6254  3  5.0   24.94     .34  6.50   9.51  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30     .61  6.67   6.56  n/a    .000
*
    RESRVR [ 2 : 5250] 8250  1  5.0   20.10     .10  7.75   8.50  n/a    .000
    {ST=   .07 ha.m }
*
    ADD [8250 + 3250]  6250  3  5.0   63.80     .49  6.50   7.18  n/a    .000
*
    RESRVR [ 2 : 2306] 8306  1  5.0    4.18     .02  7.17  11.83  n/a    .000
    {ST=   .02 ha.m }
*
    ADD [8306 + 0306]  6306  3  5.0  159.80     .71  7.58   6.45  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    1.26  8.25   5.56  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31    1.74  8.08   5.36  n/a    .000
*
    RESRVR [ 2 : 2310] 8310  1  5.0   22.21     .69  6.17  16.01  n/a    .000
    {ST=   .03 ha.m }
*
    ADD [8310 + 0310]  6310  3  5.0  184.64     .76  6.25   6.56  n/a    .000
*
    RESRVR [ 2 : 2301] 8301  1  5.0   49.24     .33  7.83   9.85  n/a    .000
    {ST=   .14 ha.m }
*
    ADD [8301 + 0301]  6301  3  5.0  235.50    1.25  7.42   6.92  n/a    .000
*
    RESRVR [ 2 : 2203] 8203  1  5.0    6.70     .06  6.92   9.49  n/a    .000
    {ST=   .02 ha.m }
*
    ADD [8203 + 0203]  6203  3  5.0   37.23     .22  7.00   6.11  n/a    .000
*
    RESRVR [ 2 : 2204] 8204  1  5.0   15.92     .10  7.33   9.26  n/a    .000
    {ST=   .06 ha.m }
*
    ADD [8204 + 0204]  6204  3  5.0   29.58     .17  7.17   7.18  n/a    .000
*
    RESRVR [ 2 : 2211] 8211  1  5.0   27.27     .73  6.25  15.08  n/a    .000
    {ST=   .03 ha.m }
*
    ADD [8211 + 0211]  6211  3  5.0   77.85     .85  6.25   9.72  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15     .72  6.08  12.68  n/a    .000
*
    RESRVR [ 2 : 2025] 8025  1  5.0   10.24     .38  6.08  16.45  n/a    .000
    {ST=   .02 ha.m }
*
    ADD [8025 + 1025]  6025  3  5.0   45.47     .47  6.17   7.62  n/a    .000
*
    RESRVR [ 2 : 2028] 8028  1  5.0    9.83     .40  6.08  16.83  n/a    .000
    {ST=   .01 ha.m }
*
    ADD [8028 + 1028]  6028  3  5.0   42.68     .42  6.17   7.18  n/a    .000
*
    RESRVR [ 2 : 2045] 8045  1  5.0    8.17     .04  7.00  11.08  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8045 + 1045]  6045  3  5.0  196.20     .56  7.17   3.54  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95     .59  7.17   3.57  n/a    .000
*
    RESRVR [ 2 : 2042] 8042  1  5.0     .87     .01  6.33   5.46  n/a    .000
    {ST=   .00 ha.m }
*
    RESRVR [ 2 : 2041] 8041  1  5.0     .96     .01  6.25  10.04  n/a    .000
    {ST=   .00 ha.m }
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    1.04  8.00   3.23  n/a    .000
*
    RESRVR [ 2 : 2071] 8071  1  5.0   16.86     .11  6.92  11.84  n/a    .000
    {ST=   .09 ha.m }
*
    ADD [8071 + 1071]  6071  3  5.0   45.58     .24  6.83   7.04  n/a    .000
*
    RESRVR [ 2 : 2076] 8076  1  5.0     .92     .01  6.50  11.50  n/a    .000
    {ST=   .00 ha.m }
*
    ADD [2075 + 1075]  6075  3  5.0   29.18     .11  7.00   4.56  n/a    .000
*
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      RESRVR [ 2 : 2110] 8110  1  5.0     .78     .05  6.08  22.17  n/a    .000
      {ST=   .00 ha.m }
*
      ADD [8110 + 0110]  6110  3  5.0   59.31     .25  7.08   4.90  n/a    .000
*
      ADD [0311 + 0312]  7211  3  5.0  565.60    1.15  9.67   5.26  n/a    .000
*
      ADD [7211 + 0313]  7212  3  5.0 1173.04    2.06 10.00   4.76  n/a    .000
*
      RESRVR [ 2 : 5145] 8145  1  5.0    3.56     .23  6.08  22.63  n/a    .000
      {ST=   .00 ha.m }
*
      ADD [8145 + 3145]  6145  3  5.0  136.10     .37  7.75   4.63  n/a    .000
*
      RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .00 12.08   9.73  n/a    .000
      {ST=   .09 ha.m }
*
      RESRVR [ 2 : 2210] 8210  1  5.0   23.61     .69  6.17  14.65  n/a    .000
      {ST=   .01 ha.m }
*
      ADD [8210 + 2212]  6212  3  5.0   24.16     .70  6.17  14.43  n/a    .000
*
      ADD [0206 + 2206]  6206  3  5.0   77.31     .38  7.25   6.17  n/a    .000
*
      RESRVR [ 2 : 2207] 8207  1  5.0   44.56     .17  8.92   8.68  n/a    .000
      {ST=   .16 ha.m }
*
      ADD [8207 + 0207]  6207  3  5.0  359.89    1.10  8.75   6.40  n/a    .000
*
      ADD [6207 + 2269]  7207  3  5.0  360.73    1.10  8.75   6.40  n/a    .000
*
      ADD [2208 + 2209]  6209  3  5.0    1.26     .03  6.08  11.39  n/a    .000
*
      RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .02 12.33   5.00  n/a    .000
      {ST=   .64 ha.m }
*
      RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .08  6.67  17.91  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 5260] 8260  1  5.0   54.55     .40  7.00  12.70  n/a    .000
      {ST=   .30 ha.m }
*
      RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .02  6.67  17.84  n/a    .000
      {ST=   .02 ha.m }
*
      ADD [8255 + 6255]  6256  3  5.0  103.33    1.34  6.25   9.32  n/a    .000
*
      ADD [6203 + 6204]  6205  3  5.0   66.81     .38  7.08   6.59  n/a    .000
*
      ADD [6025 + 6028]  6353  3  5.0   88.15     .90  6.17   7.41  n/a    .000
*
      ADD [8042 + 8041]  6042  3  5.0    1.83     .02  6.33   7.86  n/a    .000
*
      ADD [6042 + 6040]  6043  3  5.0  531.32    1.04  8.00   3.25  n/a    .000
*
      ADD [0106 + 6071]  6106  3  5.0  860.09    1.49  9.33   4.28  n/a    .000
*
      ADD [1072 + 6075]  6072  3  5.0   29.89     .11  7.00   4.53  n/a    .000
*
      ADD [0111 + 6110]  6111  3  5.0 1211.32    1.94 10.58   4.84  n/a    .000
*
      ADD [5141 + 0030]  7318  3  5.0   34.38    1.17  6.08  15.66  n/a    .000
*
      ADD [0205 + 6206]  7205  3  5.0 3237.30    3.09 13.25   4.23  n/a    .000
*
      ADD [7205 + 7207]  7208  3  5.0 3598.03    3.61 12.25   4.44  n/a    .000
*
      ADD [0040 + 0060]  6265  3  5.0   45.00     .08  6.67   7.15  n/a    .000
*
      ADD [8260 + 0070]  6263  3  5.0   56.90     .43  7.00  12.91  n/a    .000
*
      ADD [3256 + 6256]  6257  3  5.0  116.94    1.49  6.25   9.02  n/a    .000
*
      ADD [6205 + 0202]  6202  3  5.0  374.10    1.05  8.17   5.64  n/a    .000
*
      ADD [6353 + 1021]  6021  3  5.0  115.02     .92  6.17   6.45  n/a    .000
*
      ADD [6047 + 6043]  6048  3  5.0  734.27    1.54  7.58   3.34  n/a    .000
*
      ADD [1070 + 6106]  6070  3  5.0  997.91    1.79  8.75   4.32  n/a    .000
*
      ADD [8076 + 6072]  6076  3  5.0   30.81     .12  6.92   4.74  n/a    .000
*
      ADD [7318 + 5140]  6140  3  5.0  153.82    1.21  6.08   7.38  n/a    .000
*
      ADD [7208 + 0208]  6208  3  5.0 3631.66    3.64 12.25   4.47  n/a    .000
*
      ADD [6265 + 3265]  7265  3  5.0   71.53     .24  6.67   6.22  n/a    .000
*
      ADD [0103 + 6021]  6103  3  5.0  338.32    1.16  7.33   6.30  n/a    .000
*
      ADD [0105 + 6048]  6105  3  5.0 1243.52    2.76  7.92   3.81  n/a    .000
*
      ADD [6070 + 6076]  6077  3  5.0 1028.72    1.84  8.67   4.33  n/a    .000
*
      ADD [6140 + 3141]  6141  3  5.0  239.21    1.22  6.08   6.18  n/a    .000
*
      ADD [6208 + 6209]  6210  3  5.0 3632.92    3.64 12.25   4.47  n/a    .000
*
      ADD [0108 + 6077]  6108  3  5.0 1701.87    2.84  9.33   4.39  n/a    .000
*
      ADD [6145 + 6141]  6315  3  5.0  375.31    1.48  6.08   5.62  n/a    .000
*
      ADD [6210 + 0209]  7209  3  5.0 3927.97    4.00 11.42   4.46  n/a    .000
*
      ADD [6105 + 6108]  6115  3  5.0 2945.39    5.35  8.42   4.14  n/a    .000
*
      ADD [6315 + 0315]  6316  3  5.0  498.75    1.52  7.67   5.46  n/a    .000
*
      ADD [7209 + 0210]  7210  3  5.0 3946.80    4.01 11.42   4.47  n/a    .000
*
      ADD [6115 + 0109]  6109  3  5.0 3174.23    5.71  8.42   4.07  n/a    .000
*
      ADD [0316 + 6316]  7316  3  5.0  710.07    1.95  7.92   5.26  n/a    .000
*
      ADD [6212 + 7210]  6213  3  5.0 3970.96    4.04 11.33   4.53  n/a    .000
*
      ADD [6109 + 6111]  6358  3  5.0 4385.55    7.27  8.75   4.28  n/a    .000
*
      ADD [0317 + 7316]  6317  3  5.0  988.36    2.51  8.08   5.25  n/a    .000
*
      ADD [2213 + 6213]  7317  3  5.0 3971.84    4.04 11.33   4.53  n/a    .000
*
      ADD [6358 + 0112]  6112  3  5.0 4417.59    7.34  8.75   4.28  n/a    .000
*
      ADD [7212 + 6317]  7213  3  5.0 2161.40    4.24  8.75   4.98  n/a    .000
*
      ADD [6103 + 6112]  6113  3  5.0 4755.91    8.32  8.58   4.42  n/a    .000
*
      ADD [0318 + 7213]  6318  3  5.0 2174.09    4.26  8.75   4.98  n/a    .000
*
      ADD [6113 + 0113]  6361  3  5.0 4779.49    8.36  8.50   4.42  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   2 ** 5 yr 12 hr SCS
  ****************************

  W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                    min     ha     cms   hrs     mm          cms

      START @   .00 hrs
      ---------------------
      MASS STORM                    5.0
      [ Ptot= 55.81 mm ]
*
  **  CALIB NASHYD       0100  1  5.0  835.70    3.66  9.25  10.17  .18    .000
      [CN=57.8       ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD       0101  1  5.0   96.09    1.90  6.67  15.07  .27    .000
      [CN=69.2       ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD       0114  1  5.0  193.26    1.68  7.42  11.14  .20    .000
      [CN=61.3       ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD       0115  1  5.0  170.62    1.66  7.75  14.35  .26    .000
      [CN=69.3       ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD       0116  1  5.0  289.79    1.91  8.42  12.37  .22    .000
      [CN=63.5       ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD     0200  1  5.0   89.02    3.27  6.17  19.89  .36    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD       0201  1  5.0  255.45    1.55  8.58  11.80  .21    .000
      [CN=63.2       ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD     0302  1  5.0   20.91    1.48  6.00  29.25  .52    .000
      [I%=36.2:S%= 2.00]
*
  *   CALIB NASHYD       0303  1  5.0  611.79    2.67  9.08   9.78  .18    .000
      [CN=57.2       ]
      [ N = 3.0:Tp 2.51]
*
  *   CALIB STANDHYD     0304  1  5.0   46.90    1.95  6.17  21.11  .38    .000
      [I%=19.8:S%= 2.00]
*
  *   CALIB STANDHYD     0308  1  5.0   44.53    1.91  6.17  21.68  .39    .000
      [I%=20.3:S%= 2.00]
*
  *   CALIB STANDHYD     0320  1  5.0   46.41    2.27  6.08  23.43  .42    .000
```

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     [I%=25.4:S%= 2.00]
*
  *  CALIB STANDHYD     0003  1  5.0   21.92    1.11  6.00  21.98  .39    .000
     [I%=26.8:S%= 2.00]
*
  *  CALIB STANDHYD     0321  1  5.0   34.71    2.13  6.08  27.09  .49    .000
     [I%=32.5:S%= 2.00]
*
  *  CALIB NASHYD       0322  1  5.0  207.40    1.00  8.83  10.04  .18    .000
     [CN=58.1         ]
     [ N = 3.0:Tp 2.28]
*
  *  CALIB NASHYD       0323  1  5.0  236.30    2.79  7.00  11.93  .21    .000
     [CN=63.4         ]
     [ N = 3.0:Tp  .88]
*
  *  CALIB NASHYD       0324  1  5.0  303.00    2.05  8.08  11.46  .21    .000
     [CN=62.3         ]
     [ N = 3.0:Tp 1.74]
*
  *  CALIB NASHYD       0325  1  5.0  156.62    2.12  6.75  11.47  .21    .000
     [CN=62.3         ]
     [ N = 3.0:Tp  .69]
*
  *  CALIB STANDHYD     5257  1  5.0   10.19     .63  6.00  26.02  .47    .000
     [I%=28.8:S%= 2.00]
*
  *  CALIB STANDHYD     0001  1  5.0    9.26     .41  6.00  18.93  .34    .000
     [I%=22.2:S%= 2.00]
*
  *  CALIB NASHYD       3269  1  5.0  124.61    1.33  6.83   9.96  .18    .000
     [CN=57.3         ]
     [ N = 3.0:Tp  .78]
*
  *  CALIB NASHYD       0327  1  5.0  198.82    1.15  8.42  10.95  .20    .000
     [CN=60.4         ]
     [ N = 3.0:Tp 2.01]
*
  *  CALIB NASHYD       0328  1  5.0  171.14    1.91  6.92  10.64  .19    .000
     [CN=59.7         ]
     [ N = 3.0:Tp  .81]
*
  *  CALIB STANDHYD     0329  1  5.0  117.37    6.86  6.08  27.68  .50    .000
     [I%=37.0:S%= 2.00]
*
  *  CALIB NASHYD       3256  1  5.0   13.61     .33  6.33  13.11  .23    .000
     [CN=65.8         ]
     [ N = 3.0:Tp  .37]
*
  *  CALIB STANDHYD     5255  1  5.0   25.03    1.61  6.00  26.81  .48    .000
     [I%=35.2:S%= 2.00]
*
  *  CALIB NASHYD       5254  1  5.0   11.03     .46  6.25  18.03  .32    .000
     [CN=73.1         ]
     [ N = 3.0:Tp  .27]
*
  *  CALIB NASHYD       3254  1  5.0   13.91     .42  6.42  17.32  .31    .000
     [CN=74.1         ]
     [ N = 3.0:Tp  .41]
*
  *  CALIB NASHYD       3255  1  5.0   53.36     .61  6.83  10.29  .18    .000
     [CN=58.4         ]
     [ N = 3.0:Tp  .75]
*
  *  CALIB NASHYD       5250  1  5.0   20.10     .41  6.67  15.84  .28    .000
     [CN=69.8         ]
     [ N = 3.0:Tp  .63]
*
  *  CALIB NASHYD       3250  1  5.0   43.70     .90  6.42  12.77  .23    .000
     [CN=64.8         ]
     [ N = 3.0:Tp  .45]
*
  *  CALIB STANDHYD     2306  1  5.0    4.18     .17  6.00  19.09  .34    .000
     [I%=17.0:S%= 2.00]
*
  *  CALIB NASHYD       0306  1  5.0  155.62    1.40  7.50  12.37  .22    .000
     [CN=64.3         ]
     [ N = 3.0:Tp 1.32]
*
  *  CALIB NASHYD       0305  1  5.0  309.29    1.38  9.17  10.11  .18    .000
     [CN=57.8         ]
     [ N = 3.0:Tp 2.55]
*
  *  CALIB NASHYD       0307  1  5.0  165.22    1.01  7.83   9.62  .17    .000
     [CN=56.8         ]
     [ N = 3.0:Tp 1.56]
*
  *  CALIB STANDHYD     2310  1  5.0   22.21    1.22  6.00  24.40  .44    .000
     [I%=28.6:S%= 2.00]
*
  *  CALIB NASHYD       0310  1  5.0  162.43    1.00  8.08  10.52  .19    .000
     [CN=59.6         ]
     [ N = 3.0:Tp 1.74]
```

```
*
  *  CALIB NASHYD       2301  1  5.0   49.24     .94  6.92  17.98  .32    .000
     [CN=73.1         ]
     [ N = 3.0:Tp  .84]
*
  *  CALIB NASHYD       0301  1  5.0  186.26    1.98  7.17  12.11  .22    .000
     [CN=63.9         ]
     [ N = 3.0:Tp 1.03]
*
  *  CALIB NASHYD       2203  1  5.0    6.70     .23  6.33  17.49  .31    .000
     [CN=72.8         ]
     [ N = 3.0:Tp  .35]
*
  *  CALIB NASHYD       0203  1  5.0   30.53     .34  6.92  10.85  .19    .000
     [CN=61.5         ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD       2204  1  5.0   15.92     .44  6.50  17.14  .31    .000
     [CN=72.3         ]
     [ N = 3.0:Tp  .47]
*
  *  CALIB NASHYD       0204  1  5.0   13.66     .14  6.92   9.46  .17    .000
     [CN=55.5         ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD       0202  1  5.0  307.29    1.72  8.58  10.88  .20    .000
     [CN=61.0         ]
     [ N = 3.0:Tp 2.08]
*
  *  CALIB STANDHYD     2211  1  5.0   27.27    1.28  6.08  23.86  .43    .000
     [I%=21.4:S%= 2.00]
*
  *  CALIB NASHYD       0211  1  5.0   50.58     .63  7.08  13.19  .24    .000
     [CN=65.6         ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD       0300  1  5.0     .88     .03  6.17  10.50  .19    .000
     [CN=60.7         ]
     [ N = 3.0:Tp  .18]
*
  *  CALIB STANDHYD     2300  1  5.0   30.27    1.16  6.08  20.79  .37    .000
     [I%=16.6:S%= 2.00]
*
  *  CALIB NASHYD       0103  1  5.0  223.30    1.62  8.00  12.03  .22    .000
     [CN=62.2         ]
     [ N = 3.0:Tp 1.71]
*
  *  CALIB STANDHYD     2025  1  5.0   10.24     .65  6.00  24.46  .44    .000
     [I%=33.0:S%= 2.00]
*
  *  CALIB NASHYD       1025  1  5.0   35.23     .47  6.67  10.18  .18    .000
     [CN=59.0         ]
     [ N = 3.0:Tp  .60]
*
  *  CALIB STANDHYD     2028  1  5.0    9.83     .66  6.00  24.72  .44    .000
     [I%=35.6:S%= 2.00]
*
  *  CALIB NASHYD       1028  1  5.0   32.85     .31  6.92   8.91  .16    .000
     [CN=56.4         ]
     [ N = 3.0:Tp  .78]
*
  *  CALIB NASHYD       1021  1  5.0   26.87     .19  6.92   6.92  .12    .000
     [CN=48.5         ]
     [ N = 3.0:Tp  .82]
*
  *  CALIB NASHYD       0105  1  5.0  509.25    2.59  8.17   8.93  .16    .000
     [CN=53.7         ]
     [ N = 3.0:Tp 1.81]
*
  *  CALIB STANDHYD     2045  1  5.0    8.17     .33  6.00  17.21  .31    .000
     [I%=19.7:S%= 2.00]
*
  *  CALIB NASHYD       1045  1  5.0  188.03    1.10  7.17   6.60  .12    .000
     [CN=45.6         ]
     [ N = 3.0:Tp  .98]
*
  *  CALIB NASHYD       1047  1  5.0    6.75     .07  6.67   8.38  .15    .000
     [CN=50.3         ]
     [ N = 3.0:Tp  .59]
*
  *  CALIB NASHYD       2042  1  5.0     .87     .03  6.17  10.56  .19    .000
     [CN=57.4         ]
     [ N = 3.0:Tp  .16]
*
  *  CALIB STANDHYD     2041  1  5.0     .96     .04  6.00  15.93  .29    .000
     [I%=16.5:S%= 2.00]
*
  *  CALIB NASHYD       1040  1  5.0  452.51    1.93  7.92   6.89  .12    .000
     [CN=47.7         ]
     [ N = 3.0:Tp 1.59]
*
  *  CALIB NASHYD       1041  1  5.0   76.98     .30  7.67   5.67  .10    .000
     [CN=41.6         ]
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     [ N = 3.0:Tp 1.40]
*
  *  CALIB NASHYD      0108  1  5.0  673.15    2.24 10.08   9.00  .16    .000
     [CN=54.7         ]
     [ N = 3.0:Tp 3.22]
*
  *  CALIB NASHYD      1070  1  5.0  137.82     .96  7.50   9.31  .17    .000
     [CN=56.1         ]
     [ N = 3.0:Tp 1.26]
*
  *  CALIB NASHYD      0106  1  5.0  814.51    2.85  9.33   8.29  .15    .000
     [CN=51.8         ]
     [ N = 3.0:Tp 2.69]
*
  *  CALIB STANDHYD    2071  1  5.0   16.86     .65  6.00  18.65  .33    .000
     [I%=19.3:S%= 2.00]
*
  *  CALIB NASHYD      1071  1  5.0   28.72     .27  6.83   8.40  .15    .000
     [CN=51.4         ]
     [ N = 3.0:Tp  .73]
*
  *  CALIB STANDHYD    2076  1  5.0    .92     .04  6.00  18.26  .33    .000
     [I%=17.9:S%= 2.00]
*
  *  CALIB NASHYD      1072  1  5.0    .71     .02  6.08   7.29  .13    .000
     [CN=47.6         ]
     [ N = 3.0:Tp  .13]
*
  *  CALIB STANDHYD    2075  1  5.0   1.10     .11  6.00  31.94  .57    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      1075  1  5.0   28.08     .22  7.00   7.77  .14    .000
     [CN=49.5         ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0109  1  5.0  228.84     .76  8.58   6.47  .12    .000
     [CN=45.4         ]
     [ N = 3.0:Tp 2.06]
*
  *  CALIB NASHYD      0111  1  5.0 1152.01    3.81 10.58   9.67  .17    .000
     [CN=56.8         ]
     [ N = 3.0:Tp 3.59]
*
  *  CALIB STANDHYD    2110  1  5.0    .78     .08  6.00  31.95  .57    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      0110  1  5.0   58.53     .51  7.08   9.38  .17    .000
     [CN=55.9         ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD      0112  1  5.0   32.04     .20  7.42   7.98  .14    .000
     [CN=49.9         ]
     [ N = 3.0:Tp 1.20]
*
  *  CALIB NASHYD      0113  1  5.0   23.58     .18  7.08   8.19  .15    .000
     [CN=52.0         ]
     [ N = 3.0:Tp  .95]
*
  *  CALIB NASHYD      0318  1  5.0   12.69     .14  6.92  10.33  .19    .000
     [CN=58.2         ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD      0311  1  5.0  536.71    2.22  9.58  10.36  .19    .000
     [CN=58.4         ]
     [ N = 3.0:Tp 2.91]
*
  *  CALIB NASHYD      0312  1  5.0   28.89     .32  7.00  11.11  .20    .000
     [CN=60.5         ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0313  1  5.0  607.44    1.87 10.33   8.62  .15    .000
     [CN=52.9         ]
     [ N = 3.0:Tp 3.38]
*
  *  CALIB NASHYD      0317  1  5.0  278.29    1.31  9.00  10.34  .19    .000
     [CN=58.7         ]
     [ N = 3.0:Tp 2.45]
*
  *  CALIB NASHYD      0316  1  5.0  211.32    1.03  8.67   9.66  .17    .000
     [CN=57.0         ]
     [ N = 3.0:Tp 2.14]
*
  *  CALIB STANDHYD    5145  1  5.0   3.56     .36  6.00  32.55  .58    .000
     [I%=51.2:S%= 2.00]
*
  *  CALIB NASHYD      3145  1  5.0  132.54     .74  7.75   8.35  .15    .000
     [CN=52.1         ]
     [ N = 3.0:Tp 1.46]
*
  *  CALIB STANDHYD    5141  1  5.0   29.18    1.76  6.00  24.90  .45    .000
     [I%=33.8:S%= 2.00]
*
  *  CALIB STANDHYD    5142  1  5.0   5.20     .38  6.00  27.94  .50    .000
```

```
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      5140  1  5.0  119.44     .85  7.58   9.93  .18    .000
     [CN=57.3         ]
     [ N = 3.0:Tp 1.33]
*
  *  CALIB NASHYD      3141  1  5.0   85.39     .44  7.92   8.21  .15    .000
     [CN=52.3         ]
     [ N = 3.0:Tp 1.60]
*
  *  CALIB NASHYD      0315  1  5.0  123.44     .83  7.67   9.96  .18    .000
     [CN=57.8         ]
     [ N = 3.0:Tp 1.44]
*
  *  CALIB STANDHYD    2213  1  5.0    .88     .05  6.00  23.51  .42    .000
     [I%=24.4:S%= 2.00]
*
  *  CALIB STANDHYD    2210  1  5.0  23.61    1.10  6.08  23.00  .41    .000
     [I%=22.4:S%= 2.00]
*
  *  CALIB NASHYD      2212  1  5.0    .55     .01  6.17   9.37  .17    .000
     [CN=53.1         ]
     [ N = 3.0:Tp  .22]
*
  *  CALIB NASHYD      0205  1  5.0 3159.99    6.17 13.33   8.41  .15    .000
     [CN=52.3         ]
     [ N = 3.0:Tp 5.93]
*
  *  CALIB NASHYD      0206  1  5.0   73.80     .73  7.25  11.75  .21    .000
     [CN=61.6         ]
     [ N = 3.0:Tp 1.10]
*
  *  CALIB NASHYD      2206  1  5.0    3.51     .14  6.25  15.97  .29    .000
     [CN=70.5         ]
     [ N = 3.0:Tp  .24]
*
  *  CALIB NASHYD      2207  1  5.0   44.56     .63  7.17  16.14  .29    .000
     [CN=70.3         ]
     [ N = 3.0:Tp 1.06]
*
  *  CALIB NASHYD      0207  1  5.0  315.33    1.86  8.67  11.91  .21    .000
     [CN=62.7         ]
     [ N = 3.0:Tp 2.20]
*
  *  CALIB NASHYD      2269  1  5.0    .84     .02  6.25  10.65  .19    .000
     [CN=60.4         ]
     [ N = 3.0:Tp  .28]
*
  *  CALIB NASHYD      0208  1  5.0   33.63     .43  7.00  13.18  .24    .000
     [CN=65.8         ]
     [ N = 3.0:Tp  .91]
*
  *  CALIB NASHYD      2208  1  5.0    .69     .03  6.17  17.10  .31    .000
     [CN=72.3         ]
     [ N = 3.0:Tp  .20]
*
  *  CALIB STANDHYD    2209  1  5.0    .57     .03  6.00  21.79  .39    .000
     [I%=23.7:S%= 2.00]
*
  *  CALIB NASHYD      0209  1  5.0  295.05    1.32  8.58   8.86  .16    .000
     [CN=53.9         ]
     [ N = 3.0:Tp 2.11]
*
  *  CALIB NASHYD      0210  1  5.0   18.83     .18  7.25  11.09  .20    .000
     [CN=60.8         ]
     [ N = 3.0:Tp 1.09]
*
  *  CALIB NASHYD      9262  1  5.0    7.50     .12  6.42   9.32  .17    .000
     [CN=55.7         ]
     [ N = 3.0:Tp  .40]
*
  *  CALIB NASHYD      9263  1  5.0    2.35     .05  6.25   9.32  .17    .000
     [CN=55.7         ]
     [ N = 3.0:Tp  .25]
*
  *  CALIB STANDHYD    5261  1  5.0   37.50    2.36  6.08  26.74  .48    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD    5262  1  5.0    7.50     .53  6.00  26.73  .48    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      3265  1  5.0   26.53     .33  6.67   9.32  .17    .000
     [CN=55.7         ]
     [ N = 3.0:Tp  .57]
*
  *  CALIB STANDHYD    5260  1  5.0   54.55    2.15  6.17  20.20  .36    .000
     [I%=18.7:S%= 2.00]
*
  *  CALIB STANDHYD    5263  1  5.0    2.35     .18  6.00  26.73  .48    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD    9264  1  5.0   10.24     .56  6.00  21.72  .39    .000
     [I%=28.0:S%= 2.00]
```

```
*
*   CALIB NASHYD       2001  1  5.0   19.92     .38  6.42  11.53  .21    .000
    [CN=62.2          ]
    [ N = 3.0:Tp  .42]
*
*   CALIB NASHYD       0309  1 10.0  157.12    1.50  7.33  11.74  .21    .000
    [CN=63.0          ]
    [ N = 3.0:Tp 1.14]
*
    RESRVR [ 2 : 5255] 8255  1  5.0   25.03    1.52  6.08  26.81  n/a    .000
    {ST=   .04 ha.m }
*
    RESRVR [ 2 : 5254] 8254  1  5.0   11.03     .28  6.58  18.02  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8254 + 3254]  6254  3  5.0   24.94     .69  6.50  17.63  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30    1.23  6.58  12.62  n/a    .000
*
    RESRVR [ 2 : 5250] 8250  1  5.0   20.10     .19  7.75  15.83  n/a    .000
    {ST=   .12 ha.m }
*
    ADD [8250 + 3250]  6250  3  5.0   63.80     .97  6.50  13.74  n/a    .000
*
    RESRVR [ 2 : 2306] 8306  1  5.0    4.18     .03  7.08  19.02  n/a    .000
    {ST=   .04 ha.m }
*
    ADD [8306 + 0306]  6306  3  5.0  159.80    1.44  7.50  12.55  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    2.53  8.17  10.94  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31    3.53  8.00  10.60  n/a    .000
*
    RESRVR [ 2 : 2310] 8310  1  5.0   22.21    1.05  6.17  24.40  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8310 + 0310]  6310  3  5.0  184.64    1.16  6.17  12.19  n/a    .000
*
    RESRVR [ 2 : 2301] 8301  1  5.0   49.24     .64  7.75  17.98  n/a    .000
    {ST=   .25 ha.m }
*
    ADD [8301 + 0301]  6301  3  5.0  235.50    2.55  7.33  13.34  n/a    .000
*
    RESRVR [ 2 : 2203] 8203  1  5.0    6.70     .12  6.83  17.48  n/a    .000
    {ST=   .04 ha.m }
*
    ADD [8203 + 0203]  6203  3  5.0   37.23     .46  6.92  12.04  n/a    .000
*
    RESRVR [ 2 : 2204] 8204  1  5.0   15.92     .24  7.17  17.13  n/a    .000
    {ST=   .10 ha.m }
*
    ADD [8204 + 0204]  6204  3  5.0   29.58     .37  7.08  13.59  n/a    .000
*
    RESRVR [ 2 : 2211] 8211  1  5.0   27.27    1.16  6.17  23.86  n/a    .000
    {ST=   .04 ha.m }
*
    ADD [8211 + 0211]  6211  3  5.0   77.85    1.40  6.25  16.93  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15    1.19  6.08  20.50  n/a    .000
*
    RESRVR [ 2 : 2025] 8025  1  5.0   10.24     .56  6.08  24.46  n/a    .000
    {ST=   .02 ha.m }
*
    ADD [8025 + 1025]  6025  3  5.0   45.47     .78  6.17  13.40  n/a    .000
*
    RESRVR [ 2 : 2028] 8028  1  5.0    9.83     .58  6.08  24.72  n/a    .000
    {ST=   .02 ha.m }
*
    ADD [8028 + 1028]  6028  3  5.0   42.68     .66  6.17  12.55  n/a    .000
*
    RESRVR [ 2 : 2045] 8045  1  5.0    8.17     .10  6.67  17.16  n/a    .000
    {ST=   .06 ha.m }
*
    ADD [8045 + 1045]  6045  3  5.0  196.20    1.19  7.08   7.04  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95    1.25  7.08   7.08  n/a    .000
*
    RESRVR [ 2 : 2042] 8042  1  5.0     .87     .01  6.50  10.54  n/a    .000
    {ST=   .00 ha.m }
*
    RESRVR [ 2 : 2041] 8041  1  5.0     .96     .01  6.58  15.87  n/a    .000
    {ST=   .00 ha.m }
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    2.22  7.92   6.71  n/a    .000
*
    RESRVR [ 2 : 2071] 8071  1  5.0   16.86     .24  6.67  18.64  n/a    .000
    {ST=   .13 ha.m }
*
    ADD [8071 + 1071]  6071  3  5.0   45.58     .51  6.75  12.19  n/a    .000
*
    RESRVR [ 2 : 2076] 8076  1  5.0     .92     .02  6.50  18.19  n/a    .000
    {ST=   .01 ha.m }
*
```

```
*
    ADD [2075 + 1075]  6075  3  5.0   29.18     .23  7.00   8.68  n/a    .000
*
    RESRVR [ 2 : 2110] 8110  1  5.0     .78     .08  6.00  31.95  n/a    .000
    {ST=   .00 ha.m }
*
    ADD [8110 + 0110]  6110  3  5.0   59.31     .52  7.08   9.68  n/a    .000
*
    ADD [0311 + 0312]  7211  3  5.0  565.60    2.30  9.50  10.40  n/a    .000
*
    ADD [7211 + 0313]  7212  3  5.0 1173.04    4.14  9.83   9.48  n/a    .000
*
    RESRVR [ 2 : 5145] 8145  1  5.0    3.56     .32  6.08  32.55  n/a    .000
    {ST=   .01 ha.m }
*
    ADD [8145 + 3145]  6145  3  5.0  136.10     .76  7.75   8.98  n/a    .000
*
    RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .02  8.50  18.85  n/a    .000
    {ST=   .11 ha.m }
*
    RESRVR [ 2 : 2210] 8210  1  5.0   23.61    1.08  6.08  23.00  n/a    .000
    {ST=   .02 ha.m }
*
    ADD [8210 + 2212]  6212  3  5.0   24.16    1.09  6.08  22.69  n/a    .000
*
    ADD [0206 + 2206]  6206  3  5.0   77.31     .75  7.25  11.94  n/a    .000
*
    RESRVR [ 2 : 2207] 8207  1  5.0   44.56     .34  8.67  16.14  n/a    .000
    {ST=   .28 ha.m }
*
    ADD [8207 + 0207]  6207  3  5.0  359.89    2.21  8.67  12.43  n/a    .000
*
    ADD [6207 + 2269]  7207  3  5.0  360.73    2.21  8.67  12.43  n/a    .000
*
    ADD [2208 + 2209]  6209  3  5.0    1.26     .06  6.08  19.22  n/a    .000
*
    RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .02 12.42  13.80  n/a    .000
    {ST=   .96 ha.m }
*
    RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .16  6.50  26.71  n/a    .000
    {ST=   .09 ha.m }
*
    RESRVR [ 2 : 5260] 8260  1  5.0   54.55     .85  6.75  20.20  n/a    .000
    {ST=   .45 ha.m }
*
    RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .05  6.58  26.64  n/a    .000
    {ST=   .03 ha.m }
*
    ADD [8255 + 6255]  6256  3  5.0  103.33    2.15  6.17  16.06  n/a    .000
*
    ADD [6203 + 6204]  6205  3  5.0   66.81     .83  7.00  12.73  n/a    .000
*
    ADD [6025 + 6028]  6353  3  5.0   88.15    1.45  6.17  12.99  n/a    .000
*
    ADD [8042 + 8041]  6042  3  5.0    1.83     .02  6.58  13.33  n/a    .000
*
    ADD [6042 + 6040]  6043  3  5.0  531.32    2.23  7.92   6.73  n/a    .000
*
    ADD [0106 + 6071]  6106  3  5.0  860.09    2.99  9.25   8.50  n/a    .000
*
    ADD [1072 + 6075]  6072  3  5.0   29.89     .23  6.92   8.65  n/a    .000
*
    ADD [0111 + 6110]  6111  3  5.0 1211.32    3.92 10.50   9.67  n/a    .000
*
    ADD [5141 + 0030]  7318  3  5.0   34.38    1.76  6.00  23.99  n/a    .000
*
    ADD [0205 + 6206]  7205  3  5.0 3237.30    6.23 13.08   8.50  n/a    .000
*
    ADD [7205 + 7207]  7208  3  5.0 3598.03    7.21 12.17   8.89  n/a    .000
*
    ADD [0040 + 0060]  6265  3  5.0   45.00     .18  6.58  15.95  n/a    .000
*
    ADD [8260 + 0070]  6263  3  5.0   56.90     .89  6.75  20.46  n/a    .000
*
    ADD [3256 + 6256]  6257  3  5.0  116.94    2.42  6.17  15.72  n/a    .000
*
    ADD [6205 + 0202]  6202  3  5.0  374.10    2.14  8.00  11.21  n/a    .000
*
    ADD [6353 + 1021]  6021  3  5.0  115.02    1.51  6.17  11.57  n/a    .000
*
    ADD [6047 + 6043]  6048  3  5.0  734.27    3.29  7.50   6.83  n/a    .000
*
    ADD [1070 + 6106]  6070  3  5.0  997.91    3.62  8.67   8.61  n/a    .000
*
    ADD [8076 + 6072]  6076  3  5.0   30.81     .24  6.92   8.93  n/a    .000
*
    ADD [7318 + 5140]  6140  3  5.0  153.82    1.82  6.00  13.07  n/a    .000
*
    ADD [7208 + 0208]  6208  3  5.0 3631.66    7.26 12.17   8.93  n/a    .000
*
    ADD [6265 + 3265]  7265  3  5.0   71.53     .51  6.58  13.49  n/a    .000
*
    ADD [0103 + 6021]  6103  3  5.0  338.32    2.31  7.25  11.88  n/a    .000
*
```

```
*     ADD [0105 + 6048]  6105  3  5.0 1243.52    5.75  7.83   7.69  n/a    .000
*     ADD [6070 + 6076]  6077  3  5.0 1028.72    3.72  8.50   8.62  n/a    .000
*     ADD [6140 + 3141]  6141  3  5.0  239.21    1.86  6.08  11.34  n/a    .000
*     ADD [6208 + 6209]  6210  3  5.0 3632.92    7.26 12.17   8.93  n/a    .000
*     ADD [0108 + 6077]  6108  3  5.0 1701.87    5.75  9.17   8.77  n/a    .000
*     ADD [6145 + 6141]  6315  3  5.0  375.31    2.26  6.08  10.48  n/a    .000
*     ADD [6210 + 0209]  7209  3  5.0 3927.97    7.99 11.25   8.93  n/a    .000
*     ADD [6105 + 6108]  6115  3  5.0 2945.39   10.98  8.25   8.31  n/a    .000
*     ADD [6315 + 0315]  6316  3  5.0  498.75    3.06  7.67  10.35  n/a    .000
*     ADD [7209 + 0210]  7210  3  5.0 3946.80    8.02 11.17   8.94  n/a    .000
*     ADD [6115 + 0109]  6109  3  5.0 3174.23   11.73  8.33   8.18  n/a    .000
*     ADD [0316 + 6316]  7316  3  5.0  710.07    3.96  7.83  10.15  n/a    .000
*     ADD [6212 + 7210]  6213  3  5.0 3970.96    8.07 11.17   9.02  n/a    .000
*     ADD [6109 + 6111]  6358  3  5.0 4385.55   14.87  8.67   8.59  n/a    .000
*     ADD [0317 + 7316]  6317  3  5.0  988.36    5.09  8.08  10.20  n/a    .000
*     ADD [2213 + 6213]  7317  3  5.0 3971.84    8.07 11.17   9.02  n/a    .000
*     ADD [6358 + 0112]  6112  3  5.0 4417.59   15.01  8.58   8.59  n/a    .000
*     ADD [7212 + 6317]  7213  3  5.0 2161.40    8.59  8.67   9.81  n/a    .000
*     ADD [6103 + 6112]  6113  3  5.0 4755.91   16.96  8.42   8.82  n/a    .000
*     ADD [0318 + 7213]  6318  3  5.0 2174.09    8.64  8.67   9.81  n/a    .000
*     ADD [6113 + 0113]  6361  3  5.0 4779.49   17.06  8.42   8.82  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   3 ** 10 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                  min     ha     cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                  5.0
      [ Ptot= 65.99 mm ]
*
  **  CALIB NASHYD      0100  1  5.0  835.70    5.15  9.25  14.24  .22    .000
      [CN=57.8          ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD      0101  1  5.0   96.09    2.63  6.67  20.62  .31    .000
      [CN=69.2          ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD      0114  1  5.0  193.26    2.39  7.33  15.58  .24    .000
      [CN=61.3          ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD      0115  1  5.0  170.62    2.33  7.67  19.82  .30    .000
      [CN=69.3          ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD      0116  1  5.0  289.79    2.66  8.42  17.14  .26    .000
      [CN=63.5          ]
      [ N = 3.0:Tp 2.01]
*
   *  CALIB STANDHYD    0200  1  5.0   89.02    4.28  6.17  25.62  .39    .000
      [I%=17.0:S%= 2.00]
*
   *  CALIB NASHYD      0201  1  5.0  255.45    2.18  8.50  16.47  .25    .000
      [CN=63.2          ]
      [ N = 3.0:Tp 2.09]
*
   *  CALIB STANDHYD    0302  1  5.0   20.91    1.83  6.00  36.22  .55    .000
      [I%=36.2:S%= 2.00]
*
   *  CALIB NASHYD      0303  1  5.0  611.79    3.79  9.08  13.76  .21    .000
      [CN=57.2          ]
      [ N = 3.0:Tp 2.51]
*
   *  CALIB STANDHYD    0304  1  5.0   46.90    2.51  6.17  26.96  .41    .000
      [I%=19.8:S%= 2.00]
*
   *  CALIB STANDHYD    0308  1  5.0   44.53    2.46  6.17  27.65  .42    .000
      [I%=20.3:S%= 2.00]
*
   *  CALIB STANDHYD    0320  1  5.0   46.41    2.86  6.08  29.52  .45    .000
      [I%=25.4:S%= 2.00]
*
   *  CALIB STANDHYD    0003  1  5.0   21.92    1.40  6.00  27.44  .42    .000
      [I%=26.8:S%= 2.00]
*
   *  CALIB STANDHYD    0321  1  5.0   34.71    2.70  6.08  33.70  .51    .000
      [I%=32.5:S%= 2.00]
*
   *  CALIB NASHYD      0322  1  5.0  207.40    1.41  8.75  14.11  .21    .000
      [CN=58.1          ]
      [ N = 3.0:Tp 2.28]
*
   *  CALIB NASHYD      0323  1  5.0  236.30    3.94  7.00  16.63  .25    .000
      [CN=63.4          ]
      [ N = 3.0:Tp  .88]
*
   *  CALIB NASHYD      0324  1  5.0  303.00    2.90  8.08  16.02  .24    .000
      [CN=62.3          ]
      [ N = 3.0:Tp 1.74]
*
   *  CALIB NASHYD      0325  1  5.0  156.62    3.00  6.75  16.03  .24    .000
      [CN=62.3          ]
      [ N = 3.0:Tp  .69]
*
   *  CALIB STANDHYD    5257  1  5.0   10.19     .78  6.00  32.55  .49    .000
      [I%=28.8:S%= 2.00]
*
   *  CALIB STANDHYD    0001  1  5.0    9.26     .52  6.00  23.83  .36    .000
      [I%=22.2:S%= 2.00]
*
   *  CALIB NASHYD      3269  1  5.0  124.61    1.89  6.83  13.97  .21    .000
      [CN=57.3          ]
      [ N = 3.0:Tp  .78]
*
   *  CALIB NASHYD      0327  1  5.0  198.82    1.62  8.42  15.30  .23    .000
      [CN=60.4          ]
      [ N = 3.0:Tp 2.01]
*
   *  CALIB NASHYD      0328  1  5.0  171.14    2.71  6.92  14.90  .23    .000
      [CN=59.7          ]
      [ N = 3.0:Tp  .81]
*
   *  CALIB STANDHYD    0329  1  5.0  117.37    8.68  6.08  34.15  .52    .000
      [I%=37.0:S%= 2.00]
*
   *  CALIB NASHYD      3256  1  5.0   13.61     .46  6.33  18.14  .27    .000
      [CN=65.8          ]
      [ N = 3.0:Tp  .37]
*
   *  CALIB STANDHYD    5255  1  5.0   25.03    2.03  6.00  33.15  .50    .000
      [I%=35.2:S%= 2.00]
*
   *  CALIB NASHYD      5254  1  5.0   11.03     .62  6.25  24.23  .37    .000
      [CN=73.1          ]
      [ N = 3.0:Tp  .27]
*
   *  CALIB NASHYD      3254  1  5.0   13.91     .58  6.42  23.55  .36    .000
      [CN=74.1          ]
      [ N = 3.0:Tp  .41]
*
   *  CALIB NASHYD      3255  1  5.0   53.36     .86  6.83  14.41  .22    .000
      [CN=58.4          ]
      [ N = 3.0:Tp  .75]
*
   *  CALIB NASHYD      5250  1  5.0   20.10     .56  6.67  21.52  .33    .000
      [CN=69.8          ]
      [ N = 3.0:Tp  .63]
*
   *  CALIB NASHYD      3250  1  5.0   43.70    1.26  6.42  17.69  .27    .000
      [CN=64.8          ]
      [ N = 3.0:Tp  .45]
*
   *  CALIB STANDHYD    2306  1  5.0    4.18     .22  6.00  24.46  .37    .000
      [I%=17.0:S%= 2.00]
*
   *  CALIB NASHYD      0306  1  5.0  155.62    1.97  7.50  17.20  .26    .000
      [CN=64.3          ]
      [ N = 3.0:Tp 1.32]
*
   *  CALIB NASHYD      0305  1  5.0  309.29    1.95  9.08  14.17  .21    .000
      [CN=57.8          ]
      [ N = 3.0:Tp 2.55]
*
   *  CALIB NASHYD      0307  1  5.0  165.22    1.44  7.83  13.55  .21    .000
      [CN=56.8          ]
      [ N = 3.0:Tp 1.56]
*
   *  CALIB STANDHYD    2310  1  5.0   22.21    1.56  6.08  30.49  .46    .000
      [I%=28.6:S%= 2.00]
*
   *  CALIB NASHYD      0310  1  5.0  162.43    1.42  8.08  14.76  .22    .000
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      [CN=59.6        ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD      2301  1  5.0   49.24    1.27  6.92  24.18  .37    .000
      [CN=73.1        ]
      [ N = 3.0:Tp  .84]
*
  *   CALIB NASHYD      0301  1  5.0  186.26    2.80  7.17  16.88  .26    .000
      [CN=63.9        ]
      [ N = 3.0:Tp 1.03]
*
  *   CALIB NASHYD      2203  1  5.0    6.70     .31  6.33  23.62  .36    .000
      [CN=72.8        ]
      [ N = 3.0:Tp  .35]
*
  *   CALIB NASHYD      0203  1  5.0   30.53     .49  6.92  15.27  .23    .000
      [CN=61.5        ]
      [ N = 3.0:Tp  .82]
*
  *   CALIB NASHYD      2204  1  5.0   15.92     .59  6.50  23.18  .35    .000
      [CN=72.3        ]
      [ N = 3.0:Tp  .47]
*
  *   CALIB NASHYD      0204  1  5.0   13.66     .20  6.83  13.28  .20    .000
      [CN=55.5        ]
      [ N = 3.0:Tp  .79]
*
  *   CALIB NASHYD      0202  1  5.0  307.29    2.43  8.50  15.27  .23    .000
      [CN=61.0        ]
      [ N = 3.0:Tp 2.08]
*
  *   CALIB STANDHYD    2211  1  5.0   27.27    1.74  6.08  30.31  .46    .000
      [I%=21.4:S%= 2.00]
*
  *   CALIB NASHYD      0211  1  5.0   50.58     .88  7.08  18.22  .28    .000
      [CN=65.6        ]
      [ N = 3.0:Tp  .94]
*
  *   CALIB NASHYD      0300  1  5.0     .88     .04  6.17  14.80  .22    .000
      [CN=60.7        ]
      [ N = 3.0:Tp  .18]
*
  *   CALIB STANDHYD    2300  1  5.0   30.27    1.61  6.08  26.67  .40    .000
      [I%=16.6:S%= 2.00]
*
  *   CALIB NASHYD      0103  1  5.0  223.30    2.26  8.00  16.66  .25    .000
      [CN=62.2        ]
      [ N = 3.0:Tp 1.71]
*
  *   CALIB STANDHYD    2025  1  5.0   10.24     .81  6.00  30.19  .46    .000
      [I%=33.0:S%= 2.00]
*
  *   CALIB NASHYD      1025  1  5.0   35.23     .66  6.67  14.34  .22    .000
      [CN=59.0        ]
      [ N = 3.0:Tp  .60]
*
  *   CALIB STANDHYD    2028  1  5.0    9.83     .82  6.00  30.33  .46    .000
      [I%=35.6:S%= 2.00]
*
  *   CALIB NASHYD      1028  1  5.0   32.85     .45  6.92  12.71  .19    .000
      [CN=56.4        ]
      [ N = 3.0:Tp  .78]
*
  *   CALIB NASHYD      1021  1  5.0   26.87     .27  6.92   9.94  .15    .000
      [CN=48.5        ]
      [ N = 3.0:Tp  .82]
*
  *   CALIB NASHYD      0105  1  5.0  509.25    3.68  8.17  12.56  .19    .000
      [CN=53.7        ]
      [ N = 3.0:Tp 1.81]
*
  *   CALIB STANDHYD    2045  1  5.0    8.17     .40  6.00  21.72  .33    .000
      [I%=19.7:S%= 2.00]
*
  *   CALIB NASHYD      1045  1  5.0  188.03    1.59  7.08   9.41  .14    .000
      [CN=45.6        ]
      [ N = 3.0:Tp  .98]
*
  *   CALIB NASHYD      1047  1  5.0    6.75     .10  6.67  11.73  .18    .000
      [CN=50.3        ]
      [ N = 3.0:Tp  .59]
*
  *   CALIB NASHYD      2042  1  5.0     .87     .04  6.17  14.65  .22    .000
      [CN=57.4        ]
      [ N = 3.0:Tp  .16]
*
  *   CALIB STANDHYD    2041  1  5.0     .96     .05  6.00  20.29  .31    .000
      [I%=16.5:S%= 2.00]
*
  *   CALIB NASHYD      1040  1  5.0  452.51    2.79  7.92   9.86  .15    .000
      [CN=47.7        ]
      [ N = 3.0:Tp 1.59]
*
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  *   CALIB NASHYD      1041  1  5.0   76.98     .43  7.67   8.14  .12    .000
      [CN=41.6        ]
      [ N = 3.0:Tp 1.40]
*
  *   CALIB NASHYD      0108  1  5.0  673.15    3.17 10.00  12.70  .19    .000
      [CN=54.7        ]
      [ N = 3.0:Tp 3.22]
*
  *   CALIB NASHYD      1070  1  5.0  137.82    1.37  7.42  13.15  .20    .000
      [CN=56.1        ]
      [ N = 3.0:Tp 1.26]
*
  *   CALIB NASHYD      0106  1  5.0  814.51    4.05  9.33  11.71  .18    .000
      [CN=51.8        ]
      [ N = 3.0:Tp 2.69]
*
  *   CALIB STANDHYD    2071  1  5.0   16.86     .86  6.08  23.71  .36    .000
      [I%=19.3:S%= 2.00]
*
  *   CALIB NASHYD      1071  1  5.0   28.72     .38  6.83  11.81  .18    .000
      [CN=51.4        ]
      [ N = 3.0:Tp  .73]
*
  *   CALIB STANDHYD    2076  1  5.0     .92     .05  6.00  23.25  .35    .000
      [I%=17.9:S%= 2.00]
*
  *   CALIB NASHYD      1072  1  5.0     .71     .02  6.08  10.30  .16    .000
      [CN=47.6        ]
      [ N = 3.0:Tp  .13]
*
  *   CALIB STANDHYD    2075  1  5.0    1.10     .14  6.00  38.75  .59    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB NASHYD      1075  1  5.0   28.08     .31  7.00  10.98  .17    .000
      [CN=49.5        ]
      [ N = 3.0:Tp  .87]
*
  *   CALIB NASHYD      0109  1  5.0  228.84    1.09  8.50   9.26  .14    .000
      [CN=45.4        ]
      [ N = 3.0:Tp 2.06]
*
  *   CALIB NASHYD      0111  1  5.0 1152.01    5.37 10.50  13.61  .21    .000
      [CN=56.8        ]
      [ N = 3.0:Tp 3.59]
*
  *   CALIB STANDHYD    2110  1  5.0     .78     .10  6.00  38.76  .59    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB NASHYD      0110  1  5.0   58.53     .73  7.08  13.21  .20    .000
      [CN=55.9        ]
      [ N = 3.0:Tp  .94]
*
  *   CALIB NASHYD      0112  1  5.0   32.04     .28  7.33  11.25  .17    .000
      [CN=49.9        ]
      [ N = 3.0:Tp 1.20]
*
  *   CALIB NASHYD      0113  1  5.0   23.58     .26  7.08  11.61  .18    .000
      [CN=52.0        ]
      [ N = 3.0:Tp  .95]
*
  *   CALIB NASHYD      0318  1  5.0   12.69     .20  6.83  14.45  .22    .000
      [CN=58.2        ]
      [ N = 3.0:Tp  .79]
*
  *   CALIB NASHYD      0311  1  5.0  536.71    3.13  9.58  14.49  .22    .000
      [CN=58.4        ]
      [ N = 3.0:Tp 2.91]
*
  *   CALIB NASHYD      0312  1  5.0   28.89     .45  7.00  15.50  .23    .000
      [CN=60.5        ]
      [ N = 3.0:Tp  .87]
*
  *   CALIB NASHYD      0313  1  5.0  607.44    2.64 10.25  12.16  .18    .000
      [CN=52.9        ]
      [ N = 3.0:Tp 3.38]
*
  *   CALIB NASHYD      0317  1  5.0  278.29    1.85  9.00  14.49  .22    .000
      [CN=58.7        ]
      [ N = 3.0:Tp 2.45]
*
  *   CALIB NASHYD      0316  1  5.0  211.32    1.46  8.58  13.60  .21    .000
      [CN=57.0        ]
      [ N = 3.0:Tp 2.14]
*
  *   CALIB STANDHYD    5145  1  5.0    3.56     .43  6.00  39.46  .60    .000
      [I%=51.2:S%= 2.00]
*
  *   CALIB NASHYD      3145  1  5.0  132.54    1.05  7.67  11.80  .18    .000
      [CN=52.1        ]
      [ N = 3.0:Tp 1.46]
*
  *   CALIB STANDHYD    5141  1  5.0   29.18    2.16  6.00  30.77  .47    .000
      [I%=33.8:S%= 2.00]
```

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*
*   CALIB STANDHYD     5142  1  5.0    5.20     .47  6.00  34.60  .52    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD       5140  1  5.0  119.44    1.21  7.50  13.93  .21    .000
    [CN=57.3         ]
    [ N = 3.0:Tp 1.33]
*
*   CALIB NASHYD       3141  1  5.0   85.39     .62  7.92  11.65  .18    .000
    [CN=52.3         ]
    [ N = 3.0:Tp 1.60]
*
*   CALIB NASHYD       0315  1  5.0  123.44    1.18  7.67  14.00  .21    .000
    [CN=57.8         ]
    [ N = 3.0:Tp 1.44]
*
*   CALIB STANDHYD     2213  1  5.0     .88     .07  6.00  29.64  .45    .000
    [I%=24.4:S%= 2.00]
*
*   CALIB STANDHYD     2210  1  5.0   23.61    1.48  6.08  29.14  .44    .000
    [I%=22.4:S%= 2.00]
*
*   CALIB NASHYD       2212  1  5.0     .55     .02  6.17  13.02  .20    .000
    [CN=53.1         ]
    [ N = 3.0:Tp  .22]
*
*   CALIB NASHYD       0205  1  5.0 3159.99    8.72 13.25  11.88  .18    .000
    [CN=52.3         ]
    [ N = 3.0:Tp 5.93]
*
*   CALIB NASHYD       0206  1  5.0   73.80    1.02  7.25  16.30  .25    .000
    [CN=61.6         ]
    [ N = 3.0:Tp 1.10]
*
*   CALIB NASHYD       2206  1  5.0    3.51     .19  6.17  21.73  .33    .000
    [CN=70.5         ]
    [ N = 3.0:Tp  .24]
*
*   CALIB NASHYD       2207  1  5.0   44.56     .87  7.17  21.90  .33    .000
    [CN=70.3         ]
    [ N = 3.0:Tp 1.06]
*
*   CALIB NASHYD       0207  1  5.0  315.33    2.61  8.67  16.55  .25    .000
    [CN=62.7         ]
    [ N = 3.0:Tp 2.20]
*
*   CALIB NASHYD       2269  1  5.0     .84     .03  6.25  14.97  .23    .000
    [CN=60.4         ]
    [ N = 3.0:Tp  .28]
*
*   CALIB NASHYD       0208  1  5.0   33.63     .61  7.00  18.23  .28    .000
    [CN=65.8         ]
    [ N = 3.0:Tp  .91]
*
*   CALIB NASHYD       2208  1  5.0     .69     .04  6.17  23.13  .35    .000
    [CN=72.3         ]
    [ N = 3.0:Tp  .20]
*
*   CALIB STANDHYD     2209  1  5.0     .57     .04  6.00  27.52  .42    .000
    [I%=23.7:S%= 2.00]
*
*   CALIB NASHYD       0209  1  5.0  295.05    1.88  8.58  12.49  .19    .000
    [CN=53.9         ]
    [ N = 3.0:Tp 2.11]
*
*   CALIB NASHYD       0210  1  5.0   18.83     .25  7.25  15.49  .23    .000
    [CN=60.8         ]
    [ N = 3.0:Tp 1.09]
*
*   CALIB NASHYD       9262  1  5.0    7.50     .17  6.42  13.13  .20    .000
    [CN=55.7         ]
    [ N = 3.0:Tp  .40]
*
*   CALIB NASHYD       9263  1  5.0    2.35     .07  6.25  13.12  .20    .000
    [CN=55.7         ]
    [ N = 3.0:Tp  .25]
*
*   CALIB STANDHYD     5261  1  5.0   37.50    2.94  6.08  33.03  .50    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD     5262  1  5.0    7.50     .65  6.00  33.03  .50    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB NASHYD       3265  1  5.0   26.53     .47  6.58  13.13  .20    .000
    [CN=55.7         ]
    [ N = 3.0:Tp  .57]
*
*   CALIB STANDHYD     5260  1  5.0   54.55    2.77  6.17  25.78  .39    .000
    [I%=18.7:S%= 2.00]
*
*   CALIB STANDHYD     5263  1  5.0    2.35     .21  6.00  33.03  .50    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD     9264  1  5.0   10.24     .70  6.00  27.02  .41    .000
    [I%=28.0:S%= 2.00]
*
*   CALIB NASHYD       2001  1  5.0   19.92     .54  6.42  16.09  .24    .000
    [CN=62.2         ]
    [ N = 3.0:Tp  .42]
*
*   CALIB NASHYD       0309  1 10.0  157.12    2.11  7.33  16.39  .25    .000
    [CN=63.0         ]
    [ N = 3.0:Tp 1.14]
*
    RESRVR [ 2 : 5255] 8255  1  5.0   25.03    1.91  6.08  33.15  n/a    .000
    {ST=   .05 ha.m }
*
    RESRVR [ 2 : 5254] 8254  1  5.0   11.03     .40  6.58  24.22  n/a    .000
    {ST=   .07 ha.m }
*
    ADD [8254 + 3254]  6254  3  5.0   24.94     .96  6.50  23.85  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30    1.72  6.58  17.42  n/a    .000
*
    RESRVR [ 2 : 5250] 8250  1  5.0   20.10     .27  7.67  21.51  n/a    .000
    {ST=   .17 ha.m }
*
    ADD [8250 + 3250]  6250  3  5.0   63.80    1.36  6.50  18.90  n/a    .000
*
    RESRVR [ 2 : 2306] 8306  1  5.0    4.18     .05  7.00  24.39  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8306 + 0306]  6306  3  5.0  159.80    2.02  7.50  17.39  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    3.56  8.08  15.27  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31    4.99  8.00  14.82  n/a    .000
*
    RESRVR [ 2 : 2310] 8310  1  5.0   22.21    1.35  6.17  30.49  n/a    .000
    {ST=   .07 ha.m }
*
    ADD [8310 + 0310]  6310  3  5.0  184.64    1.57  8.00  16.65  n/a    .000
*
    RESRVR [ 2 : 2301] 8301  1  5.0   49.24     .91  7.67  24.18  n/a    .000
    {ST=   .32 ha.m }
*
    ADD [8301 + 0301]  6301  3  5.0  235.50    3.61  7.33  18.40  n/a    .000
*
    RESRVR [ 2 : 2203] 8203  1  5.0    6.70     .19  6.75  23.60  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8203 + 0203]  6203  3  5.0   37.23     .67  6.83  16.77  n/a    .000
*
    RESRVR [ 2 : 2204] 8204  1  5.0   15.92     .35  7.08  23.17  n/a    .000
    {ST=   .12 ha.m }
*
    ADD [8204 + 0204]  6204  3  5.0   29.58     .54  7.00  18.60  n/a    .000
*
    RESRVR [ 2 : 2211] 8211  1  5.0   27.27    1.57  6.17  30.31  n/a    .000
    {ST=   .06 ha.m }
*
    ADD [8211 + 0211]  6211  3  5.0   77.85    1.94  6.25  22.45  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15    1.65  6.08  26.34  n/a    .000
*
    RESRVR [ 2 : 2025] 8025  1  5.0   10.24     .69  6.08  30.19  n/a    .000
    {ST=   .03 ha.m }
*
    ADD [8025 + 1025]  6025  3  5.0   45.47    1.05  6.25  17.91  n/a    .000
*
    RESRVR [ 2 : 2028] 8028  1  5.0    9.83     .70  6.08  30.33  n/a    .000
    {ST=   .03 ha.m }
*
    ADD [8028 + 1028]  6028  3  5.0   42.68     .85  6.17  16.77  n/a    .000
*
    RESRVR [ 2 : 2045] 8045  1  5.0    8.17     .13  6.67  21.67  n/a    .000
    {ST=   .08 ha.m }
*
    ADD [8045 + 1045]  6045  3  5.0  196.20    1.71  7.08   9.92  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95    1.80  7.08   9.98  n/a    .000
*
    RESRVR [ 2 : 2042] 8042  1  5.0     .87     .02  6.42  14.63  n/a    .000
    {ST=   .00 ha.m }
*
    RESRVR [ 2 : 2041] 8041  1  5.0     .96     .02  6.50  20.23  n/a    .000
    {ST=   .01 ha.m }
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    3.21  7.83   9.61  n/a    .000
*
    RESRVR [ 2 : 2071] 8071  1  5.0   16.86     .34  6.58  23.70  n/a    .000
    {ST=   .16 ha.m }
*
    ADD [8071 + 1071]  6071  3  5.0   45.58     .72  6.75  16.21  n/a    .000
*
    RESRVR [ 2 : 2076] 8076  1  5.0     .92     .02  6.50  23.18  n/a    .000
```

```
      {ST=   .01 ha.m }
*
      ADD [2075 + 1075]  6075  3  5.0   29.18     .32  6.92  12.03  n/a    .000
*
      RESRVR [ 2 : 2110] 8110  1  5.0     .78     .09  6.08  38.76  n/a    .000
      {ST=   .00 ha.m }
*
      ADD [8110 + 0110]  6110  3  5.0   59.31     .74  7.08  13.55  n/a    .000
*
      ADD [0311 + 0312]  7211  3  5.0  565.60    3.24  9.42  14.54  n/a    .000
*
      ADD [7211 + 0313]  7212  3  5.0 1173.04    5.83  9.83  13.31  n/a    .000
*
      RESRVR [ 2 : 5145] 8145  1  5.0    3.56     .39  6.08  39.46  n/a    .000
      {ST=   .01 ha.m }
*
      ADD [8145 + 3145]  6145  3  5.0  136.10    1.08  7.67  12.52  n/a    .000
*
      RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .03  8.25  25.44  n/a    .000
      {ST=   .14 ha.m }
*
      RESRVR [ 2 : 2210] 8210  1  5.0   23.61    1.42  6.17  29.14  n/a    .000
      {ST=   .03 ha.m }
*
      ADD [8210 + 2212]  6212  3  5.0   24.16    1.44  6.17  28.78  n/a    .000
*
      ADD [0206 + 2206]  6206  3  5.0   77.31    1.05  7.17  16.55  n/a    .000
*
      RESRVR [ 2 : 2207] 8207  1  5.0   44.56     .49  8.58  21.90  n/a    .000
      {ST=   .37 ha.m }
*
      ADD [8207 + 0207]  6207  3  5.0  359.89    3.10  8.67  17.22  n/a    .000
*
      ADD [6207 + 2269]  7207  3  5.0  360.73    3.10  8.67  17.21  n/a    .000
*
      ADD [2208 + 2209]  6209  3  5.0    1.26     .07  6.08  25.12  n/a    .000
*
      RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .05 12.17  20.09  n/a    .000
      {ST=  1.15 ha.m }
*
      RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .22  6.50  33.01  n/a    .000
      {ST=   .10 ha.m }
*
      RESRVR [ 2 : 5260] 8260  1  5.0   54.55    1.19  6.75  25.77  n/a    .000
      {ST=   .55 ha.m }
*
      RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .06  6.50  32.94  n/a    .000
      {ST=   .03 ha.m }
*
      ADD [8255 + 6255]  6256  3  5.0  103.33    2.86  6.17  21.23  n/a    .000
*
      ADD [6203 + 6204]  6205  3  5.0   66.81    1.20  6.92  17.58  n/a    .000
*
      ADD [6025 + 6028]  6353  3  5.0   88.15    1.89  6.17  17.36  n/a    .000
*
      ADD [8042 + 8041]  6042  3  5.0    1.83     .04  6.42  17.56  n/a    .000
*
      ADD [6042 + 6040]  6043  3  5.0  531.32    3.23  7.83   9.63  n/a    .000
*
      ADD [0106 + 6071]  6106  3  5.0  860.09    4.23  9.17  11.95  n/a    .000
*
      ADD [1072 + 6075]  6072  3  5.0   29.89     .32  6.92  11.99  n/a    .000
*
      ADD [0111 + 6110]  6111  3  5.0 1211.32    5.53 10.42  13.60  n/a    .000
*
      ADD [5141 + 0030]  7318  3  5.0   34.38    2.16  6.00  29.96  n/a    .000
*
      ADD [0205 + 6206]  7205  3  5.0 3237.30    8.81 13.08  11.99  n/a    .000
*
      ADD [7205 + 7207]  7208  3  5.0 3598.03   10.13 12.17  12.51  n/a    .000
*
      ADD [0040 + 0060]  6265  3  5.0   45.00     .24  6.50  22.25  n/a    .000
*
      ADD [8260 + 0070]  6263  3  5.0   56.90    1.25  6.75  26.07  n/a    .000
*
      ADD [3256 + 6256]  6257  3  5.0  116.94    3.28  6.25  20.87  n/a    .000
*
      ADD [6205 + 0202]  6202  3  5.0  374.10    3.02  7.92  15.68  n/a    .000
*
      ADD [6353 + 1021]  6021  3  5.0  115.02    1.98  6.17  15.62  n/a    .000
*
      ADD [6047 + 6043]  6048  3  5.0  734.27    4.75  7.50   9.73  n/a    .000
*
      ADD [1070 + 6106]  6070  3  5.0  997.91    5.12  8.58  12.11  n/a    .000
*
      ADD [8076 + 6072]  6076  3  5.0   30.81     .34  6.92  12.32  n/a    .000
*
      ADD [7318 + 5140]  6140  3  5.0  153.82    2.27  6.00  17.51  n/a    .000
*
      ADD [7208 + 0208]  6208  3  5.0 3631.66   10.20 12.17  12.57  n/a    .000
*
      ADD [6265 + 3265]  7265  3  5.0   71.53     .70  6.58  18.87  n/a    .000
*
      ADD [0103 + 6021]  6103  3  5.0  338.32    3.23  7.25  16.31  n/a    .000
*
      ADD [0105 + 6048]  6105  3  5.0 1243.52    8.24  7.75  10.89  n/a    .000
*
      ADD [6070 + 6076]  6077  3  5.0 1028.72    5.27  8.50  12.12  n/a    .000
*
      ADD [6140 + 3141]  6141  3  5.0  239.21    2.33  6.08  15.42  n/a    .000
*
      ADD [6208 + 6209]  6210  3  5.0 3632.92   10.21 12.08  12.57  n/a    .000
*
      ADD [0108 + 6077]  6108  3  5.0 1701.87    8.15  9.08  12.35  n/a    .000
*
      ADD [6145 + 6141]  6315  3  5.0  375.31    3.14  7.58  14.37  n/a    .000
*
      ADD [6210 + 0209]  7209  3  5.0 3927.97   11.23 11.08  12.56  n/a    .000
*
      ADD [6105 + 6108]  6115  3  5.0 2945.39   15.65  8.25  11.73  n/a    .000
*
      ADD [6315 + 0315]  6316  3  5.0  498.75    4.31  7.67  14.28  n/a    .000
*
      ADD [7209 + 0210]  7210  3  5.0 3946.80   11.28 11.00  12.58  n/a    .000
*
      ADD [6115 + 0109]  6109  3  5.0 3174.23   16.73  8.25  11.55  n/a    .000
*
      ADD [0316 + 6316]  7316  3  5.0  710.07    5.60  7.83  14.08  n/a    .000
*
      ADD [6212 + 7210]  6213  3  5.0 3970.96   11.34 11.00  12.68  n/a    .000
*
      ADD [6109 + 6111]  6358  3  5.0 4385.55   21.16  8.58  12.12  n/a    .000
*
      ADD [0317 + 7316]  6317  3  5.0  988.36    7.20  8.00  14.19  n/a    .000
*
      ADD [2213 + 6213]  7317  3  5.0 3971.84   11.34 11.00  12.68  n/a    .000
*
      ADD [6358 + 0112]  6112  3  5.0 4417.59   21.36  8.58  12.11  n/a    .000
*
      ADD [7212 + 6317]  7213  3  5.0 2161.40   12.14  8.67  13.71  n/a    .000
*
      ADD [6103 + 6112]  6113  3  5.0 4755.91   24.08  8.42  12.41  n/a    .000
*
      ADD [0318 + 7213]  6318  3  5.0 2174.09   12.21  8.58  13.72  n/a    .000
*
      ADD [6113 + 0113]  6361  3  5.0 4779.49   24.23  8.33  12.41  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   4 ** 25 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                   5.0
      [ Ptot= 78.77 mm ]
*
  **  CALIB NASHYD       0100  1  5.0  835.70    7.29  9.17  20.03  .25    .000
      [CN=57.8       ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD       0101  1  5.0   96.09    3.64  6.67  28.30  .36    .000
      [CN=69.2       ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD       0114  1  5.0  193.26    3.39  7.33  21.87  .28    .000
      [CN=61.3       ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD       0115  1  5.0  170.62    3.25  7.67  27.43  .35    .000
      [CN=69.3       ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD       0116  1  5.0  289.79    3.73  8.33  23.84  .30    .000
      [CN=63.5       ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD     0200  1  5.0   89.02    5.68  6.17  33.41  .42    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD       0201  1  5.0  255.45    3.08  8.50  23.05  .29    .000
      [CN=63.2       ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD     0302  1  5.0   20.91    2.29  6.00  45.39  .58    .000
      [I%=36.2:S%= 2.00]
*
  *   CALIB NASHYD       0303  1  5.0  611.79    5.38  9.00  19.44  .25    .000
      [CN=57.2       ]
      [ N = 3.0:Tp 2.51]
*
  *   CALIB STANDHYD     0304  1  5.0   46.90    3.38  6.08  34.86  .44    .000
      [I%=19.8:S%= 2.00]
*
```

```
*   CALIB STANDHYD     0308  1  5.0   44.53    3.30  6.08  35.70  .45    .000
    [I%=20.3:S%= 2.00]
*
*   CALIB STANDHYD     0320  1  5.0   46.41    3.81  6.08  37.68  .48    .000
    [I%=25.4:S%= 2.00]
*
*   CALIB STANDHYD     0003  1  5.0   21.92    1.76  6.00  34.74  .44    .000
    [I%=26.8:S%= 2.00]
*
*   CALIB STANDHYD     0321  1  5.0   34.71    3.41  6.08  42.45  .54    .000
    [I%=32.5:S%= 2.00]
*
*   CALIB NASHYD       0322  1  5.0  207.40    2.01  8.75  19.92  .25    .000
    [CN=58.1        ]
    [ N = 3.0:Tp 2.28]
*
*   CALIB NASHYD       0323  1  5.0  236.30    5.57  7.00  23.26  .30    .000
    [CN=63.4        ]
    [ N = 3.0:Tp  .88]
*
*   CALIB NASHYD       0324  1  5.0  303.00    4.10  8.00  22.46  .29    .000
    [CN=62.3        ]
    [ N = 3.0:Tp 1.74]
*
*   CALIB NASHYD       0325  1  5.0  156.62    4.26  6.75  22.48  .29    .000
    [CN=62.3        ]
    [ N = 3.0:Tp  .69]
*
*   CALIB STANDHYD     5257  1  5.0   10.19    1.04  6.08  41.22  .52    .000
    [I%=28.8:S%= 2.00]
*
*   CALIB STANDHYD     0001  1  5.0    9.26     .66  6.00  30.45  .39    .000
    [I%=22.2:S%= 2.00]
*
*   CALIB NASHYD       3269  1  5.0  124.61    2.69  6.83  19.68  .25    .000
    [CN=57.3        ]
    [ N = 3.0:Tp  .78]
*
*   CALIB NASHYD       0327  1  5.0  198.82    2.30  8.42  21.47  .27    .000
    [CN=60.4        ]
    [ N = 3.0:Tp 2.01]
*
*   CALIB NASHYD       0328  1  5.0  171.14    3.85  6.92  20.95  .27    .000
    [CN=59.7        ]
    [ N = 3.0:Tp  .81]
*
*   CALIB STANDHYD     0329  1  5.0  117.37   10.92  6.08  42.68  .54    .000
    [I%=37.0:S%= 2.00]
*
*   CALIB NASHYD       3256  1  5.0   13.61     .65  6.33  25.19  .32    .000
    [CN=65.8        ]
    [ N = 3.0:Tp  .37]
*
*   CALIB STANDHYD     5255  1  5.0   25.03    2.53  6.00  41.51  .53    .000
    [I%=35.2:S%= 2.00]
*
*   CALIB NASHYD       5254  1  5.0   11.03     .85  6.25  32.70  .42    .000
    [CN=73.1        ]
    [ N = 3.0:Tp  .27]
*
*   CALIB NASHYD       3254  1  5.0   13.91     .79  6.42  32.08  .41    .000
    [CN=74.1        ]
    [ N = 3.0:Tp  .41]
*
*   CALIB NASHYD       3255  1  5.0   53.36    1.22  6.83  20.27  .26    .000
    [CN=58.4        ]
    [ N = 3.0:Tp  .75]
*
*   CALIB NASHYD       5250  1  5.0   20.10     .78  6.67  29.35  .37    .000
    [CN=69.8        ]
    [ N = 3.0:Tp  .63]
*
*   CALIB NASHYD       3250  1  5.0   43.70    1.77  6.42  24.59  .31    .000
    [CN=64.8        ]
    [ N = 3.0:Tp  .45]
*
*   CALIB STANDHYD     2306  1  5.0    4.18     .31  6.08  31.76  .40    .000
    [I%=17.0:S%= 2.00]
*
*   CALIB NASHYD       0306  1  5.0  155.62    2.78  7.50  23.99  .30    .000
    [CN=64.3        ]
    [ N = 3.0:Tp 1.32]
*
*   CALIB NASHYD       0305  1  5.0  309.29    2.76  9.08  19.95  .25    .000
    [CN=57.8        ]
    [ N = 3.0:Tp 2.55]
*
*   CALIB NASHYD       0307  1  5.0  165.22    2.05  7.83  19.16  .24    .000
    [CN=56.8        ]
    [ N = 3.0:Tp 1.56]
*
*   CALIB STANDHYD     2310  1  5.0   22.21    1.97  6.08  38.61  .49    .000
    [I%=28.6:S%= 2.00]
*
*   CALIB NASHYD       0310  1  5.0  162.43    2.02  8.08  20.78  .26    .000
    [CN=59.6        ]
    [ N = 3.0:Tp 1.74]
*
*   CALIB NASHYD       2301  1  5.0   49.24    1.73  6.92  32.65  .41    .000
    [CN=73.1        ]
    [ N = 3.0:Tp  .84]
*
*   CALIB NASHYD       0301  1  5.0  186.26    3.95  7.17  23.58  .30    .000
    [CN=63.9        ]
    [ N = 3.0:Tp 1.03]
*
*   CALIB NASHYD       2203  1  5.0    6.70     .43  6.33  31.99  .41    .000
    [CN=72.8        ]
    [ N = 3.0:Tp  .35]
*
*   CALIB NASHYD       0203  1  5.0   30.53     .70  6.92  21.54  .27    .000
    [CN=61.5        ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD       2204  1  5.0   15.92     .82  6.42  31.45  .40    .000
    [CN=72.3        ]
    [ N = 3.0:Tp  .47]
*
*   CALIB NASHYD       0204  1  5.0   13.66     .28  6.83  18.73  .24    .000
    [CN=55.5        ]
    [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD       0202  1  5.0  307.29    3.46  8.50  21.50  .27    .000
    [CN=61.0        ]
    [ N = 3.0:Tp 2.08]
*
*   CALIB STANDHYD     2211  1  5.0   27.27    2.27  6.08  38.94  .49    .000
    [I%=21.4:S%= 2.00]
*
*   CALIB NASHYD       0211  1  5.0   50.58    1.24  7.00  25.25  .32    .000
    [CN=65.6        ]
    [ N = 3.0:Tp  .94]
*
*   CALIB NASHYD       0300  1  5.0     .88     .05  6.17  20.92  .27    .000
    [CN=60.7        ]
    [ N = 3.0:Tp  .18]
*
*   CALIB STANDHYD     2300  1  5.0   30.27    2.13  6.17  34.62  .44    .000
    [I%=16.6:S%= 2.00]
*
*   CALIB NASHYD       0103  1  5.0  223.30    3.16  8.00  23.17  .29    .000
    [CN=62.2        ]
    [ N = 3.0:Tp 1.71]
*
*   CALIB STANDHYD     2025  1  5.0   10.24    1.01  6.00  37.80  .48    .000
    [I%=33.0:S%= 2.00]
*
*   CALIB NASHYD       1025  1  5.0   35.23     .95  6.67  20.25  .26    .000
    [CN=59.0        ]
    [ N = 3.0:Tp  .60]
*
*   CALIB STANDHYD     2028  1  5.0    9.83    1.01  6.00  37.73  .48    .000
    [I%=35.6:S%= 2.00]
*
*   CALIB NASHYD       1028  1  5.0   32.85     .65  6.83  18.16  .23    .000
    [CN=56.4        ]
    [ N = 3.0:Tp  .78]
*
*   CALIB NASHYD       1021  1  5.0   26.87     .40  6.92  14.33  .18    .000
    [CN=48.5        ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD       0105  1  5.0  509.25    5.24  8.17  17.76  .23    .000
    [CN=53.7        ]
    [ N = 3.0:Tp 1.81]
*
*   CALIB STANDHYD     2045  1  5.0    8.17     .52  6.00  27.84  .35    .000
    [I%=19.7:S%= 2.00]
*
*   CALIB NASHYD       1045  1  5.0  188.03    2.31  7.08  13.51  .17    .000
    [CN=45.6        ]
    [ N = 3.0:Tp  .98]
*
*   CALIB NASHYD       1047  1  5.0    6.75     .15  6.58  16.54  .21    .000
    [CN=50.3        ]
    [ N = 3.0:Tp  .59]
*
*   CALIB NASHYD       2042  1  5.0     .87     .05  6.17  20.44  .26    .000
    [CN=57.4        ]
    [ N = 3.0:Tp  .16]
*
*   CALIB STANDHYD     2041  1  5.0     .96     .06  6.00  26.25  .33    .000
    [I%=16.5:S%= 2.00]
*
*   CALIB NASHYD       1040  1  5.0  452.51    4.05  7.92  14.18  .18    .000
    [CN=47.7        ]
```

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     [ N = 3.0:Tp 1.59]
*
  *  CALIB NASHYD      1041  1  5.0   76.98     .63  7.67  11.75  .15    .000
     [CN=41.6          ]
     [ N = 3.0:Tp 1.40]
*
  *  CALIB NASHYD      0108  1  5.0  673.15    4.52 10.00  18.01  .23    .000
     [CN=54.7          ]
     [ N = 3.0:Tp 3.22]
*
  *  CALIB NASHYD      1070  1  5.0  137.82    1.96  7.42  18.64  .24    .000
     [CN=56.1          ]
     [ N = 3.0:Tp 1.26]
*
  *  CALIB NASHYD      0106  1  5.0  814.51    5.79  9.25  16.63  .21    .000
     [CN=51.8          ]
     [ N = 3.0:Tp 2.69]
*
  *  CALIB STANDHYD    2071  1  5.0   16.86    1.11  6.08  30.57  .39    .000
     [I%=19.3:S%= 2.00]
*
  *  CALIB NASHYD      1071  1  5.0   28.72     .55  6.83  16.72  .21    .000
     [CN=51.4          ]
     [ N = 3.0:Tp  .73]
*
  *  CALIB STANDHYD    2076  1  5.0     .92     .07  6.00  30.02  .38    .000
     [I%=17.9:S%= 2.00]
*
  *  CALIB NASHYD      1072  1  5.0     .71     .03  6.08  14.65  .19    .000
     [CN=47.6          ]
     [ N = 3.0:Tp  .13]
*
  *  CALIB STANDHYD    2075  1  5.0    1.10     .16  6.00  47.59  .60    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      1075  1  5.0   28.08     .44  6.92  15.62  .20    .000
     [CN=49.5          ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0109  1  5.0  228.84    1.59  8.50  13.32  .17    .000
     [CN=45.4          ]
     [ N = 3.0:Tp 2.06]
*
  *  CALIB NASHYD      0111  1  5.0 1152.01    7.62 10.42  19.22  .24    .000
     [CN=56.8          ]
     [ N = 3.0:Tp 3.59]
*
  *  CALIB STANDHYD    2110  1  5.0     .78     .12  6.00  47.61  .60    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      0110  1  5.0   58.53    1.04  7.00  18.69  .24    .000
     [CN=55.9          ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD      0112  1  5.0   32.04     .40  7.33  15.95  .20    .000
     [CN=49.9          ]
     [ N = 3.0:Tp 1.20]
*
  *  CALIB NASHYD      0113  1  5.0   23.58     .37  7.08  16.54  .21    .000
     [CN=52.0          ]
     [ N = 3.0:Tp  .95]
*
  *  CALIB NASHYD      0318  1  5.0   12.69     .28  6.83  20.31  .26    .000
     [CN=58.2          ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD      0311  1  5.0  536.71    4.42  9.50  20.37  .26    .000
     [CN=58.4          ]
     [ N = 3.0:Tp 2.91]
*
  *  CALIB NASHYD      0312  1  5.0   28.89     .64  6.92  21.70  .28    .000
     [CN=60.5          ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0313  1  5.0  607.44    3.76 10.17  17.24  .22    .000
     [CN=52.9          ]
     [ N = 3.0:Tp 3.38]
*
  *  CALIB NASHYD      0317  1  5.0  278.29    2.62  8.92  20.39  .26    .000
     [CN=58.7          ]
     [ N = 3.0:Tp 2.45]
*
  *  CALIB NASHYD      0316  1  5.0  211.32    2.08  8.58  19.23  .24    .000
     [CN=57.0          ]
     [ N = 3.0:Tp 2.14]
*
  *  CALIB STANDHYD    5145  1  5.0    3.56     .53  6.00  48.41  .61    .000
     [I%=51.2:S%= 2.00]
*
  *  CALIB NASHYD      3145  1  5.0  132.54    1.51  7.67  16.76  .21    .000
     [CN=52.1          ]
     [ N = 3.0:Tp 1.46]
*
```

```
  *  CALIB STANDHYD    5141  1  5.0   29.18    2.74  6.00  38.55  .49    .000
     [I%=33.8:S%= 2.00]
*
  *  CALIB STANDHYD    5142  1  5.0    5.20     .61  6.00  43.40  .55    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      5140  1  5.0  119.44    1.72  7.50  19.63  .25    .000
     [CN=57.3          ]
     [ N = 3.0:Tp 1.33]
*
  *  CALIB NASHYD      3141  1  5.0   85.39     .90  7.83  16.60  .21    .000
     [CN=52.3          ]
     [ N = 3.0:Tp 1.60]
*
  *  CALIB NASHYD      0315  1  5.0  123.44    1.68  7.67  19.76  .25    .000
     [CN=57.8          ]
     [ N = 3.0:Tp 1.44]
*
  *  CALIB STANDHYD    2213  1  5.0     .88     .09  6.00  37.84  .48    .000
     [I%=24.4:S%= 2.00]
*
  *  CALIB STANDHYD    2210  1  5.0   23.61    1.91  6.08  37.38  .47    .000
     [I%=22.4:S%= 2.00]
*
  *  CALIB NASHYD      2212  1  5.0     .55     .03  6.17  18.23  .23    .000
     [CN=53.1          ]
     [ N = 3.0:Tp  .22]
*
  *  CALIB NASHYD      0205  1  5.0 3159.99   12.39 13.17  16.87  .21    .000
     [CN=52.3          ]
     [ N = 3.0:Tp 5.93]
*
  *  CALIB NASHYD      0206  1  5.0   73.80    1.43  7.25  22.71  .29    .000
     [CN=61.6          ]
     [ N = 3.0:Tp 1.10]
*
  *  CALIB NASHYD      2206  1  5.0    3.51     .26  6.17  29.66  .38    .000
     [CN=70.5          ]
     [ N = 3.0:Tp  .24]
*
  *  CALIB NASHYD      2207  1  5.0   44.56    1.19  7.17  29.83  .38    .000
     [CN=70.3          ]
     [ N = 3.0:Tp 1.06]
*
  *  CALIB NASHYD      0207  1  5.0  315.33    3.67  8.58  23.10  .29    .000
     [CN=62.7          ]
     [ N = 3.0:Tp 2.20]
*
  *  CALIB NASHYD      2269  1  5.0     .84     .04  6.25  21.09  .27    .000
     [CN=60.4          ]
     [ N = 3.0:Tp  .28]
*
  *  CALIB NASHYD      0208  1  5.0   33.63     .85  7.00  25.29  .32    .000
     [CN=65.8          ]
     [ N = 3.0:Tp  .91]
*
  *  CALIB NASHYD      2208  1  5.0     .69     .06  6.17  31.40  .40    .000
     [CN=72.3          ]
     [ N = 3.0:Tp  .20]
*
  *  CALIB STANDHYD    2209  1  5.0     .57     .05  6.00  35.24  .45    .000
     [I%=23.7:S%= 2.00]
*
  *  CALIB NASHYD      0209  1  5.0  295.05    2.69  8.50  17.69  .22    .000
     [CN=53.9          ]
     [ N = 3.0:Tp 2.11]
*
  *  CALIB NASHYD      0210  1  5.0   18.83     .35  7.25  21.72  .28    .000
     [CN=60.8          ]
     [ N = 3.0:Tp 1.09]
*
  *  CALIB NASHYD      9262  1  5.0    7.50     .24  6.42  18.58  .24    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .40]
*
  *  CALIB NASHYD      9263  1  5.0    2.35     .10  6.25  18.57  .24    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .25]
*
  *  CALIB STANDHYD    5261  1  5.0   37.50    3.68  6.08  41.36  .53    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD    5262  1  5.0    7.50     .81  6.00  41.36  .53    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      3265  1  5.0   26.53     .67  6.58  18.58  .24    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .57]
*
  *  CALIB STANDHYD    5260  1  5.0   54.55    3.92  6.17  33.32  .42    .000
     [I%=18.7:S%= 2.00]
*
  *  CALIB STANDHYD    5263  1  5.0    2.35     .27  6.00  41.36  .53    .000
```

```
      [I%=35.0:S%= 2.00]
*
  *   CALIB STANDHYD     9264  1  5.0   10.24     .87  6.00  34.11  .43    .000
      [I%=28.0:S%= 2.00]
*
  *   CALIB NASHYD       2001  1  5.0   19.92     .77  6.42  22.53  .29    .000
      [CN=62.2       ]
      [ N = 3.0:Tp  .42]
*
  *   CALIB NASHYD       0309  1 10.0  157.12    2.99  7.17  22.94  .29    .000
      [CN=63.0       ]
      [ N = 3.0:Tp 1.14]
*
      RESRVR [ 2 : 5255] 8255  1  5.0   25.03    2.37  6.08  41.51  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 5254] 8254  1  5.0   11.03     .55  6.50  32.69  n/a    .000
      {ST=   .09 ha.m }
*
      ADD [8254 + 3254]  6254  3  5.0   24.94    1.32  6.42  32.35  n/a    .000
*
      ADD [6254 + 3255]  6255  3  5.0   78.30    2.41  6.58  24.12  n/a    .000
*
      RESRVR [ 2 : 5250] 8250  1  5.0   20.10     .40  7.50  29.35  n/a    .000
      {ST=   .22 ha.m }
*
      ADD [8250 + 3250]  6250  3  5.0   63.80    1.90  6.50  26.09  n/a    .000
*
      RESRVR [ 2 : 2306] 8306  1  5.0    4.18     .07  6.83  31.69  n/a    .000
      {ST=   .07 ha.m }
*
      ADD [8306 + 0306]  6306  3  5.0  159.80    2.85  7.50  24.19  n/a    .000
*
      ADD [6306 + 0305]  6305  3  5.0  469.09    5.04  8.08  21.39  n/a    .000
*
      ADD [6305 + 0307]  6307  3  5.0  634.31    7.07  8.00  20.81  n/a    .000
*
      RESRVR [ 2 : 2310] 8310  1  5.0   22.21    1.71  6.17  38.61  n/a    .000
      {ST=   .08 ha.m }
*
      ADD [8310 + 0310]  6310  3  5.0  184.64    2.21  8.00  22.93  n/a    .000
*
      RESRVR [ 2 : 2301] 8301  1  5.0   49.24    1.28  7.58  32.65  n/a    .000
      {ST=   .41 ha.m }
*
      ADD [8301 + 0301]  6301  3  5.0  235.50    5.12  7.25  25.48  n/a    .000
*
      RESRVR [ 2 : 2203] 8203  1  5.0    6.70     .26  6.75  31.98  n/a    .000
      {ST=   .06 ha.m }
*
      ADD [8203 + 0203]  6203  3  5.0   37.23     .96  6.83  23.41  n/a    .000
*
      RESRVR [ 2 : 2204] 8204  1  5.0   15.92     .49  7.00  31.44  n/a    .000
      {ST=   .16 ha.m }
*
      ADD [8204 + 0204]  6204  3  5.0   29.58     .76  7.00  25.57  n/a    .000
*
      RESRVR [ 2 : 2211] 8211  1  5.0   27.27    1.96  6.25  38.94  n/a    .000
      {ST=   .09 ha.m }
*
      ADD [8211 + 0211]  6211  3  5.0   77.85    2.65  6.42  30.05  n/a    .000
*
      ADD [0300 + 2300]  6300  3  5.0   31.15    2.19  6.17  34.24  n/a    .000
*
      RESRVR [ 2 : 2025] 8025  1  5.0   10.24     .86  6.08  37.80  n/a    .000
      {ST=   .04 ha.m }
*
      ADD [8025 + 1025]  6025  3  5.0   45.47    1.40  6.25  24.20  n/a    .000
*
      RESRVR [ 2 : 2028] 8028  1  5.0    9.83     .88  6.08  37.73  n/a    .000
      {ST=   .03 ha.m }
*
      ADD [8028 + 1028]  6028  3  5.0   42.68    1.10  6.17  22.67  n/a    .000
*
      RESRVR [ 2 : 2045] 8045  1  5.0    8.17     .21  6.50  27.79  n/a    .000
      {ST=   .09 ha.m }
*
      ADD [8045 + 1045]  6045  3  5.0  196.20    2.47  7.00  14.10  n/a    .000
*
      ADD [6045 + 1047]  6047  3  5.0  202.95    2.59  7.00  14.19  n/a    .000
*
      RESRVR [ 2 : 2042] 8042  1  5.0     .87     .02  6.42  20.42  n/a    .000
      {ST=   .01 ha.m }
*
      RESRVR [ 2 : 2041] 8041  1  5.0     .96     .03  6.50  26.19  n/a    .000
      {ST=   .01 ha.m }
*
      ADD [1040 + 1041]  6040  3  5.0  529.49    4.67  7.83  13.83  n/a    .000
*
      RESRVR [ 2 : 2071] 8071  1  5.0   16.86     .48  6.58  30.56  n/a    .000
      {ST=   .20 ha.m }
*
      ADD [8071 + 1071]  6071  3  5.0   45.58    1.01  6.75  21.84  n/a    .000
*
      RESRVR [ 2 : 2076] 8076  1  5.0     .92     .03  6.42  29.96  n/a    .000
      {ST=   .01 ha.m }
*
      ADD [2075 + 1075]  6075  3  5.0   29.18     .46  6.92  16.82  n/a    .000
*
      RESRVR [ 2 : 2110] 8110  1  5.0     .78     .10  6.08  47.61  n/a    .000
      {ST=   .00 ha.m }
*
      ADD [8110 + 0110]  6110  3  5.0   59.31    1.06  7.00  19.07  n/a    .000
*
      ADD [0311 + 0312]  7211  3  5.0  565.60    4.57  9.42  20.44  n/a    .000
*
      ADD [7211 + 0313]  7212  3  5.0 1173.04    8.27  9.75  18.78  n/a    .000
*
      RESRVR [ 2 : 5145] 8145  1  5.0    3.56     .47  6.08  48.41  n/a    .000
      {ST=   .01 ha.m }
*
      ADD [8145 + 3145]  6145  3  5.0  136.10    1.54  7.67  17.59  n/a    .000
*
      RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .04  8.25  34.13  n/a    .000
      {ST=   .17 ha.m }
*
      RESRVR [ 2 : 2210] 8210  1  5.0   23.61    1.85  6.17  37.38  n/a    .000
      {ST=   .04 ha.m }
*
      ADD [8210 + 2212]  6212  3  5.0   24.16    1.88  6.17  36.95  n/a    .000
*
      ADD [0206 + 2206]  6206  3  5.0   77.31    1.47  7.17  23.03  n/a    .000
*
      RESRVR [ 2 : 2207] 8207  1  5.0   44.56     .70  8.50  29.83  n/a    .000
      {ST=   .48 ha.m }
*
      ADD [8207 + 0207]  6207  3  5.0  359.89    4.37  8.58  23.94  n/a    .000
*
      ADD [6207 + 2269]  7207  3  5.0  360.73    4.37  8.58  23.93  n/a    .000
*
      ADD [2208 + 2209]  6209  3  5.0    1.26     .10  6.08  33.14  n/a    .000
*
      RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .15 10.33  28.42  n/a    .000
      {ST=  1.32 ha.m }
*
      RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .29  6.50  41.33  n/a    .000
      {ST=   .13 ha.m }
*
      RESRVR [ 2 : 5260] 8260  1  5.0   54.55    1.72  6.67  33.32  n/a    .000
      {ST=   .69 ha.m }
*
      RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .09  6.42  41.27  n/a    .000
      {ST=   .04 ha.m }
*
      ADD [8255 + 6255]  6256  3  5.0  103.33    3.81  6.25  28.33  n/a    .000
*
      ADD [6203 + 6204]  6205  3  5.0   66.81    1.71  6.92  24.37  n/a    .000
*
      ADD [6025 + 6028]  6353  3  5.0   88.15    2.47  6.17  23.46  n/a    .000
*
      ADD [8042 + 8041]  6042  3  5.0    1.83     .05  6.50  23.45  n/a    .000
*
      ADD [6042 + 6040]  6043  3  5.0  531.32    4.69  7.83  13.86  n/a    .000
*
      ADD [0106 + 6071]  6106  3  5.0  860.09    6.02  9.17  16.91  n/a    .000
*
      ADD [1072 + 6075]  6072  3  5.0   29.89     .46  6.92  16.77  n/a    .000
*
      ADD [0111 + 6110]  6111  3  5.0 1211.32    7.84 10.33  19.21  n/a    .000
*
      ADD [5141 + 0030]  7318  3  5.0   34.38    2.74  6.00  37.88  n/a    .000
*
      ADD [0205 + 6206]  7205  3  5.0 3237.30   12.51 13.00  17.01  n/a    .000
*
      ADD [7205 + 7207]  7208  3  5.0 3598.03   14.33 12.08  17.71  n/a    .000
*
      ADD [0040 + 0060]  6265  3  5.0   45.00     .32  6.58  30.57  n/a    .000
*
      ADD [8260 + 0070]  6263  3  5.0   56.90    1.80  6.67  33.65  n/a    .000
*
      ADD [3256 + 6256]  6257  3  5.0  116.94    4.43  6.25  27.97  n/a    .000
*
      ADD [6205 + 0202]  6202  3  5.0  374.10    4.28  7.83  22.01  n/a    .000
*
      ADD [6353 + 1021]  6021  3  5.0  115.02    2.63  6.25  21.33  n/a    .000
*
      ADD [6047 + 6043]  6048  3  5.0  734.27    6.87  7.50  13.95  n/a    .000
*
      ADD [1070 + 6106]  6070  3  5.0  997.91    7.30  8.58  17.15  n/a    .000
*
      ADD [8076 + 6072]  6076  3  5.0   30.81     .49  6.92  17.16  n/a    .000
*
      ADD [7318 + 5140]  6140  3  5.0  153.82    2.96  6.08  23.71  n/a    .000
*
      ADD [7208 + 0208]  6208  3  5.0 3631.66   14.42 12.08  17.78  n/a    .000
*
```

```
      ADD [6265 + 3265]  7265  3  5.0   71.53     .99  6.58  26.12  n/a    .000
*
      ADD [0103 + 6021]  6103  3  5.0  338.32    4.56  7.25  22.54  n/a    .000
*
      ADD [0105 + 6048]  6105  3  5.0 1243.52   11.84  7.75  15.51  n/a    .000
*
      ADD [6070 + 6076]  6077  3  5.0 1028.72    7.51  8.50  17.15  n/a    .000
*
      ADD [6140 + 3141]  6141  3  5.0  239.21    3.06  6.08  21.17  n/a    .000
*
      ADD [6208 + 6209]  6210  3  5.0 3632.92   14.43 12.08  17.78  n/a    .000
*
      ADD [0108 + 6077]  6108  3  5.0 1701.87   11.61  9.08  17.49  n/a    .000
*
      ADD [6145 + 6141]  6315  3  5.0  375.31    4.43  7.58  19.87  n/a    .000
*
      ADD [6210 + 0209]  7209  3  5.0 3927.97   15.89 11.08  17.78  n/a    .000
*
      ADD [6105 + 6108]  6115  3  5.0 2945.39   22.40  8.17  16.65  n/a    .000
*
      ADD [6315 + 0315]  6316  3  5.0  498.75    6.11  7.58  19.84  n/a    .000
*
      ADD [7209 + 0210]  7210  3  5.0 3946.80   15.96 11.00  17.79  n/a    .000
*
      ADD [6115 + 0109]  6109  3  5.0 3174.23   23.97  8.25  16.41  n/a    .000
*
      ADD [0316 + 6316]  7316  3  5.0  710.07    7.95  7.83  19.66  n/a    .000
*
      ADD [6212 + 7210]  6213  3  5.0 3970.96   16.03 11.00  17.91  n/a    .000
*
      ADD [6109 + 6111]  6358  3  5.0 4385.55   30.26  8.58  17.19  n/a    .000
*
      ADD [0317 + 7316]  6317  3  5.0  988.36   10.23  8.00  19.87  n/a    .000
*
      ADD [2213 + 6213]  7317  3  5.0 3971.84   16.03 11.00  17.92  n/a    .000
*
      ADD [6358 + 0112]  6112  3  5.0 4417.59   30.55  8.50  17.18  n/a    .000
*
      ADD [7212 + 6317]  7213  3  5.0 2161.40   17.24  8.58  19.28  n/a    .000
*
      ADD [6103 + 6112]  6113  3  5.0 4755.91   34.38  8.33  17.56  n/a    .000
*
      ADD [0318 + 7213]  6318  3  5.0 2174.09   17.33  8.58  19.28  n/a    .000
*
      ADD [6113 + 0113]  6361  3  5.0 4779.49   34.59  8.33  17.55  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   5 ** 50 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm          cms

      START @   .00 hrs
      ----------------------
      MASS STORM                5.0
      [ Ptot= 88.25 mm ]
*
  **  CALIB NASHYD      0100  1  5.0  835.70    9.05  9.17  24.76  .28    .000
      [CN=57.8          ]
      [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD      0101  1  5.0   96.09    4.45  6.67  34.43  .39    .000
      [CN=69.2          ]
      [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD      0114  1  5.0  193.26    4.20  7.33  26.98  .31    .000
      [CN=61.3          ]
      [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD      0115  1  5.0  170.62    4.00  7.67  33.52  .38    .000
      [CN=69.3          ]
      [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD      0116  1  5.0  289.79    4.60  8.33  29.26  .33    .000
      [CN=63.5          ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB STANDHYD    0200  1  5.0   89.02    7.52  6.17  39.54  .45    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD      0201  1  5.0  255.45    3.81  8.50  28.38  .32    .000
      [CN=63.2          ]
      [ N = 3.0:Tp 2.09]
*
  *   CALIB STANDHYD    0302  1  5.0   20.91    2.79  6.08  52.47  .59    .000
      [I%=36.2:S%= 2.00]
*
  *   CALIB NASHYD      0303  1  5.0  611.79    6.70  9.00  24.08  .27    .000
      [CN=57.2          ]
      [ N = 3.0:Tp 2.51]
*
  *   CALIB STANDHYD    0304  1  5.0   46.90    4.03  6.08  41.07  .47    .000
      [I%=19.8:S%= 2.00]
*
  *   CALIB STANDHYD    0308  1  5.0   44.53    3.94  6.08  42.02  .48    .000
      [I%=20.3:S%= 2.00]
*
  *   CALIB STANDHYD    0320  1  5.0   46.41    4.50  6.08  44.05  .50    .000
      [I%=25.4:S%= 2.00]
*
  *   CALIB STANDHYD    0003  1  5.0   21.92    2.04  6.00  40.46  .46    .000
      [I%=26.8:S%= 2.00]
*
  *   CALIB STANDHYD    0321  1  5.0   34.71    3.98  6.08  49.22  .56    .000
      [I%=32.5:S%= 2.00]
*
  *   CALIB NASHYD      0322  1  5.0  207.40    2.50  8.75  24.66  .28    .000
      [CN=58.1          ]
      [ N = 3.0:Tp 2.28]
*
  *   CALIB NASHYD      0323  1  5.0  236.30    6.89  6.92  28.63  .32    .000
      [CN=63.4          ]
      [ N = 3.0:Tp  .88]
*
  *   CALIB NASHYD      0324  1  5.0  303.00    5.08  8.00  27.69  .31    .000
      [CN=62.3          ]
      [ N = 3.0:Tp 1.74]
*
  *   CALIB NASHYD      0325  1  5.0  156.62    5.28  6.75  27.71  .31    .000
      [CN=62.3          ]
      [ N = 3.0:Tp  .69]
*
  *   CALIB STANDHYD    5257  1  5.0   10.19    1.23  6.08  47.96  .54    .000
      [I%=28.8:S%= 2.00]
*
  *   CALIB STANDHYD    0001  1  5.0    9.26     .76  6.00  35.67  .40    .000
      [I%=22.2:S%= 2.00]
*
  *   CALIB NASHYD      3269  1  5.0  124.61    3.35  6.83  24.35  .28    .000
      [CN=57.3          ]
      [ N = 3.0:Tp  .78]
*
  *   CALIB NASHYD      0327  1  5.0  198.82    2.85  8.33  26.49  .30    .000
      [CN=60.4          ]
      [ N = 3.0:Tp 2.01]
*
  *   CALIB NASHYD      0328  1  5.0  171.14    4.79  6.83  25.88  .29    .000
      [CN=59.7          ]
      [ N = 3.0:Tp  .81]
*
  *   CALIB STANDHYD    0329  1  5.0  117.37   13.16  6.08  49.27  .56    .000
      [I%=37.0:S%= 2.00]
*
  *   CALIB NASHYD      3256  1  5.0   13.61     .80  6.33  30.87  .35    .000
      [CN=65.8          ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD    5255  1  5.0   25.03    2.92  6.00  47.99  .54    .000
      [I%=35.2:S%= 2.00]
*
  *   CALIB NASHYD      5254  1  5.0   11.03    1.02  6.25  39.39  .45    .000
      [CN=73.1          ]
      [ N = 3.0:Tp  .27]
*
  *   CALIB NASHYD      3254  1  5.0   13.91     .96  6.42  38.82  .44    .000
      [CN=74.1          ]
      [ N = 3.0:Tp  .41]
*
  *   CALIB NASHYD      3255  1  5.0   53.36    1.52  6.83  25.06  .28    .000
      [CN=58.4          ]
      [ N = 3.0:Tp  .75]
*
  *   CALIB NASHYD      5250  1  5.0   20.10     .94  6.67  35.59  .40    .000
      [CN=69.8          ]
      [ N = 3.0:Tp  .63]
*
  *   CALIB NASHYD      3250  1  5.0   43.70    2.19  6.42  30.15  .34    .000
      [CN=64.8          ]
      [ N = 3.0:Tp  .45]
*
  *   CALIB STANDHYD    2306  1  5.0    4.18     .37  6.08  37.52  .43    .000
      [I%=17.0:S%= 2.00]
*
  *   CALIB NASHYD      0306  1  5.0  155.62    3.44  7.50  29.47  .33    .000
      [CN=64.3          ]
      [ N = 3.0:Tp 1.32]
*
  *   CALIB NASHYD      0305  1  5.0  309.29    3.42  9.00  24.67  .28    .000
      [CN=57.8          ]
      [ N = 3.0:Tp 2.55]
*
  *   CALIB NASHYD      0307  1  5.0  165.22    2.56  7.83  23.76  .27    .000
      [CN=56.8          ]
      [ N = 3.0:Tp 1.56]
*
```

```
  *   CALIB STANDHYD     2310  1  5.0   22.21    2.30  6.08  44.93  .51    .000
      [I%=28.6:S%= 2.00]
  *
  *   CALIB NASHYD       0310  1  5.0  162.43    2.51  8.00  25.69  .29    .000
      [CN=59.6          ]
      [ N = 3.0:Tp 1.74]
  *
  *   CALIB NASHYD       2301  1  5.0   49.24    2.10  6.83  39.34  .45    .000
      [CN=73.1          ]
      [ N = 3.0:Tp  .84]
  *
  *   CALIB NASHYD       0301  1  5.0  186.26    4.89  7.17  29.00  .33    .000
      [CN=63.9          ]
      [ N = 3.0:Tp 1.03]
  *
  *   CALIB NASHYD       2203  1  5.0    6.70     .52  6.33  38.62  .44    .000
      [CN=72.8          ]
      [ N = 3.0:Tp  .35]
  *
  *   CALIB NASHYD       0203  1  5.0   30.53     .87  6.92  26.64  .30    .000
      [CN=61.5          ]
      [ N = 3.0:Tp  .82]
  *
  *   CALIB NASHYD       2204  1  5.0   15.92     .99  6.42  38.01  .43    .000
      [CN=72.3          ]
      [ N = 3.0:Tp  .47]
  *
  *   CALIB NASHYD       0204  1  5.0   13.66     .35  6.83  23.20  .26    .000
      [CN=55.5          ]
      [ N = 3.0:Tp  .79]
  *
  *   CALIB NASHYD       0202  1  5.0  307.29    4.29  8.50  26.57  .30    .000
      [CN=61.0          ]
      [ N = 3.0:Tp 2.08]
  *
  *   CALIB STANDHYD     2211  1  5.0   27.27    2.96  6.08  45.68  .52    .000
      [I%=21.4:S%= 2.00]
  *
  *   CALIB NASHYD       0211  1  5.0   50.58    1.52  7.00  30.91  .35    .000
      [CN=65.6          ]
      [ N = 3.0:Tp  .94]
  *
  *   CALIB NASHYD       0300  1  5.0     .88     .06  6.17  25.91  .29    .000
      [CN=60.7          ]
      [ N = 3.0:Tp  .18]
  *
  *   CALIB STANDHYD     2300  1  5.0   30.27    2.59  6.17  40.88  .46    .000
      [I%=16.6:S%= 2.00]
  *
  *   CALIB NASHYD       0103  1  5.0  223.30    3.90  8.00  28.44  .32    .000
      [CN=62.2          ]
      [ N = 3.0:Tp 1.71]
  *
  *   CALIB STANDHYD     2025  1  5.0   10.24    1.16  6.00  43.70  .50    .000
      [I%=33.0:S%= 2.00]
  *
  *   CALIB NASHYD       1025  1  5.0   35.23    1.18  6.67  25.08  .28    .000
      [CN=59.0          ]
      [ N = 3.0:Tp  .60]
  *
  *   CALIB STANDHYD     2028  1  5.0    9.83    1.16  6.00  43.46  .49    .000
      [I%=35.6:S%= 2.00]
  *
  *   CALIB NASHYD       1028  1  5.0   32.85     .82  6.83  22.65  .26    .000
      [CN=56.4          ]
      [ N = 3.0:Tp  .78]
  *
  *   CALIB NASHYD       1021  1  5.0   26.87     .51  6.92  18.00  .20    .000
      [CN=48.5          ]
      [ N = 3.0:Tp  .82]
  *
  *   CALIB NASHYD       0105  1  5.0  509.25    6.52  8.08  22.03  .25    .000
      [CN=53.7          ]
      [ N = 3.0:Tp 1.81]
  *
  *   CALIB STANDHYD     2045  1  5.0    8.17     .61  6.00  32.67  .37    .000
      [I%=19.7:S%= 2.00]
  *
  *   CALIB NASHYD       1045  1  5.0  188.03    2.91  7.08  16.92  .19    .000
      [CN=45.6          ]
      [ N = 3.0:Tp  .98]
  *
  *   CALIB NASHYD       1047  1  5.0    6.75     .19  6.58  20.50  .23    .000
      [CN=50.3          ]
      [ N = 3.0:Tp  .59]
  *
  *   CALIB NASHYD       2042  1  5.0     .87     .06  6.17  25.16  .29    .000
      [CN=57.4          ]
      [ N = 3.0:Tp  .16]
  *
  *   CALIB STANDHYD     2041  1  5.0     .96     .07  6.00  30.99  .35    .000
      [I%=16.5:S%= 2.00]
  *
```

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  *   CALIB NASHYD       1040  1  5.0  452.51    5.10  7.83  17.78  .20    .000
      [CN=47.7          ]
      [ N = 3.0:Tp 1.59]
  *
  *   CALIB NASHYD       1041  1  5.0   76.98     .79  7.58  14.78  .17    .000
      [CN=41.6          ]
      [ N = 3.0:Tp 1.40]
  *
  *   CALIB NASHYD       0108  1  5.0  673.15    5.63  9.92  22.37  .25    .000
      [CN=54.7          ]
      [ N = 3.0:Tp 3.22]
  *
  *   CALIB NASHYD       1070  1  5.0  137.82    2.45  7.42  23.15  .26    .000
      [CN=56.1          ]
      [ N = 3.0:Tp 1.26]
  *
  *   CALIB NASHYD       0106  1  5.0  814.51    7.23  9.25  20.69  .23    .000
      [CN=51.8          ]
      [ N = 3.0:Tp 2.69]
  *
  *   CALIB STANDHYD     2071  1  5.0   16.86    1.31  6.08  36.00  .41    .000
      [I%=19.3:S%= 2.00]
  *
  *   CALIB NASHYD       1071  1  5.0   28.72     .69  6.75  20.76  .24    .000
      [CN=51.4          ]
      [ N = 3.0:Tp  .73]
  *
  *   CALIB STANDHYD     2076  1  5.0     .92     .08  6.00  35.39  .40    .000
      [I%=17.9:S%= 2.00]
  *
  *   CALIB NASHYD       1072  1  5.0     .71     .04  6.08  18.26  .21    .000
      [CN=47.6          ]
      [ N = 3.0:Tp  .13]
  *
  *   CALIB STANDHYD     2075  1  5.0    1.10     .19  6.00  54.34  .62    .000
      [I%=50.0:S%= 2.00]
  *
  *   CALIB NASHYD       1075  1  5.0   28.08     .55  6.92  19.45  .22    .000
      [CN=49.5          ]
      [ N = 3.0:Tp  .87]
  *
  *   CALIB NASHYD       0109  1  5.0  228.84    2.00  8.50  16.71  .19    .000
      [CN=45.4          ]
      [ N = 3.0:Tp 2.06]
  *
  *   CALIB NASHYD       0111  1  5.0 1152.01    9.46 10.42  23.82  .27    .000
      [CN=56.8          ]
      [ N = 3.0:Tp 3.59]
  *
  *   CALIB STANDHYD     2110  1  5.0     .78     .14  6.00  54.37  .62    .000
      [I%=50.0:S%= 2.00]
  *
  *   CALIB NASHYD       0110  1  5.0   58.53    1.30  7.00  23.19  .26    .000
      [CN=55.9          ]
      [ N = 3.0:Tp  .94]
  *
  *   CALIB NASHYD       0112  1  5.0   32.04     .50  7.33  19.84  .22    .000
      [CN=49.9          ]
      [ N = 3.0:Tp 1.20]
  *
  *   CALIB NASHYD       0113  1  5.0   23.58     .46  7.08  20.61  .23    .000
      [CN=52.0          ]
      [ N = 3.0:Tp  .95]
  *
  *   CALIB NASHYD       0318  1  5.0   12.69     .35  6.83  25.09  .28    .000
      [CN=58.2          ]
      [ N = 3.0:Tp  .79]
  *
  *   CALIB NASHYD       0311  1  5.0  536.71    5.48  9.50  25.16  .29    .000
      [CN=58.4          ]
      [ N = 3.0:Tp 2.91]
  *
  *   CALIB NASHYD       0312  1  5.0   28.89     .79  6.92  26.75  .30    .000
      [CN=60.5          ]
      [ N = 3.0:Tp  .87]
  *
  *   CALIB NASHYD       0313  1  5.0  607.44    4.69 10.17  21.43  .24    .000
      [CN=52.9          ]
      [ N = 3.0:Tp 3.38]
  *
  *   CALIB NASHYD       0317  1  5.0  278.29    3.25  8.92  25.21  .29    .000
      [CN=58.7          ]
      [ N = 3.0:Tp 2.45]
  *
  *   CALIB NASHYD       0316  1  5.0  211.32    2.59  8.50  23.85  .27    .000
      [CN=57.0          ]
      [ N = 3.0:Tp 2.14]
  *
  *   CALIB STANDHYD     5145  1  5.0    3.56     .60  6.00  55.24  .63    .000
      [I%=51.2:S%= 2.00]
  *
  *   CALIB NASHYD       3145  1  5.0  132.54    1.89  7.67  20.85  .24    .000
      [CN=52.1          ]
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     [ N = 3.0:Tp 1.46]
*
  *  CALIB STANDHYD     5141  1  5.0   29.18    3.16  6.00  44.58  .51    .000
     [I%=33.8:S%= 2.00]
*
  *  CALIB STANDHYD     5142  1  5.0    5.20     .71  6.00  50.19  .57    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD       5140  1  5.0  119.44    2.14  7.50  24.29  .28    .000
     [CN=57.3       ]
     [ N = 3.0:Tp 1.33]
*
  *  CALIB NASHYD       3141  1  5.0   85.39    1.13  7.83  20.69  .23    .000
     [CN=52.3       ]
     [ N = 3.0:Tp 1.60]
*
  *  CALIB NASHYD       0315  1  5.0  123.44    2.09  7.67  24.48  .28    .000
     [CN=57.8       ]
     [ N = 3.0:Tp 1.44]
*
  *  CALIB STANDHYD     2213  1  5.0     .88     .10  6.00  44.25  .50    .000
     [I%=24.4:S%= 2.00]
*
  *  CALIB STANDHYD     2210  1  5.0   23.61    2.27  6.08  43.83  .50    .000
     [I%=22.4:S%= 2.00]
*
  *  CALIB NASHYD       2212  1  5.0     .55     .03  6.17  22.51  .26    .000
     [CN=53.1       ]
     [ N = 3.0:Tp  .22]
*
  *  CALIB NASHYD       0205  1  5.0 3159.99   15.41 13.17  20.98  .24    .000
     [CN=52.3       ]
     [ N = 3.0:Tp 5.93]
*
  *  CALIB NASHYD       0206  1  5.0   73.80    1.77  7.25  27.91  .32    .000
     [CN=61.6       ]
     [ N = 3.0:Tp 1.10]
*
  *  CALIB NASHYD       2206  1  5.0    3.51     .32  6.17  35.97  .41    .000
     [CN=70.5       ]
     [ N = 3.0:Tp  .24]
*
  *  CALIB NASHYD       2207  1  5.0   44.56    1.45  7.17  36.14  .41    .000
     [CN=70.3       ]
     [ N = 3.0:Tp 1.06]
*
  *  CALIB NASHYD       0207  1  5.0  315.33    4.54  8.58  28.41  .32    .000
     [CN=62.7       ]
     [ N = 3.0:Tp 2.20]
*
  *  CALIB NASHYD       2269  1  5.0     .84     .05  6.25  26.08  .30    .000
     [CN=60.4       ]
     [ N = 3.0:Tp  .28]
*
  *  CALIB NASHYD       0208  1  5.0   33.63    1.05  7.00  30.98  .35    .000
     [CN=65.8       ]
     [ N = 3.0:Tp  .91]
*
  *  CALIB NASHYD       2208  1  5.0     .69     .07  6.17  37.94  .43    .000
     [CN=72.3       ]
     [ N = 3.0:Tp  .20]
*
  *  CALIB STANDHYD     2209  1  5.0     .57     .06  6.00  41.30  .47    .000
     [I%=23.7:S%= 2.00]
*
  *  CALIB NASHYD       0209  1  5.0  295.05    3.35  8.50  21.98  .25    .000
     [CN=53.9       ]
     [ N = 3.0:Tp 2.11]
*
  *  CALIB NASHYD       0210  1  5.0   18.83     .44  7.17  26.78  .30    .000
     [CN=60.8       ]
     [ N = 3.0:Tp 1.09]
*
  *  CALIB NASHYD       9262  1  5.0    7.50     .30  6.42  23.05  .26    .000
     [CN=55.7       ]
     [ N = 3.0:Tp  .40]
*
  *  CALIB NASHYD       9263  1  5.0    2.35     .13  6.25  23.04  .26    .000
     [CN=55.7       ]
     [ N = 3.0:Tp  .25]
*
  *  CALIB STANDHYD     5261  1  5.0   37.50    4.27  6.08  47.80  .54    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD     5262  1  5.0    7.50     .97  6.00  47.80  .54    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD       3265  1  5.0   26.53     .84  6.58  23.05  .26    .000
     [CN=55.7       ]
     [ N = 3.0:Tp  .57]
*
  *  CALIB STANDHYD     5260  1  5.0   54.55    4.42  6.08  39.27  .44    .000
     [I%=18.7:S%= 2.00]
```

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*
  *  CALIB STANDHYD     5263  1  5.0    2.35     .32  6.00  47.80  .54    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD     9264  1  5.0   10.24    1.00  6.00  39.65  .45    .000
     [I%=28.0:S%= 2.00]
*
  *  CALIB NASHYD       2001  1  5.0   19.92     .95  6.42  27.75  .31    .000
     [CN=62.2       ]
     [ N = 3.0:Tp  .42]
*
  *  CALIB NASHYD       0309  1 10.0  157.12    3.71  7.17  28.25  .32    .000
     [CN=63.0       ]
     [ N = 3.0:Tp 1.14]
*
     RESRVR [ 2 : 5255] 8255  1  5.0   25.03    2.75  6.08  47.99  n/a    .000
     {ST=   .07 ha.m }
*
     RESRVR [ 2 : 5254] 8254  1  5.0   11.03     .72  6.50  39.38  n/a    .000
     {ST=   .11 ha.m }
*
     ADD [8254 + 3254]  6254  3  5.0   24.94    1.66  6.42  39.07  n/a    .000
*
     ADD [6254 + 3255]  6255  3  5.0   78.30    2.99  6.58  29.52  n/a    .000
*
     RESRVR [ 2 : 5250] 8250  1  5.0   20.10     .52  7.50  35.58  n/a    .000
     {ST=   .26 ha.m }
*
     ADD [8250 + 3250]  6250  3  5.0   63.80    2.35  6.50  31.86  n/a    .000
*
     RESRVR [ 2 : 2306] 8306  1  5.0    4.18     .10  6.75  37.45  n/a    .000
     {ST=   .08 ha.m }
*
     ADD [8306 + 0306]  6306  3  5.0  159.80    3.51  7.50  29.68  n/a    .000
*
     ADD [6306 + 0305]  6305  3  5.0  469.09    6.23  8.00  26.37  n/a    .000
*
     ADD [6305 + 0307]  6307  3  5.0  634.31    8.77  7.92  25.69  n/a    .000
*
     RESRVR [ 2 : 2310] 8310  1  5.0   22.21    2.01  6.17  44.93  n/a    .000
     {ST=   .10 ha.m }
*
     ADD [8310 + 0310]  6310  3  5.0  184.64    2.73  8.00  28.01  n/a    .000
*
     RESRVR [ 2 : 2301] 8301  1  5.0   49.24    1.61  7.50  39.34  n/a    .000
     {ST=   .48 ha.m }
*
     ADD [8301 + 0301]  6301  3  5.0  235.50    6.37  7.25  31.16  n/a    .000
*
     RESRVR [ 2 : 2203] 8203  1  5.0    6.70     .35  6.67  38.60  n/a    .000
     {ST=   .07 ha.m }
*
     ADD [8203 + 0203]  6203  3  5.0   37.23    1.20  6.83  28.79  n/a    .000
*
     RESRVR [ 2 : 2204] 8204  1  5.0   15.92     .63  7.00  38.00  n/a    .000
     {ST=   .19 ha.m }
*
     ADD [8204 + 0204]  6204  3  5.0   29.58     .97  6.92  31.16  n/a    .000
*
     RESRVR [ 2 : 2211] 8211  1  5.0   27.27    2.51  6.25  45.68  n/a    .000
     {ST=   .13 ha.m }
*
     ADD [8211 + 0211]  6211  3  5.0   77.85    3.21  6.25  36.09  n/a    .000
*
     ADD [0300 + 2300]  6300  3  5.0   31.15    2.65  6.17  40.46  n/a    .000
*
     RESRVR [ 2 : 2025] 8025  1  5.0   10.24    1.01  6.08  43.70  n/a    .000
     {ST=   .04 ha.m }
*
     ADD [8025 + 1025]  6025  3  5.0   45.47    1.68  6.25  29.27  n/a    .000
*
     RESRVR [ 2 : 2028] 8028  1  5.0    9.83    1.03  6.08  43.46  n/a    .000
     {ST=   .04 ha.m }
*
     ADD [8028 + 1028]  6028  3  5.0   42.68    1.30  6.17  27.44  n/a    .000
*
     RESRVR [ 2 : 2045] 8045  1  5.0    8.17     .27  6.50  32.63  n/a    .000
     {ST=   .11 ha.m }
*
     ADD [8045 + 1045]  6045  3  5.0  196.20    3.11  7.08  17.58  n/a    .000
*
     ADD [6045 + 1047]  6047  3  5.0  202.95    3.26  7.00  17.68  n/a    .000
*
     RESRVR [ 2 : 2042] 8042  1  5.0     .87     .03  6.42  25.14  n/a    .000
     {ST=   .01 ha.m }
*
     RESRVR [ 2 : 2041] 8041  1  5.0     .96     .03  6.50  30.93  n/a    .000
     {ST=   .01 ha.m }
*
     ADD [1040 + 1041]  6040  3  5.0  529.49    5.89  7.83  17.34  n/a    .000
*
     RESRVR [ 2 : 2071] 8071  1  5.0   16.86     .62  6.58  35.98  n/a    .000
     {ST=   .23 ha.m }
```

```
*
*    ADD [8071 + 1071]  6071  3  5.0   45.58    1.28  6.67  26.39  n/a    .000
*    RESRVR [ 2 : 2076] 8076  1  5.0     .92     .04  6.42  35.32  n/a    .000
     {ST=   .01 ha.m }
*    ADD [2075 + 1075]  6075  3  5.0   29.18     .57  6.92  20.77  n/a    .000
*    RESRVR [ 2 : 2110] 8110  1  5.0     .78     .12  6.08  54.37  n/a    .000
     {ST=   .00 ha.m }
*    ADD [8110 + 0110]  6110  3  5.0   59.31    1.32  7.00  23.60  n/a    .000
*    ADD [0311 + 0312]  7211  3  5.0  565.60    5.67  9.33  25.25  n/a    .000
*    ADD [7211 + 0313]  7212  3  5.0 1173.04   10.27  9.75  23.27  n/a    .000
*    RESRVR [ 2 : 5145] 8145  1  5.0    3.56     .56  6.08  55.24  n/a    .000
     {ST=   .01 ha.m }
*    ADD [8145 + 3145]  6145  3  5.0  136.10    1.93  7.67  21.75  n/a    .000
*    RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .04  8.25  40.86  n/a    .000
     {ST=   .19 ha.m }
*    RESRVR [ 2 : 2210] 8210  1  5.0   23.61    2.06  6.17  43.83  n/a    .000
     {ST=   .05 ha.m }
*    ADD [8210 + 2212]  6212  3  5.0   24.16    2.09  6.17  43.34  n/a    .000
*    ADD [0206 + 2206]  6206  3  5.0   77.31    1.82  7.17  28.27  n/a    .000
*    RESRVR [ 2 : 2207] 8207  1  5.0   44.56     .88  8.42  36.14  n/a    .000
     {ST=   .57 ha.m }
*    ADD [8207 + 0207]  6207  3  5.0  359.89    5.41  8.50  29.37  n/a    .000
*    ADD [6207 + 2269]  7207  3  5.0  360.73    5.42  8.50  29.36  n/a    .000
*    ADD [2208 + 2209]  6209  3  5.0    1.26     .12  6.08  39.46  n/a    .000
*    RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .21 10.08  34.86  n/a    .000
     {ST=  1.44 ha.m }
*    RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .37  6.42  47.77  n/a    .000
     {ST=   .14 ha.m }
*    RESRVR [ 2 : 5260] 8260  1  5.0   54.55    2.18  6.58  39.26  n/a    .000
     {ST=   .79 ha.m }
*    RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .12  6.33  47.71  n/a    .000
     {ST=   .05 ha.m }
*    ADD [8255 + 6255]  6256  3  5.0  103.33    4.56  6.25  34.00  n/a    .000
*    ADD [6203 + 6204]  6205  3  5.0   66.81    2.16  6.83  29.84  n/a    .000
*    ADD [6025 + 6028]  6353  3  5.0   88.15    2.95  6.17  28.39  n/a    .000
*    ADD [8042 + 8041]  6042  3  5.0    1.83     .06  6.42  28.18  n/a    .000
*    ADD [6042 + 6040]  6043  3  5.0  531.32    5.91  7.83  17.38  n/a    .000
*    ADD [0106 + 6071]  6106  3  5.0  860.09    7.50  9.17  21.00  n/a    .000
*    ADD [1072 + 6075]  6072  3  5.0   29.89     .58  6.92  20.71  n/a    .000
*    ADD [0111 + 6110]  6111  3  5.0 1211.32    9.73 10.33  23.81  n/a    .000
*    ADD [5141 + 0030]  7318  3  5.0   34.38    3.17  6.00  44.02  n/a    .000
*    ADD [0205 + 6206]  7205  3  5.0 3237.30   15.56 13.00  21.15  n/a    .000
*    ADD [7205 + 7207]  7208  3  5.0 3598.03   17.78 12.08  21.98  n/a    .000
*    ADD [0040 + 0060]  6265  3  5.0   45.00     .43  6.67  37.01  n/a    .000
*    ADD [8260 + 0070]  6263  3  5.0   56.90    2.29  6.58  39.61  n/a    .000
*    ADD [3256 + 6256]  6257  3  5.0  116.94    5.33  6.25  33.63  n/a    .000
*    ADD [6205 + 0202]  6202  3  5.0  374.10    5.30  7.83  27.15  n/a    .000
*    ADD [6353 + 1021]  6021  3  5.0  115.02    3.16  6.50  25.96  n/a    .000
*    ADD [6047 + 6043]  6048  3  5.0  734.27    8.65  7.50  17.46  n/a    .000
*    ADD [1070 + 6106]  6070  3  5.0  997.91    9.10  8.58  21.29  n/a    .000
*    ADD [8076 + 6072]  6076  3  5.0   30.81     .61  6.92  21.14  n/a    .000
*    ADD [7318 + 5140]  6140  3  5.0  153.82    3.47  6.08  28.70  n/a    .000
*    ADD [7208 + 0208]  6208  3  5.0 3631.66   17.89 12.08  22.06  n/a    .000
*    ADD [6265 + 3265]  7265  3  5.0   71.53    1.26  6.67  31.84  n/a    .000
*    ADD [0103 + 6021]  6103  3  5.0  338.32    5.64  7.17  27.59  n/a    .000
*    ADD [0105 + 6048]  6105  3  5.0 1243.52   14.84  7.75  19.33  n/a    .000
*    ADD [6070 + 6076]  6077  3  5.0 1028.72    9.37  8.42  21.29  n/a    .000
*    ADD [6140 + 3141]  6141  3  5.0  239.21    3.60  6.08  25.84  n/a    .000
*    ADD [6208 + 6209]  6210  3  5.0 3632.92   17.90 12.08  22.07  n/a    .000
*    ADD [0108 + 6077]  6108  3  5.0 1701.87   14.47  9.08  21.72  n/a    .000
*    ADD [6145 + 6141]  6315  3  5.0  375.31    5.50  7.58  24.36  n/a    .000
*    ADD [6210 + 0209]  7209  3  5.0 3927.97   19.71 11.00  22.06  n/a    .000
*    ADD [6105 + 6108]  6115  3  5.0 2945.39   28.01  8.17  20.71  n/a    .000
*    ADD [6315 + 0315]  6316  3  5.0  498.75    7.59  7.58  24.39  n/a    .000
*    ADD [7209 + 0210]  7210  3  5.0 3946.80   19.80 11.00  22.08  n/a    .000
*    ADD [6115 + 0109]  6109  3  5.0 3174.23   29.98  8.25  20.42  n/a    .000
*    ADD [0316 + 6316]  7316  3  5.0  710.07    9.89  7.83  24.23  n/a    .000
*    ADD [6212 + 7210]  6213  3  5.0 3970.96   19.88 10.92  22.21  n/a    .000
*    ADD [6109 + 6111]  6358  3  5.0 4385.55   37.79  8.50  21.36  n/a    .000
*    ADD [0317 + 7316]  6317  3  5.0  988.36   12.72  8.00  24.50  n/a    .000
*    ADD [2213 + 6213]  7317  3  5.0 3971.84   19.88 10.92  22.22  n/a    .000
*    ADD [6358 + 0112]  6112  3  5.0 4417.59   38.15  8.50  21.35  n/a    .000
*    ADD [7212 + 6317]  7213  3  5.0 2161.40   21.43  8.58  23.83  n/a    .000
*    ADD [6103 + 6112]  6113  3  5.0 4755.91   42.89  8.33  21.79  n/a    .000
*    ADD [0318 + 7213]  6318  3  5.0 2174.09   21.55  8.58  23.84  n/a    .000
*    ADD [6113 + 0113]  6361  3  5.0 4779.49   43.15  8.33  21.78  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   6 ** 100 yr 12 hr SCS
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm         cms

     START @   .00 hrs
     --------------------
     MASS STORM                    5.0
     [ Ptot= 97.64 mm ]
*
  **  CALIB NASHYD       0100  1  5.0  835.70   10.91  9.17  29.77  .30    .000
     [CN=57.8         ]
     [ N = 3.0:Tp 2.64]
*
  **  CALIB NASHYD       0101  1  5.0   96.09    5.29  6.67  40.80  .42    .000
     [CN=69.2         ]
     [ N = 3.0:Tp  .61]
*
  **  CALIB NASHYD       0114  1  5.0  193.26    5.07  7.33  32.36  .33    .000
     [CN=61.3         ]
     [ N = 3.0:Tp 1.20]
*
  **  CALIB NASHYD       0115  1  5.0  170.62    4.78  7.67  39.86  .41    .000
     [CN=69.3         ]
     [ N = 3.0:Tp 1.46]
*
  **  CALIB NASHYD       0116  1  5.0  289.79    5.51  8.33  34.94  .36    .000
     [CN=63.5         ]
     [ N = 3.0:Tp 2.01]
*
   *  CALIB STANDHYD     0200  1  5.0   89.02    8.87  6.17  45.88  .47    .000
     [I%=17.0:S%= 2.00]
*
   *  CALIB NASHYD       0201  1  5.0  255.45    4.58  8.42  33.99  .35    .000
     [CN=63.2         ]
     [ N = 3.0:Tp 2.09]
*
   *  CALIB STANDHYD     0302  1  5.0   20.91    3.20  6.08  59.67  .61    .000
     [I%=36.2:S%= 2.00]
*
   *  CALIB NASHYD       0303  1  5.0  611.79    8.09  9.00  29.00  .30    .000
     [CN=57.2         ]
     [ N = 3.0:Tp 2.51]
```

```
*
*   CALIB STANDHYD     0304  1  5.0   46.90    4.70  6.08  47.47  .49    .000
    [I%=19.8:S%= 2.00]
*
*   CALIB STANDHYD     0308  1  5.0   44.53    4.59  6.08  48.52  .50    .000
    [I%=20.3:S%= 2.00]
*
*   CALIB STANDHYD     0320  1  5.0   46.41    5.19  6.08  50.59  .52    .000
    [I%=25.4:S%= 2.00]
*
*   CALIB STANDHYD     0003  1  5.0   21.92    2.35  6.08  46.33  .47    .000
    [I%=26.8:S%= 2.00]
*
*   CALIB STANDHYD     0321  1  5.0   34.71    4.86  6.08  56.14  .57    .000
    [I%=32.5:S%= 2.00]
*
*   CALIB NASHYD       0322  1  5.0  207.40    3.02  8.67  29.68  .30    .000
    [CN=58.1        ]
    [ N = 3.0:Tp 2.28]
*
*   CALIB NASHYD       0323  1  5.0  236.30    8.30  6.92  34.26  .35    .000
    [CN=63.4        ]
    [ N = 3.0:Tp  .88]
*
*   CALIB NASHYD       0324  1  5.0  303.00    6.11  8.00  33.19  .34    .000
    [CN=62.3        ]
    [ N = 3.0:Tp 1.74]
*
*   CALIB NASHYD       0325  1  5.0  156.62    6.36  6.75  33.22  .34    .000
    [CN=62.3        ]
    [ N = 3.0:Tp  .69]
*
*   CALIB STANDHYD     5257  1  5.0   10.19    1.41  6.08  54.85  .56    .000
    [I%=28.8:S%= 2.00]
*
*   CALIB STANDHYD     0001  1  5.0    9.26     .92  6.00  41.07  .42    .000
    [I%=22.2:S%= 2.00]
*
*   CALIB NASHYD       3269  1  5.0  124.61    4.05  6.83  29.29  .30    .000
    [CN=57.3        ]
    [ N = 3.0:Tp  .78]
*
*   CALIB NASHYD       0327  1  5.0  198.82    3.43  8.33  31.78  .33    .000
    [CN=60.4        ]
    [ N = 3.0:Tp 2.01]
*
*   CALIB NASHYD       0328  1  5.0  171.14    5.78  6.83  31.08  .32    .000
    [CN=59.7        ]
    [ N = 3.0:Tp  .81]
*
*   CALIB STANDHYD     0329  1  5.0  117.37   15.10  6.08  55.99  .57    .000
    [I%=37.0:S%= 2.00]
*
*   CALIB NASHYD       3256  1  5.0   13.61     .96  6.33  36.80  .38    .000
    [CN=65.8        ]
    [ N = 3.0:Tp  .37]
*
*   CALIB STANDHYD     5255  1  5.0   25.03    3.47  6.08  54.60  .56    .000
    [I%=35.2:S%= 2.00]
*
*   CALIB NASHYD       5254  1  5.0   11.03    1.21  6.25  46.28  .47    .000
    [CN=73.1        ]
    [ N = 3.0:Tp  .27]
*
*   CALIB NASHYD       3254  1  5.0   13.91    1.14  6.42  45.78  .47    .000
    [CN=74.1        ]
    [ N = 3.0:Tp  .41]
*
*   CALIB NASHYD       3255  1  5.0   53.36    1.83  6.83  30.13  .31    .000
    [CN=58.4        ]
    [ N = 3.0:Tp  .75]
*
*   CALIB NASHYD       5250  1  5.0   20.10    1.12  6.67  42.06  .43    .000
    [CN=69.8        ]
    [ N = 3.0:Tp  .63]
*
*   CALIB NASHYD       3250  1  5.0   43.70    2.62  6.42  35.98  .37    .000
    [CN=64.8        ]
    [ N = 3.0:Tp  .45]
*
*   CALIB STANDHYD     2306  1  5.0    4.18     .44  6.08  43.49  .45    .000
    [I%=17.0:S%= 2.00]
*
*   CALIB NASHYD       0306  1  5.0  155.62    4.13  7.50  35.21  .36    .000
    [CN=64.3        ]
    [ N = 3.0:Tp 1.32]
*
*   CALIB NASHYD       0305  1  5.0  309.29    4.13  9.00  29.66  .30    .000
    [CN=57.8        ]
    [ N = 3.0:Tp 2.55]
*
*   CALIB NASHYD       0307  1  5.0  165.22    3.09  7.75  28.63  .29    .000
    [CN=56.8        ]
    [ N = 3.0:Tp 1.56]
*
*   CALIB STANDHYD     2310  1  5.0   22.21    2.84  6.08  51.41  .53    .000
    [I%=28.6:S%= 2.00]
*
*   CALIB NASHYD       0310  1  5.0  162.43    3.03  8.00  30.88  .32    .000
    [CN=59.6        ]
    [ N = 3.0:Tp 1.74]
*
*   CALIB NASHYD       2301  1  5.0   49.24    2.47  6.83  46.24  .47    .000
    [CN=73.1        ]
    [ N = 3.0:Tp  .84]
*
*   CALIB NASHYD       0301  1  5.0  186.26    5.87  7.17  34.69  .36    .000
    [CN=63.9        ]
    [ N = 3.0:Tp 1.03]
*
*   CALIB NASHYD       2203  1  5.0    6.70     .61  6.33  45.46  .47    .000
    [CN=72.8        ]
    [ N = 3.0:Tp  .35]
*
*   CALIB NASHYD       0203  1  5.0   30.53    1.05  6.92  32.02  .33    .000
    [CN=61.5        ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD       2204  1  5.0   15.92    1.17  6.42  44.78  .46    .000
    [CN=72.3        ]
    [ N = 3.0:Tp  .47]
*
*   CALIB NASHYD       0204  1  5.0   13.66     .42  6.83  27.94  .29    .000
    [CN=55.5        ]
    [ N = 3.0:Tp  .79]
*
*   CALIB NASHYD       0202  1  5.0  307.29    5.17  8.42  31.91  .33    .000
    [CN=61.0        ]
    [ N = 3.0:Tp 2.08]
*
*   CALIB STANDHYD     2211  1  5.0   27.27    3.45  6.08  52.59  .54    .000
    [I%=21.4:S%= 2.00]
*
*   CALIB NASHYD       0211  1  5.0   50.58    1.82  7.00  36.83  .38    .000
    [CN=65.6        ]
    [ N = 3.0:Tp  .94]
*
*   CALIB NASHYD       0300  1  5.0     .88     .08  6.17  31.17  .32    .000
    [CN=60.7        ]
    [ N = 3.0:Tp  .18]
*
*   CALIB STANDHYD     2300  1  5.0   30.27    3.34  6.17  47.33  .48    .000
    [I%=16.6:S%= 2.00]
*
*   CALIB NASHYD       0103  1  5.0  223.30    4.68  7.92  33.97  .35    .000
    [CN=62.2        ]
    [ N = 3.0:Tp 1.71]
*
*   CALIB STANDHYD     2025  1  5.0   10.24    1.37  6.00  49.73  .51    .000
    [I%=33.0:S%= 2.00]
*
*   CALIB NASHYD       1025  1  5.0   35.23    1.43  6.67  30.19  .31    .000
    [CN=59.0        ]
    [ N = 3.0:Tp  .60]
*
*   CALIB STANDHYD     2028  1  5.0    9.83    1.30  6.00  49.31  .51    .000
    [I%=35.6:S%= 2.00]
*
*   CALIB NASHYD       1028  1  5.0   32.85     .99  6.83  27.41  .28    .000
    [CN=56.4        ]
    [ N = 3.0:Tp  .78]
*
*   CALIB NASHYD       1021  1  5.0   26.87     .62  6.92  21.92  .22    .000
    [CN=48.5        ]
    [ N = 3.0:Tp  .82]
*
*   CALIB NASHYD       0105  1  5.0  509.25    7.90  8.08  26.58  .27    .000
    [CN=53.7        ]
    [ N = 3.0:Tp 1.81]
*
*   CALIB STANDHYD     2045  1  5.0    8.17     .69  6.00  37.69  .39    .000
    [I%=19.7:S%= 2.00]
*
*   CALIB NASHYD       1045  1  5.0  188.03    3.56  7.08  20.59  .21    .000
    [CN=45.6        ]
    [ N = 3.0:Tp  .98]
*
*   CALIB NASHYD       1047  1  5.0    6.75     .22  6.58  24.72  .25    .000
    [CN=50.3        ]
    [ N = 3.0:Tp  .59]
*
*   CALIB NASHYD       2042  1  5.0     .87     .08  6.17  30.15  .31    .000
    [CN=57.4        ]
    [ N = 3.0:Tp  .16]
*
*   CALIB STANDHYD     2041  1  5.0     .96     .08  6.00  35.91  .37    .000
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     [I%=16.5:S%= 2.00]
*
  *  CALIB NASHYD      1040  1  5.0  452.51    6.24  7.83  21.64  .22    .000
     [CN=47.7          ]
     [ N = 3.0:Tp 1.59]
*
  *  CALIB NASHYD      1041  1  5.0   76.98     .97  7.58  18.04  .18    .000
     [CN=41.6          ]
     [ N = 3.0:Tp 1.40]
*
  *  CALIB NASHYD      0108  1  5.0  673.15    6.81  9.92  27.01  .28    .000
     [CN=54.7          ]
     [ N = 3.0:Tp 3.22]
*
  *  CALIB NASHYD      1070  1  5.0  137.82    2.97  7.42  27.93  .29    .000
     [CN=56.1          ]
     [ N = 3.0:Tp 1.26]
*
  *  CALIB NASHYD      0106  1  5.0  814.51    8.76  9.25  25.02  .26    .000
     [CN=51.8          ]
     [ N = 3.0:Tp 2.69]
*
  *  CALIB STANDHYD    2071  1  5.0   16.86    1.52  6.08  41.61  .43    .000
     [I%=19.3:S%= 2.00]
*
  *  CALIB NASHYD      1071  1  5.0   28.72     .83  6.75  25.07  .26    .000
     [CN=51.4          ]
     [ N = 3.0:Tp  .73]
*
  *  CALIB STANDHYD    2076  1  5.0     .92     .09  6.00  40.94  .42    .000
     [I%=17.9:S%= 2.00]
*
  *  CALIB NASHYD      1072  1  5.0     .71     .05  6.08  22.12  .23    .000
     [CN=47.6          ]
     [ N = 3.0:Tp  .13]
*
  *  CALIB STANDHYD    2075  1  5.0    1.10     .21  6.00  61.17  .63    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      1075  1  5.0   28.08     .67  6.92  23.55  .24    .000
     [CN=49.5          ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0109  1  5.0  228.84    2.44  8.50  20.35  .21    .000
     [CN=45.4          ]
     [ N = 3.0:Tp 2.06]
*
  *  CALIB NASHYD      0111  1  5.0 1152.01   11.42 10.42  28.69  .29    .000
     [CN=56.8          ]
     [ N = 3.0:Tp 3.59]
*
  *  CALIB STANDHYD    2110  1  5.0     .78     .15  6.00  61.20  .63    .000
     [I%=50.0:S%= 2.00]
*
  *  CALIB NASHYD      0110  1  5.0   58.53    1.58  7.00  27.96  .29    .000
     [CN=55.9          ]
     [ N = 3.0:Tp  .94]
*
  *  CALIB NASHYD      0112  1  5.0   32.04     .61  7.33  23.99  .25    .000
     [CN=49.9          ]
     [ N = 3.0:Tp 1.20]
*
  *  CALIB NASHYD      0113  1  5.0   23.58     .56  7.00  24.95  .26    .000
     [CN=52.0          ]
     [ N = 3.0:Tp  .95]
*
  *  CALIB NASHYD      0318  1  5.0   12.69     .42  6.83  30.14  .31    .000
     [CN=58.2          ]
     [ N = 3.0:Tp  .79]
*
  *  CALIB NASHYD      0311  1  5.0  536.71    6.60  9.50  30.23  .31    .000
     [CN=58.4          ]
     [ N = 3.0:Tp 2.91]
*
  *  CALIB NASHYD      0312  1  5.0   28.89     .95  6.92  32.06  .33    .000
     [CN=60.5          ]
     [ N = 3.0:Tp  .87]
*
  *  CALIB NASHYD      0313  1  5.0  607.44    5.67 10.17  25.88  .27    .000
     [CN=52.9          ]
     [ N = 3.0:Tp 3.38]
*
  *  CALIB NASHYD      0317  1  5.0  278.29    3.92  8.92  30.30  .31    .000
     [CN=58.7          ]
     [ N = 3.0:Tp 2.45]
*
  *  CALIB NASHYD      0316  1  5.0  211.32    3.13  8.50  28.74  .29    .000
     [CN=57.0          ]
     [ N = 3.0:Tp 2.14]
*
  *  CALIB STANDHYD    5145  1  5.0    3.56     .69  6.00  62.14  .64    .000
     [I%=51.2:S%= 2.00]
*
```

```
  *  CALIB NASHYD      3145  1  5.0  132.54    2.29  7.67  25.21  .26    .000
     [CN=52.1          ]
     [ N = 3.0:Tp 1.46]
*
  *  CALIB STANDHYD    5141  1  5.0   29.18    3.59  6.00  50.76  .52    .000
     [I%=33.8:S%= 2.00]
*
  *  CALIB STANDHYD    5142  1  5.0    5.20     .81  6.00  57.12  .58    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      5140  1  5.0  119.44    2.59  7.50  29.22  .30    .000
     [CN=57.3          ]
     [ N = 3.0:Tp 1.33]
*
  *  CALIB NASHYD      3141  1  5.0   85.39    1.37  7.83  25.06  .26    .000
     [CN=52.3          ]
     [ N = 3.0:Tp 1.60]
*
  *  CALIB NASHYD      0315  1  5.0  123.44    2.53  7.67  29.46  .30    .000
     [CN=57.8          ]
     [ N = 3.0:Tp 1.44]
*
  *  CALIB STANDHYD    2213  1  5.0     .88     .12  6.00  50.82  .52    .000
     [I%=24.4:S%= 2.00]
*
  *  CALIB STANDHYD    2210  1  5.0   23.61    2.88  6.08  50.45  .52    .000
     [I%=22.4:S%= 2.00]
*
  *  CALIB NASHYD      2212  1  5.0     .55     .04  6.17  27.04  .28    .000
     [CN=53.1          ]
     [ N = 3.0:Tp  .22]
*
  *  CALIB NASHYD      0205  1  5.0 3159.99   18.64 13.17  25.36  .26    .000
     [CN=52.3          ]
     [ N = 3.0:Tp 5.93]
*
  *  CALIB NASHYD      0206  1  5.0   73.80    2.13  7.17  33.37  .34    .000
     [CN=61.6          ]
     [ N = 3.0:Tp 1.10]
*
  *  CALIB NASHYD      2206  1  5.0    3.51     .37  6.17  42.52  .44    .000
     [CN=70.5          ]
     [ N = 3.0:Tp  .24]
*
  *  CALIB NASHYD      2207  1  5.0   44.56    1.71  7.17  42.68  .44    .000
     [CN=70.3          ]
     [ N = 3.0:Tp 1.06]
*
  *  CALIB NASHYD      0207  1  5.0  315.33    5.45  8.58  33.98  .35    .000
     [CN=62.7          ]
     [ N = 3.0:Tp 2.20]
*
  *  CALIB NASHYD      2269  1  5.0     .84     .06  6.25  31.35  .32    .000
     [CN=60.4          ]
     [ N = 3.0:Tp  .28]
*
  *  CALIB NASHYD      0208  1  5.0   33.63    1.25  7.00  36.92  .38    .000
     [CN=65.8          ]
     [ N = 3.0:Tp  .91]
*
  *  CALIB NASHYD      2208  1  5.0     .69     .09  6.17  44.71  .46    .000
     [CN=72.3          ]
     [ N = 3.0:Tp  .20]
*
  *  CALIB STANDHYD    2209  1  5.0     .57     .07  6.00  47.53  .49    .000
     [I%=23.7:S%= 2.00]
*
  *  CALIB NASHYD      0209  1  5.0  295.05    4.06  8.50  26.53  .27    .000
     [CN=53.9          ]
     [ N = 3.0:Tp 2.11]
*
  *  CALIB NASHYD      0210  1  5.0   18.83     .53  7.17  32.12  .33    .000
     [CN=60.8          ]
     [ N = 3.0:Tp 1.09]
*
  *  CALIB NASHYD      9262  1  5.0    7.50     .37  6.42  27.80  .28    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .40]
*
  *  CALIB NASHYD      9263  1  5.0    2.35     .15  6.25  27.78  .28    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .25]
*
  *  CALIB STANDHYD    5261  1  5.0   37.50    4.86  6.08  54.38  .56    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB STANDHYD    5262  1  5.0    7.50    1.11  6.00  54.38  .56    .000
     [I%=35.0:S%= 2.00]
*
  *  CALIB NASHYD      3265  1  5.0   26.53    1.02  6.58  27.80  .28    .000
     [CN=55.7          ]
     [ N = 3.0:Tp  .57]
*
```

```
*   CALIB STANDHYD     5260  1  5.0   54.55    5.17  6.17  45.40  .47    .000
    [I%=18.7:S%= 2.00]
*
*   CALIB STANDHYD     5263  1  5.0    2.35     .36  6.00  54.37  .56    .000
    [I%=35.0:S%= 2.00]
*
*   CALIB STANDHYD     9264  1  5.0   10.24    1.20  6.00  45.35  .46    .000
    [I%=28.0:S%= 2.00]
*
*   CALIB NASHYD       2001  1  5.0   19.92    1.15  6.42  33.25  .34    .000
    [CN=62.2       ]
    [ N = 3.0:Tp  .42]
*
*   CALIB NASHYD       0309  1 10.0  157.12    4.47  7.17  33.83  .35    .000
    [CN=63.0       ]
    [ N = 3.0:Tp 1.14]
*
    RESRVR [ 2 : 5255] 8255  1  5.0   25.03    3.30  6.08  54.60  n/a    .000
    {ST=   .09 ha.m }
*
    RESRVR [ 2 : 5254] 8254  1  5.0   11.03     .88  6.50  46.28  n/a    .000
    {ST=   .12 ha.m }
*
    ADD [8254 + 3254]  6254  3  5.0   24.94    2.01  6.42  46.00  n/a    .000
*
    ADD [6254 + 3255]  6255  3  5.0   78.30    3.59  6.58  35.18  n/a    .000
*
    RESRVR [ 2 : 5250] 8250  1  5.0   20.10     .65  7.42  42.06  n/a    .000
    {ST=   .30 ha.m }
*
    ADD [8250 + 3250]  6250  3  5.0   63.80    2.82  6.50  37.89  n/a    .000
*
    RESRVR [ 2 : 2306] 8306  1  5.0    4.18     .13  6.67  43.42  n/a    .000
    {ST=   .09 ha.m }
*
    ADD [8306 + 0306]  6306  3  5.0  159.80    4.22  7.42  35.43  n/a    .000
*
    ADD [6306 + 0305]  6305  3  5.0  469.09    7.50  8.00  31.63  n/a    .000
*
    ADD [6305 + 0307]  6307  3  5.0  634.31   10.57  7.92  30.85  n/a    .000
*
    RESRVR [ 2 : 2310] 8310  1  5.0   22.21    2.32  6.17  51.41  n/a    .000
    {ST=   .13 ha.m }
*
    ADD [8310 + 0310]  6310  3  5.0  184.64    3.28  8.00  33.35  n/a    .000
*
    RESRVR [ 2 : 2301] 8301  1  5.0   49.24    1.96  7.50  46.23  n/a    .000
    {ST=   .54 ha.m }
*
    ADD [8301 + 0301]  6301  3  5.0  235.50    7.72  7.25  37.11  n/a    .000
*
    RESRVR [ 2 : 2203] 8203  1  5.0    6.70     .43  6.67  45.44  n/a    .000
    {ST=   .08 ha.m }
*
    ADD [8203 + 0203]  6203  3  5.0   37.23    1.45  6.75  34.43  n/a    .000
*
    RESRVR [ 2 : 2204] 8204  1  5.0   15.92     .77  6.92  44.77  n/a    .000
    {ST=   .21 ha.m }
*
    ADD [8204 + 0204]  6204  3  5.0   29.58    1.19  6.92  37.00  n/a    .000
*
    RESRVR [ 2 : 2211] 8211  1  5.0   27.27    3.09  6.17  52.59  n/a    .000
    {ST=   .15 ha.m }
*
    ADD [8211 + 0211]  6211  3  5.0   77.85    3.92  6.25  42.35  n/a    .000
*
    ADD [0300 + 2300]  6300  3  5.0   31.15    3.42  6.17  46.87  n/a    .000
*
    RESRVR [ 2 : 2025] 8025  1  5.0   10.24    1.19  6.08  49.73  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8025 + 1025]  6025  3  5.0   45.47    2.04  6.25  34.59  n/a    .000
*
    RESRVR [ 2 : 2028] 8028  1  5.0    9.83    1.15  6.08  49.31  n/a    .000
    {ST=   .04 ha.m }
*
    ADD [8028 + 1028]  6028  3  5.0   42.68    1.52  6.17  32.46  n/a    .000
*
    RESRVR [ 2 : 2045] 8045  1  5.0    8.17     .34  6.50  37.64  n/a    .000
    {ST=   .12 ha.m }
*
    ADD [8045 + 1045]  6045  3  5.0  196.20    3.78  7.08  21.30  n/a    .000
*
    ADD [6045 + 1047]  6047  3  5.0  202.95    3.97  7.00  21.42  n/a    .000
*
    RESRVR [ 2 : 2042] 8042  1  5.0     .87     .05  6.33  30.13  n/a    .000
    {ST=   .01 ha.m }
*
    RESRVR [ 2 : 2041] 8041  1  5.0     .96     .04  6.42  35.85  n/a    .000
    {ST=   .01 ha.m }
*
    ADD [1040 + 1041]  6040  3  5.0  529.49    7.20  7.83  21.12  n/a    .000
*
    RESRVR [ 2 : 2071] 8071  1  5.0   16.86     .78  6.50  41.60  n/a    .000
    {ST=   .25 ha.m }
*
    ADD [8071 + 1071]  6071  3  5.0   45.58    1.56  6.67  31.19  n/a    .000
*
    RESRVR [ 2 : 2076] 8076  1  5.0     .92     .06  6.33  40.87  n/a    .000
    {ST=   .01 ha.m }
*
    ADD [2075 + 1075]  6075  3  5.0   29.18     .69  6.92  24.97  n/a    .000
*
    RESRVR [ 2 : 2110] 8110  1  5.0     .78     .14  6.08  61.20  n/a    .000
    {ST=   .00 ha.m }
*
    ADD [8110 + 0110]  6110  3  5.0   59.31    1.59  7.00  28.40  n/a    .000
*
    ADD [0311 + 0312]  7211  3  5.0  565.60    6.83  9.33  30.33  n/a    .000
*
    ADD [7211 + 0313]  7212  3  5.0 1173.04   12.39  9.67  28.03  n/a    .000
*
    RESRVR [ 2 : 5145] 8145  1  5.0    3.56     .63  6.08  62.14  n/a    .000
    {ST=   .01 ha.m }
*
    ADD [8145 + 3145]  6145  3  5.0  136.10    2.34  7.67  26.18  n/a    .000
*
    RESRVR [ 2 : 5142] 0030  1  5.0    5.20     .05  8.25  47.71  n/a    .000
    {ST=   .22 ha.m }
*
    RESRVR [ 2 : 2210] 8210  1  5.0   23.61    2.86  6.17  50.45  n/a    .000
    {ST=   .06 ha.m }
*
    ADD [8210 + 2212]  6212  3  5.0   24.16    2.90  6.17  49.91  n/a    .000
*
    ADD [0206 + 2206]  6206  3  5.0   77.31    2.18  7.17  33.78  n/a    .000
*
    RESRVR [ 2 : 2207] 8207  1  5.0   44.56    1.10  8.33  42.68  n/a    .000
    {ST=   .65 ha.m }
*
    ADD [8207 + 0207]  6207  3  5.0  359.89    6.53  8.50  35.06  n/a    .000
*
    ADD [6207 + 2269]  7207  3  5.0  360.73    6.53  8.50  35.05  n/a    .000
*
    ADD [2208 + 2209]  6209  3  5.0    1.26     .14  6.08  45.98  n/a    .000
*
    RESRVR [ 2 : 5261] 0040  1  5.0   37.50     .28  8.50  41.44  n/a    .000
    {ST=  1.58 ha.m }
*
    RESRVR [ 2 : 5262] 0060  1  5.0    7.50     .43  6.33  54.35  n/a    .000
    {ST=   .16 ha.m }
*
    RESRVR [ 2 : 5260] 8260  1  5.0   54.55    2.67  6.58  45.40  n/a    .000
    {ST=   .90 ha.m }
*
    RESRVR [ 2 : 5263] 0070  1  5.0    2.35     .14  6.33  54.29  n/a    .000
    {ST=   .05 ha.m }
*
    ADD [8255 + 6255]  6256  3  5.0  103.33    5.50  6.25  39.88  n/a    .000
*
    ADD [6203 + 6204]  6205  3  5.0   66.81    2.63  6.83  35.57  n/a    .000
*
    ADD [6025 + 6028]  6353  3  5.0   88.15    3.51  6.17  33.56  n/a    .000
*
    ADD [8042 + 8041]  6042  3  5.0    1.83     .09  6.42  33.13  n/a    .000
*
    ADD [6042 + 6040]  6043  3  5.0  531.32    7.22  7.83  21.16  n/a    .000
*
    ADD [0106 + 6071]  6106  3  5.0  860.09    9.09  9.08  25.35  n/a    .000
*
    ADD [1072 + 6075]  6072  3  5.0   29.89     .70  6.92  24.90  n/a    .000
*
    ADD [0111 + 6110]  6111  3  5.0 1211.32   11.74 10.25  28.68  n/a    .000
*
    ADD [5141 + 0030]  7318  3  5.0   34.38    3.61  6.00  50.30  n/a    .000
*
    ADD [0205 + 6206]  7205  3  5.0 3237.30   18.82 13.00  25.56  n/a    .000
*
    ADD [7205 + 7207]  7208  3  5.0 3598.03   21.44 12.08  26.51  n/a    .000
*
    ADD [0040 + 0060]  6265  3  5.0   45.00     .58  6.67  43.59  n/a    .000
*
    ADD [8260 + 0070]  6263  3  5.0   56.90    2.80  6.58  45.76  n/a    .000
*
    ADD [3256 + 6256]  6257  3  5.0  116.94    6.42  6.25  39.53  n/a    .000
*
    ADD [6205 + 0202]  6202  3  5.0  374.10    6.36  7.83  32.56  n/a    .000
*
    ADD [6353 + 1021]  6021  3  5.0  115.02    3.79  6.25  30.84  n/a    .000
*
    ADD [6047 + 6043]  6048  3  5.0  734.27   10.57  7.42  21.23  n/a    .000
*
    ADD [1070 + 6106]  6070  3  5.0  997.91   11.03  8.50  25.71  n/a    .000
*
    ADD [8076 + 6072]  6076  3  5.0   30.81     .73  6.92  25.38  n/a    .000
*
```

```
*      ADD [7318 + 5140]  6140  3  5.0  153.82    3.99  6.08  33.93  n/a    .000
*      ADD [7208 + 0208]  6208  3  5.0 3631.66   21.57 12.08  26.61  n/a    .000
*      ADD [6265 + 3265]  7265  3  5.0   71.53    1.59  6.67  37.73  n/a    .000
*      ADD [0103 + 6021]  6103  3  5.0  338.32    6.78  7.17  32.91  n/a    .000
*      ADD [0105 + 6048]  6105  3  5.0 1243.52   18.06  7.75  23.42  n/a    .000
*      ADD [6070 + 6076]  6077  3  5.0 1028.72   11.34  8.42  25.70  n/a    .000
*      ADD [6140 + 3141]  6141  3  5.0  239.21    4.31  7.50  30.76  n/a    .000
*      ADD [6208 + 6209]  6210  3  5.0 3632.92   21.58 12.00  26.62  n/a    .000
*      ADD [0108 + 6077]  6108  3  5.0 1701.87   17.52  9.00  26.21  n/a    .000
*      ADD [6145 + 6141]  6315  3  5.0  375.31    6.64  7.58  29.10  n/a    .000
*      ADD [6210 + 0209]  7209  3  5.0 3927.97   23.76 11.00  26.61  n/a    .000
*      ADD [6105 + 6108]  6115  3  5.0 2945.39   33.99  8.17  25.03  n/a    .000
*      ADD [6315 + 0315]  6316  3  5.0  498.75    9.17  7.58  29.19  n/a    .000
*      ADD [7209 + 0210]  7210  3  5.0 3946.80   23.86 10.92  26.64  n/a    .000
*      ADD [6115 + 0109]  6109  3  5.0 3174.23   36.40  8.17  24.70  n/a    .000
*      ADD [0316 + 6316]  7316  3  5.0  710.07   11.95  7.75  29.06  n/a    .000
*      ADD [6212 + 7210]  6213  3  5.0 3970.96   23.96 10.92  26.78  n/a    .000
*      ADD [6109 + 6111]  6358  3  5.0 4385.55   45.84  8.50  25.80  n/a    .000
*      ADD [0317 + 7316]  6317  3  5.0  988.36   15.36  8.00  29.41  n/a    .000
*      ADD [2213 + 6213]  7317  3  5.0 3971.84   23.96 10.92  26.78  n/a    .000
*      ADD [6358 + 0112]  6112  3  5.0 4417.59   46.27  8.50  25.78  n/a    .000
*      ADD [7212 + 6317]  7213  3  5.0 2161.40   25.88  8.58  28.66  n/a    .000
*      ADD [6103 + 6112]  6113  3  5.0 4755.91   51.96  8.33  26.29  n/a    .000
*      ADD [0318 + 7213]  6318  3  5.0 2174.09   26.03  8.50  28.67  n/a    .000
*      ADD [6113 + 0113]  6361  3  5.0 4779.49   52.27  8.25  26.28  n/a    .000
 FINISH
================================================================================================================
```

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 results for 4 hour Chicago and Regional storm
Future condition
Aug-15

Flownode	Settlement	VO2ID	Area	2year	5year	10year	25 year	50 year	100 year	Regional
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	997.91	1.92	5.88	7.68	9.63	10.26	12.48	56.69
F3	Forest Home	6353	88.15	0.92	1.55	2.00	2.36	2.63	3.14	8.90
G1	Guthrie	6140	153.82	1.13	1.92	2.42	2.87	3.21	3.72	13.01
H1	Hawkestone	6207	359.89	1.16	3.43	4.46	5.59	5.96	7.20	25.41
H4	Hawkestone	6204	29.58	0.15	0.44	0.62	0.81	0.90	1.11	3.20
H5	Hawkestone	6301	235.5	1.18	3.46	4.59	5.93	6.38	7.77	23.33
R3	Rugby	8045	8.17	0.04	0.11	0.16	0.20	0.23	0.29	0.97
R4	Rugby	6048	734.27	1.59	5.10	6.72	8.60	9.23	11.32	52.86
S2	Shanty Bay	8250	20.1	0.09	0.25	0.35	0.46	0.51	0.62	2.29
S3	Shanty Bay	6256	103.33	1.29	2.23	2.88	3.55	3.93	4.73	11.06

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 result comparison for 4 hr Chicago and Regional Storm
Aug-15

Flownode	Settlement	VO2ID		Area	2year	5year	10year	25 year	50 year	100 year	Hazel
				(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	Ex.	997.91	1.25	2.58	3.71	5.37	6.69	8.12	56.82
	East Oro	6070	Future w contr.	997.91	1.29	2.63	3.77	5.44	6.76	8.19	56.69
			% inc./decr.	0.0%	3.2%	1.9%	1.6%	1.3%	1.0%	0.9%	-0.2%
F3	Forest Home	6353	Ex.	88.15	1.07	1.47	1.76	2.16	2.45	2.75	8.87
	Forest Home	6353	Future w contr.	88.15	0.95	1.32	1.59	1.99	2.30	2.59	8.90
			% inc./decr.	0.0%	-11.2%	-10.2%	-9.7%	-7.9%	-6.1%	-5.8%	0.3%
G1	Guthrie	6140	Ex.	153.82	1.62	2.23	2.68	3.28	3.71	4.16	12.88
	Guthrie	6140	Future w contr.	153.82	1.60	2.21	2.65	3.24	3.67	4.11	13.01
			% inc./decr.	0.0%	-1.2%	-0.9%	-1.1%	-1.2%	-1.1%	-1.2%	1.0%
H1	Hawkestone	6207	Ex.	359.89	0.76	1.54	2.19	3.12	3.85	4.64	25.27
	Hawkestone	6207	Future w contr.	359.89	0.79	1.59	2.28	3.25	4.02	4.83	25.41
			% inc./decr.	0.0%	3.9%	3.2%	4.1%	4.2%	4.4%	4.1%	0.6%
H4	Hawkestone	6204	Ex.	29.58	0.11	0.23	0.34	0.49	0.62	0.76	3.07
	Hawkestone	6204	Future w contr.	29.58	0.10	0.23	0.35	0.51	0.64	0.77	3.20
			% inc./decr.	0.0%	-9.1%	0.0%	2.9%	4.1%	3.2%	1.3%	4.2%
H5	Hawkestone	6301	Ex.	235.5	0.86	1.76	2.52	3.61	4.46	5.42	23.16
	Hawkestone	6301	Future w contr.	235.5	0.84	1.72	2.46	3.56	4.40	5.35	23.33
			% inc./decr.	0.0%	-2.3%	-2.3%	-2.4%	-1.4%	-1.3%	-1.3%	0.7%
R3	Rugby	2045	Ex.	8.17	0.03	0.07	0.1	0.14	0.18	0.22	0.87
	Rugby	8045	Future w contr.	8.17	0.03	0.07	0.100	0.13	0.18	0.22	0.97
			% inc./decr.	0.0%	0.0%	0.0%	0.0%	-7.1%	0.0%	0.0%	10.6%
R4	Rugby	6048	Ex.	734.27	1.02	2.18	3.19	4.70	5.91	7.26	52.94
	Rugby	6048	Future w contr.	734.27	1.04	2.22	3.25	4.77	5.98	7.34	52.86
			% inc./decr.	0.0%	2.0%	1.8%	1.9%	1.5%	1.2%	1.1%	-0.2%
S2	Shanty Bay	5250	Ex.	20.1	0.07	0.13	0.19	0.28	0.35	0.43	2.00
	Shanty Bay	8250	Future w contr.	20.1	0.07	0.13	0.19	0.27	0.35	0.43	2.29
			% inc./decr.	0.0%	0.0%	0.0%	0.0%	-3.6%	0.0%	0.0%	14.6%
S3	Shanty Bay	6256	Ex.	103.33	1.42	2.02	2.46	3.08	3.54	4.01	10.91
	Shanty Bay	6256	Future w contr.	103.33	1.27	1.83	2.24	2.83	3.26	3.73	11.06
			% inc./decr.	0.0%	-10.6%	-9.4%	-8.9%	-8.1%	-7.9%	-7.0%	1.4%

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
HYDROLOGIC MODELING RESULT
VO2 result comparison for SCS 24 hour
Aug-15

Flownode	Settlement	VO2ID		Area	2year	5year	10year	25 year	50 year	100 year
				(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
E5	East Oro	6070	Ex.	997.91	2.08	4.21	5.93	8.42	10.48	12.68
		6070	Future w contr.	997.91	2.13	4.27	6.00	8.51	10.58	12.78
			% inc./decr.	0.0%	2.4%	1.4%	1.2%	1.1%	1.0%	0.8%
F3	Forest Home	6353	Ex.	88.15	1.09	1.77	2.25	2.91	3.62	4.22
		6353	Future w contr.	88.15	1.08	1.76	2.26	3.02	3.66	4.26
			% inc./decr.	0.0%	-0.9%	-0.6%	0.4%	3.8%	1.1%	0.9%
G1	Guthrie	6140	Ex.	153.82	1.49	2.44	3.13	3.99	4.67	5.71
		6140	Future w contr.	153.82	1.47	2.41	3.09	3.94	4.62	5.64
			% inc./decr.	0.0%	-1.3%	-1.2%	-1.3%	-1.3%	-1.1%	-1.2%
H1	Hawkestone	6207	Ex.	359.89	1.27	2.50	3.48	4.86	5.98	7.16
		6207	Future w contr.	359.89	1.31	2.60	3.61	5.05	6.25	7.50
			% inc./decr.	0.0%	3.1%	4.0%	3.7%	3.9%	4.5%	4.7%
H4	Hawkestone	6204	Ex.	29.58	0.22	0.45	0.64	0.90	1.11	1.34
		6204	Future w contr.	29.58	0.20	0.44	0.63	0.90	1.13	1.37
			% inc./decr.	0.0%	-9.1%	-2.2%	-1.6%	0.0%	1.8%	2.2%
H5	Hawkestone	6301	Ex.	235.5	1.58	3.13	4.35	6.06	7.45	8.90
		6301	Future w contr.	235.5	1.51	3.01	4.21	5.91	7.35	8.82
			% inc./decr.	0.0%	-4.4%	-3.8%	-3.2%	-2.5%	-1.3%	-0.9%
R3	Rugby	2045	Ex.	8.17	0.07	0.13	0.19	0.27	0.33	0.4
		8045	Future w contr.	8.17	0.05	0.11	0.170	0.25	0.33	0.41
			% inc./decr.	0.0%	-28.6%	-15.4%	-10.5%	-7.4%	0.0%	2.5%
R4	Rugby	6048	Ex.	734.27	1.86	3.89	5.57	8.02	10.07	12.27
		6048	Future w contr.	734.27	1.89	3.96	5.65	8.11	10.17	12.40
			% inc./decr.	0.0%	1.6%	1.8%	1.4%	1.1%	1.0%	1.1%
S2	Shanty Bay	5250	Ex.	20.1	0.13	0.25	0.35	0.50	0.62	0.75
		8250	Future w contr.	20.1	0.11	0.22	0.32	0.48	0.62	0.75
			% inc./decr.	0.0%	-15.4%	-12.0%	-8.6%	-4.0%	0.0%	0.0%
S3	Shanty Bay	6256	Ex.	103.33	1.66	2.77	3.55	4.64	5.77	6.73
		6256	Future w contr.	103.33	1.55	2.63	3.40	4.48	5.55	6.49
			% inc./decr.	0.0%	-6.6%	-5.1%	-4.2%	-3.4%	-3.8%	-3.6%

EXISTING AND SYNTHETIC POND SUMMARY

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
LIST OF SYNTHETIC PONDS FOR FUTURE DEVELOPMENT
Aug-15

Pond No.	Location	VO2ID	US VO2ID	service area	Storage	governing event
1	Forest Home	8025	2025	10.24	472	SCS
2	Forest Home	8028	2028	9.83	434	Chicago
3	Rugby	8045	2045	8.17	1171	SCS
4	Rugby	8041	2041	0.96	108	SCS
5	Rugby	8042	2042	0.87	72	SCS
6	East Oro	8071	2071	16.86	2539	SCS
7	East Oro	8076	2076	0.92	109	SCS
8	East Oro	8110	2110	0.78	28	Chicago
9	Guthrie	8145	5145	3.56	151	Chicago
10	Oro Station	8310	2310	22.21	1277	SCS
11	Oro Station	8306	2306	4.18	874	SCS
12	Shanty Bay	8260	5260	54.55	8959	SCS
13	Shanty Bay	8254	5254	11.03	1202	SCS
14	Shanty Bay	8255	5255	25.03	874	SCS
15	Shanty Bay	8250	5250	20.1	2973	SCS
16	Hawkestone	8301	2301	49.24	5386	SCS
17	Hawkestone	8207	2207	44.56	6540	SCS
18	Hawkestone	8211	2211	27.27	1487	SCS
19	Hawkestone	8204	2204	15.92	2144	SCS
20	Hawkestone	8203	2203	6.7	828	SCS
21	Hawkestone	8210	2210	23.61	605	SCS

Notes: A synthetic pond is a route reservoir command used in the VO2 model to match post to pre development peak flows for areas where future development is planned upstream. Synthetic ponds with smaller storage volumes indicates lower future development planned for the area upstream. Ponds used for servicing areas less than 5 ha may not be needed.

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWN OF ORO-MEDONTE
HYDROLOGIC MODELING

SUMMARY OF EXISTING PONDS

Pond ID	Site Location	Approximate Date of Construction	COA	COA Number	Lot, Concession and Township	Road Address	Type of SWM Facility1	Level of Protection	Immediate Receiver	Estimated Distance to Ult. Receiver (km)	Approximate Area Serviced (ha)	Land Use of Area Serviced
1	Houben Subdivision	N/A	Yes	4900-7E5HAZ	Part of Lot 10, Concession 10, Township of Oro-Medonte	North of County Road 11 and East of 9th Line	Wet Pond	Basic - 60% TSS Removal	County Road No.11 roadside ditch	8.5	44.4	17.2 ha residential, 27.1 ha external drainage area
2	Guthrie Industrial Subdivision	1988	No	N/A	Lot 21, and West Half of Lot 22, Concession 5, Township of Oro-Medonte	Between Winstar Road and Holick Road	Dry Pond	Basic - 60% TSS Removal (Assumed)	Highway 11 Roadside ditch	4.5	38.2	Industrial
3	Hastings Estates Subdivision	N/A	Yes	3-1127-96-006	Lot 20, Concession 5, Township of Oro-Medonte	Melville Court and Line 5 N	Dry Pond	Basic - 60% TSS Removal (Assumed)	Ditch which drains beneath Highway 11	5.0	5.2 (estimated)	Residential
4	Arbourwood Estates (Shanty Bay)	N/A	Yes	7663-5CDPBF	Lot 2, Range 2 Township of Oro-Medonte	South-West of Red Oak Crescent	Wet Pond	Enhanced - 80% TSS Removal	Adjacent wetland area, and south to Martine Crescent and Ridge Road West SWM facility	1.0	37.5	Residential
5	Sprucewood Subdivision (Greenshields Drive)	1993	No	N/A	Part of Lot 11, Concession 10, Township of Oro-Medonte	South of Greenshields Crescent at Nevis Ridge Drive	Dry Pond	Basic - 60% TSS Removal (Assumed)	Wooded area south of SWM facility	9.0	10.0 (estimated)	Residential
6	Shanty Bay (Martine Crescent and Ridge Road West)	1987	No	N/A	Part of Lot 22, ND Range Township of Oro-Medonte	North East Corner of Ridge Road and Martine Crescent	Dry Pond	Basic - 60% TSS Removal (Assumed)	Watercourse on the south side of Ridge Road West	0.5	7.5 (estimated) + outflow from Arbourwood Estates	Residential
7	Shanty Bay (Martine Crescent)	1987	No	N/A	Part of Lot 22, ND Range Township of Oro-Medonte	End of Martine Crescent	Dry Pond	Basic - 60% TSS Removal (Assumed)	Ditch which drains to Ridge Road West	0.5	2.3 (estimated)	Residential
8	Shanty Bay (Spencer Trail)	1995	No	N/A	Part of Lot 27, Concession 2 Township of Oro-Medonte	East along Spencer Trail	Dry Pond	Basic - 60% TSS Removal (Assumed)	Open area, overland flow towards Ridge Road West	0.5	2.0 (estimated)	Residential
9	Windfields Drive (Roberta Park Area)	1978	No	N/A	Part of Lot 27, Concession 5 Township of Oro-Medonte	Windfields Drive Line 5 South	Dry Pond	Basic - 60% TSS Removal (Assumed)	Line 5 South, west roadside ditch	0.5	Unknown	Open Field also Residential

APPENDIX B:
PHOSPHOROUS BUDGET

APPENDIX B:
PHOSPHOROUS BUDGET

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: East Oro
CREEK REFERENCE: Oro Creeks North

Total Drainage Area (ha): 19.66

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.36	0.36	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.10	0.10	1.14	1.82	0.114	0.182	0.07	59.4%	0.114	0.114	0.000	0.0%	0.18	0.18	0.18	0.18
Hay - Pasture	0.12	0.12	7.82	3.98	0.939	0.477	-0.46	-49.2%	0.939	0.939	0.000	0.0%	0.48	0.48	0.48	0.48
High Intensity Development - Res	1.32	1.32	5.56	9.31	7.33	12.29	4.96	0.68	7.334	7.334	0.000	0.0%	12.29	12.29	9.17	8.08
High Intensity Development - Com	1.82	1.82	3.39	4.48	6.165	8.156	1.99	32.3%	6.165	6.165	0.000	0.0%	8.16	8.16	6.90	6.46
Low Intensity Development	0.13	0.13	0.87	0.07	0.113	0.009	-0.10	-92.3%	0.113	0.113	0.000	0.0%	0.01	0.01	0.01	0.01
Open Water	0.26	0.26	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Quarry	0.08	0.08	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.24	0.24	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.16	0.16	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Wetland	0.10	0.10	0.89	0.00	0.089	0.000	-0.09	-100.0%	0.089	0.089	0.000	0.0%	0.00	0.00	0.00	0.00
Existing SWM controlled area-dry pond			0													
Existing SWM controlled area-wet pond			0													
Total			19.66	19.66	14.75	21.12	6.37	43.1%	14.75	14.75	0.0	0%	21.12	21.12	16.74	15.21

Notes and Information:
1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report

Removal Efficiency Assumptions:
No existing ponds in the Settlement area

Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: Forest home
CREEK REFERENCE: Oro Creeks North

Total Drainage Area (ha): 20.07

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.36	0.36	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.10	0.10	4.14	0.49	0.414	0.049	-0.37	-88.3%	0.414	0.414	0.000	0.0%	0.05	0.05	0.05	0.05
Hay - Pasture	0.12	0.12	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
High Intensity Development - Res	1.32	1.32	15.12	17.25	19.95	22.77	2.82	0.14	19.95	19.95	0.000	0.0%	22.77	22.77	21.00	20.38
High Intensity Development - Com	1.82	1.82	0.81	2.33	1.477	4.242	2.76	187.1%	1.477	1.477	0.000	0.0%	4.24	4.24	2.50	1.89
Low Intensity Development	0.13	0.13	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Open Water	0.26	0.26	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Quarry	0.08	0.08	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.24	0.24	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.16	0.16	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Wetland	0.10	0.10	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Existing SWM controlled area-dry pond			0													
Existing SWM controlled area-wet pond			0													
Total			20.07	20.07	21.85	27.07	5.22	23.9%	21.85	21.85	0.0	0%	27.07	27.07	23.55	22.32

Notes and Information:
1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report

Removal Efficiency Assumptions:
No existing ponds in the Settlement area

Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: Guthrie
CREEK REFERENCE: Oro Creeks South

Total Drainage Area (ha): 37.94

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.19	0.19	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.05	0.05	4.83	0.08	0.241	0.004	-0.24	-98.4%	0.241	0.241	0.000	0.0%	0.00	0.00	0.00	0.00
Hay - Pasture	0.07	0.07	1.06	0.53	0.074	0.037	-0.04	-49.5%	0.074	0.074	0.000	0.0%	0.04	0.04	0.04	0.04
High Intensity Development - Residential	1.32	1.32	17.97	18.61	23.72	24.56	0.84	0.04	23.032	19.394	-3.638	-15.8%	23.87	20.24	19.71	19.52
High Intensity Development - Commercial/Industrial	1.82	1.82	12.82	17.05	23.341	31.026	7.68	32.9%	23.341	23.341	0.000	0.0%	31.03	31.03	26.18	24.49
Low Intensity Development	0.13	0.13	0.00	1.28	0.000	0.166	0.17	0.0%	0.000	0.000	0.000	0.0%	0.17	0.17	0.06	0.02
Open Water	0.26	0.26	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Quarry	0.08	0.08	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.12	0.12	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.06	0.06	0.00	0.25	0.000	0.015	0.02	0.0%	0.000	0.000	0.000	0.0%	0.02	0.02	0.02	0.02
Wetland	0.05	0.05	1.26	0.15	0.063	0.007	-0.06	-88.3%	0.063	0.063	0.000	0.0%	0.01	0.01	0.01	0.01
Existing SWM controlled area-dry pond			5.2													
Existing SWM controlled area-wet pond			0													
Total			37.94	37.94	47.44	55.82	8.38	17.7%	46.75	43.11	-3.6	-7.8%	55.13	51.49	46.02	44.10

Notes and Information:

1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report
5) Settlement area only includes area that drains into Lake Simcoe

Removal Efficiency Assumptions:

Pond No. 3 is a dry pond, with 5.2 ha of servcing area. (assume 10% existing Removal, convert to 63% for retrofit to Wet Pond)
Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: Hawkestone
CREEK REFERENCE: Hawkestone Creek

Total Drainage Area (ha): 204.45

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.19	0.19	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.03	0.03	69.32	13.18	2.080	0.395	-1.68	-81.0%	2.080	2.080	0.000	0.0%	0.40	0.40	0.40	0.40
Hay - Pasture	0.10	0.10	27.79	47.94	2.779	4.794	2.01	72.5%	2.779	2.779	0.000	0.0%	4.79	4.79	4.79	4.79
High Intensity Development - Res	1.32	1.32	62.64	116.71	82.69	154.06	71.37	0.86	82.689	82.689	0.000	0.0%	154.06	154.06	109.10	93.39
High Intensity Development - Com	1.82	1.82	5.32	8.25	9.678	15.016	5.34	55.2%	9.678	9.678	0.000	0.0%	15.02	15.02	11.65	10.48
Low Intensity Development	0.09	0.09	7.99	14.10	0.719	1.269	0.55	76.5%	0.719	0.719	0.000	0.0%	1.27	1.27	0.92	0.80
Open Water	0.26	0.26	1.22	0.61	0.317	0.158	-0.16	-50.3%	0.317	0.317	0.000	0.0%	0.16	0.16	0.16	0.16
Quarry	0.10	0.10	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.06	0.06	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.04	0.04	16.83	3.28	0.673	0.131	-0.54	-80.5%	0.673	0.673	0.000	0.0%	0.13	0.13	0.13	0.13
Wetland	0.03	0.03	13.33	0.39	0.400	0.012	-0.39	-97.1%	0.400	0.400	0.000	0.0%	0.01	0.01	0.01	0.01
Existing SWM controlled area-dry pond			0													
Existing SWM controlled area-wet pond			0													
Total			204.45	204.45	99.34	175.83	76.50	77.0%	99.3	99.3	0.0	0%	175.83	175.83	127.16	110.16

Notes and Information:
1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report

Removal Efficiency Assumptions:
No existing ponds in the Settlement area

Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: Oro Station
CREEK REFERENCE: Oro Creeks South

Total Drainage Area (ha): 26.39

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.19	0.19	0.03	0.02	0.005	0.003	0.00	-35.5%	0.005	0.005	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.05	0.05	4.14	0.22	0.207	0.011	-0.20	-94.8%	0.207	0.207	0.000	0.0%	0.01	0.01	0.01	0.01
Hay - Pasture	0.07	0.07	5.38	3.80	0.377	0.266	-0.11	-29.3%	0.377	0.377	0.000	0.0%	0.27	0.27	0.27	0.27
High Intensity Development - Res	1.32	1.32	15.55	20.55	20.52	27.12	6.60	0.32	20.522	20.522	0.000	0.0%	27.12	27.12	22.96	21.51
High Intensity Development - Com	1.82	1.82	1.00	1.77	1.819	3.230	1.41	77.6%	1.819	1.819	0.000	0.0%	3.23	3.23	2.34	2.03
Low Intensity Development	0.13	0.13	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Open Water	0.26	0.26	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Quarry	0.08	0.08	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.12	0.12	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.06	0.06	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Wetland	0.05	0.05	0.30	0.03	0.015	0.002	-0.01	-88.5%	0.015	0.015	0.000	0.0%	0.00	0.00	0.00	0.00
Existing SWM controlled area-dry pond			0													
Existing SWM controlled area-wet pond			0													
Total			26.39	26.39	22.94	30.63	7.69	33.5%	22.94	22.94	0.00	0.00	30.63	30.63	25.59	23.82

Notes and Information:
1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report

Removal Efficiency Assumptions:
No existing ponds in the Settlement area

Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: Rugby
CREEK REFERENCE: Oro Creeks North

Total Drainage Area (ha): 10.01

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.36	0.36	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.10	0.10	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Hay - Pasture	0.12	0.12	4.09	2.06	0.491	0.247	-0.24	-49.6%	0.491	0.491	0.000	0.0%	0.25	0.25	0.25	0.25
High Intensity Development - Res	1.32	1.32	4.98	6.44	6.57	8.49	1.92	0.29	6.570	6.570	0.000	0.0%	8.49	8.49	7.28	6.86
High Intensity Development - Com	1.82	1.82	0.44	1.48	0.806	2.698	1.89	234.7%	0.806	0.806	0.000	0.0%	2.70	2.70	1.51	1.09
Low Intensity Development	0.13	0.13	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Open Water	0.26	0.26	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Quarry	0.08	0.08	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.24	0.24	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.16	0.16	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Wetland	0.10	0.10	0.50	0.03	0.050	0.003	-0.05	-94.0%	0.050	0.050	0.000	0.0%	0.00	0.00	0.00	0.00
Existing SWM controlled area-dry pond			0													
Existing SWM controlled area-wet pond			0													
Total			10.01	10.01	7.92	11.44	3.53	44.5%	7.92	7.92	0.00	0.00	11.44	11.44	9.04	8.20

Notes and Information:
1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report

Removal Efficiency Assumptions:
No existing ponds in the Settlement area

Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
PHOSPHOROUS BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: Shanty Bay
CREEK REFERENCE: Oro Creeks South

Total Drainage Area (ha): 168.3

LAND USE CATEGORY	Existing Phosphorous Loading Rate (kg/ha/year)	Future Phosphorous Loading Rate (kg/ha/year)	Existing Area (ha)	Future Area (ha)	Existing Phosphorous Loadings (kg/year) (no controls)	Future Phosphorous Loadings (kg/year) (no controls)	Difference +/- (kg/year)	Difference (%) (kg/year)	Existing Phosphorous Loadings (kg/year) with existing controls	Existing Phosphorous Loadings (kg/year) with retrofit controls	Difference +/- (kg/year)	Difference (%) (kg/year)	Future Phosphorous Loadings (kg/year) with only existing controls	Future Phosphorous Loadings (kg/year) with retrofits	Future Phosphorous Loadings (kg/year) with retrofits and controls (Wet Pond (63%))	Future Phosphorous Loadings (kg/year) with retrofits and controls (LID (85%))
Cropland	0.19	0.19	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Forest	0.05	0.05	23.84	1.24	1.192	0.062	-1.13	-94.8%	1.192	1.192	0.000	0.0%	0.06	0.06	0.06	0.06
Hay - Pasture	0.07	0.07	31.89	21.69	2.232	1.518	-0.71	-32.0%	2.232	2.232	0.000	0.0%	1.52	1.52	1.52	1.52
High Intensity Development - Res	1.32	1.32	99.03	123.67	130.72	163.249	32.53	24.9%	97.974	89.718	-8.255	-8.4%	130.51	122.25	101.76	94.60
High Intensity Development - Com	1.82	1.82	9.47	17.63	17.242	32.093	14.85	86.1%	17.242	17.242	0.000	0.0%	32.09	32.09	22.74	19.47
Low Intensity Development	0.13	0.13	2.92	3.08	0.379	0.401	0.02	5.6%	0.379	0.379	0.000	0.0%	0.40	0.40	0.39	0.38
Open Water	0.26	0.26	0.71	0.70	0.183	0.182	0.00	-0.6%	0.183	0.183	0.000	0.0%	0.18	0.18	0.18	0.18
Quarry	0.08	0.08	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Sod farm/ Golf Course	0.12	0.12	0.00	0.00	0.000	0.000	0.00	0.0%	0.000	0.000	0.000	0.0%	0.00	0.00	0.00	0.00
Transition	0.06	0.06	0.01	0.13	0.001	0.008	0.01	1048.1%	0.001	0.001	0.000	0.0%	0.01	0.01	0.01	0.01
Wetland	0.05	0.05	0.46	0.18	0.023	0.009	-0.01	-61.6%	0.023	0.023	0.000	0.0%	0.01	0.01	0.01	0.01
Existing SWM controlled area-dry pond			11.8													
Existing SWM controlled area-wet pond			37.5													
Total			168.3	168.3	152.0	197.5	45.6	30.0%	119.2	111.0	-8.3	-6.9%	164.78	156.52	126.66	116.23

Notes and Information:

1) Phosphorus Loading Rates determined from MOE's Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed (2012)
2) Loading Rate of Septic Systems in Watershed determined using area weighted method with total septic load in sub-watershed from Berger report
3) Length of streambanks for Watershed set as watercourse length as determined from Town of Oro Medonte Innisifl watercourse GIS files.
4) Groundwater calculation using weighted method for the subwatershed from Berger Report
5) Settlement area only includes area that drains into Lake Simcoe

Removal Efficiency Assumptions:

Pond No. 4 is a wet pond, with 37.5 ha of approximate servicing area. (assume 10% existing Removal, convert to 63% for retrofit to Wet Pond)
Pond No. 6, 7, 8 are dry ponds, with 11.8 ha of total servcing area. (assume 10% existing Removal, convert to 63% for retrofit to Wet Pond)

Future controls assume all development will be controlled by either Wet Pond (63% Removal Efficiency) or LID controls (85% Removal Efficiency)

APPENDIX C:
WATER BUDGET

APPENDIX C:
WATER BUDGET

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
TOWNSHIP OF ORO-MEDONTE
WATER BUDGET ASSESSMENT
STEP 5 - CSWM-MP GUIDELINES (LSRCA, April 2011)
SETTLEMENT AREA: EAST ORO

Thornthwaite Coefficient 1.081
Area (ha) 19.66

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-7.7	82.5	0.0	0	0.8	0	0	83
February	-6.6	61.9	0.0	0	0.8	0	0	62
March	-2.1	58.2	0.0	0	1.0	0	0	58
April	5.6	62.3	1.2	28	1.1	31	31	31
May	12.3	82.4	3.9	74	1.3	94	82	0
June	17.9	84.8	6.9	113	1.3	144	85	0
July	20.8	77.2	8.7	134	1.3	174	77	0
August	19.7	89.9	8.0	116	1.2	139	90	0
September	15.3	94	5.4	76	1.0	79	79	15
October	8.7	77.5	2.3	37	1.0	35	35	42
November	2.7	88.8	0.4	9	0.8	7	7	82
December	-3.5	73.6	0.0	0	0.8	0	0	74
Total		933.1	36.8	587.2		705.1	487.2	445.9
						Total Surplus	445.9	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	East Oro Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	501.3	445.9	746.5	526.5
Net surplus (mm/yr)	445.9	746.5	501.3	445.9	746.5	526.5
Evapotranspiration (mm/yr)	487.2	186.6	431.8	487.2	186.6	406.6
Inflitration (mm/yr)	244.2	0.0	199.2	244.1	0.0	178.6
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	244.2	0.0	199.2	244.1	0.0	178.6
Run-off Pervious Areas (mm/yr)	201.7	0.0	164.5	201.8	0.0	147.6
Run-off Impervious Areas (mm/yr)	0.0	746.5	137.5	0.0	746.5	200.3
Total Run-off (mm/yr)	201.7	746.5	302.0	201.8	746.5	347.9
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Outputs						
Precipitation surplus (m3/yr)	71,520	27,031	98,552	64,145	39,378	103,523
Net surplus (m3/yr)	71,520	27,031	98,552	64,145	39,378	103,523
Evapotranspiration (m3/yr)	78,144	6,758	84,902	70,086	9,845	79,931
Inflitration (m3/yr)	39,173	0	39,173	35,117	0	35,117
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	39,173	0	39,173	35,117	0	35,117
Run-off Pervious Areas (m3/yr)	32,347	0	32,347	29,028	0	29,028
Run-off Impervious Areas (m3/yr)	0	27,031	27,031	0	39,378	39,378
Total Run-off (m3/yr)	32,347	27,031	59,379	29,028	39,378	68,407
Total Outputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	Forest Home Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	12.7	7.4	20.1	11.3	8.8	20.1
Inflitration Factors						
Infiltration Factor	0.60	-	-	0.59	-	-
Run-Off Coefficient	0.40	0.95	-	0.41	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	556.9	445.9	746.5	577.4
Net surplus (mm/yr)	445.9	746.5	556.9	445.9	746.5	577.4
Evapotranspiration (mm/yr)	487.2	186.6	376.2	487.2	186.6	355.7
Inflitration (mm/yr)	269.1	0.0	169.8	263.6	0.0	148.2
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	269.1	0.0	169.8	263.6	0.0	148.2
Run-off Pervious Areas (mm/yr)	176.8	0.0	111.5	182.3	0.0	102.6
Run-off Impervious Areas (mm/yr)	0.0	746.5	275.6	0.0	746.5	326.6
Total Run-off (mm/yr)	176.8	746.5	387.1	182.3	746.5	429.2
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	118,150	69,153	187,304	105,359	81,945	187,304
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	118,150	69,153	187,304	105,359	81,945	187,304
Outputs						
Precipitation surplus (m3/yr)	56,461	55,323	111,783	50,348	65,556	115,904
Net surplus (m3/yr)	56,461	55,323	111,783	50,348	65,556	115,904
Evapotranspiration (m3/yr)	61,690	13,831	75,521	55,011	16,389	71,400
Inflitration (m3/yr)	34,080	0	34,080	29,759	0	29,759
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	34,080	0	34,080	29,759	0	29,759
Run-off Pervious Areas (m3/yr)	22,381	0	22,381	20,589	0	20,589
Run-off Impervious Areas (m3/yr)	0	55,323	55,323	0	65,556	65,556
Total Run-off (m3/yr)	22,381	55,323	77,704	20,589	65,556	86,145
Total Outputs (m3/yr)	118,150	69,153	187,304	105,359	81,945	187,304

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	Guthrie Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	22.7	15.2	37.94	20.7	17.2	37.94
Inflitration Factors						
Infiltration Factor	0.54	-	-	0.54	-	-
Run-Off Coefficient	0.46	0.95	-	0.46	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	566.3	445.9	746.5	582.3
Net surplus (mm/yr)	445.9	746.5	566.3	445.9	746.5	582.3
Evapotranspiration (mm/yr)	487.2	186.6	366.8	487.2	186.6	350.8
Inflitration (mm/yr)	241.5	0.0	144.8	241.7	0.0	132.0
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	241.5	0.0	144.8	241.7	0.0	132.0
Run-off Pervious Areas (mm/yr)	204.4	0.0	122.5	204.2	0.0	111.5
Run-off Impervious Areas (mm/yr)	0.0	746.5	299.0	0.0	746.5	338.8
Total Run-off (mm/yr)	204.4	746.5	421.5	204.2	746.5	450.3
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	212,209	141,793	354,002	193,328	160,674	354,002
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	212,209	141,793	354,002	193,328	160,674	354,002
Outputs						
Precipitation surplus (m3/yr)	101,408	113,434	214,843	92,385	128,539	220,925
Net surplus (m3/yr)	101,408	113,434	214,843	92,385	128,539	220,925
Evapotranspiration (m3/yr)	110,801	28,359	139,159	100,942	32,135	133,077
Inflitration (m3/yr)	54,918	0	54,918	50,070	0	50,070
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	54,918	0	54,918	50,070	0	50,070
Run-off Pervious Areas (m3/yr)	46,490	0	46,490	42,315	0	42,315
Run-off Impervious Areas (m3/yr)	0	113,434	113,434	0	128,539	128,539
Total Run-off (m3/yr)	46,490	113,434	159,924	42,315	128,539	170,855
Total Outputs (m3/yr)	212,209	141,793	354,002	193,328	160,674	354,002

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	Hawkestone Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	176.2	27.3	203.5	166.1	37.4	203.5
Inflitration Factors						
Infiltration Factor	0.50	-	-	0.50	-	-
Run-Off Coefficient	0.50	0.95	-	0.50	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	486.3	445.9	746.5	501.2
Net surplus (mm/yr)	445.9	746.5	486.3	445.9	746.5	501.2
Evapotranspiration (mm/yr)	487.2	186.6	446.8	487.2	186.6	431.9
Inflitration (mm/yr)	222.8	0.0	192.9	223.2	0.0	182.1
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	222.8	0.0	192.9	223.2	0.0	182.1
Run-off Pervious Areas (mm/yr)	223.1	0.0	193.1	222.7	0.0	181.8
Run-off Impervious Areas (mm/yr)	0.0	746.5	100.2	0.0	746.5	137.2
Total Run-off (mm/yr)	223.1	746.5	293.4	222.7	746.5	319.0
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	1,644,062	255,007	1,899,069	1,549,954	349,114	1,899,069
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	1,644,062	255,007	1,899,069	1,549,954	349,114	1,899,069
Outputs						
Precipitation surplus (m3/yr)	785,648	204,006	989,653	740,677	279,292	1,019,968
Net surplus (m3/yr)	785,648	204,006	989,653	740,677	279,292	1,019,968
Evapotranspiration (m3/yr)	858,414	51,001	909,416	809,278	69,823	879,101
Inflitration (m3/yr)	392,572	0	392,572	370,708	0	370,708
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	392,572	0	392,572	370,708	0	370,708
Run-off Pervious Areas (m3/yr)	393,075	0	393,075	369,968	0	369,968
Run-off Impervious Areas (m3/yr)	0	204,006	204,006	0	279,292	279,292
Total Run-off (m3/yr)	393,075	204,006	597,081	369,968	279,292	649,260
Total Outputs (m3/yr)	1,644,062	255,007	1,899,069	1,549,954	349,114	1,899,069

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	Oro Station Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	18.7	7.7	26.4	17.4	9.0	26.4
Inflitration Factors						
Infiltration Factor	0.59	-	-	0.56	-	-
Run-Off Coefficient	0.41	0.95	-	0.44	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	533.4	445.9	746.5	548.8
Net surplus (mm/yr)	445.9	746.5	533.4	445.9	746.5	548.8
Evapotranspiration (mm/yr)	487.2	186.6	399.7	487.2	186.6	384.3
Inflitration (mm/yr)	264.8	0.0	187.7	250.1	0.0	164.4
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	264.8	0.0	187.7	250.1	0.0	164.4
Run-off Pervious Areas (mm/yr)	181.1	0.0	128.3	195.8	0.0	128.7
Run-off Impervious Areas (mm/yr)	0.0	746.5	217.3	0.0	746.5	255.7
Total Run-off (mm/yr)	181.1	746.5	345.7	195.8	746.5	384.4
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	174,552	71,693	246,246	161,906	84,340	246,246
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	174,552	71,693	246,246	161,906	84,340	246,246
Outputs						
Precipitation surplus (m3/yr)	83,413	57,355	140,768	77,370	67,472	144,842
Net surplus (m3/yr)	83,413	57,355	140,768	77,370	67,472	144,842
Evapotranspiration (m3/yr)	91,139	14,339	105,478	84,536	16,868	101,404
Inflitration (m3/yr)	49,543	0	49,543	43,398	0	43,398
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	49,543	0	49,543	43,398	0	43,398
Run-off Pervious Areas (m3/yr)	33,870	0	33,870	33,972	0	33,972
Run-off Impervious Areas (m3/yr)	0	57,355	57,355	0	67,472	67,472
Total Run-off (m3/yr)	33,870	57,355	91,225	33,972	67,472	101,444
Total Outputs (m3/yr)	174,552	71,693	246,246	161,906	84,340	246,246

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	Rugby Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	8.9	1.1	10.0	7.6	2.4	10.0
Inflitration Factors						
Infiltration Factor	0.60	-	-	0.59	-	-
Run-Off Coefficient	0.40	0.95	-	0.41	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	478.3	445.9	746.5	519.3
Net surplus (mm/yr)	445.9	746.5	478.3	445.9	746.5	519.3
Evapotranspiration (mm/yr)	487.2	186.6	454.8	487.2	186.6	413.8
Inflitration (mm/yr)	267.5	0.0	238.7	262.0	0.0	198.0
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	267.5	0.0	238.7	262.0	0.0	198.0
Run-off Pervious Areas (mm/yr)	178.4	0.0	159.1	183.9	0.0	139.0
Run-off Impervious Areas (mm/yr)	0.0	746.5	80.5	0.0	746.5	182.4
Total Run-off (mm/yr)	178.4	746.5	239.6	183.9	746.5	321.4
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	83,326	10,066	93,393	70,573	22,820	93,393
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	83,326	10,066	93,393	70,573	22,820	93,393
Outputs						
Precipitation surplus (m3/yr)	39,819	8,053	47,872	33,725	18,256	51,980
Net surplus (m3/yr)	39,819	8,053	47,872	33,725	18,256	51,980
Evapotranspiration (m3/yr)	43,507	2,013	45,520	36,848	4,564	41,412
Inflitration (m3/yr)	23,892	0	23,892	19,813	0	19,813
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	23,892	0	23,892	19,813	0	19,813
Run-off Pervious Areas (m3/yr)	15,928	0	15,928	13,911	0	13,911
Run-off Impervious Areas (m3/yr)	0	8,053	8,053	0	18,256	18,256
Total Run-off (m3/yr)	15,928	8,053	23,981	13,911	18,256	32,167
Total Outputs (m3/yr)	83,326	10,066	93,393	70,573	22,820	93,393

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

C.C. Tatham & Associates Ltd. Consulting Engineers	Project:	Oro-Medonte CSWMMP	Date:	Aug-15
	File No.:	113238	Designed:	JSN
	Subject:	Shanty Bay Infiltration Model	Checked:	JA

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	124.4	43.9	168.2	114.4	53.8	168.2
Inflitration Factors						
Infiltration Factor	0.53	-	-	0.53	-	-
Run-Off Coefficient	0.47	0.95	-	0.47	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	524.3	445.9	746.5	542.1
Net surplus (mm/yr)	445.9	746.5	524.3	445.9	746.5	542.1
Evapotranspiration (mm/yr)	487.2	186.6	408.8	487.2	186.6	391.0
Inflitration (mm/yr)	234.9	0.0	173.6	234.8	0.0	159.7
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	234.9	0.0	173.6	234.8	0.0	159.7
Run-off Pervious Areas (mm/yr)	211.0	0.0	156.0	211.1	0.0	143.5
Run-off Impervious Areas (mm/yr)	0.0	746.5	194.6	0.0	746.5	238.8
Total Run-off (mm/yr)	211.0	746.5	350.6	211.1	746.5	382.4
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	1,160,687	409,225	1,569,912	1,067,601	502,311	1,569,912
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	1,160,687	409,225	1,569,912	1,067,601	502,311	1,569,912
Outputs						
Precipitation surplus (m3/yr)	554,657	327,380	882,037	510,174	401,849	912,023
Net surplus (m3/yr)	554,657	327,380	882,037	510,174	401,849	912,023
Evapotranspiration (m3/yr)	606,030	81,845	687,875	557,426	100,462	657,889
Inflitration (m3/yr)	292,154	0	292,154	268,670	0	268,670
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	292,154	0	292,154	268,670	0	268,670
Run-off Pervious Areas (m3/yr)	262,503	0	262,503	241,504	0	241,504
Run-off Impervious Areas (m3/yr)	0	327,380	327,380	0	401,849	401,849
Total Run-off (m3/yr)	262,503	327,380	589,883	241,504	401,849	643,353
Total Outputs (m3/yr)	1,160,687	409,225	1,569,912	1,067,601	502,311	1,569,912

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 1 (Baseline)

Thornthwaite Coefficient 1.081
Preciptation change 0%
Temperature change ^{O}C 0

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-7.7	82.5	0.0	0	0.8	0	0	83
February	-6.6	61.9	0.0	0	0.8	0	0	62
March	-2.1	58.2	0.0	0	1.0	0	0	58
April	5.6	62.3	1.2	28	1.1	31	31	31
May	12.3	82.4	3.9	74	1.3	94	82	0
June	17.9	84.8	6.9	113	1.3	144	85	0
July	20.8	77.2	8.7	134	1.3	174	77	0
August	19.7	89.9	8.0	116	1.2	139	90	0
September	15.3	94	5.4	76	1.0	79	79	15
October	8.7	77.5	2.3	37	1.0	35	35	42
November	2.7	88.8	0.4	9	0.8	7	7	82
December	-3.5	73.6	0.0	0	0.8	0	0	74
Total		933.1	36.8	587.2		705.1	487.2	445.9
						Total Surplus	445.9	

Note: 1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 2

Thornthwaite Coefficient 1.139
Preciptation change 0%
Temperature change °C 1

Month	Temperature (°C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-6.7	82.5	0.0	0	0.8	0	0	83
February	-5.6	61.9	0.0	0	0.8	0	0	62
March	-1.1	58.2	0.0	0	1.0	0	0	58
April	6.6	62.3	1.5	31	1.1	35	35	28
May	13.3	82.4	4.4	78	1.3	99	82	0
June	18.9	84.8	7.5	117	1.3	150	85	0
July	21.8	77.2	9.3	139	1.3	181	77	0
August	20.7	89.9	8.6	121	1.2	145	90	0
September	16.3	94	6.0	79	1.0	82	82	12
October	9.7	77.5	2.7	39	1.0	38	38	40
November	3.7	88.8	0.6	11	0.8	9	9	80
December	-2.5	73.6	0.0	0	0.8	0	0	74
Total		933.1	40.6	615.9		738.5	497.7	435.4
						Total Surplus	435.4	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 3

Thornthwaite Coefficient 1.199
Preciptation change 0%
Temperature change ^{O}C 2

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-5.7	82.5	0.0	0	0.8	0	0	83
February	-4.6	61.9	0.0	0	0.8	0	0	62
March	-0.1	58.2	0.0	0	1.0	0	0	58
April	7.6	62.3	1.9	34	1.1	38	38	25
May	14.3	82.4	4.9	81	1.3	103	82	0
June	19.9	84.8	8.1	122	1.3	157	85	0
July	22.8	77.2	9.9	145	1.3	189	77	0
August	21.7	89.9	9.2	126	1.2	151	90	0
September	17.3	94	6.5	83	1.0	86	86	8
October	10.7	77.5	3.2	42	1.0	40	40	38
November	4.7	88.8	0.9	13	0.8	11	11	78
December	-1.5	73.6	0.0	0	0.8	0	0	74
Total		933.1	44.7	646.1		773.9	508.1	425.0
						Total Surplus	425.0	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 4

Thornthwaite Coefficient 1.334
Preciptation change 0%
Temperature change ^{O}C 4

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-3.7	82.5	0.0	0	0.8	0	0	83
February	-2.6	61.9	0.0	0	0.8	0	0	62
March	1.9	58.2	0.2	4	1.0	4	4	54
April	9.6	62.3	2.7	39	1.1	43	43	19
May	16.3	82.4	6.0	89	1.3	113	82	0
June	21.9	84.8	9.4	134	1.3	171	85	0
July	24.8	77.2	11.3	159	1.3	207	77	0
August	23.7	89.9	10.5	138	1.2	165	90	0
September	19.3	94	7.7	90	1.0	94	94	0
October	12.7	77.5	4.1	46	1.0	44	44	33
November	6.7	88.8	1.6	17	0.8	14	14	75
December	0.5	73.6	0.0	1	0.8	0	0	73
Total		933.1	53.5	716.3		855.8	533.6	399.5
						Total Surplus	399.5	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 5

Thornthwaite Coefficient 1.081
Preciptation change -10%
Temperature change ^{O}C 0

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-7.7	74.25	0.0	0	0.8	0	0	74
February	-6.6	55.71	0.0	0	0.8	0	0	56
March	-2.1	52.38	0.0	0	1.0	0	0	52
April	5.6	56.07	1.2	28	1.1	31	31	25
May	12.3	74.16	3.9	74	1.3	94	74	0
June	17.9	76.32	6.9	113	1.3	144	76	0
July	20.8	69.48	8.7	134	1.3	174	69	0
August	19.7	80.91	8.0	116	1.2	139	81	0
September	15.3	84.6	5.4	76	1.0	79	79	6
October	8.7	69.75	2.3	37	1.0	35	35	34
November	2.7	79.92	0.4	9	0.8	7	7	73
December	-3.5	66.24	0.0	0	0.8	0	0	66
Total		839.79	36.8	587.2		705.1	453.8	386.0
						Total Surplus	386.0	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 6

Thornthwaite Coefficient 1.139
Preciptation change -10%
Temperature change ^{O}C 1

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-6.7	74.25	0.0	0	0.8	0	0	74
February	-5.6	55.71	0.0	0	0.8	0	0	56
March	-1.1	52.38	0.0	0	1.0	0	0	52
April	6.6	56.07	1.5	31	1.1	35	35	22
May	13.3	74.16	4.4	78	1.3	99	74	0
June	18.9	76.32	7.5	117	1.3	150	76	0
July	21.8	69.48	9.3	139	1.3	181	69	0
August	20.7	80.91	8.6	121	1.2	145	81	0
September	16.3	84.6	6.0	79	1.0	82	82	2
October	9.7	69.75	2.7	39	1.0	38	38	32
November	3.7	79.92	0.6	11	0.8	9	9	71
December	-2.5	66.24	0.0	0	0.8	0	0	66
Total		839.79	40.6	615.9		738.5	464.3	375.5
						Total Surplus	375.5	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 7

Thornthwaite Coefficient 1.199
Preciptation change -10%
Temperature change ^{O}C 2

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-5.7	74.25	0.0	0	0.8	0	0	74
February	-4.6	55.71	0.0	0	0.8	0	0	56
March	-0.1	52.38	0.0	0	1.0	0	0	52
April	7.6	56.07	1.9	34	1.1	38	38	18
May	14.3	74.16	4.9	81	1.3	103	74	0
June	19.9	76.32	8.1	122	1.3	157	76	0
July	22.8	69.48	9.9	145	1.3	189	69	0
August	21.7	80.91	9.2	126	1.2	151	81	0
September	17.3	84.6	6.5	83	1.0	86	85	0
October	10.7	69.75	3.2	42	1.0	40	40	30
November	4.7	79.92	0.9	13	0.8	11	11	69
December	-1.5	66.24	0.0	0	0.8	0	0	66
Total		839.79	44.7	646.1		773.9	473.4	366.3
						Total Surplus	366.3	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 8

Thornthwaite Coefficient 1.334
Preciptation change -10%
Temperature change ^{O}C 4

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-3.7	74.25	0.0	0	0.8	0	0	74
February	-2.6	55.71	0.0	0	0.8	0	0	56
March	1.9	52.38	0.2	4	1.0	4	4	48
April	9.6	56.07	2.7	39	1.1	43	43	13
May	16.3	74.16	6.0	89	1.3	113	74	0
June	21.9	76.32	9.4	134	1.3	171	76	0
July	24.8	69.48	11.3	159	1.3	207	69	0
August	23.7	80.91	10.5	138	1.2	165	81	0
September	19.3	84.6	7.7	90	1.0	94	85	0
October	12.7	69.75	4.1	46	1.0	44	44	26
November	6.7	79.92	1.6	17	0.8	14	14	66
December	0.5	66.24	0.0	1	0.8	0	0	66
Total		839.79	53.5	716.3		855.8	491.1	348.7
						Total Surplus	348.7	

Note: 1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 9

Thornthwaite Coefficient 1.081
Preciptation change 10%
Temperature change ^{O}C 0

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-7.7	90.75	0.0	0	0.8	0	0	91
February	-6.6	68.09	0.0	0	0.8	0	0	68
March	-2.1	64.02	0.0	0	1.0	0	0	64
April	5.6	68.53	1.2	28	1.1	31	31	37
May	12.3	90.64	3.9	74	1.3	94	91	0
June	17.9	93.28	6.9	113	1.3	144	93	0
July	20.8	84.92	8.7	134	1.3	174	85	0
August	19.7	98.89	8.0	116	1.2	139	99	0
September	15.3	103.4	5.4	76	1.0	79	79	24
October	8.7	85.25	2.3	37	1.0	35	35	50
November	2.7	97.68	0.4	9	0.8	7	7	90
December	-3.5	80.96	0.0	0	0.8	0	0	81
Total		1026.41	36.8	587.2		705.1	520.6	505.8
						Total Surplus	505.8	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 10

Thornthwaite Coefficient 1.139
Preciptation change 10%
Temperature change ^{O}C 1

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-6.7	90.75	0.0	0	0.8	0	0	91
February	-5.6	68.09	0.0	0	0.8	0	0	68
March	-1.1	64.02	0.0	0	1.0	0	0	64
April	6.6	68.53	1.5	31	1.1	35	35	34
May	13.3	90.64	4.4	78	1.3	99	91	0
June	18.9	93.28	7.5	117	1.3	150	93	0
July	21.8	84.92	9.3	139	1.3	181	85	0
August	20.7	98.89	8.6	121	1.2	145	99	0
September	16.3	103.4	6.0	79	1.0	82	82	21
October	9.7	85.25	2.7	39	1.0	38	38	48
November	3.7	97.68	0.6	11	0.8	9	9	89
December	-2.5	80.96	0.0	0	0.8	0	0	81
Total		1026.41	40.6	615.9		738.5	531.1	495.3
						Total Surplus	495.3	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 11

Thornthwaite Coefficient 1.199
Preciptation change 10%
Temperature change ^{O}C 2

Month	Temperature (^{o}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-5.7	90.75	0.0	0	0.8	0	0	91
February	-4.6	68.09	0.0	0	0.8	0	0	68
March	-0.1	64.02	0.0	0	1.0	0	0	64
April	7.6	68.53	1.9	34	1.1	38	38	31
May	14.3	90.64	4.9	81	1.3	103	91	0
June	19.9	93.28	8.1	122	1.3	157	93	0
July	22.8	84.92	9.9	145	1.3	189	85	0
August	21.7	98.89	9.2	126	1.2	151	99	0
September	17.3	103.4	6.5	83	1.0	86	86	18
October	10.7	85.25	3.2	42	1.0	40	40	46
November	4.7	97.68	0.9	13	0.8	11	11	87
December	-1.5	80.96	0.0	0	0.8	0	0	81
Total		1026.41	44.7	646.1		773.9	541.6	484.8
						Total Surplus	484.8	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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SETTLEMENT AREA: EAST ORO

Climate Change Scenario: 12

Thornthwaite Coefficient 1.334
Preciptation change 10%
Temperature change ^{O}C 4

Month	Temperature (^{O}C)	Precipitation (mm)	Heat Index	PET (mm)	Daylight Factor	Adjusted PET (mm)	AET (mm)	Surplus (mm)
January	-3.7	90.75	0.0	0	0.8	0	0	91
February	-2.6	68.09	0.0	0	0.8	0	0	68
March	1.9	64.02	0.2	4	1.0	4	4	60
April	9.6	68.53	2.7	39	1.1	43	43	25
May	16.3	90.64	6.0	89	1.3	113	91	0
June	21.9	93.28	9.4	134	1.3	171	93	0
July	24.8	84.92	11.3	159	1.3	207	85	0
August	23.7	98.89	10.5	138	1.2	165	99	0
September	19.3	103.4	7.7	90	1.0	94	94	10
October	12.7	85.25	4.1	46	1.0	44	44	41
November	6.7	97.68	1.6	17	0.8	14	14	84
December	0.5	80.96	0.0	1	0.8	0	0	81
Total		1026.41	53.5	716.3		855.8	567.0	459.4
						Total Surplus	459.4	

Note:
1) Source - Barrie WPCC Climate Normal Data for 1981 - 2010 (Environment Canada).
2) Thornthwaite method used to determine the potential Evapotranspiration.
3) PET - potential evapotranspiration; AET - actual evapotranspiration.

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Climate Change Scenario 1

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	445.9	746.5	501.3	445.9	746.5	526.5
Net surplus (mm/yr)	445.9	746.5	501.3	445.9	746.5	526.5
Evapotranspiration (mm/yr)	487.2	186.6	431.8	487.2	186.6	406.6
Inflitration (mm/yr)	244.2	0.0	199.2	244.1	0.0	178.6
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	244.2	0.0	199.2	244.1	0.0	178.6
Run-off Pervious Areas (mm/yr)	201.7	0.0	164.5	201.8	0.0	147.6
Run-off Impervious Areas (mm/yr)	0.0	746.5	137.5	0.0	746.5	200.3
Total Run-off (mm/yr)	201.7	746.5	302.0	201.8	746.5	347.9
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Outputs						
Precipitation surplus (m3/yr)	71,520	27,031	98,552	64,145	39,378	103,523
Net surplus (m3/yr)	71,520	27,031	98,552	64,145	39,378	103,523
Evapotranspiration (m3/yr)	78,144	6,758	84,902	70,086	9,845	79,931
Inflitration (m3/yr)	39,173	0	39,173	35,117	0	35,117
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	39,173	0	39,173	35,117	0	35,117
Run-off Pervious Areas (m3/yr)	32,347	0	32,347	29,028	0	29,028
Run-off Impervious Areas (m3/yr)	0	27,031	27,031	0	39,378	39,378
Total Run-off (m3/yr)	32,347	27,031	59,379	29,028	39,378	68,407
Total Outputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 2

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	435.4	746.5	492.7	435.4	746.5	518.9
Net surplus (mm/yr)	435.4	746.5	492.7	435.4	746.5	518.9
Evapotranspiration (mm/yr)	497.7	186.6	440.4	497.7	186.6	414.2
Inflitration (mm/yr)	238.5	0.0	194.6	238.4	0.0	174.4
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	238.5	0.0	194.6	238.4	0.0	174.4
Run-off Pervious Areas (mm/yr)	196.9	0.0	160.7	197.0	0.0	144.2
Run-off Impervious Areas (mm/yr)	0.0	746.5	137.5	0.0	746.5	200.3
Total Run-off (mm/yr)	196.9	746.5	298.1	197.0	746.5	344.5
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Outputs						
Precipitation surplus (m3/yr)	69,835	27,031	96,867	62,634	39,378	102,012
Net surplus (m3/yr)	69,835	27,031	96,867	62,634	39,378	102,012
Evapotranspiration (m3/yr)	79,829	6,758	86,587	71,597	9,845	81,442
Inflitration (m3/yr)	38,250	0	38,250	34,289	0	34,289
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	38,250	0	38,250	34,289	0	34,289
Run-off Pervious Areas (m3/yr)	31,585	0	31,585	28,345	0	28,345
Run-off Impervious Areas (m3/yr)	0	27,031	27,031	0	39,378	39,378
Total Run-off (m3/yr)	31,585	27,031	58,617	28,345	39,378	67,723
Total Outputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 3

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	425.0	746.5	484.2	425.0	746.5	511.2
Net surplus (mm/yr)	425.0	746.5	484.2	425.0	746.5	511.2
Evapotranspiration (mm/yr)	508.1	186.6	448.9	508.1	186.6	421.9
Inflitration (mm/yr)	232.8	0.0	189.9	232.7	0.0	170.2
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	232.8	0.0	189.9	232.7	0.0	170.2
Run-off Pervious Areas (mm/yr)	192.2	0.0	156.8	192.3	0.0	140.7
Run-off Impervious Areas (mm/yr)	0.0	746.5	137.5	0.0	746.5	200.3
Total Run-off (mm/yr)	192.2	746.5	294.3	192.3	746.5	341.0
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Outputs						
Precipitation surplus (m3/yr)	68,163	27,031	95,194	61,134	39,378	100,512
Net surplus (m3/yr)	68,163	27,031	95,194	61,134	39,378	100,512
Evapotranspiration (m3/yr)	81,502	6,758	88,260	73,097	9,845	82,942
Inflitration (m3/yr)	37,334	0	37,334	33,468	0	33,468
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	37,334	0	37,334	33,468	0	33,468
Run-off Pervious Areas (m3/yr)	30,829	0	30,829	27,666	0	27,666
Run-off Impervious Areas (m3/yr)	0	27,031	27,031	0	39,378	39,378
Total Run-off (m3/yr)	30,829	27,031	57,860	27,666	39,378	67,044
Total Outputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 4

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Outputs						
Precipitation surplus (mm/yr)	399.5	746.5	463.4	399.5	746.5	492.6
Net surplus (mm/yr)	399.5	746.5	463.4	399.5	746.5	492.6
Evapotranspiration (mm/yr)	533.6	186.6	469.7	533.6	186.6	440.5
Inflitration (mm/yr)	218.8	0.0	178.5	218.7	0.0	160.0
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	218.8	0.0	178.5	218.7	0.0	160.0
Run-off Pervious Areas (mm/yr)	180.7	0.0	147.4	180.8	0.0	132.3
Run-off Impervious Areas (mm/yr)	0.0	746.5	137.5	0.0	746.5	200.3
Total Run-off (mm/yr)	180.7	746.5	284.9	180.8	746.5	332.6
Total Outputs (mm/yr)	933.1	933.1	933.1	933.1	933.1	933.1
Inputs						
Precipitation (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454
Outputs						
Precipitation surplus (m3/yr)	64,075	27,031	91,106	57,467	39,378	96,846
Net surplus (m3/yr)	64,075	27,031	91,106	57,467	39,378	96,846
Evapotranspiration (m3/yr)	85,590	6,758	92,348	76,764	9,845	86,608
Inflitration (m3/yr)	35,095	0	35,095	31,461	0	31,461
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	35,095	0	35,095	31,461	0	31,461
Run-off Pervious Areas (m3/yr)	28,980	0	28,980	26,007	0	26,007
Run-off Impervious Areas (m3/yr)	0	27,031	27,031	0	39,378	39,378
Total Run-off (m3/yr)	28,980	27,031	56,011	26,007	39,378	65,385
Total Outputs (m3/yr)	149,665	33,789	183,454	134,231	49,223	183,454

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 5

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Outputs						
Precipitation surplus (mm/yr)	386.0	671.8	438.7	386.0	671.8	462.7
Net surplus (mm/yr)	386.0	671.8	438.7	386.0	671.8	462.7
Evapotranspiration (mm/yr)	453.8	168.0	401.1	453.8	168.0	377.1
Inflitration (mm/yr)	211.4	0.0	172.5	211.3	0.0	154.6
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	211.4	0.0	172.5	211.3	0.0	154.6
Run-off Pervious Areas (mm/yr)	174.6	0.0	142.4	174.7	0.0	127.8
Run-off Impervious Areas (mm/yr)	0.0	671.8	123.7	0.0	671.8	180.3
Total Run-off (mm/yr)	174.6	671.8	266.2	174.7	671.8	308.1
Total Outputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Inputs						
Precipitation (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Outputs						
Precipitation surplus (m3/yr)	61,916	24,328	86,244	55,531	35,440	90,971
Net surplus (m3/yr)	61,916	24,328	86,244	55,531	35,440	90,971
Evapotranspiration (m3/yr)	72,782	6,082	78,865	65,277	8,860	74,137
Inflitration (m3/yr)	33,912	0	33,912	30,401	0	30,401
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	33,912	0	33,912	30,401	0	30,401
Run-off Pervious Areas (m3/yr)	28,004	0	28,004	25,130	0	25,130
Run-off Impervious Areas (m3/yr)	0	24,328	24,328	0	35,440	35,440
Total Run-off (m3/yr)	28,004	24,328	52,332	25,130	35,440	60,571
Total Outputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 6

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Outputs						
Precipitation surplus (mm/yr)	375.5	671.8	430.1	375.5	671.8	455.0
Net surplus (mm/yr)	375.5	671.8	430.1	375.5	671.8	455.0
Evapotranspiration (mm/yr)	464.3	168.0	409.7	464.3	168.0	384.8
Inflitration (mm/yr)	205.7	0.0	167.8	205.6	0.0	150.4
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	205.7	0.0	167.8	205.6	0.0	150.4
Run-off Pervious Areas (mm/yr)	169.8	0.0	138.6	169.9	0.0	124.3
Run-off Impervious Areas (mm/yr)	0.0	671.8	123.7	0.0	671.8	180.3
Total Run-off (mm/yr)	169.8	671.8	262.3	169.9	671.8	304.6
Total Outputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Inputs						
Precipitation (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Outputs						
Precipitation surplus (m3/yr)	60,231	24,328	84,559	54,020	35,440	89,460
Net surplus (m3/yr)	60,231	24,328	84,559	54,020	35,440	89,460
Evapotranspiration (m3/yr)	74,467	6,082	80,549	66,788	8,860	75,648
Inflitration (m3/yr)	32,990	0	32,990	29,573	0	29,573
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	32,990	0	32,990	29,573	0	29,573
Run-off Pervious Areas (m3/yr)	27,241	0	27,241	24,446	0	24,446
Run-off Impervious Areas (m3/yr)	0	24,328	24,328	0	35,440	35,440
Total Run-off (m3/yr)	27,241	24,328	51,570	24,446	35,440	59,887
Total Outputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 7

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Outputs						
Precipitation surplus (mm/yr)	366.3	671.8	422.6	366.3	671.8	448.3
Net surplus (mm/yr)	366.3	671.8	422.6	366.3	671.8	448.3
Evapotranspiration (mm/yr)	473.4	168.0	417.2	473.4	168.0	391.5
Inflitration (mm/yr)	200.7	0.0	163.7	200.6	0.0	146.7
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	200.7	0.0	163.7	200.6	0.0	146.7
Run-off Pervious Areas (mm/yr)	165.7	0.0	135.2	165.8	0.0	121.3
Run-off Impervious Areas (mm/yr)	0.0	671.8	123.7	0.0	671.8	180.3
Total Run-off (mm/yr)	165.7	671.8	258.9	165.8	671.8	301.6
Total Outputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Inputs						
Precipitation (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Outputs						
Precipitation surplus (m3/yr)	58,760	24,328	83,088	52,701	35,440	88,141
Net surplus (m3/yr)	58,760	24,328	83,088	52,701	35,440	88,141
Evapotranspiration (m3/yr)	75,938	6,082	82,020	68,107	8,860	76,967
Inflitration (m3/yr)	32,184	0	32,184	28,851	0	28,851
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	32,184	0	32,184	28,851	0	28,851
Run-off Pervious Areas (m3/yr)	26,576	0	26,576	23,849	0	23,849
Run-off Impervious Areas (m3/yr)	0	24,328	24,328	0	35,440	35,440
Total Run-off (m3/yr)	26,576	24,328	50,904	23,849	35,440	59,290
Total Outputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 8

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Outputs						
Precipitation surplus (mm/yr)	348.7	671.8	408.2	348.7	671.8	435.4
Net surplus (mm/yr)	348.7	671.8	408.2	348.7	671.8	435.4
Evapotranspiration (mm/yr)	491.1	168.0	431.6	491.1	168.0	404.4
Inflitration (mm/yr)	191.0	0.0	155.8	190.9	0.0	139.7
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	191.0	0.0	155.8	190.9	0.0	139.7
Run-off Pervious Areas (mm/yr)	157.7	0.0	128.7	157.8	0.0	115.5
Run-off Impervious Areas (mm/yr)	0.0	671.8	123.7	0.0	671.8	180.3
Total Run-off (mm/yr)	157.7	671.8	252.4	157.8	671.8	295.7
Total Outputs (mm/yr)	839.8	839.8	839.8	839.8	839.8	839.8
Inputs						
Precipitation (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108
Outputs						
Precipitation surplus (m3/yr)	55,933	24,328	80,261	50,165	35,440	85,605
Net surplus (m3/yr)	55,933	24,328	80,261	50,165	35,440	85,605
Evapotranspiration (m3/yr)	78,766	6,082	84,848	70,643	8,860	79,503
Inflitration (m3/yr)	30,635	0	30,635	27,463	0	27,463
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	30,635	0	30,635	27,463	0	27,463
Run-off Pervious Areas (m3/yr)	25,297	0	25,297	22,702	0	22,702
Run-off Impervious Areas (m3/yr)	0	24,328	24,328	0	35,440	35,440
Total Run-off (m3/yr)	25,297	24,328	49,626	22,702	35,440	58,142
Total Outputs (m3/yr)	134,698	30,410	165,108	120,808	44,301	165,108

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 9

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Outputs						
Precipitation surplus (mm/yr)	505.8	821.1	563.9	505.8	821.1	590.4
Net surplus (mm/yr)	505.8	821.1	563.9	505.8	821.1	590.4
Evapotranspiration (mm/yr)	520.6	205.3	462.5	520.6	205.3	436.0
Inflitration (mm/yr)	277.0	0.0	226.0	276.9	0.0	202.6
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	277.0	0.0	226.0	276.9	0.0	202.6
Run-off Pervious Areas (mm/yr)	228.8	0.0	186.6	228.9	0.0	167.5
Run-off Impervious Areas (mm/yr)	0.0	821.1	151.2	0.0	821.1	220.3
Total Run-off (mm/yr)	228.8	821.1	337.9	228.9	821.1	387.8
Total Outputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Inputs						
Precipitation (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Outputs						
Precipitation surplus (m3/yr)	81,125	29,734	110,859	72,759	43,316	116,075
Net surplus (m3/yr)	81,125	29,734	110,859	72,759	43,316	116,075
Evapotranspiration (m3/yr)	83,506	7,434	90,940	74,895	10,829	85,724
Inflitration (m3/yr)	44,433	0	44,433	39,832	0	39,832
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	44,433	0	44,433	39,832	0	39,832
Run-off Pervious Areas (m3/yr)	36,691	0	36,691	32,927	0	32,927
Run-off Impervious Areas (m3/yr)	0	29,734	29,734	0	43,316	43,316
Total Run-off (m3/yr)	36,691	29,734	66,426	32,927	43,316	76,243
Total Outputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 10

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Outputs						
Precipitation surplus (mm/yr)	495.3	821.1	555.3	495.3	821.1	582.7
Net surplus (mm/yr)	495.3	821.1	555.3	495.3	821.1	582.7
Evapotranspiration (mm/yr)	531.1	205.3	471.1	531.1	205.3	443.7
Inflitration (mm/yr)	271.3	0.0	221.3	271.1	0.0	198.4
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	271.3	0.0	221.3	271.1	0.0	198.4
Run-off Pervious Areas (mm/yr)	224.0	0.0	182.7	224.1	0.0	164.0
Run-off Impervious Areas (mm/yr)	0.0	821.1	151.2	0.0	821.1	220.3
Total Run-off (mm/yr)	224.0	821.1	334.0	224.1	821.1	384.3
Total Outputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Inputs						
Precipitation (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Outputs						
Precipitation surplus (m3/yr)	79,440	29,734	109,174	71,248	43,316	114,564
Net surplus (m3/yr)	79,440	29,734	109,174	71,248	43,316	114,564
Evapotranspiration (m3/yr)	85,191	7,434	92,625	76,406	10,829	87,235
Inflitration (m3/yr)	43,511	0	43,511	39,005	0	39,005
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	43,511	0	43,511	39,005	0	39,005
Run-off Pervious Areas (m3/yr)	35,929	0	35,929	32,243	0	32,243
Run-off Impervious Areas (m3/yr)	0	29,734	29,734	0	43,316	43,316
Total Run-off (m3/yr)	35,929	29,734	65,664	32,243	43,316	75,559
Total Outputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 11

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Outputs						
Precipitation surplus (mm/yr)	484.8	821.1	546.8	484.8	821.1	575.1
Net surplus (mm/yr)	484.8	821.1	546.8	484.8	821.1	575.1
Evapotranspiration (mm/yr)	541.6	205.3	479.6	541.6	205.3	451.3
Inflitration (mm/yr)	265.6	0.0	216.6	265.4	0.0	194.2
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	265.6	0.0	216.6	265.4	0.0	194.2
Run-off Pervious Areas (mm/yr)	219.3	0.0	178.9	219.4	0.0	160.5
Run-off Impervious Areas (mm/yr)	0.0	821.1	151.2	0.0	821.1	220.3
Total Run-off (mm/yr)	219.3	821.1	330.1	219.4	821.1	380.9
Total Outputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Inputs						
Precipitation (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Outputs						
Precipitation surplus (m3/yr)	77,767	29,734	107,502	69,748	43,316	113,064
Net surplus (m3/yr)	77,767	29,734	107,502	69,748	43,316	113,064
Evapotranspiration (m3/yr)	86,864	7,434	94,298	77,906	10,829	88,735
Inflitration (m3/yr)	42,594	0	42,594	38,184	0	38,184
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	42,594	0	42,594	38,184	0	38,184
Run-off Pervious Areas (m3/yr)	35,173	0	35,173	31,564	0	31,564
Run-off Impervious Areas (m3/yr)	0	29,734	29,734	0	43,316	43,316
Total Run-off (m3/yr)	35,173	29,734	64,907	31,564	43,316	74,880
Total Outputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

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Climate Change Scenario 12

Catchment Designation	Pre-Development			Post-Development		
	Pervious	Impervious	Total	Pervious	Impervious	Total
Catchment Area (ha)	16.0	3.6	19.7	14.4	5.3	19.7
Inflitration Factors						
Infiltration Factor	0.55	-	-	0.55	-	-
Run-Off Coefficient	0.45	0.95	-	0.45	0.95	-
Runoff from Impervious Surfaces	0.00	0.80	-	0.00	0.80	-
Inputs						
Precipitation (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Run-on (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Other Inputs (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Inputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Outputs						
Precipitation surplus (mm/yr)	459.4	821.1	526.0	459.4	821.1	556.4
Net surplus (mm/yr)	459.4	821.1	526.0	459.4	821.1	556.4
Evapotranspiration (mm/yr)	567.0	205.3	500.4	567.0	205.3	470.0
Inflitration (mm/yr)	251.6	0.0	205.3	251.5	0.0	184.0
Infiltration of Pervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Infiltration of Impervious Runoff (mm/yr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Infiltration (mm/yr)	251.6	0.0	205.3	251.5	0.0	184.0
Run-off Pervious Areas (mm/yr)	207.8	0.0	169.5	207.9	0.0	152.1
Run-off Impervious Areas (mm/yr)	0.0	821.1	151.2	0.0	821.1	220.3
Total Run-off (mm/yr)	207.8	821.1	320.7	207.9	821.1	372.4
Total Outputs (mm/yr)	1026.4	1026.4	1026.4	1026.4	1026.4	1026.4
Inputs						
Precipitation (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Run-on (m3/yr)	0	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0	0
Total Inputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799
Outputs						
Precipitation surplus (m3/yr)	73,679	29,734	103,414	66,081	43,316	109,398
Net surplus (m3/yr)	73,679	29,734	103,414	66,081	43,316	109,398
Evapotranspiration (m3/yr)	90,952	7,434	98,385	81,573	10,829	92,402
Inflitration (m3/yr)	40,355	0	40,355	36,177	0	36,177
Infiltration of Pervious Runoff (m3/yr)	0	0	0	0	0	0
Infiltration of Impervious Runoff (m3/yr)	0	0	0	0	0	0
Total Infiltration (m3/yr)	40,355	0	40,355	36,177	0	36,177
Run-off Pervious Areas (m3/yr)	33,324	0	33,324	29,905	0	29,905
Run-off Impervious Areas (m3/yr)	0	29,734	29,734	0	43,316	43,316
Total Run-off (m3/yr)	33,324	29,734	63,058	29,905	43,316	73,221
Total Outputs (m3/yr)	164,631	37,168	201,799	147,654	54,145	201,799

Notes: 1. Evaporation from impervious areas was assumed to be 20% of precipitation and is within the acceptable range as per the Conservation Authority Guidelines for Hydrogeological Assessment Submissions (June, 2013)

2. Infiltration factors derived from MOE SWM Design Manual Table 3.1

APPENDIX D:
EROSION ASSESSMENT ANALYSIS

Erosion Threshold Analysis
Kempenfelt Bay Tributaries, Shellswell's Creek Tributary, Hawkestone Creek Tributary, Bluffs Creek, Shingle Bay Tributary
Township of Oro-Medonte Stormwater Management Master Plan



Submitted to:

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October 20, 2014

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Erosion Threshold Analysis
Kempenfelt Bay Tributaries, Shellswell's Creek Tributary, Hawkestone Creek Tributary, Bluffs Creek, Shingle Bay Tributary
Township of Oro-Medonte Stormwater Management Master Plan

Erosion threshold analysis has been undertaken for seven watercourse locations that will receive stormwater discharge from future proposed development in the Township of Oro-Medonte.

Table 1 presents of summary of the watershed context for each watercourse location selected for detailed analysis.

Table 1: Watershed Context Summary

	Stream Order	Manmade Drain	Catchment Area (ha)	Physiog. Region
Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)	1	N	103	SL
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)	1	N	20	SL
Shellswell's Creek Tributary (5 Line S., Guthrie)	1	N	153	SU
Hawkestone Creek Tributary (Line 11 N., Hawkestone)	2	Y	360	SL
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)	2	N	347	SL
Bluffs Creek (Line 11 N., East Oro)	3	N	998	SU
Shingle Bay Tributary (Forest Lane Rd., Forest Home)	2	Y	88	SL

Y -yes / N - no
SL - Simcoe Lowlands physiographic region
SU – Simcoe Uplands physiographic region

Rapid Assessment Analysis

Three rapid assessment protocols were undertaken for each of the features in the reaches in proximity to proposed development area outlets. Background review and field reconnaissance generally suggested that the reaches closest to proposed stormwater outlets will have the greatest sensitivity to future flow changes, except for the Kempenfelt Tributary C which is confluent with a larger branch close to the potential future outlet. The larger branch was deemed to be more sensitive due to increased slope and channel entrenchment, and closer proximity to existing development.

Field observations were used to score relative geomorphic and environmental attributes. Rapid Geomorphic Assessment (RGA) was used to rate channel stability and infrastructure impact. Rapid Habitat Assessment (RHA) was used to define in-stream and riparian habitat. Rapid Stream Assessment Technique (RSAT) was used to test

broad indicators of channel stability, aquatic habitat, and water quality. A prorated score out of 100 was transposed from the results of each protocol and a combined average score was determined from the three tests. Four qualifying ranges of poor, fair, good, and optimal are maintained in the RHA and RSAT protocols, between the original scoring and the weighted scoring out of 100, while the three original ranges in RGA scoring are reflected as poor, fair, and good. The combined average score is qualified by poor to optimal ranges designed as a best fit of the individual protocol ranges. The detailed results are appended. **Table 2** presents a summary of the rapid assessment results.

Table 2: Rapid Assessment Results

	RGA Score	RHA Score	RSAT Score	Combined Score
Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)	63.6	46.5	52.0	54.0
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)	63.6	44.0	44.0	50.5
Shellswell's Creek Tributary (5 Line S., Guthrie)	79.3	58.5	68.0	68.6
Hawkestone Creek Tributary (Line 11 N., Hawkestone)	92.9	54.0	64.0	75.6
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)	68.6	64.0	62.0	64.9
Bluffs Creek (Line 11 N., East Oro)	91.4	81.0	86.0	86.0
Shingle Bay Tributary (Forest Lane Rd., Forest Home)	83.2	47.5	54.0	62.0

RGA - Rapid Geomorphic Assessment

RHA - Rapid Habitat Assessment

RSAT - Rapid Stream Assessment Technique

All scores are prorated to be out of 100.

Erosion Threshold Characterization

Erosion threshold characterization was undertaken to establish benchmark targets for discharge control provided by stormwater management treatment of the proposed development blocks. Sensitivity was measured and modeled at either three or five surveyed bankfull or channel forming cross-sections. Three sections were done based on field estimation of high levels of stability in some features while five were done at sites that appeared less stable and that received lower RGA scores. Backwater influences caused by large woody debris were avoided. Channel forming debris flow lines, fallen and matted groundcover vegetation lines, and well defined scour lines were used as field indicators as deemed appropriate to identify cross-section width under a variety of conditions. Deeper channel capacity geometry for locations that were entrenched was not surveyed but rather the depth of entrenchment was judged with respect to what range of return event flows might be captured below the top of bank capacity level. This was subsequently used as a target for the type of hydrology

analysis, as described further below. Channel geometry was measured laterally at each cross-section and the longitudinal profile was shot using bankfull and channel bed indicators, with cross-reference subsequently made to available topographic mapping. Channel bed substrates were measured through random-step Wolman pebble counts and recorded using the Wentworth sediment distribution scale.

Open channel flow models were created for each cross-section location. Each model required input of channel bed substrate data, cross-section dimensions, gradient, and bank geometry. Modeling tests were done for each cross-section and erosion indicators and thresholds were reviewed.

Subsequent checks were done to determine the critical stability threshold discharge. This discharge represents a reach based average point at which channel instability begins to occur with rising flow stage and rising discharge, or conversely when instability stops with falling flow stage and falling discharge. This discharge then becomes the comparative flow regime target for detailed analysis of stormwater management hydrology. Iterative flow stage adjustments were made in each cross-section model until appropriate stability criteria were judged to have been achieved over the primary shear stress and velocity threshold tests, with secondary checks made of stream power and Froude number. **Table 3** presents the threshold criteria used for this analysis based on 'small' watercourse channel typology which display the influence of vegetation control.

Table 3: Critical stability threshold criteria

	low flow morphology		
	riffle	run	pool / glide
semi-alluvial firm to dense till channels	D_{84} pavement	D_{84} pavement or vegetation control*	D_{100} pavement or vegetation control*
alluvial cohesionless channels	D_{50} pavement	D_{50} pavement or vegetation control*	D_{84} pavement or vegetation control*

*vegetation control criteria varies depending on vegetation type and density
note: step-pool and cascade-step-pool channels require case by case study

The second row criteria are applied for this study case, based on soil conditions and channel type. A mix of low flow morphology types, wide ranging sediment sizing, and degrees of vegetation control exist over the scale of surveyed channels. Conservative vegetation control criteria are identified as 40N m^{-2} for shear stress and 1.2m s^{-1} for channel velocity. Higher thresholds for vegetation control are common and viable under very high levels of vegetative encroachment and this could be argued as applicable for

some of the smaller channels. Channel run and pool sections that have partial vegetation control but are not judged to be fully protected are deemed to have thresholds of approximately 0.4-0.7m s^{-1} for velocities acting on pure sand to graded sediments, with shear stress values approximately 10-30N m^{-1} being acceptable when large volumes of sub coarse sand sized sediment forms both the banks and the channel pavement and subpavement (individual sand particle size values would be too low to be practical). More cohesive gradations of silt-clay or gradations that include some gravel with sand were deemed to have thresholds of approximately 30N m^{-2} and 0.8m s^{-1} respectively for shear stress and velocity (ranges summarized in Fischenich 2001). Additional consideration was made at specific cross-sections where distinct bed armouring geometry influenced how flow stage iterations were tested (locations are noted within the erosion threshold summary models described further below). Several references vary on specific erosion threshold levels for sediment sizing, mixes of sizes, vegetative influence, entrenchment risk, and duration of flow effects, but notwithstanding the multiplicity of methods, the noted targets have proven practical over several similar studies and modelling efforts. Detailed results of stable conditions modelling are appended after the existing conditions bankfull flow modelling.

Four of seven watercourse locations were determined to require downward adjustment in flow rate to meet dynamic stability on a balance of vegetation control and particle size transport. Existing condition shear and velocity results reviewed for all seven locations were seen to generally meet criteria for vegetation control, however the depth and density of observed vegetation is not consistent over all sites nor does it influence the full cross-section of many sites, i.e. rooting and stem density does not cover full bank height and/or does not fully traverse under the bed. All stream power results are below a stability threshold of 400 watts m^{-1} (Sear et. al. 2003) and all Froude numbers are less than one, confirming subcritical and tranquil flow.

Appended after the stable conditions models are summary models that show the comparisons of key variables between the respective conditions cross-section models. The summary models include the breakdown of three conditions of dynamic stability, cautionary dynamic stability, and potential instability. The adjustments made to achieve stability reflect bump ups from cautionary dynamic stability to full dynamic stability and from potential instability to cautionary dynamic stability (or full dynamic stability), with an averaged final condition judged to be a realistic stable regime in the watercourse.

Based on the results of erosion threshold characterization, the method of subsequent hydrology analysis was considered. Three general approaches are available including exceedance-duration analysis, unit-area flow rate analysis, and vegetation-hydroperiod analysis. The latter, vegetation-hydroperiod analysis would not be applicable for larger

and well shaded watercourse locations and would thus not be comparable to or consistent over all sites. Nonetheless, given the observed conditions for each of the stable sites with biotechnical reinforcement, there would be no anticipated issues or restraints from a hydroperiod perspective on just these locations. Exceedance-duration analysis is best applied when continuous hydrology modelling is undertaken although a variant is possible with event modelling. In this study, the variation in entrenchment levels would mean having to specifically determine the top of channel capacity for entrenched locations and then correlate this to the selected period of time used in the continuous analysis. Invariably some long term inaccuracy results in this analysis because of potential differences in return event flows and actual flow frequency recurrence that would be available from continuous modelling. The alternative way to address this variability is to apply unit-area flow rate targets for the receiving reaches and then identify a reasonable range of frequent flow events that are qualitatively judged to be contained within channel capacity. This is deemed appropriate when the receiving reach locations are close to the ultimate receiver or the receiver locations are essentially the only isolated location receiving future development flows. This method also provides long term flexibility because the target is not modified by types of land use change which may ultimately be modified from current planning (which by comparison to exceedance-duration analysis would specifically affect continuous modelling efforts of future conditions, i.e. the need to redo modelling for any modified proposal change in land use). The unit-area flow target qualifying criteria are therefore felt to be the best fit across the study area for consistent application.

Unit-Area Flow Rate Targets

The results of erosion threshold analysis were used to establish unit-area flow rate targets for each watercourse location. **Table 4** summarizes the channel forming flow rates and erosion threshold flow rates for all locations. The unit-area flow rate is based on the erosion threshold rate divided by the total drainage area to the point of field measurement. Entrenchment qualification is noted and the suggested events that will require analysis for unit-area target compliance are listed. All locations require the 25mm event by default to be included. The 2yr is listed for all sites to conservatively address and include all frequent flows from the thresholds below bankfull and those at bankfull. For sites that are not entrenched, the peak of flood flows entering the flood plain do not need to be over-controlled but for those that are entrenched, best efforts should be made to over-control to the unit-area flow rate. If these events prove problematic from a volume perspective, a modified exceedance-duration analysis check could be made to identify the time component of flows over and under the threshold, based on some level of over-control or standard peak matching control.

Table 4: Unit-Area Flow Rate Summary

	Q_{cf} $m^3 s^{-1}$	Q_{ds} $m^3 s^{-1}$	Q_{ua} $l s^{-1} ha^{-1}$	entr.	control events
Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)	0.78	0.38	3.69	Y	25mm, 2-25yr
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)	0.10	0.09	4.50	Y(P)	25mm, 2-5yr
Shellswell's Creek Tributary (5 Line S., Guthrie)	0.77	0.52	3.40	Y(P)	25mm, 2-5yr
Hawkestone Creek Tributary (Line 11 N., Hawkestone)	0.82	0.82	2.27	N	25mm, 2yr
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)	0.78	0.53	1.53	Y(P)	25mm, 2-5yr
Bluffs Creek (Line 11 N., East Oro)	1.71	1.71	1.71	N	25mm, 2yr
Shingle Bay Tributary (Forest Lane Rd., Forest Home)	0.69	0.69	7.84	Y(P)	25mm, 2-10yr

Q_{cf} - channel forming discharge
Q_{ds} - dynamic stability discharge
Q_{ua} – unit-area flow rate target for SWM
entr. - entrenched: Y – yes / N – no / Y(P) – yes, partial

Conclusions

Erosion threshold analysis has been undertaken for seven watercourse locations that will receive stormwater discharge from future proposed development in the Township of Oro-Medonte. Field review of channel sensitivity and detailed cross-section surveys were undertaken for data input into erosion threshold modelling. Results determined three of seven sites were dynamically stable and four required downward adjustment in flow rate to achieve stability. Unit-area flow targets for future development were determined based on the final results. The methods of analysis presented in this report do not preclude a catastrophic event potentially causing some erosion due to unforeseen circumstances (e.g. SWM pond failure, culvert failures, major debris jam scour, beaver dam construction/breaching, or combinations thereof, etc.). The results presented here are also contingent on long term preservation and maintenance of natural vegetation conditions within the respective corridors, and maintenance of drainage areas without diversions between watersheds.

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Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)
Shellswell's Creek Tributary (5 Line S., Guthrie)
Hawkestone Creek Tributary (Line 11 N., Hawkestone)
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)
Bluffs Creek (Line 11 N., East Oro)
Shingle Bay Tributary (Forest Lane Rd., Forest Home)

Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan

AquaLogic

GEO-RAP v.1.2 Rapid Assessment Protocol Model

B. de Geus 03.12

Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	1
	Siltation in pools	1
	Medial bars	1
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.57
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	1
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	1
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.40
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.29

STABILITY INDEX (SI) = (A + D + W + P) / 4 = **0.36**

SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	**63.6**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	11	20--16	15-11	10-6	5-0
Embeddedness	11	20--16	15-11	10-6	5-0
Velocity / Depth Regime	2	20--16	15-11	10-6	5-0
Sediment Deposition	5	20--16	15-11	10-6	5-0
Channel Flow Status	4	20--16	15-11	10-6	5-0
Channel Alteration	10	20--16	15-11	10-6	5-0
Frequency of Riffles	12	20--16	15-11	10-6	5-0
Bank Stability u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	93				
/100	**46.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	6	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	5	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	1	8-7	6-5	4-3	2-0
/50	26				
/100	**52.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**54.0**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-RAP v.1.2 Rapid Assessment Protocol Model

B. de Geus 03.12

Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	1
	Siltation in pools	1
	Medial bars	1
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.57
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	1
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	1
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.40
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.29
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.36**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**63.6**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	11	20--16	15-11	10-6	5-0
Embeddedness	11	20--16	15-11	10-6	5-0
Velocity / Depth Regime	0	20--16	15-11	10-6	5-0
Sediment Deposition	4	20--16	15-11	10-6	5-0
Channel Flow Status	2	20--16	15-11	10-6	5-0
Channel Alteration	10	20--16	15-11	10-6	5-0
Frequency of Riffles	12	20--16	15-11	10-6	5-0
Bank Stability u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	88				
/100	**44.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	6	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	4	8-7	6-5	4-3	2-0
Water Quality	5	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	3	7-6	5-4	3-2	1-0
Biological Indicators	0	8-7	6-5	4-3	2-0
/50	22				
/100	**44.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**50.5**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

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Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Shellswell's Creek Tributary (5 Line S., Guthrie)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	1
	Siltation in pools	1
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.29
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	1
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.20
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.21**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**79.3**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Embeddedness		20--16	15-11	10-6	5-0
Velocity / Depth Regime		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Frequency of Riffles		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	14	20--16	15-11	10-6	5-0
Pool Substrate Characterization	8	20--16	15-11	10-6	5-0
Pool Variability	10	20--16	15-11	10-6	5-0
Sediment Deposition	7	20--16	15-11	10-6	5-0
Channel Flow Status	10	20--16	15-11	10-6	5-0
Channel Alteration	6	20--16	15-11	10-6	5-0
Channel Sinuosity	12	20--16	15-11	10-6	5-0
Bank Stability u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
/200	117				
/100	**58.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	8	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	7	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	3	8-7	6-5	4-3	2-0
/50	34				
/100	**68.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =	**68.6**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

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Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Hawkestone Creek Tributary (Line 11 N., Hawkestone)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	1
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.00

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	1
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.07**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**92.9**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Embeddedness		20--16	15-11	10-6	5-0
Velocity / Depth Regime		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Frequency of Riffles		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	13	20--16	15-11	10-6	5-0
Pool Substrate Characterization	7	20--16	15-11	10-6	5-0
Pool Variability	7	20--16	15-11	10-6	5-0
Sediment Deposition	7	20--16	15-11	10-6	5-0
Channel Flow Status	2	20--16	15-11	10-6	5-0
Channel Alteration	7	20--16	15-11	10-6	5-0
Channel Sinuosity	7	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	10	10-8	7-6	5-3	2-0
u/s R	10	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	10	10-8	7-6	5-3	2-0
u/s R	10	10-8	7-6	5-3	2-0
/200	108				
/100	**54**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	7	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	0	8-7	6-5	4-3	2-0
/50	32				
/100	**64.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**75.6**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

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Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	1
	Siltation in pools	1
	Medial bars	1
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.71
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.10

Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.30
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.31**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**68.6**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	13	20--16	15-11	10-6	5-0
Embeddedness	12	20--16	15-11	10-6	5-0
Velocity / Depth Regime	12	20--16	15-11	10-6	5-0
Sediment Deposition	6	20--16	15-11	10-6	5-0
Channel Flow Status	13	20--16	15-11	10-6	5-0
Channel Alteration	12	20--16	15-11	10-6	5-0
Frequency of Riffles	12	20--16	15-11	10-6	5-0
Bank Stability u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	10	10-8	7-6	5-3	2-0
u/s R	10	10-8	7-6	5-3	2-0
/200	128				
/100	**64.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	7	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	5	7-6	5-4	3-2	1-0
Biological Indicators	2	8-7	6-5	4-3	2-0
/50	31				
/100	**62.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**64.9**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

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Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Bluffs Creek (Line 11 N., East Oro)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	1
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.00

Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.20
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.00

STABILITY INDEX (SI) = (A + D + W + P) / 4 = **0.09**

SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	**91.4**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Embeddedness		20--16	15-11	10-6	5-0
Velocity / Depth Regime		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Frequency of Riffles		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	11	20--16	15-11	10-6	5-0
Pool Substrate Characterization	8	20--16	15-11	10-6	5-0
Pool Variability	16	20--16	15-11	10-6	5-0
Sediment Deposition	16	20--16	15-11	10-6	5-0
Channel Flow Status	19	20--16	15-11	10-6	5-0
Channel Alteration	19	20--16	15-11	10-6	5-0
Channel Sinuosity	17	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	10	10-8	7-6	5-3	2-0
u/s R	10	10-8	7-6	5-3	2-0
/200	162				
/100	**81**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	10	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	7	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	7	8-7	6-5	4-3	2-0
/50	43				
/100	**86.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =	**86**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

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Project: **Erosion Threshold Analysis**
Township of Oro-Medonte Stormwater Management Master Plan
Shingle Bay Tributary (Forest Lane Rd., Forest Home)

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	1
	Coarse material in riffles embedded	
	Siltation in pools	1
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.43
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.00

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	1
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.10
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	1
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.17**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**83.2**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Embeddedness		20--16	15-11	10-6	5-0
Velocity / Depth Regime		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Frequency of Riffles		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Pool Substrate Characterization	10	20--16	15-11	10-6	5-0
Pool Variability	8	20--16	15-11	10-6	5-0
Sediment Deposition	7	20--16	15-11	10-6	5-0
Channel Flow Status	11	20--16	15-11	10-6	5-0
Channel Alteration	4	20--16	15-11	10-6	5-0
Channel Sinuosity	4	20--16	15-11	10-6	5-0
Bank Stability u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	3	10-8	7-6	5-3	2-0
u/s R	5	10-8	7-6	5-3	2-0
/200	95				
/100	**47.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	8	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	4	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	3	7-6	5-4	3-2	1-0
Biological Indicators	2	8-7	6-5	4-3	2-0
/50	27				
/100	**54.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**62**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-X v.5.1 Geomorphic Cross-Section Analysis Models
Channel Forming / Bankfull Conditions

Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)
Shellswell's Creek Tributary (5 Line S., Guthrie)
Hawkestone Creek Tributary (Line 11 N., Hawkestone)
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)
Bluffs Creek (Line 11 N., East Oro)
Shingle Bay Tributary (Forest Lane Rd., Forest Home)

Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan

AquaLogic

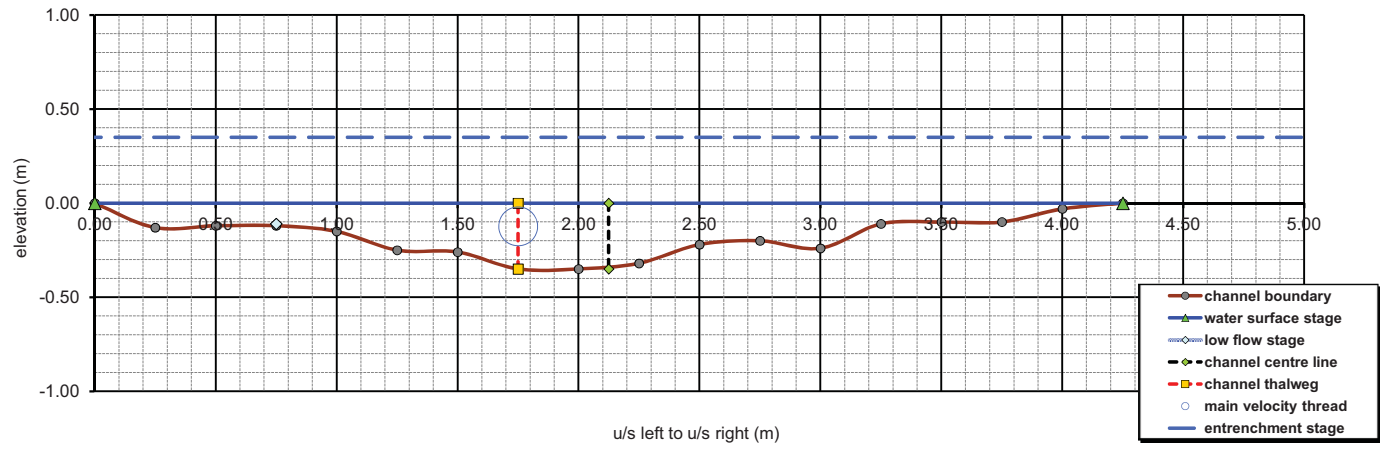


GEO-X v.5.1 Geomorphic Cross-section Analysis Model

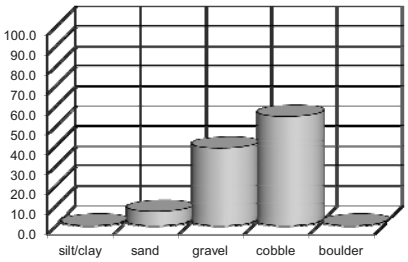
Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

B. de Geus 05.11

Cross Section Plot







Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.76
R (m)	0.17
TW (m)	4.25
WP (m)	4.39
max d (m)	0.35
mean d (m)	0.18
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.45
ff V mean/V*	4.72
ff D_{84}	3.83
ff mean	4.27
ROUGH BED	

Hydraulic Ratios	
ER max d	5.88
r_c / TW	
TW / Lf_w	
TW/max d	12.1
TW/mean d	23.7

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	22.40	NO	NO	NO	NO
V_* (m s^{-1})	0.087	D_{50}	1.183	32.99	NO	NO	NO	NO
		D_{84}	1.608	44.83	NO	NO	NO	NO

Section Data				
ER_e (m)	0.35	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	4.25	4.25
Lf_e (m)	-0.110	Lf stations L / R	0.75	0.75	
W_{fp} (m)	25.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.35	1.75	
E_g (m m^{-1})	0.0220				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	8.00	30.00	65.00	120.00	170.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		29.10	63.05	116.40	164.90
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	3.82		
τ_{calc} (N m^{-2})	37.47	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	38.63		
D_{50} V_c (vcs +) (m s^{-1})	1.25	1.75	
D_{84} V_c (vcs +) (m s^{-1})	1.70	2.38	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	6.8	38.6	54.5	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Bedload Transport Data						
	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0016	T_*	1.3	0.6	0.3
C3	0.0002	0.0001	saltation	NO	NO	NO
C4	0.0058	0.0052	rolling	YES	NO	NO
			Ø	NO	YES	YES

Flow Regime Strickler method	
Q (cms)	0.778
V (m s^{-1})	1.02
n	0.045
Fr	0.77
D_c rectangular (m)	0.15
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.29
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	167.77
ω_a (watts m^{-2})	38.24
ω_a/TW (watts m^{-1})	9.00
Re^*	125.2
Re	155581
turbulence	HIGH

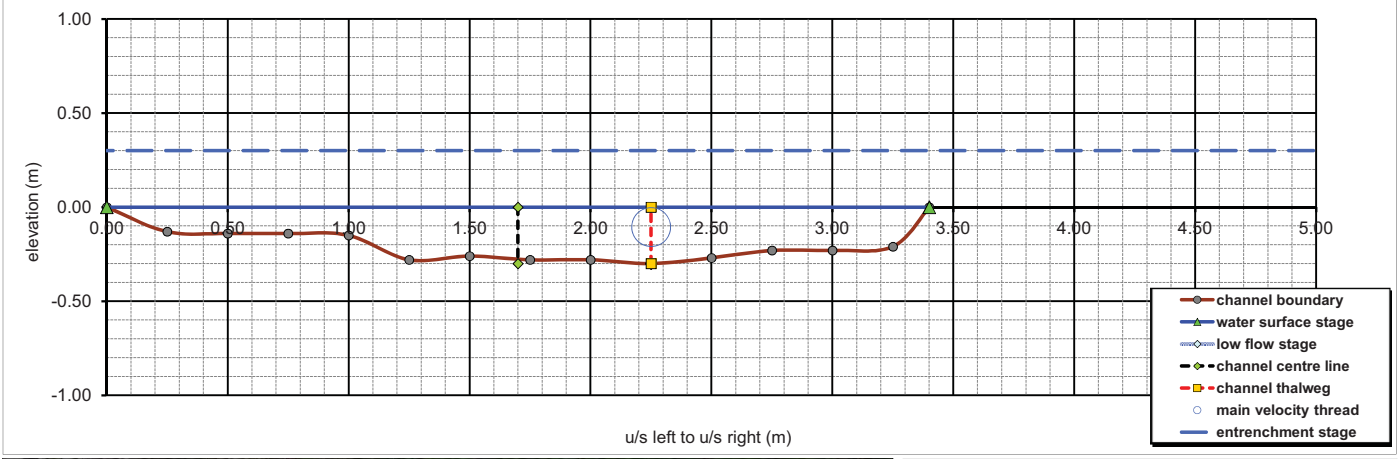
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

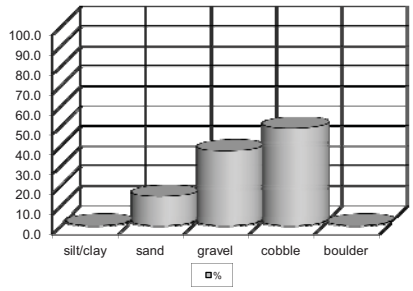
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.71
R (m)	0.20
TW (m)	3.40
WP (m)	3.58
max d (m)	0.30
mean d (m)	0.21
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.25
ff V mean/V*	4.62
ff D_{84}	3.50
ff mean	4.06
ROUGH BED	

Hydraulic Ratios	
ER max d	7.35
r_c / TW	
TW / Lf_w	
TW/max d	11.3
TW/mean d	16.2

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.462	12.30	NO	NO	NO	NO
V_* (m s^{-1})	0.092	D_{50}	1.183	31.51	NO	NO	NO	NO
		D_{84}	1.857	49.45	NO	NO	NO	NO

Section Data

ER_e (m)	0.30	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.40	3.40
Lf_e (m)	-0.300	Lf stations L / R	2.25	2.25	
W_{fp} (m)	25.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.30	2.25	
E_g (m m^{-1})	0.0210				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})
B3	0.0018	0.0016
C3	0.0002	0.0001
C4	0.0058	0.0049

	D_{30}	D_{50}	D_{84}
T_*	4.2	0.7	0.3
saltation	YES	NO	NO
rolling	YES	NO	NO
Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	2.00	10.00	65.00	160.00	180.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		9.70	63.05	155.20	174.60
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	4.19		
τ_{calc} (N m^{-2})	41.07		
τ D_{crit} (gr-co) (mm)	42.34		
D_{50} V_c (vcs +) (m s^{-1})	1.25	1.63	
D_{84} V_c (vcs +) (m s^{-1})	1.96	2.56	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	14.3	37.1	48.6	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.782
V (m s^{-1})	1.09
n	0.045
Fr	0.76
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.28
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	160.85
ω_a (watts m^{-2})	44.93
ω_a/TW (watts m^{-1})	13.21
Re^*	123.5
Re	191492
turbulence	HIGH

Flow Regime — Limerinos method

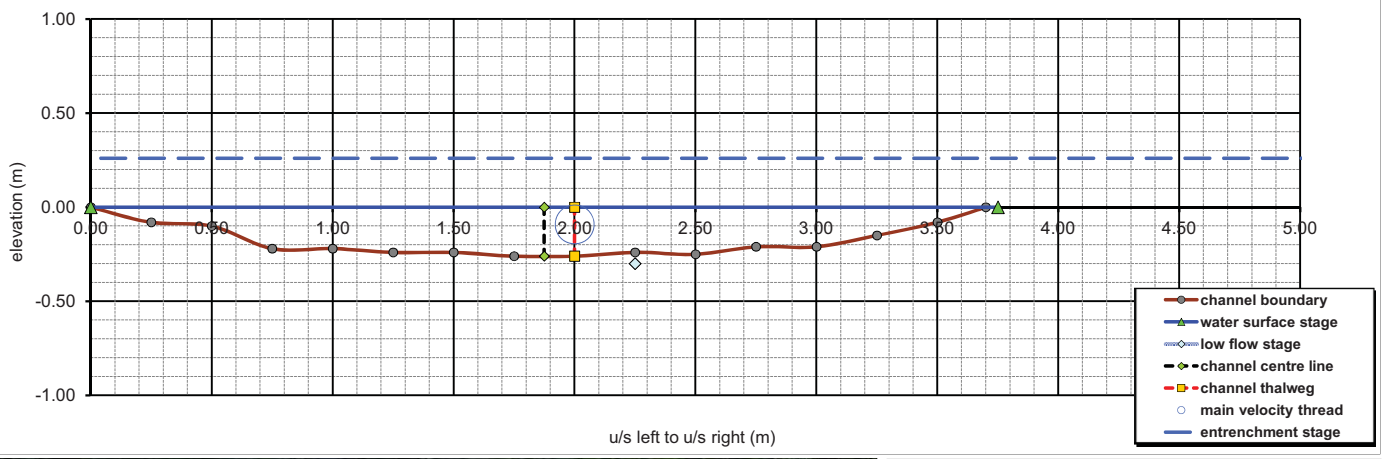
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

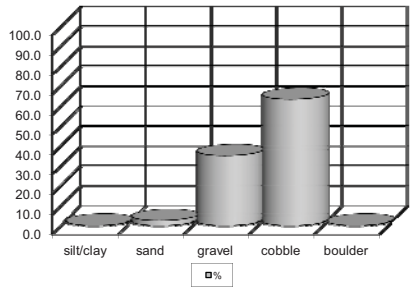
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.69
R (m)	0.18
TW (m)	3.70
WP (m)	3.78
max d (m)	0.26
mean d (m)	0.19
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.07
ff V mean/V*	4.37
ff D_{84}	3.05
ff mean	3.71
ROUGH BED	

Hydraulic Ratios	
ER max d	4.86
r_c / TW	
TW / Lf_w	
TW/max d	14.2
TW/mean d	19.9

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	1.038	26.00	NO	NO	NO	NO
V_* (m s^{-1})	0.097	D_{50}	1.468	36.78	NO	NO	NO	NO
		D_{84}	1.914	47.96	NO	NO	NO	NO

Section Data

ER_e (m)	0.26	ER stations L / R	-3.00	15.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.75	3.75
Lf_e (m)	-0.300	Lf stations L / R	2.25	2.25	
W_{fp} (m)	18.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.26	2.00	
E_g (m m^{-1})	0.0260				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0018	0.0016	saltation	NO	NO	NO
C3	0.0002	0.0001	rolling	NO	NO	NO
C4	0.0058	0.0047	Ø	YES	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	20.00	50.00	100.00	170.00	220.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	19.40	48.50	97.00	164.90	213.40
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	4.73		
τ_{calc} (N m^{-2})	46.39	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	47.83		
D_{50} V_c (vcs +) (m s^{-1})	1.55	1.93	
D_{84} V_c (vcs +) (m s^{-1})	2.02	2.52	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	2.2	34.8	63.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.787
V (m s^{-1})	1.14
n	0.045
Fr	0.85
D_c rectangular (m)	0.17
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.29
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	200.65
ω_a (watts m^{-2})	53.10
ω_a/TW (watts m^{-1})	14.35
Re^*	190.1
Re	182818
turbulence	HIGH

Flow Regime — Limerinos method

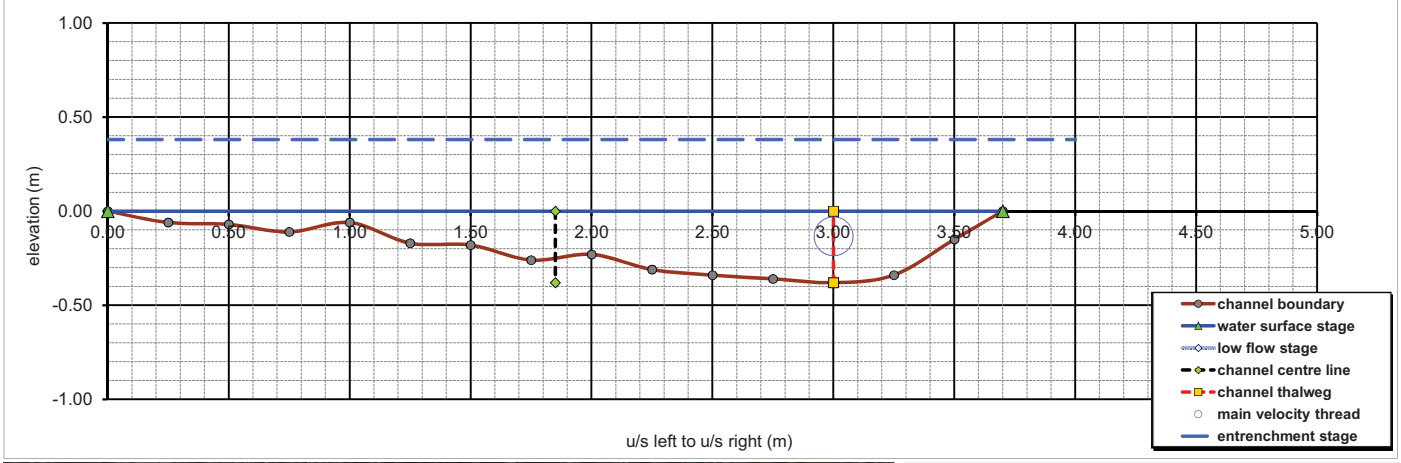
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

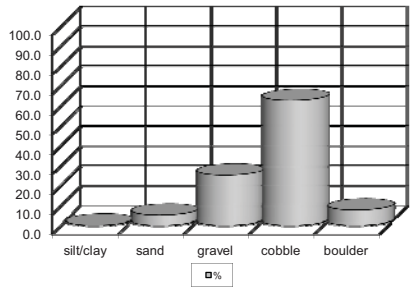
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.75
R (m)	0.19
TW (m)	3.70
WP (m)	3.89
max d (m)	0.38
mean d (m)	0.20
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.92
ff V mean/V*	3.75
ff D_{84}	2.75
ff mean	3.25
ROUGH BED	

Hydraulic Ratios	
ER max d	2.43
r_c / TW	
TW / Lf_w	
TW/max d	9.7
TW/mean d	18.2

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	1.137	25.74	NO	NO	NO	NO
V_* (m s^{-1})	0.108	D_{50}	1.737	39.32	NO	NO	NO	NO
		D_{84}	2.128	48.16	NO	NO	NO	NO

Section Data

ER_e (m)	0.38	ER stations L / R	-5.00	4.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.70	3.70
Lf_e (m)	-0.380	Lf stations L / R	3.00	3.00	
W_{fp} (m)	9.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.38	3.00	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	D_{30} 1.0	D_{50} 0.4	D_{84} 0.3
B3	0.0018	0.0016	saltation	NO	NO	NO
C3	0.0002	0.0001	rolling	NO	NO	NO
C4	0.0058	0.0049	Ø	YES	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	20.00	60.00	140.00	210.00	290.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	19.40	58.20	135.80	203.70	281.30
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	5.80		
τ_{calc} (N m^{-2})	56.84	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	58.59		
D_{50} V_c (vcs +) (m s^{-1})	1.83	2.50	
D_{84} V_c (vcs +) (m s^{-1})	2.25	3.06	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	5.0	25.0	62.5	7.5

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.787
V (m s^{-1})	1.05
n	0.055
Fr	0.74
D_c rectangular (m)	0.17
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.28
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	231.28
ω_a (watts m^{-2})	59.51
ω_a/TW (watts m^{-1})	16.08
Re^*	326.5
Re	177568
turbulence	HIGH

Flow Regime — Limerinos method

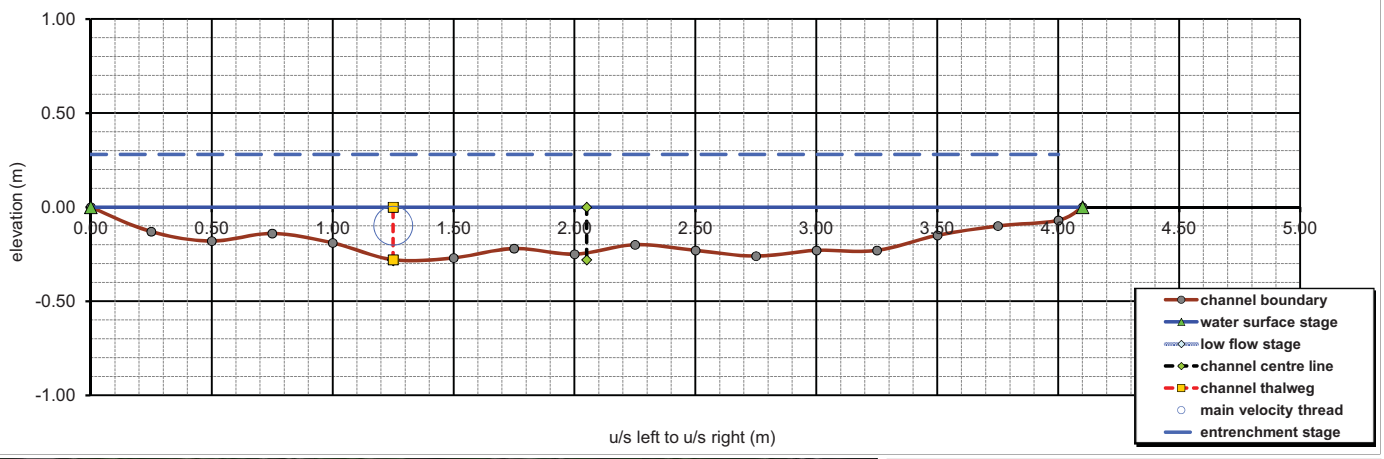
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

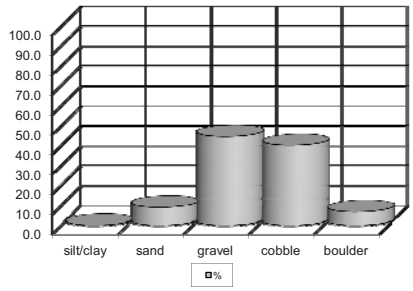
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.78
R (m)	0.18
TW (m)	4.10
WP (m)	4.22
max d (m)	0.28
mean d (m)	0.19
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.15
ff V mean/V*	3.98
ff D_{84}	3.25
ff mean	3.62
ROUGH BED	

Hydraulic Ratios	
ER max d	2.20
r_c / TW	
TW / Lf_w	
TW/max d	14.6
TW/mean d	21.6

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	13.15	NO	NO	NO	NO
V_* (m s^{-1})	0.105	D_{50}	1.038	24.06	NO	NO	NO	NO
		D_{84}	1.857	43.06	NO	NO	NO	NO

Section Data

ER_e (m)	0.28	ER stations L / R	-5.00	4.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	4.10	4.10
Lf_e (m)	-0.280	Lf stations L / R	1.25	1.25	
W_{fp} (m)	9.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.28	1.25	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0017	T_*	3.7	1.1	0.3
C3	0.0002	0.0001	saltation	YES	NO	NO
C4	0.0058	0.0053	rolling	YES	YES	NO
			Ø	NO	NO	YES

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	5.00	15.00	50.00	160.00	300.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	4.85	14.55	48.50	155.20	291.00
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	5.53		
τ_{calc} (N m^{-2})	54.16	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	55.84		
D_{50} V_c (vcs +) (m s^{-1})	1.10	1.54	
D_{84} V_c (vcs +) (m s^{-1})	1.96	2.76	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	8.9	44.4	40.0	6.7

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.788
V (m s^{-1})	1.01
n	0.055
Fr	0.74
D_c rectangular (m)	0.16
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.29
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	231.68
ω_a (watts m^{-2})	54.91
ω_a/TW (watts m^{-1})	13.39
*Re**	116.4
Re	163834
turbulence	HIGH

Flow Regime — Limerinos method

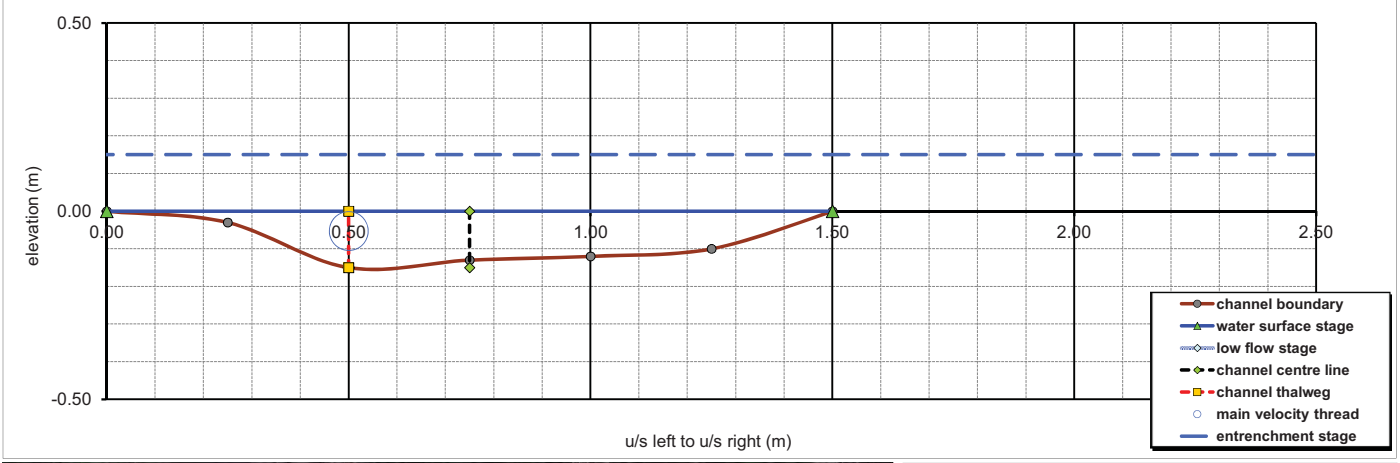
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

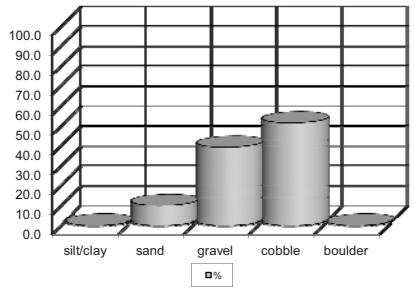
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.13
R (m)	0.09
TW (m)	1.50
WP (m)	1.55
max d (m)	0.15
mean d (m)	0.09
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.68
ff V mean/V*	3.28
ff D_{84}	1.97
ff mean	2.62
ROUGH BED	

Hydraulic Ratios	
ER max d	8.00
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	10.0
TW/mean d	17.0

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	24.97	NO	NO	NO	NO
V_* (m s^{-1})	0.078	D_{50}	1.183	36.78	NO	NO	NO	NO
		D_{84}	1.641	51.01	NO	NO	NO	NO

Section Data				
ER_e (m)	0.15	ER stations L / R	-5.00	7.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	1.50	1.50
Lf_e (m)	-0.150	Lf stations L / R	0.50	0.50	
W_{fp} (m)	12.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.15	0.50	
E_g (m m^{-1})	0.0360				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	3.00	30.00	65.00	125.00	160.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		29.10	63.05	121.25	155.20
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds			
τ_{calc} (kg m^{-2})	3.08		
τ_{calc} (N m^{-2})	30.16	V_c / V_b	
τ D_{crit} (gr-co) (mm)	31.09	Strickler	Limerinos
D_{50} V_c (vcs +) (m s^{-1})	1.25	2.44	
D_{84} V_c (vcs +) (m s^{-1})	1.73	3.39	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	9.8	39.0	51.2	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Bedload Transport Data						
	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	1.0	0.5	0.2
B3	0.0010	0.0008	saltation	NO	NO	NO
C3	0.0000	0.0000	rolling	YES	NO	NO
C4	0.0022	0.0016	Ø	NO	YES	YES

Flow Regime Strickler method	
Q (cms)	0.097
V (m s^{-1})	0.73
n	0.050
Fr	0.78
D_c rectangular (m)	0.08
D_c trapezoidal (m)	0.13
D_c triangular (m)	0.18
D_c parabolic (m)	0.12
D_c mean (m)	0.13
flow type	SUBCRITICAL
Ω (watts m^{-1})	34.14
ω_a (watts m^{-2})	22.02
ω_a/TW (watts m^{-1})	14.68
*Re**	157.0
Re	54758
turbulence	HIGH

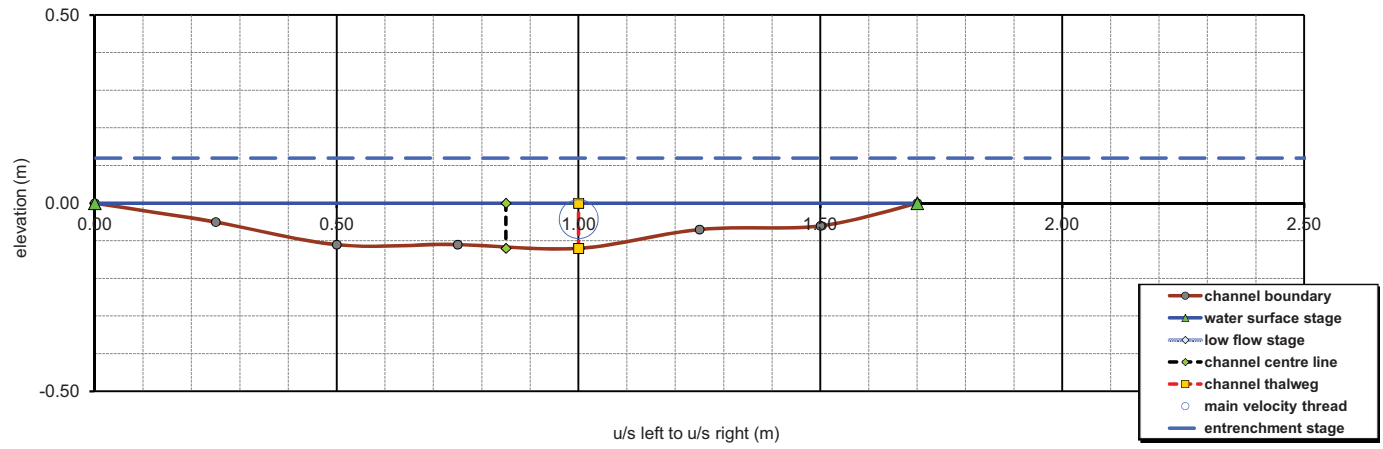
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

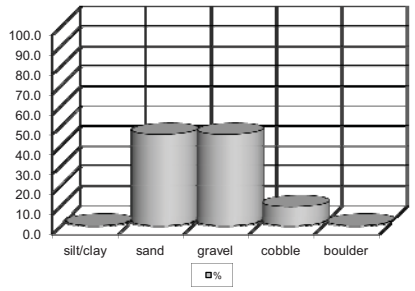
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.13
R (m)	0.07
TW (m)	1.70
WP (m)	1.73
max d (m)	0.12
mean d (m)	0.08
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.86
ff V mean/V*	4.40
ff D_{84}	4.41
ff mean	4.41
	ROUGH BED

Hydraulic Ratios	
ER max d	6.47
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	14.2
TW/mean d	22.5

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.040	1.19	NO	YES	YES	YES
V_* (m s^{-1})	0.083	D_{50}	0.247	7.26	NO	NO	NO	YES
		D_{84}	0.928	27.34	NO	NO	NO	NO

Section Data				
ER_e (m)	0.12	ER stations L / R	-6.00	5.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	1.70	1.70
Lf_e (m)	-0.120	Lf stations L / R	1.00	1.00	
W_{fp} (m)	11.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.12	1.00	
E_g (m m^{-1})	0.0460				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	0.30	3.00	40.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		0.29	2.91	38.80	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	3.42		
τ_{calc} (N m^{-2})	33.56	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	34.60		
D_{50} V_c (vcs +) (m s^{-1})	0.27	0.51	
D_{84} V_c (vcs +) (m s^{-1})	0.98	1.86	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	45.5	45.5	9.1	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Bedload Transport Data						
	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	115.3	11.5	0.9
B3	0.0010	0.0010	saltation	YES	YES	NO
C3	0.0000	0.0000	rolling	YES	YES	NO
C4	0.0022	0.0023	Ø	NO	NO	YES

Flow Regime Strickler method	
Q (cms)	0.097
V (m s^{-1})	0.75
n	0.050
Fr	0.87
D_c rectangular (m)	0.07
D_c trapezoidal (m)	0.13
D_c triangular (m)	0.18
D_c parabolic (m)	0.13
D_c mean (m)	0.13
flow type	SUBCRITICAL
Ω (watts m^{-1})	43.59
ω_a (watts m^{-2})	25.25
ω_a/TW (watts m^{-1})	14.85
*Re**	7.4
Re	49139
turbulence	LOW

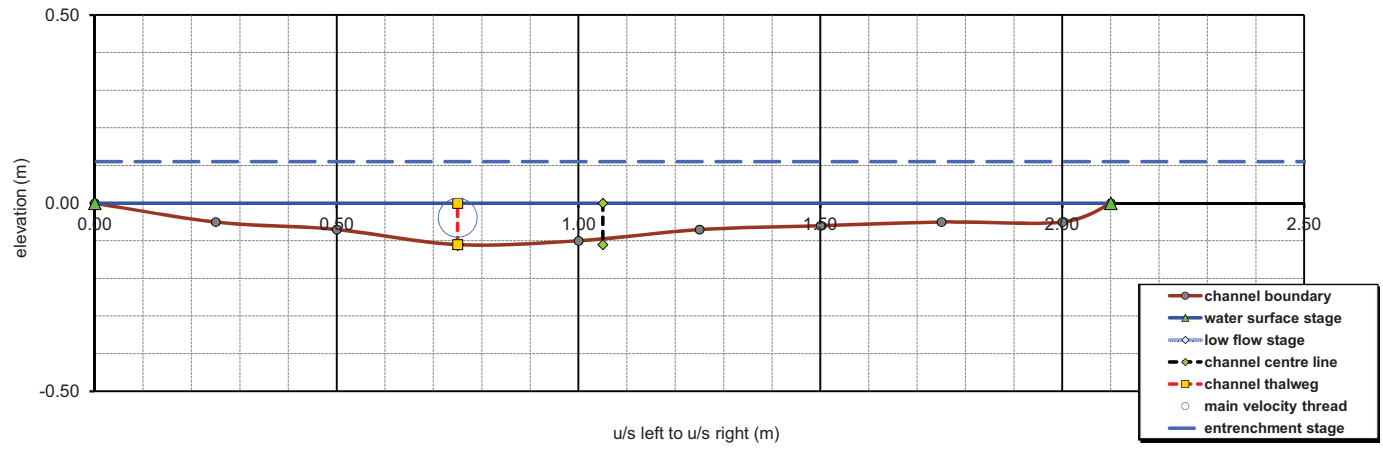
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

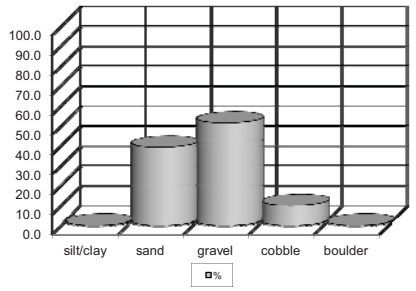
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.14
R (m)	0.06
TW (m)	2.10
WP (m)	2.12
max d (m)	0.11
mean d (m)	0.06
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.83
ff V mean/V*	4.33
ff D_{84}	4.36
ff mean	4.34
ROUGH BED	

Hydraulic Ratios	
ER max d	6.19
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	19.1
TW/mean d	32.4

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.126	4.00	NO	NO	NO	YES
V_* (m s^{-1})	0.077	D_{50}	0.324	10.27	NO	NO	NO	NO
		D_{84}	0.868	27.54	NO	NO	NO	NO

Section Data

ER_e (m)	0.11	ER stations L / R	-8.00	5.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.10	2.10
Lf_e (m)	-0.110	Lf stations L / R	0.75	0.75	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.11	0.75	
E_g (m m^{-1})	0.0460				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	D_{30} 29.8	D_{50} 6.0	D_{84} 0.9
B3	0.0009	0.0010	saltation	YES	YES	NO
C3	0.0000	0.0000	rolling	YES	YES	NO
C4	0.0021	0.0023	Ø	NO	NO	YES

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.30	1.00	5.00	35.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		0.97	4.85	33.95	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	Limerinos
τ_{calc} (kg m^{-2})	2.95		
τ_{calc} (N m^{-2})	28.93		
τ D_{crit} (gr-co) (mm)	29.82		
D_{50} V_c (vcs +) (m s^{-1})	0.35	0.73	
D_{84} V_c (vcs +) (m s^{-1})	0.92	1.92	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	39.0	51.2	9.8	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.093
V (m s^{-1})	0.68
n	0.050
Fr	0.85
D_c rectangular (m)	0.06
D_c trapezoidal (m)	0.12
D_c triangular (m)	0.18
D_c parabolic (m)	0.13
D_c mean (m)	0.12
flow type	SUBCRITICAL
Ω (watts m^{-1})	41.85
ω_a (watts m^{-2})	19.71
ω_a/TW (watts m^{-1})	9.39
Re^*	12.5
Re	38353
turbulence	HIGH

Flow Regime — Limerinos method

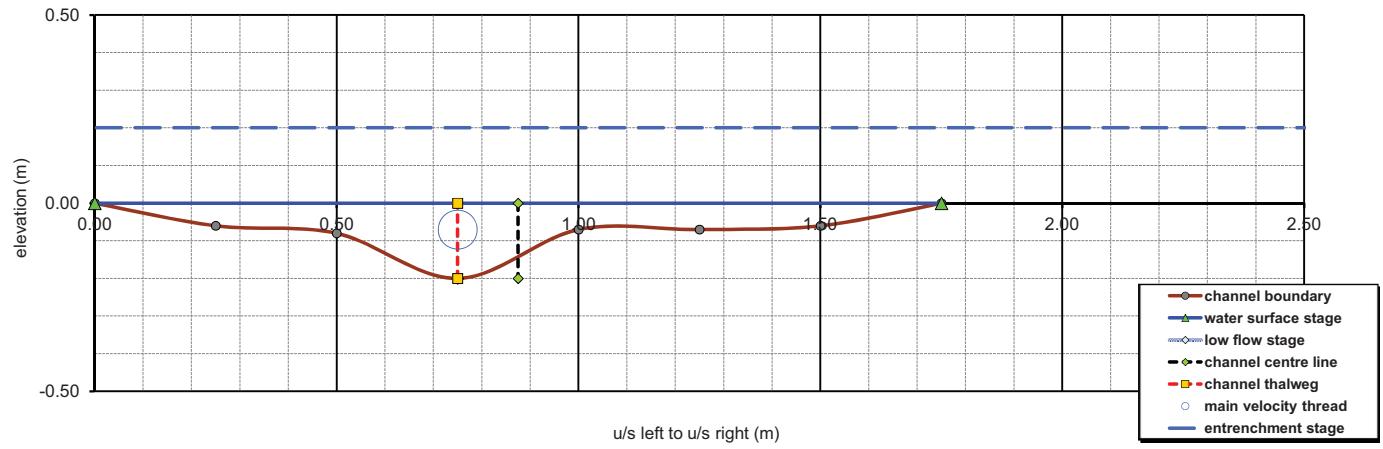
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

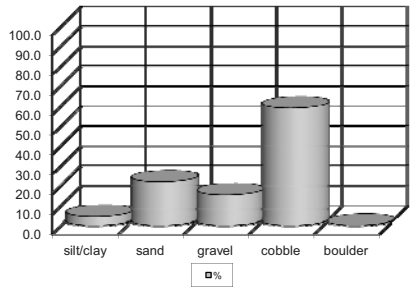
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.14
R (m)	0.07
TW (m)	1.75
WP (m)	1.82
max d (m)	0.20
mean d (m)	0.08
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.44
ff V mean/V*	2.70
ff D_{84}	0.87
ff mean	1.79
ROUGH BED	

Hydraulic Ratios	
ER max d	7.43
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	8.8
TW/mean d	22.7

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.462	14.64	NO	NO	NO	NO
V_* (m s^{-1})	0.077	D_{50}	1.313	41.60	NO	NO	NO	NO
		D_{84}	1.914	60.65	NO	NO	NO	NO

Section Data

ER_e (m)	0.20	ER stations L / R	-8.00	5.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	1.75	1.75
Lf_e (m)	-0.200	Lf stations L / R	0.75	0.75	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.20	0.75	
E_g (m m^{-1})	0.0400				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})
B3	0.0010	0.0007
C3	0.0000	0.0000
C4	0.0021	0.0012

T_*	D_{30}	D_{50}	D_{84}
3.0	0.4	0.2	
saltation	YES	NO	NO
rolling	YES	NO	NO
Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.50	10.00	80.00	170.00	190.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		9.70	77.60	164.90	184.30
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	2.96		
τ_{calc} (N m^{-2})	29.01		
τ D_{crit} (gr-co) (mm)	29.91		
D_{50} V_c (vcs +) (m s^{-1})	1.39	2.83	
D_{84} V_c (vcs +) (m s^{-1})	2.02	4.13	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
4.3	21.7	15.2	58.7	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (m)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.094
V (m s^{-1})	0.70
n	0.050
Fr	0.80
D_c rectangular (m)	0.07
D_c trapezoidal (m)	0.13
D_c triangular (m)	0.18
D_c parabolic (m)	0.12
D_c mean (m)	0.13
flow type	SUBCRITICAL
Ω (watts m^{-1})	36.99
ω_a (watts m^{-2})	20.28
ω_a/TW (watts m^{-1})	11.59
*Re**	198.9
Re	45372
turbulence	HIGH

Flow Regime — Limerinos method

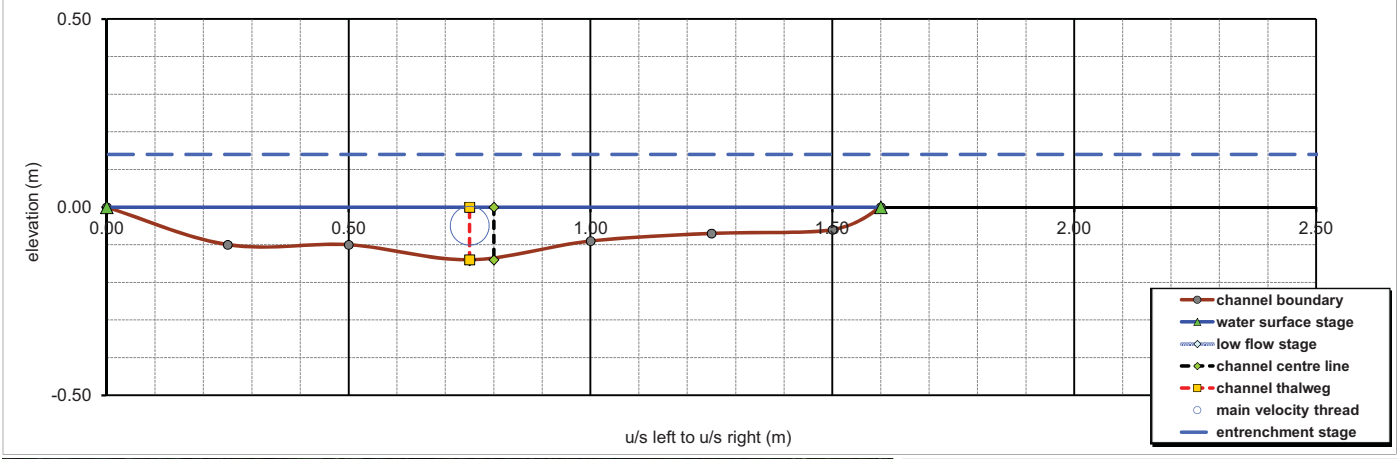
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

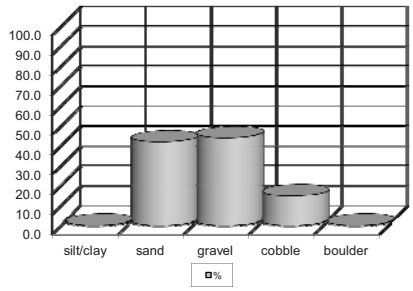
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	

Hydraulic Roughness	
rr R/D_{84}	1.37
ff V mean/V*	4.32
ff D_{84}	3.68
ff mean	4.00
	ROUGH BED

Hydraulic Geometry	
A (m^2)	0.14
R (m)	0.08
TW (m)	1.60
WP (m)	1.65
max d (m)	0.14
mean d (m)	0.08
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Ratios	
ER max d	8.13
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	11.4
TW/mean d	18.9

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.126	4.38	NO	NO	NO	YES
V_* (m s^{-1})	0.070	D_{50}	0.356	12.33	NO	NO	NO	NO
		D_{84}	1.137	39.43	NO	NO	NO	NO

Section Data

ER_e (m)	0.14	ER stations L / R	-8.00	5.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	1.60	1.60
Lf_e (m)	-0.140	Lf stations L / R	0.75	0.75	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.14	0.75	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

	Strickler Q Q_{sb} (kg sec^{-1})	Limerinos Q Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
Rosgen type			T_*	25.0	4.2	0.4
B3	0.0010	0.0009	saltation	YES	YES	NO
C3	0.0000	0.0000	rolling	YES	YES	NO
C4	0.0022	0.0020	Ø	NO	NO	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.25	1.00	6.00	60.00	150.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		0.97	5.82	58.20	145.50
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	2.47		
τ_{calc} (N m^{-2})	24.22	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	24.97		
D_{50} V_c (vcs +) (m s^{-1})	0.38	0.75	
D_{84} V_c (vcs +) (m s^{-1})	1.20	2.37	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	41.7	43.8	14.6	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.098
V (m s^{-1})	0.72
n	0.045
Fr	0.79
D_c rectangular (m)	0.07
D_c trapezoidal (m)	0.13
D_c triangular (m)	0.19
D_c parabolic (m)	0.12
D_c mean (m)	0.13
flow type	SUBCRITICAL
Ω (watts m^{-1})	28.79
ω_a (watts m^{-2})	17.50
ω_a/TW (watts m^{-1})	10.94
Re^*	13.1
Re	52213
turbulence	HIGH

Flow Regime — Limerinos method

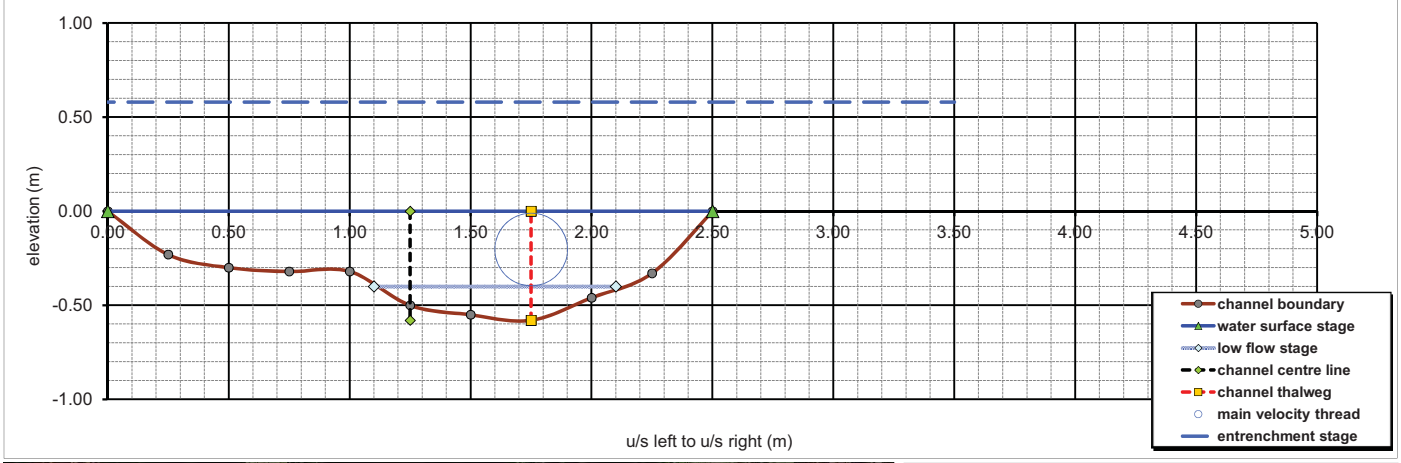
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

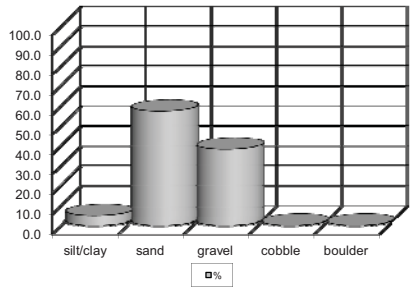
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.90
R (m)	0.31
TW (m)	2.50
WP (m)	2.89
max d (m)	0.58
mean d (m)	0.36
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	20.72
ff V mean/V*	7.96
ff D_{84}	10.69
ff mean	9.33
	SMOOTH BED

Hydraulic Ratios	
ER max d	5.40
r_c / TW	
TW / Lf_w	2.50
TW/max d	4.3
TW/mean d	7.0

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.023	0.77	YES	YES	YES	YES
V_* (m s^{-1})	0.074	D_{50}	0.071	2.35	NO	NO	YES	YES
		D_{84}	0.567	18.80	NO	NO	NO	NO

Section Data

ER_e (m)	0.58	ER stations L / R	-10.00	3.50	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.50	2.50
Lf_e (m)	-0.400	Lf stations L / R	1.10	2.10	
W_{fp} (m)	13.50	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.58	1.75	
E_g (m m^{-1})	0.0087				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0022	T_*	136.6	54.6	1.8
C3	0.0002	0.0007	saltation	YES	YES	NO
C4	0.0057	0.0080	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	0.20	0.50	15.00	50.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				14.55	48.50
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	Limerinos
τ_{calc} (kg m^{-2})	2.70		
τ_{calc} (N m^{-2})	26.50		
τ D_{crit} (gr-co) (mm)	27.32		
D_{50} V_c (vcs +) (m s^{-1})	0.11	0.18	
D_{84} V_c (vcs +) (m s^{-1})	0.60	1.01	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
4.8	57.1	38.1	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.765
V (m s^{-1})	0.85
n	0.050
Fr	0.45
D_c rectangular (m)	0.22
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.24
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	65.24
ω_a (watts m^{-2})	22.59
ω_a/TW (watts m^{-1})	9.04
Re^*	1.0
Re	232408
turbulence	LOW

Flow Regime — Limerinos method

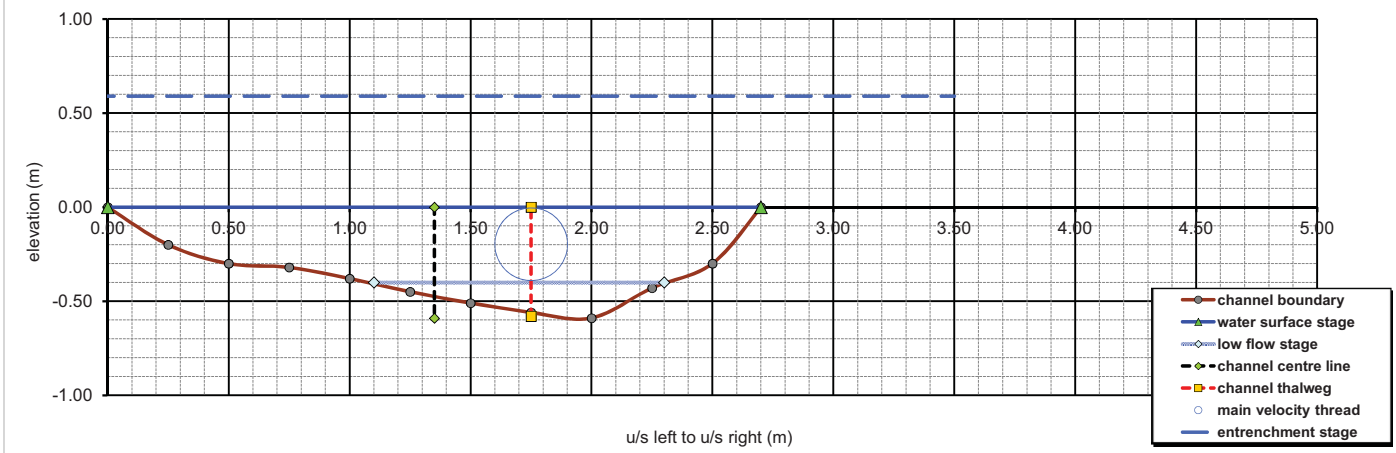
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

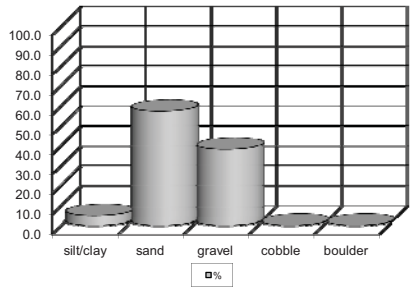
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	1.00
R (m)	0.33
TW (m)	2.70
WP (m)	3.06
max d (m)	0.59
mean d (m)	0.37
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	21.84
ff V mean/V*	8.05
ff D_{84}	10.77
ff mean	9.41
	SMOOTH BED

Hydraulic Ratios	
ER max d	5.00
r_c / TW	
TW / Lf_w	2.25
TW/max d	4.6
TW/mean d	7.3

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.023	0.86	NO	YES	YES	YES
V_* (m s^{-1})	0.066	D_{50}	0.071	2.63	NO	NO	NO	YES
		D_{84}	0.567	21.02	NO	NO	NO	NO

Section Data

ER_e (m)	0.59	ER stations L / R	-10.00	3.50	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.70	2.70
Lf_e (m)	-0.400	Lf stations L / R	1.10	2.30	
W_{fp} (m)	13.50	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
$\underline{z}$		T_e (m) $T_{o/s}$ (m)	-0.58	1.75	
E_g (m m^{-1})	0.0066				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0022	T_*	109.2	43.7	1.5
C3	0.0002	0.0007	saltation	YES	YES	NO
C4	0.0057	0.0081	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	0.20	0.50	15.00	50.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				14.55	48.50
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	2.16		
τ_{calc} (N m^{-2})	21.19	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	21.85		
D_{50} V_c (vcs +) (m s^{-1})	0.11	0.20	
D_{84} V_c (vcs +) (m s^{-1})	0.60	1.11	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
4.8	57.1	38.1	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.771
V (m s^{-1})	0.77
n	0.050
Fr	0.40
D_c rectangular (m)	0.21
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.24
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	49.88
ω_a (watts m^{-2})	16.30
ω_a/TW (watts m^{-1})	6.04
Re^*	1.0
Re	221091
turbulence	LOW

Flow Regime — Limerinos method

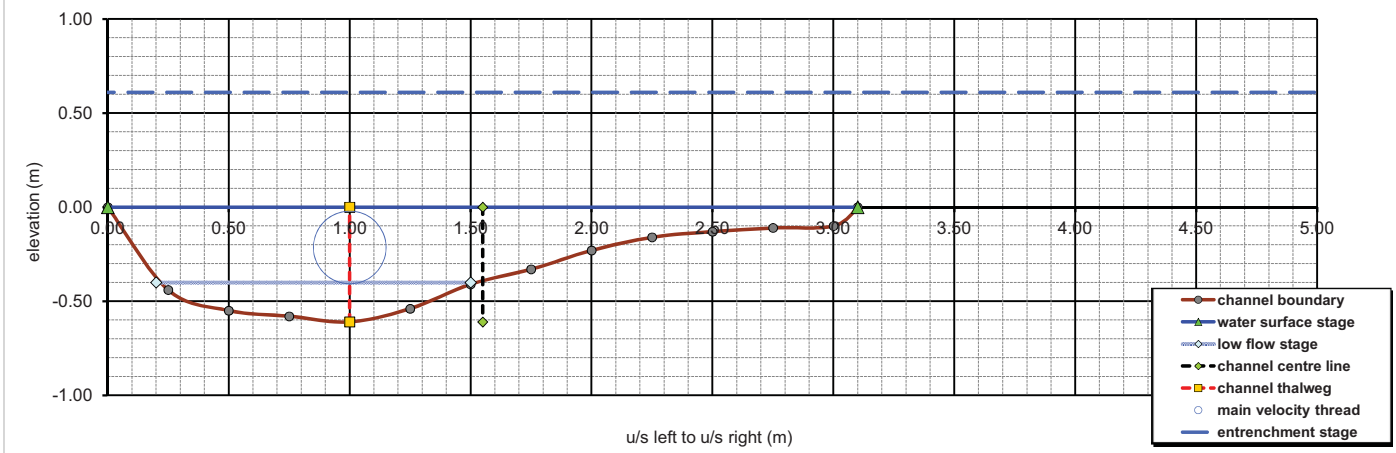
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

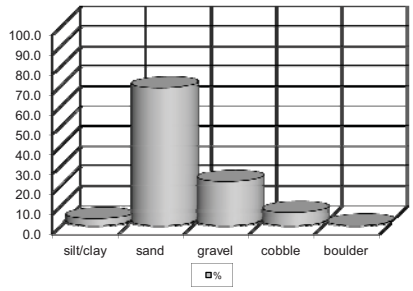
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Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	1.04
R (m)	0.30
TW (m)	3.10
WP (m)	3.51
max d (m)	0.61
mean d (m)	0.34
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	37.04
ff V mean/V*	8.62
ff D_{84}	12.08
ff mean	10.35
	SMOOTH BED

Hydraulic Ratios	
ER max d	6.45
r_c / TW	
TW / Lf_w	2.38
TW/max d	5.1
TW/mean d	9.2

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.023	0.88	NO	YES	YES	YES
V_* (m s^{-1})	0.064	D_{50}	0.071	2.69	NO	NO	NO	YES
		D_{84}	0.412	15.61	NO	NO	NO	NO

Section Data

ER_e (m)	0.61	ER stations L / R	-10.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.10	3.10
Lf_e (m)	-0.400	Lf stations L / R	0.20	1.50	
W_{fp} (m)	20.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.61	1.00	
E_g (m m^{-1})	0.0070				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0023	T_*	104.8	41.9	2.6
C3	0.0002	0.0009	saltation	YES	YES	YES
C4	0.0057	0.0086	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.06	0.20	0.50	8.00	90.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				7.76	87.30
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	2.07		
τ_{calc} (N m^{-2})	20.33		
τ D_{crit} (gr-co) (mm)	20.96		
D_{50} V_c (vcs +) (m s^{-1})	0.11	0.21	
D_{84} V_c (vcs +) (m s^{-1})	0.44	0.85	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
3.1	68.8	21.9	6.3	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (m)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.770
V (m s^{-1})	0.74
n	0.050
Fr	0.41
D_c rectangular (m)	0.19
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.25
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	52.85
ω_a (watts m^{-2})	15.06
ω_a/TW (watts m^{-1})	4.86
Re^*	1.0
Re	192534
turbulence	LOW

Flow Regime — Limerinos method

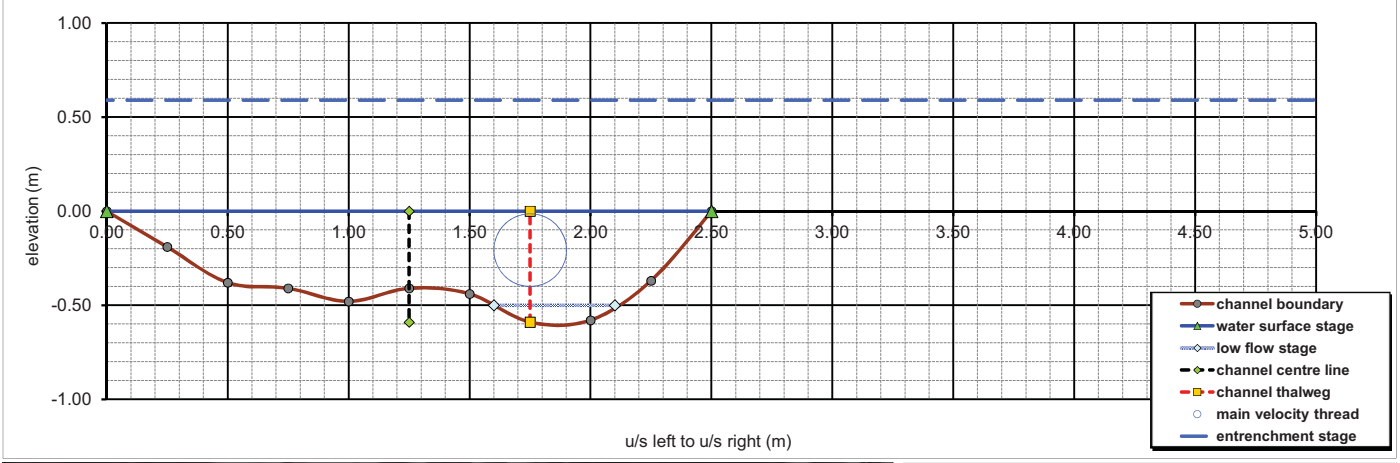
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

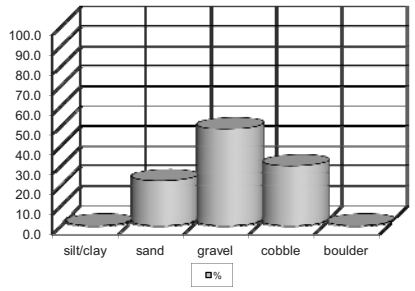
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.96
R (m)	0.32
TW (m)	2.50
WP (m)	2.97
max d (m)	0.59
mean d (m)	0.39
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	3.82
ff V mean/V*	6.00
ff D_{84}	6.57
ff mean	6.28
ROUGH BED	

Hydraulic Ratios	
ER max d	8.00
r_c / TW	
TW / Lf_w	5.00
TW/max d	4.2
TW/mean d	6.5

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.412	14.50	NO	NO	NO	NO
V_* (m s^{-1})	0.069	D_{50}	0.803	28.26	NO	NO	NO	NO
		D_{84}	1.353	47.61	NO	NO	NO	NO

Section Data				
ER_e (m)	0.59	ER stations L / R	-10.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.50	2.50
Lf_e (m)	-0.500	Lf stations L / R	1.60	2.10	
W_{fp} (m)	20.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.59	1.75	
E_g (m m^{-1})	0.0074				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	1.00	8.00	30.00	85.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				82.45	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	2.40		
τ_{calc} (N m^{-2})	23.54	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	24.26		
D_{50} V_c (vcs +) (m s^{-1})	0.85	1.50	
D_{84} V_c (vcs +) (m s^{-1})	1.43	2.52	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	22.2	48.1	29.6	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Bedload Transport Data						
	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	3.0	0.8	0.3
B3	0.0018	0.0019	saltation	YES	NO	NO
C3	0.0002	0.0003	rolling	YES	NO	NO
C4	0.0058	0.0065	Ø	NO	YES	YES

Flow Regime Strickler method	
Q (cms)	0.779
V (m s^{-1})	0.81
n	0.050
Fr	0.42
D_c rectangular (m)	0.22
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.24
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	56.50
ω_a (watts m^{-2})	19.05
ω_a/TW (watts m^{-1})	7.62
Re^*	61.9
Re	230456
turbulence	HIGH

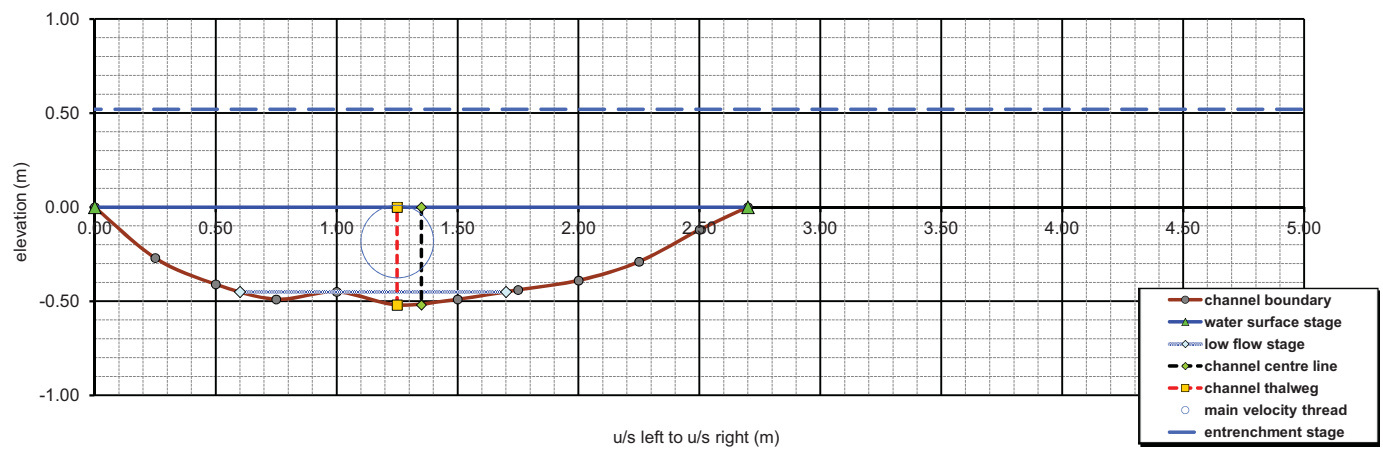
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

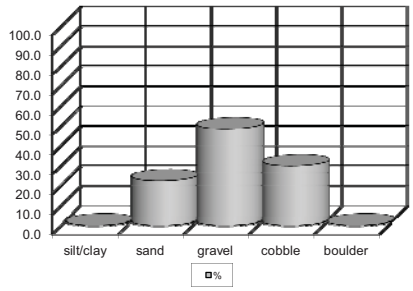
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.96
R (m)	0.32
TW (m)	2.70
WP (m)	3.00
max d (m)	0.52
mean d (m)	0.36
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	3.79
ff V mean/V*	5.94
ff D_{84}	6.38
ff mean	6.16
	ROUGH BED

Hydraulic Ratios	
ER max d	9.26
r_c / TW	
TW / Lf_w	2.45
TW/max d	5.2
TW/mean d	7.6

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.412	14.47	NO	NO	NO	NO
V_* (m s^{-1})	0.070	D_{50}	0.803	28.19	NO	NO	NO	NO
		D_{84}	1.353	47.48	NO	NO	NO	NO

Section Data					
ER_e (m)	0.52	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.70	2.70
Lf_e (m)	-0.450	Lf stations L / R	0.60	1.70	
W_{fp} (m)	25.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.52	1.25	
E_g (m m^{-1})	0.0075				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	1.00	8.00	30.00	85.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				82.45	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	2.41		
τ_{calc} (N m^{-2})	23.66		
τ D_{crit} (gr-co) (mm)	24.39	Strickler	Limerinos
D_{50} V_c (vcs +) (m s^{-1})	0.85	1.50	
D_{84} V_c (vcs +) (m s^{-1})	1.43	2.52	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	22.2	48.1	29.6	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Bedload Transport Data						
	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	3.0	0.8	0.3
B3	0.0018	0.0019	saltation	YES	NO	NO
C3	0.0002	0.0003	rolling	YES	NO	NO
C4	0.0058	0.0064	Ø	NO	YES	YES

Flow Regime Strickler method	
Q (cms)	0.782
V (m s^{-1})	0.81
n	0.050
Fr	0.43
D_c rectangular (m)	0.21
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.42
D_c parabolic (m)	0.24
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	57.45
ω_a (watts m^{-2})	19.18
ω_a/TW (watts m^{-1})	7.10
*Re**	59.9
Re	228846
turbulence	HIGH

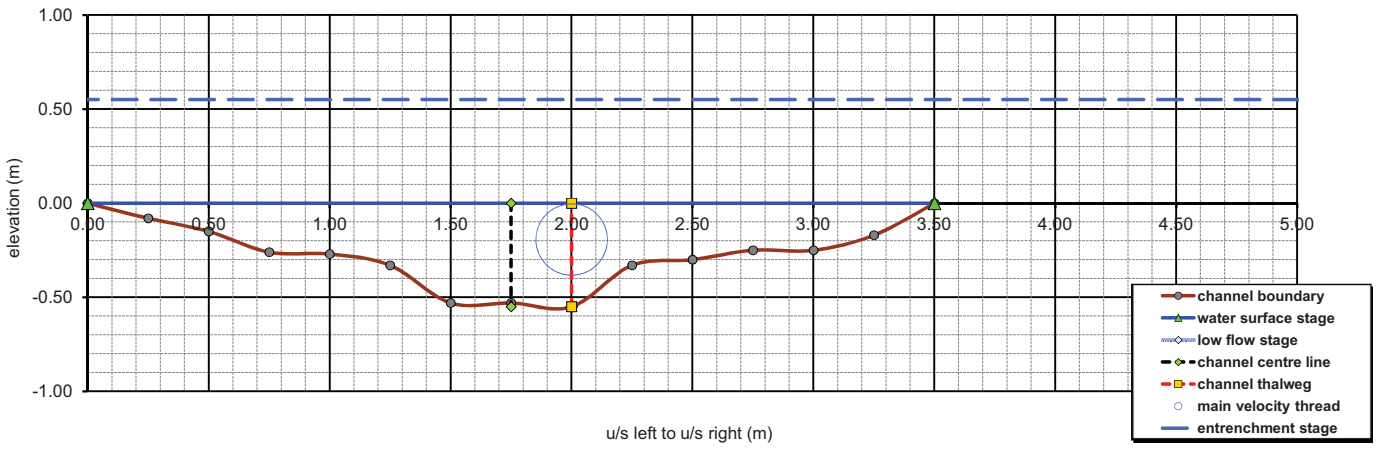
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Hawkestone Creek Tributary (Line 11 N., Hawkestone) - Node H1

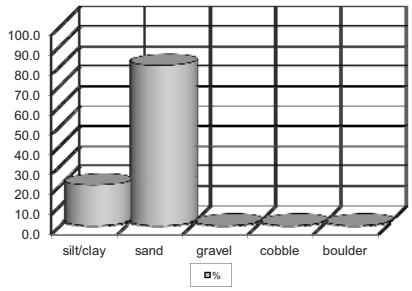
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	●
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	1.00
R (m)	0.26
TW (m)	3.50
WP (m)	3.78
max d (m)	0.55
mean d (m)	0.29
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	882.29
ff V mean/V*	12.35
ff D_{84}	19.81
ff mean	16.08
	SMOOTH BED

Hydraulic Ratios	
ER max d	28.57
r_c / TW	
TW / Lf_w	
TW/max d	6.4
TW/mean d	12.3

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.003	0.10	YES	YES	YES	YES
V_* (m s^{-1})	0.073	D_{50}	0.008	0.25	YES	YES	YES	YES
		D_{84}	0.040	1.35	NO	NO	YES	YES

Section Data

ER_e (m)	0.55	ER stations L / R	-50.00	50.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.50	3.50
Lf_e (m)	-0.550	Lf stations L / R	2.00	2.00	
W_{fp} (m)	100.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.55	2.00	
E_g (m m^{-1})	0.0100				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0027	T_*	445.7	267.4	89.1
C3	0.0002	0.0028	saltation	YES	YES	YES
C4	0.0059	0.0112	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.03	0.06	0.10	0.30	0.50
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})					
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	2.65		
τ_{calc} (N m^{-2})	25.94	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	26.74		
D_{50} V_c (vcs +) (m s^{-1})	0.05	0.09	
D_{84} V_c (vcs +) (m s^{-1})	0.08	0.15	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
20.0	80.0	0.0	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.821
V (m s^{-1})	0.82
n	0.050
Fr	0.49
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.26
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	80.44
ω_a (watts m^{-2})	21.29
ω_a/TW (watts m^{-1})	6.08
Re^*	0.2
Re	190584
turbulence	LOW

Flow Regime — Limerinos method

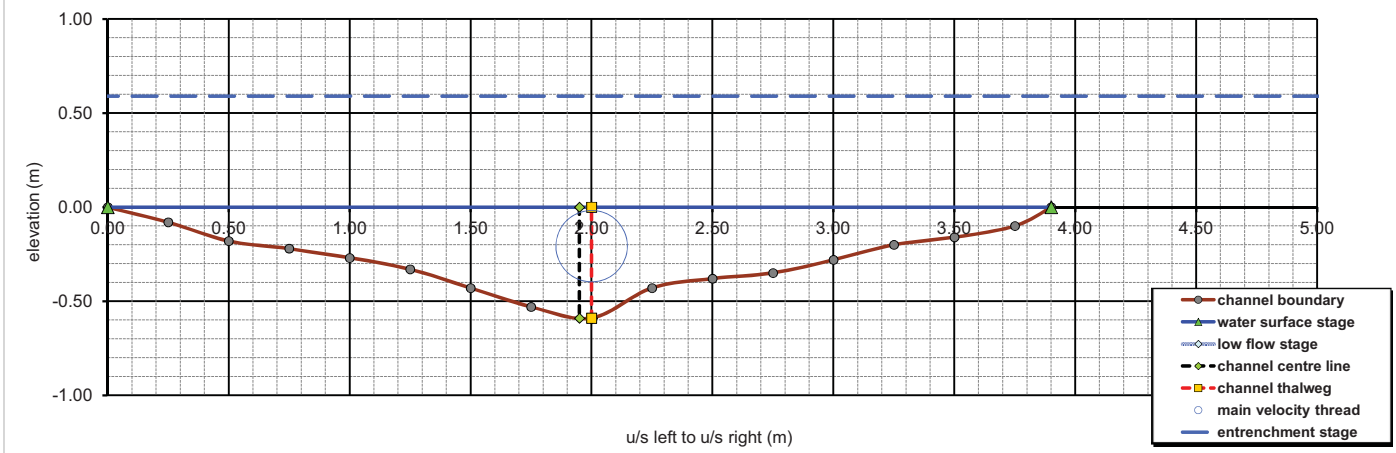
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Hawkestone Creek Tributary (Line 11 N., Hawkestone) - Node H1

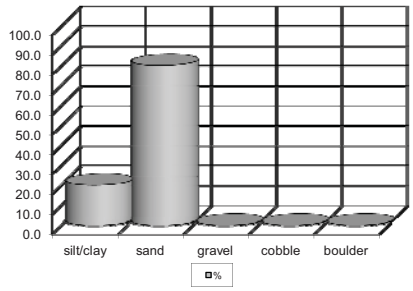
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	●
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	1.13
R (m)	0.27
TW (m)	3.90
WP (m)	4.11
max d (m)	0.59
mean d (m)	0.29
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	914.70
ff V mean/V*	12.42
ff D_{84}	19.84
ff mean	16.13
SMOOTH BED	

Hydraulic Ratios	
ER max d	25.64
r_c / TW	
TW / Lf_w	
TW/max d	6.6
TW/mean d	13.5

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.003	0.11	YES	YES	YES	YES
V_* (m s^{-1})	0.064	D_{50}	0.008	0.29	YES	YES	YES	YES
		D_{84}	0.040	1.53	NO	NO	YES	YES

Section Data

ER_e (m)	0.59	ER stations L / R	-50.00	50.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.90	3.90
Lf_e (m)	-0.590	Lf stations L / R	2.00	2.00	
W_{fp} (m)	100.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.59	2.00	
E_g (m m^{-1})	0.0075				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0027	T_*	346.5	207.9	69.3
C3	0.0002	0.0028	saltation	YES	YES	YES
C4	0.0059	0.0112	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.03	0.06	0.10	0.30	0.50
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})					
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	2.06		
τ_{calc} (N m^{-2})	20.17	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	20.79		
D_{50} V_c (vcs +) (m s^{-1})	0.05	0.10	
D_{84} V_c (vcs +) (m s^{-1})	0.08	0.17	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
20.0	80.0	0.0	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.821
V (m s^{-1})	0.73
n	0.050
Fr	0.43
D_c rectangular (m)	0.17
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.26
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	60.35
ω_a (watts m^{-2})	14.69
ω_a/TW (watts m^{-1})	3.77
Re^*	0.2
Re	175301
turbulence	LOW

Flow Regime — Limerinos method

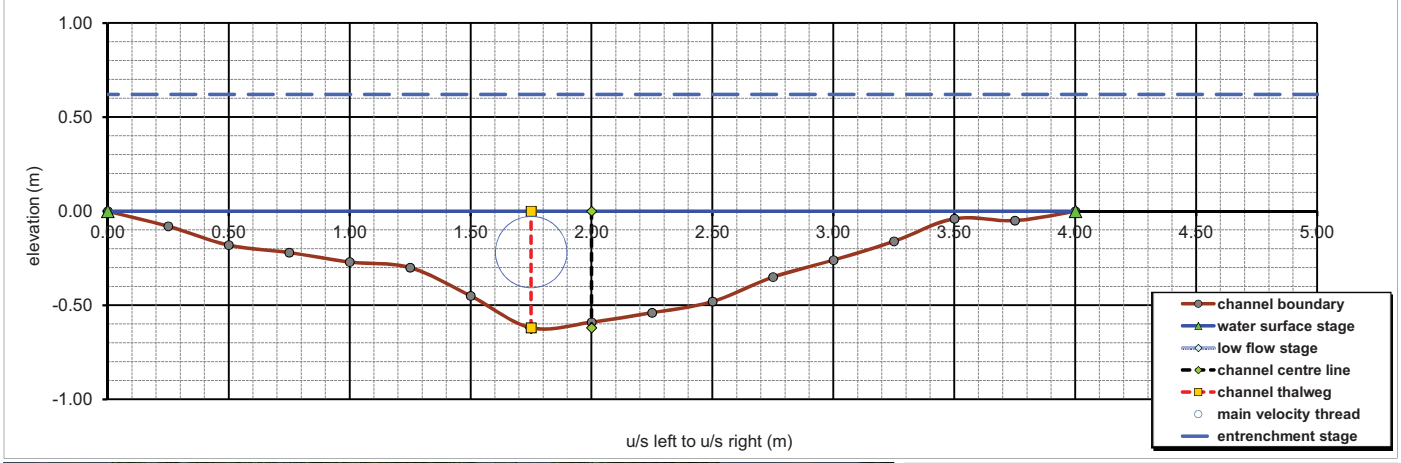
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Hawkestone Creek Tributary (Line 11 N., Hawkestone) - Node H1

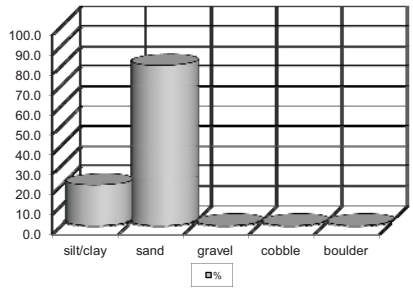
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	●
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	1.15
R (m)	0.27
TW (m)	4.00
WP (m)	4.25
max d (m)	0.62
mean d (m)	0.29
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	900.30
ff V mean/V*	12.39
ff D_{84}	19.82
ff mean	16.10
SMOOTH BED	

Hydraulic Ratios	
ER max d	25.00
r_c / TW	
TW / Lf_w	
TW/max d	6.5
TW/mean d	13.9

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.003	0.11	YES	YES	YES	YES
V_* (m s^{-1})	0.064	D_{50}	0.008	0.29	YES	YES	YES	YES
		D_{84}	0.040	1.54	NO	NO	YES	YES

Section Data

ER_e (m)	0.62	ER stations L / R	-50.00	50.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	4.00	4.00
Lf_e (m)	-0.620	Lf stations L / R	1.75	1.75	
W_{fp} (m)	100.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.62	1.75	
E_g (m m^{-1})	0.0075				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})
B3	0.0018	0.0027
C3	0.0002	0.0029
C4	0.0059	0.0112

	D_{30}	D_{50}	D_{84}
T_*	341.1	204.7	68.2
saltation	YES	YES	YES
rolling	YES	YES	YES
Ø	NO	NO	NO

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.03	0.06	0.10	0.30	0.50
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})					
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	2.03		
τ_{calc} (N m^{-2})	19.85		
τ D_{crit} (gr-co) (mm)	20.47	Strickler	Limerinos
D_{50} V_c (vcs +) (m s^{-1})	0.05	0.10	
D_{84} V_c (vcs +) (m s^{-1})	0.08	0.17	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
20.0	80.0	0.0	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (m)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.827
V (m s^{-1})	0.72
n	0.050
Fr	0.43
D_c rectangular (m)	0.17
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.27
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	60.77
ω_a (watts m^{-2})	14.30
ω_a/TW (watts m^{-1})	3.58
Re^*	0.2
Re	170716
turbulence	LOW

Flow Regime — Limerinos method

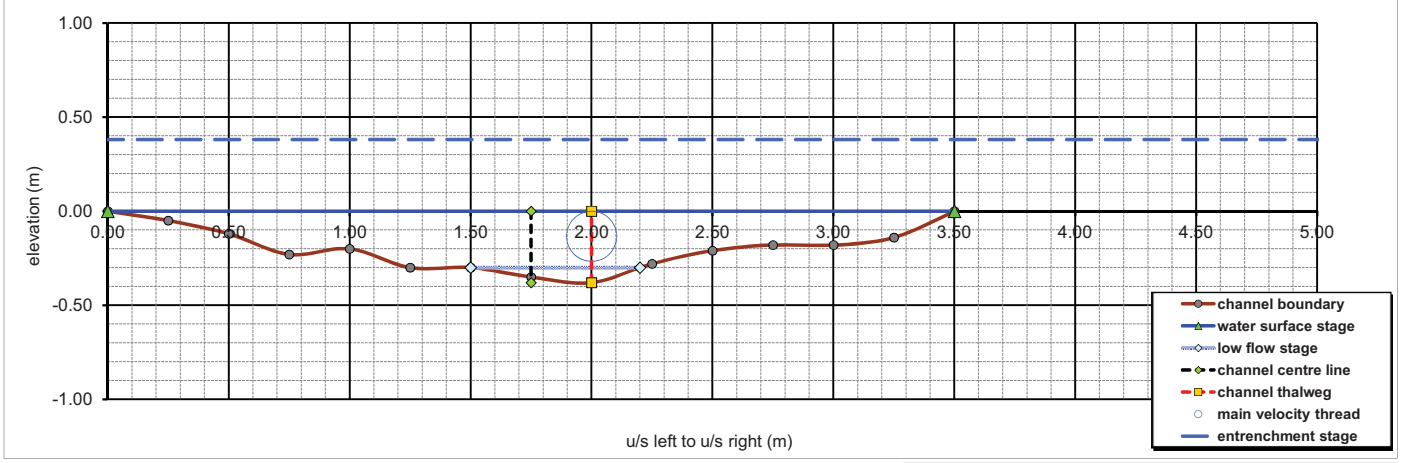
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

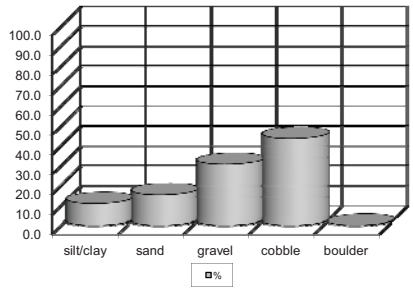
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.73
R (m)	0.20
TW (m)	3.50
WP (m)	3.64
max d (m)	0.38
mean d (m)	0.21
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.83
ff V mean/V*	4.58
ff D_{84}	4.41
ff mean	4.50
ROUGH BED	

Hydraulic Ratios	
ER max d	4.29
r_c / TW	
TW / Lf_w	5.00
TW/max d	9.2
TW/mean d	16.8

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.462	10.26	NO	NO	NO	NO
V_* (m s^{-1})	0.110	D_{50}	0.984	21.87	NO	NO	NO	NO
		D_{84}	1.540	34.20	NO	NO	NO	NO

Section Data

ER_e (m)	0.38	ER stations L / R	-5.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.50	3.50
Lf_e (m)	-0.300	Lf stations L / R	1.50	2.20	
W_{fp} (m)	15.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.38	2.00	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0018	0.0018	saltation	YES	NO	NO
C3	0.0002	0.0002	rolling	YES	YES	NO
C4	0.0058	0.0060	Ø	NO	NO	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	10.00	45.00	110.00	220.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		9.70	43.65	106.70	213.40
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	6.02		
τ_{calc} (N m^{-2})	59.03		
τ D_{crit} (gr-co) (mm)	60.85		
D_{50} V_c (vcs +) (m s^{-1})	1.04	1.38	
D_{84} V_c (vcs +) (m s^{-1})	1.63	2.16	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
10.9	15.2	30.4	43.5	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.784
V (m s^{-1})	1.07
n	0.055
Fr	0.75
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.28
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	230.51
ω_a (watts m^{-2})	63.40
ω_a/TW (watts m^{-1})	18.11
Re^*	103.7
Re	189159
turbulence	HIGH

Flow Regime — Limerinos method

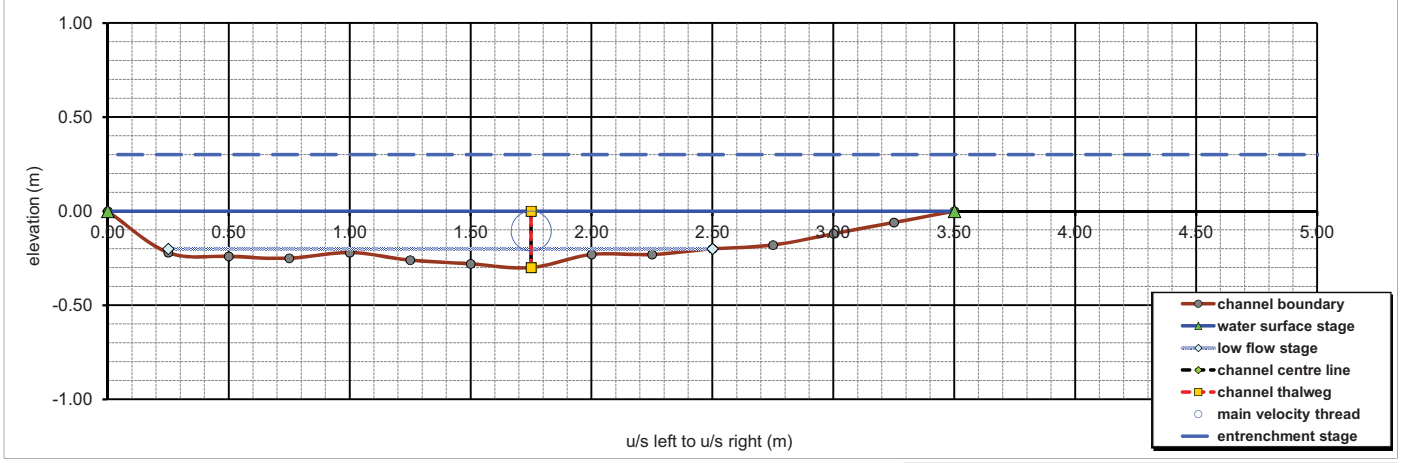
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

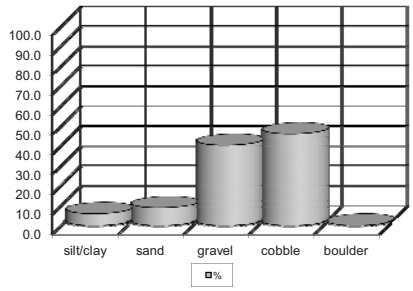
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.70
R (m)	0.19
TW (m)	3.50
WP (m)	3.62
max d (m)	0.30
mean d (m)	0.20
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.48
ff V mean/V*	4.31
ff D_{84}	3.89
ff mean	4.10
ROUGH BED	

Hydraulic Ratios	
ER max d	3.71
r_c / TW	
TW / Lf_w	1.56
TW/max d	11.7
TW/mean d	17.6

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	11.91	NO	NO	NO	NO
V_* (m s^{-1})	0.116	D_{50}	1.038	21.80	NO	NO	NO	NO
		D_{84}	1.674	35.16	NO	NO	NO	NO

Section Data

ER_e (m)	0.30	ER stations L / R	-3.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.50	3.50
Lf_e (m)	-0.200	Lf stations L / R	0.25	2.50	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.30	1.75	
E_g (m m^{-1})	0.0350				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0018	T_*	4.5	1.4	0.5
C3	0.0002	0.0002	saltation	YES	NO	NO
C4	0.0058	0.0057	rolling	YES	YES	NO
			Ø	NO	NO	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	3.00	15.00	50.00	130.00	260.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		14.55	48.50	126.10	252.20
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	6.74		
τ_{calc} (N m^{-2})	66.01		
τ D_{crit} (gr-co) (mm)	68.06		
D_{50} V_c (vcs +) (m s^{-1})	1.10	1.39	
D_{84} V_c (vcs +) (m s^{-1})	1.77	2.24	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
5.7	8.6	40.0	45.7	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.787
V (m s^{-1})	1.13
n	0.055
Fr	0.81
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.29
D_c triangular (m)	0.43
D_c parabolic (m)	0.28
D_c mean (m)	0.29
flow type	SUBCRITICAL
Ω (watts m^{-1})	269.79
ω_a (watts m^{-2})	74.44
ω_a/TW (watts m^{-1})	21.27
*Re**	115.9
Re	190381
turbulence	HIGH

Flow Regime — Limerinos method

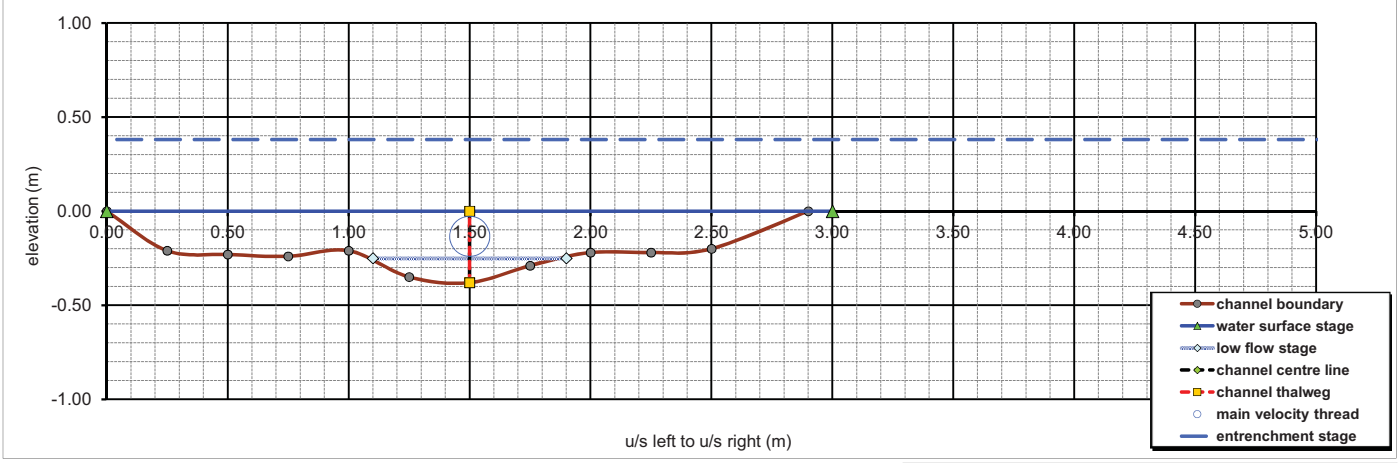
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

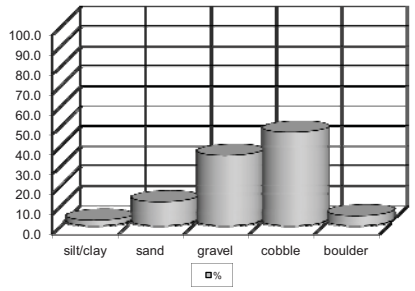
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.65
R (m)	0.21
TW (m)	2.90
WP (m)	3.09
max d (m)	0.38
mean d (m)	0.23
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.41
ff V mean/V*	4.31
ff D_{84}	3.83
ff mean	4.07
ROUGH BED	

Hydraulic Ratios	
ER max d	4.48
r_c / TW	
TW / Lf_w	3.63
TW/max d	7.6
TW/mean d	12.9

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	16.11	NO	NO	NO	NO
V_* (m s^{-1})	0.122	D_{50}	1.313	26.33	NO	NO	NO	NO
		D_{84}	1.798	36.06	NO	NO	NO	NO

Section Data

ER_e (m)	0.38	ER stations L / R	-3.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.00	3.00
Lf_e (m)	-0.250	Lf stations L / R	1.10	1.90	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.38	1.50	
E_g (m m^{-1})	0.0350				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0017	T_*	2.5	0.9	0.5
C3	0.0002	0.0002	saltation	YES	NO	NO
C4	0.0058	0.0056	rolling	YES	NO	NO
			Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	7.00	30.00	80.00	150.00	300.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	6.79	29.10	77.60	145.50	291.00
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	7.39		
τ_{calc} (N m^{-2})	72.41	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	74.65		
D_{50} V_c (vcs +) (m s^{-1})	1.39	1.65	
D_{84} V_c (vcs +) (m s^{-1})	1.90	2.26	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
2.3	11.6	34.9	46.5	4.7

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.783
V (m s^{-1})	1.20
n	0.055
Fr	0.81
D_c rectangular (m)	0.20
D_c trapezoidal (m)	0.30
D_c triangular (m)	0.43
D_c parabolic (m)	0.27
D_c mean (m)	0.30
flow type	SUBCRITICAL
Ω (watts m^{-1})	268.51
ω_a (watts m^{-2})	86.87
ω_a/TW (watts m^{-1})	29.95
*Re**	185.2
Re	222159
turbulence	HIGH

Flow Regime — Limerinos method

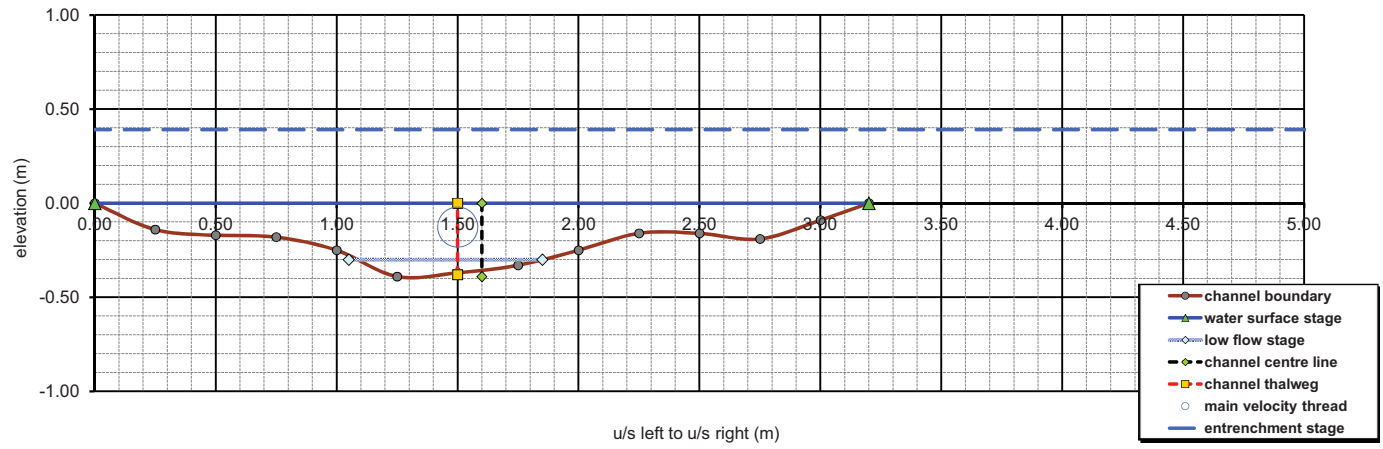
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

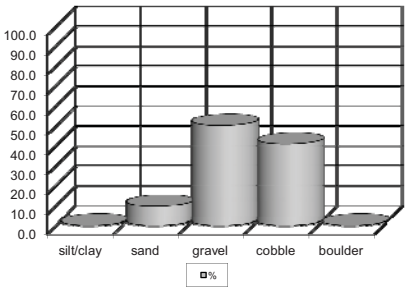
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.67
R (m)	0.20
TW (m)	3.20
WP (m)	3.36
max d (m)	0.39
mean d (m)	0.21
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.99
ff V mean/V*	4.91
ff D_{84}	4.65
ff mean	4.78
ROUGH BED	

Hydraulic Ratios	
ER max d	4.69
r_c / TW	
TW / Lf_w	4.00
TW/max d	8.2
TW/mean d	15.3

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	12.65	NO	NO	NO	NO
V_* (m s^{-1})	0.109	D_{50}	1.038	23.16	NO	NO	NO	NO
		D_{84}	1.468	32.76	NO	NO	NO	NO

Section Data

ER_e (m)	0.39	ER stations L / R	-5.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.20	3.20
Lf_e (m)	-0.300	Lf stations L / R	1.05	1.85	
W_{fp} (m)	15.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.38	1.50	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0018	0.0018	T_*	4.0	1.2	0.6
C3	0.0002	0.0002	saltation	YES	NO	NO
C4	0.0058	0.0059	rolling	YES	YES	NO
			Ø	NO	NO	YES

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	4.00	15.00	50.00	100.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	3.88	14.55	48.50	97.00	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	5.97		
τ_{calc} (N m^{-2})	58.48	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	60.29		
D_{50} V_c (vcs +) (m s^{-1})	1.10	1.33	
D_{84} V_c (vcs +) (m s^{-1})	1.55	1.89	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	9.4	50.0	40.6	0.0

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.784
V (m s^{-1})	1.17
n	0.050
Fr	0.82
D_c rectangular (m)	0.19
D_c trapezoidal (m)	0.30
D_c triangular (m)	0.43
D_c parabolic (m)	0.28
D_c mean (m)	0.30
flow type	SUBCRITICAL
Ω (watts m^{-1})	230.48
ω_a (watts m^{-2})	68.65
ω_a/TW (watts m^{-1})	21.45
*Re**	105.4
Re	204836
turbulence	HIGH

Flow Regime — Limerinos method

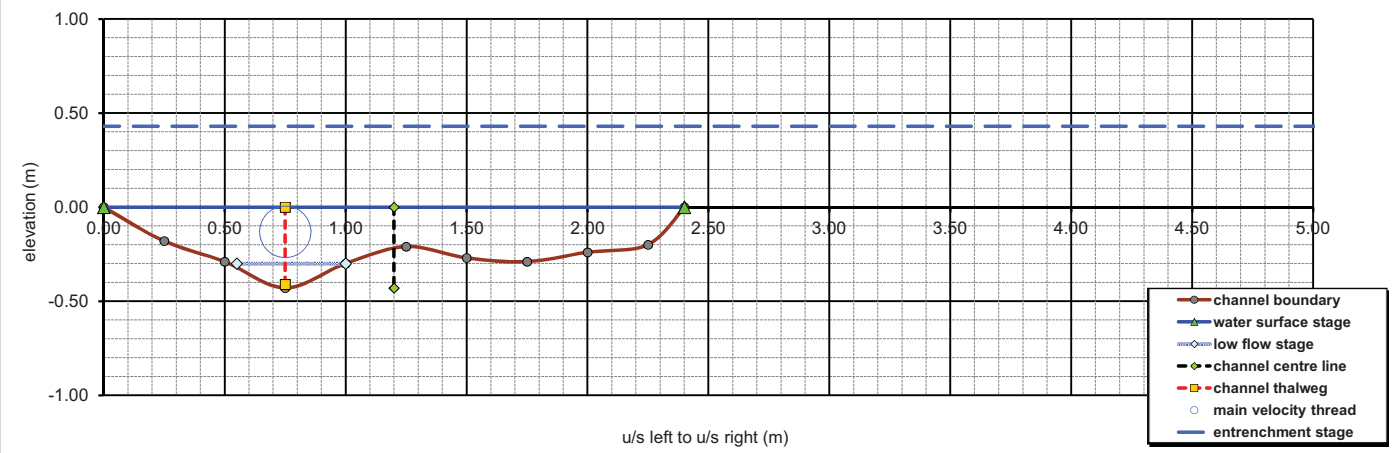
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

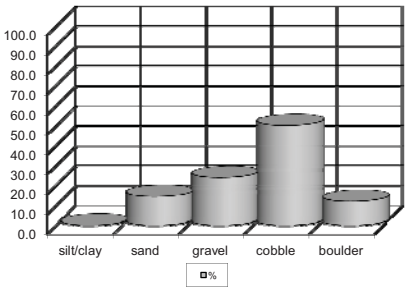
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	

Hydraulic Roughness	
rr R/D_{84}	0.96
ff V mean/V*	3.92
ff D_{84}	3.01
ff mean	3.46
	ROUGH BED

Hydraulic Geometry	
A (m^2)	0.59
R (m)	0.22
TW (m)	2.40
WP (m)	2.68
max d (m)	0.43
mean d (m)	0.25
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Ratios	
ER max d	6.25
r_c / TW	
TW / Lf_w	5.33
TW/max d	5.6
TW/mean d	9.7

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	14.73	NO	NO	NO	NO
V_* (m s^{-1})	0.133	D_{50}	1.540	28.23	NO	NO	NO	NO
		D_{84}	2.227	40.83	NO	NO	NO	NO

Section Data

ER_e (m)	0.43	ER stations L / R	-5.00	10.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.40	2.40
Lf_e (m)	-0.300	Lf stations L / R	0.55	1.00	
W_{fp} (m)	15.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.41	0.75	
E_g (m m^{-1})	0.0400				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0018	0.0016	3.0	0.8	0.4	
C3	0.0002	0.0001	saltation	YES	NO	NO
C4	0.0058	0.0050	rolling	YES	NO	NO
			Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	3.00	30.00	110.00	230.00	340.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		29.10	106.70	223.10	329.80
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	8.84		
τ_{calc} (N m^{-2})	86.62		
τ D_{crit} (gr-co) (mm)	89.30		
D_{50} V_c (vcs +) (m s^{-1})	1.63	1.76	
D_{84} V_c (vcs +) (m s^{-1})	2.35	2.54	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	14.3	23.8	50.0	11.9

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.784
V (m s^{-1})	1.32
n	0.055
Fr	0.85
D_c rectangular (m)	0.22
D_c trapezoidal (m)	0.31
D_c triangular (m)	0.43
D_c parabolic (m)	0.27
D_c mean (m)	0.31
flow type	SUBCRITICAL
Ω (watts m^{-1})	307.16
ω_a (watts m^{-2})	114.56
ω_a/TW (watts m^{-1})	47.73
*Re**	258.6
Re	256350
turbulence	HIGH

Flow Regime — Limerinos method

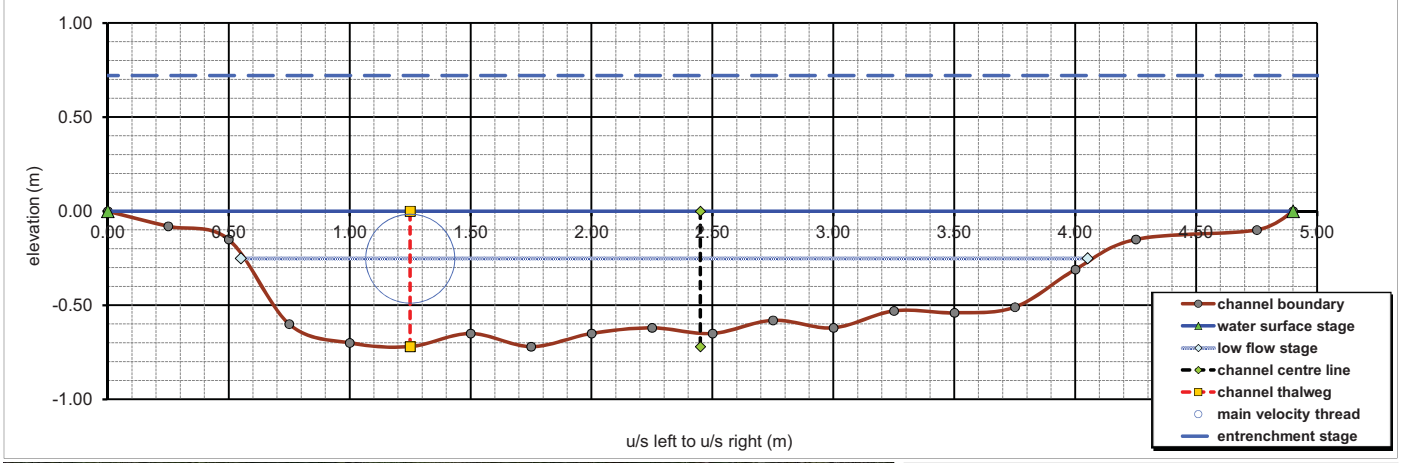
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Bluffs Creek (Line 11 N., East Oro) - Node E5

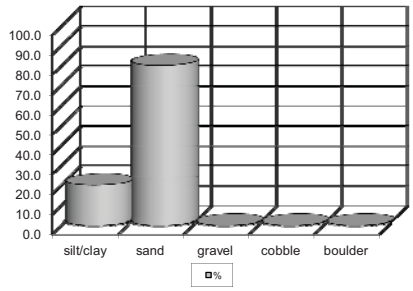
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	2.25
R (m)	0.41
TW (m)	4.90
WP (m)	5.42
max d (m)	0.72
mean d (m)	0.46
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1381.56
ff V mean/V*	13.81
ff D_{84}	20.98
ff mean	17.39
	SMOOTH BED

Hydraulic Ratios	
ER max d	20.41
r_c / TW	
TW / Lf_w	1.40
TW/max d	6.8
TW/mean d	10.7

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.003	0.15	YES	YES	YES	YES
V_* (m s^{-1})	0.050	D_{50}	0.008	0.37	YES	YES	YES	YES
		D_{84}	0.040	1.97	NO	NO	YES	YES

Section Data

ER_e (m)	0.72	ER stations L / R	-50.00	50.00
WS_e (m)	0.000	WS stations L / R	0.00	4.90
Lf_e (m)	-0.250	Lf stations L / R	0.55	4.05
W_{fp} (m)	100.00	E_s sta. (Limerinos) L / R		
r_c (m)		E_s sta. (Strickler) L / R		
z		T_e (m) / $T_{o/s}$ (m)	-0.72	1.25
E_g (m m^{-1})	0.0030			

TW ck: 4.90

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.03	0.06	0.10	0.30	0.50
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})					
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	1.24		
τ_{calc} (N m^{-2})	12.19	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	12.56		
D_{50} V_c (vcs +) (m s^{-1})	0.05	0.09	
D_{84} V_c (vcs +) (m s^{-1})	0.08	0.16	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
20.0	80.0	0.0	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Bedload Transport Data

	Strickler Q Q_{sb} (kg sec^{-1})	Limerinos Q Q_{sb} (kg sec^{-1})
Rosgen type		
B3	0.0022	0.0031
C3	0.0008	0.0073
C4	0.0084	0.0141

	D_{30}	D_{50}	D_{84}
T_*	209.4	125.6	41.9
saltation	YES	YES	YES
rolling	YES	YES	YES
Ø	NO	NO	NO

Flow Regime
Strickler method

Q (cms)	1.705
V (m s^{-1})	0.76
n	0.040
Fr	0.36
D_c rectangular (m)	0.23
D_c trapezoidal (m)	0.38
D_c triangular (m)	0.58
D_c parabolic (m)	0.34
D_c mean (m)	0.38
flow type	SUBCRITICAL
Ω (watts m^{-1})	50.12
ω_a (watts m^{-2})	9.25
ω_a/TW (watts m^{-1})	1.89
*Re**	0.2
Re	275933
turbulence	LOW

Flow Regime
Limerinos method

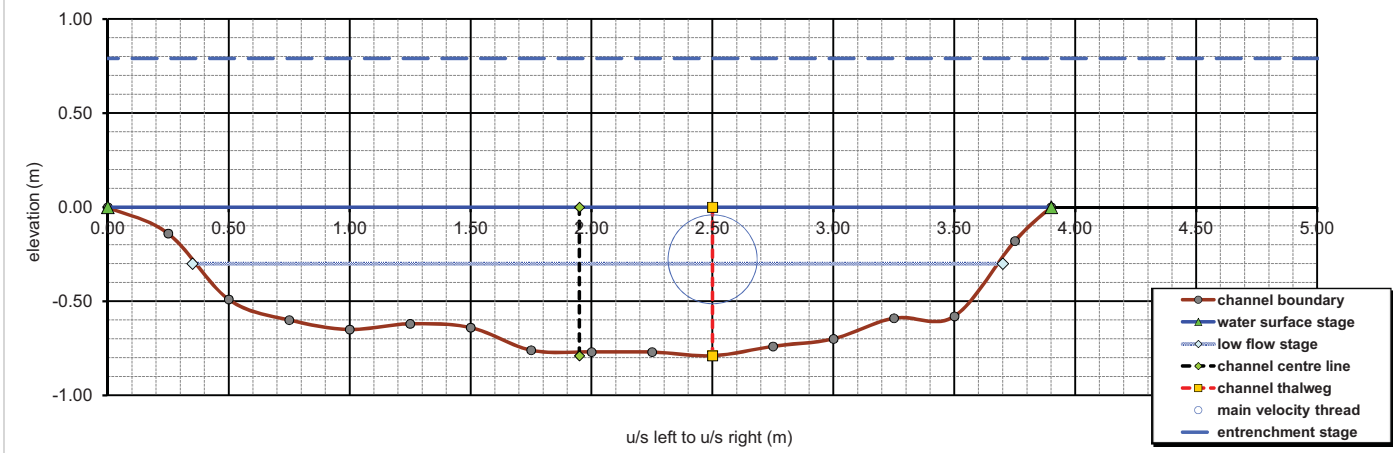
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Bluffs Creek (Line 11 N., East Oro) - Node E5

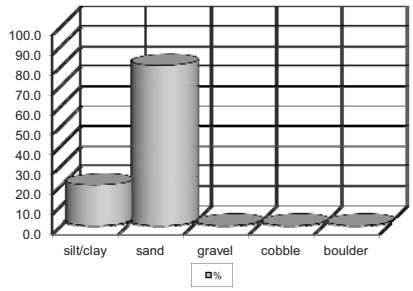
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	2.25
R (m)	0.50
TW (m)	3.90
WP (m)	4.51
max d (m)	0.79
mean d (m)	0.58
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1658.88
ff V mean/V*	13.74
ff D_{84}	21.54
ff mean	17.64
	SMOOTH BED

Hydraulic Ratios	
ER max d	25.64
r_c / TW	
TW / Lf_w	1.16
TW/max d	4.9
TW/mean d	6.8

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.003	0.13	YES	YES	YES	YES
V_* (m s^{-1})	0.055	D_{50}	0.008	0.34	YES	YES	YES	YES
		D_{84}	0.040	1.80	NO	NO	YES	YES

Section Data

ER_e (m)	0.79	ER stations L / R	-50.00	50.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.90	3.90
Lf_e (m)	-0.300	Lf stations L / R	0.35	3.70	
W_{fp} (m)	100.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.79	2.50	
E_g (m m^{-1})	0.0030				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0022	0.0032	T_*	251.4	150.8	50.3
C3	0.0009	0.0091	saltation	YES	YES	YES
C4	0.0084	0.0149	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.03	0.06	0.10	0.30	0.50
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})					
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	1.49		
τ_{calc} (N m^{-2})	14.63	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	15.08		
D_{50} V_c (vcs +) (m s^{-1})	0.05	0.09	
D_{84} V_c (vcs +) (m s^{-1})	0.08	0.16	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
20.0	80.0	0.0	0.0	0.0

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (m)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	1.713
V (m s^{-1})	0.76
n	0.045
Fr	0.32
D_c rectangular (m)	0.27
D_c trapezoidal (m)	0.39
D_c triangular (m)	0.58
D_c parabolic (m)	0.32
D_c mean (m)	0.39
flow type	SUBCRITICAL
Ω (watts m^{-1})	50.36
ω_a (watts m^{-2})	11.16
ω_a/TW (watts m^{-1})	2.86
*Re**	0.2
Re	332909
turbulence	LOW

Flow Regime — Limerinos method

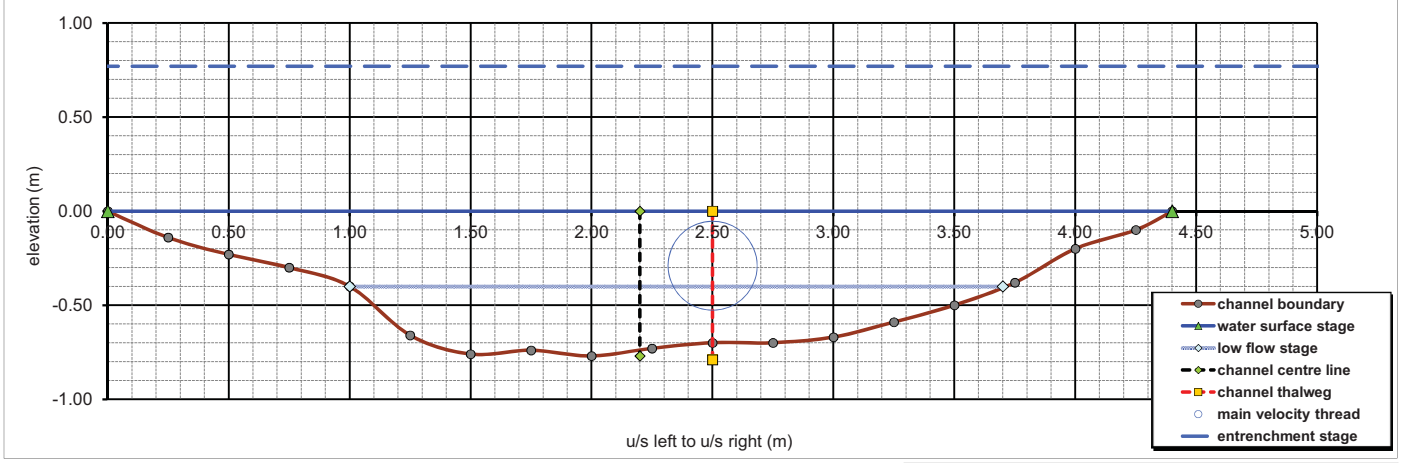
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Bluffs Creek (Line 11 N., East Oro) - Node E5

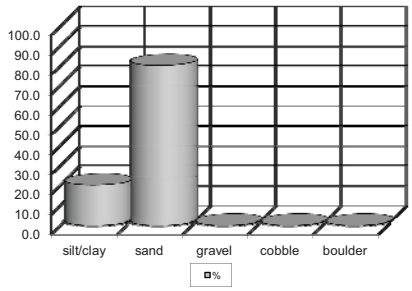
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Roughness	
rr R/D_{84}	1489.49
ff V mean/V*	13.96
ff D_{84}	21.12
ff mean	17.54
	SMOOTH BED

Hydraulic Geometry	
A (m^2)	2.14
R (m)	0.45
TW (m)	4.40
WP (m)	4.78
max d (m)	0.77
mean d (m)	0.49
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Ratios	
ER max d	22.73
r_c / TW	
TW / Lf_w	1.63
TW/max d	5.7
TW/mean d	9.1

Sediment Transport Mode			w_s ($m\ s^{-1}$)	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.003	0.14	YES	YES	YES	YES
V_* ($m\ s^{-1}$)	0.052	D_{50}	0.008	0.35	YES	YES	YES	YES
		D_{84}	0.040	1.90	NO	NO	YES	YES

Section Data				
ER_e (m)	0.77	ER stations L / R	-50.00	50.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	4.40	4.40
Lf_e (m)	-0.400	Lf stations L / R	1.00	3.70	
W_{fp} (m)	100.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.79	2.50	
E_g ($m\ m^{-1}$)	0.0030				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.03	0.06	0.10	0.30	0.50
Stability Design Targets (mm)					
τ_{cr} ($N\ m^{-2}$)					
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} ($kg\ m^{-2}$)	1.34		
τ_{calc} ($N\ m^{-2}$)	13.14		
$\tau\ D_{crit}$ (gr-co) (mm)	13.54	Strickler	Limerinos
D_{50} V_c (vcs +) ($m\ s^{-1}$)	0.05	0.09	
D_{84} V_c (vcs +) ($m\ s^{-1}$)	0.08	0.15	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
20.0	80.0	0.0	0.0	0.0

Bank Data u/s L	u/s R
H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Bedload Transport Data	Strickler Q_{sb} ($kg\ sec^{-1}$)	Limerinos Q_{sb} ($kg\ sec^{-1}$)		D_{30}	D_{50}	D_{84}
Rosgen type			T_*	225.7	135.4	45.1
B3	0.0022	0.0031	saltation	YES	YES	YES
C3	0.0008	0.0073	rolling	YES	YES	YES
C4	0.0084	0.0141	Ø	NO	NO	NO

Flow Regime Strickler method	
Q (cms)	1.706
V ($m\ s^{-1}$)	0.80
n	0.040
Fr	0.37
D_c rectangular (m)	0.25
D_c trapezoidal (m)	0.39
D_c triangular (m)	0.58
D_c parabolic (m)	0.33
D_c mean (m)	0.39
flow type	SUBCRITICAL
Ω ($watts\ m^{-1}$)	50.16
ω_a ($watts\ m^{-2}$)	10.49
ω_a/TW ($watts\ m^{-1}$)	2.38
*Re**	0.1
Re	312868
turbulence	LOW

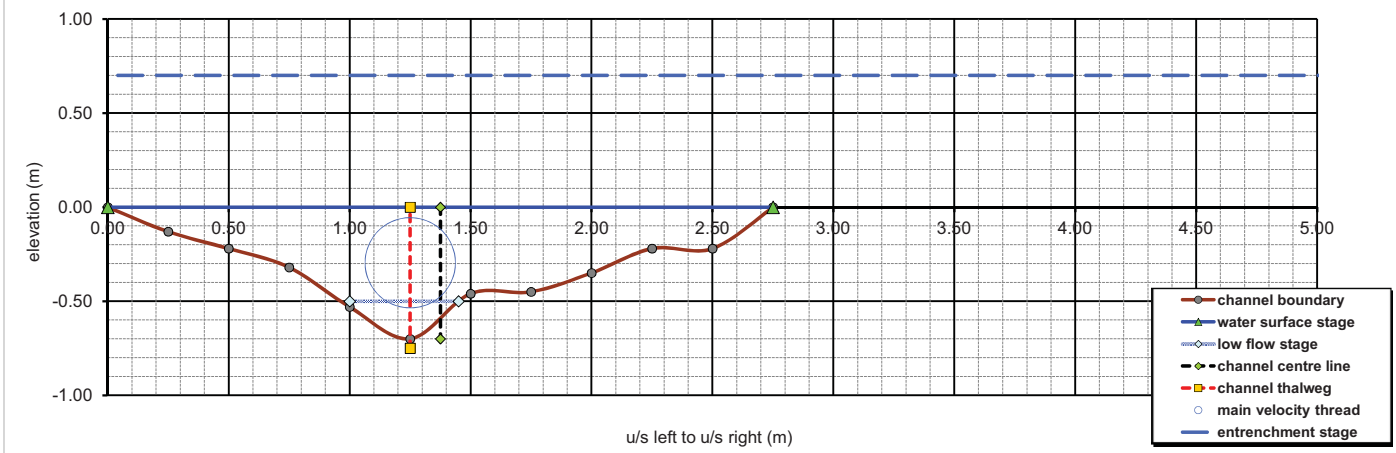
Flow Regime Limerinos method	
Q (cms)	
V ($m\ s^{-1}$)	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω ($watts\ m^{-1}$)	
ω_a ($watts\ m^{-2}$)	
ω_a/TW ($watts\ m^{-1}$)	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 - Shingle Bay Tributary (Forest Lane Rd., Forest Home) - Node F3

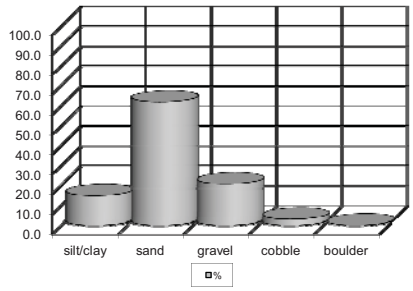
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type

cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry

A (m^2)	0.90
R (m)	0.28
TW (m)	2.75
WP (m)	3.18
max d (m)	0.70
mean d (m)	0.33
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness

rr R/D_{84}	18.89
ff V mean/V*	8.09
ff D_{84}	10.46
ff mean	9.28
	SMOOTH BED

Hydraulic Ratios

ER max d	3.27
r_c / TW	
TW / Lf_w	6.11
TW/max d	3.9
TW/mean d	8.4

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.008	0.30	YES	YES	YES	YES
V_* (m s^{-1})	0.061	D_{50}	0.023	0.93	NO	YES	YES	YES
		D_{84}	0.567	22.78	NO	NO	NO	NO

Section Data

ER_e (m)	0.70	ER stations L / R	-3.00	6.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	2.75	2.75
Lf_e (m)	-0.500	Lf stations L / R	1.00	1.45	
W_{fp} (m)	9.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.75	1.25	
E_g (m m^{-1})	0.0065				

Bedload Transport Data

Rosgen type	Strickler Q Q_{sb} (kg sec^{-1})	Limerinos Q Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0017	0.0020	T_*	186.1	93.0	1.2
C3	0.0001	0.0005	saltation	YES	YES	NO
C4	0.0055	0.0073	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.06	0.10	0.20	15.00	80.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				14.55	77.60
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Flow Regime
Strickler method

Q (cms)	0.693
V (m s^{-1})	0.77
n	0.045
Fr	0.43
D_c rectangular (m)	0.19
D_c trapezoidal (m)	0.28
D_c triangular (m)	0.40
D_c parabolic (m)	0.23
D_c mean (m)	0.28
flow type	SUBCRITICAL
Ω (watts m^{-1})	44.12
ω_a (watts m^{-2})	13.89
ω_a/TW (watts m^{-1})	5.05
*Re**	0.4
Re	191293
turbulence	LOW

Flow Regime
Limerinos method

Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

Erosion Thresholds

		V_c / V_b Strickler	Limerinos
τ_{calc} (kg m^{-2})	1.84		
τ_{calc} (N m^{-2})	18.05		
τ D_{crit} (gr-co) (mm)	18.61		
D_{50} V_c (vcs +) (m s^{-1})	0.07	0.13	
D_{84} V_c (vcs +) (m s^{-1})	0.60	1.11	

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Substrate Type (%)

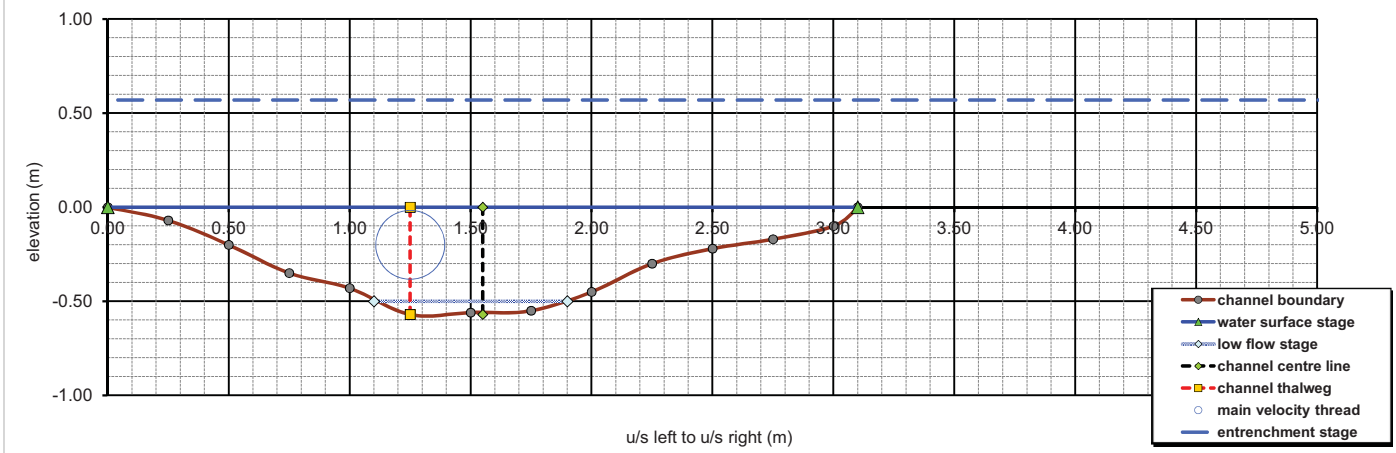
silt/clay	sand	gravel	cobble	boulder
14.7	61.8	20.6	2.9	0.0

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Shingle Bay Tributary (Forest Lane Rd., Forest Home) - Node F3

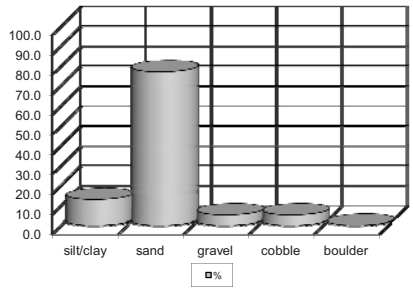
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.99
R (m)	0.29
TW (m)	3.10
WP (m)	3.36
max d (m)	0.57
mean d (m)	0.32
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	146.51
ff V mean/V*	10.25
ff D_{84}	15.38
ff mean	12.81
	SMOOTH BED

Hydraulic Ratios	
ER max d	3.55
r_c / TW	
TW / Lf_w	3.88
TW/max d	5.4
TW/mean d	9.8

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.008	0.30	YES	YES	YES	YES
V_* (m s^{-1})	0.062	D_{50}	0.032	1.26	NO	NO	YES	YES
		D_{84}	0.196	7.75	NO	NO	NO	NO

Section Data					
ER_e (m)	0.57	ER stations L / R	-3.00	8.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.10	3.10
Lf_e (m)	-0.500	Lf stations L / R	1.10	1.90	
W_{fp} (m)	11.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.57	1.25	
E_g (m m^{-1})	0.0065				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.06	0.10	0.25	2.00	120.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				1.94	116.40
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	1.90		
τ_{calc} (N m^{-2})	18.66	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	19.24		
D_{50} V_c (vcs +) (m s^{-1})	0.08	0.16	
D_{84} V_c (vcs +) (m s^{-1})	0.22	0.44	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
12.8	76.9	5.1	5.1	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Bedload Transport Data						
	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	192.4	77.0	9.6
B3	0.0017	0.0023	saltation	YES	YES	YES
C3	0.0001	0.0012	rolling	YES	YES	YES
C4	0.0055	0.0092	Ø	NO	NO	NO

Flow Regime Strickler method	
Q (cms)	0.698
V (m s^{-1})	0.71
n	0.050
Fr	0.40
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.27
D_c triangular (m)	0.41
D_c parabolic (m)	0.24
D_c mean (m)	0.27
flow type	SUBCRITICAL
Ω (watts m^{-1})	44.45
ω_a (watts m^{-2})	13.22
ω_a/TW (watts m^{-1})	4.27
*Re**	0.5
Re	182087
turbulence	LOW

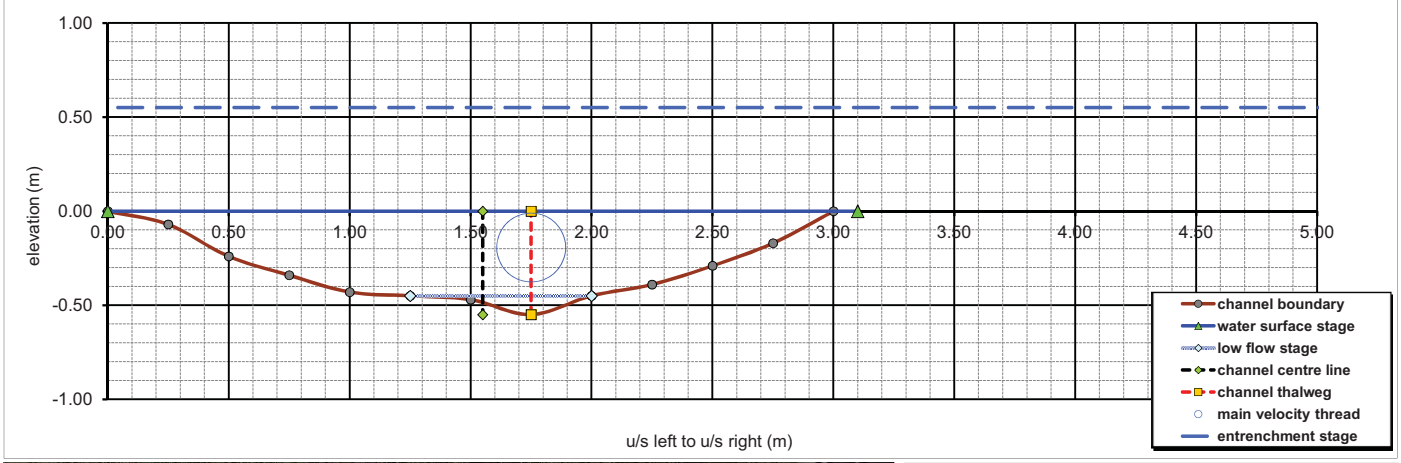
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 - Shingle Bay Tributary (Forest Lane Rd., Forest Home) - Node F3

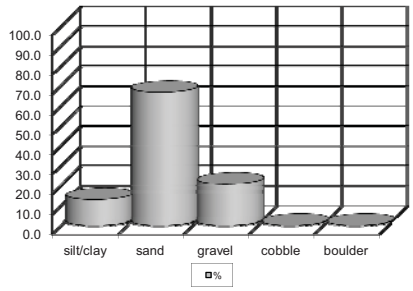
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.96
R (m)	0.30
TW (m)	3.00
WP (m)	3.24
max d (m)	0.55
mean d (m)	0.32
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	49.57
ff V mean/V*	8.96
ff D_{84}	12.68
ff mean	10.82
	SMOOTH BED

Hydraulic Ratios	
ER max d	3.67
r_c / TW	
TW / Lf_w	4.00
TW/max d	5.5
TW/mean d	9.4

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.008	0.30	YES	YES	YES	YES
V_* (m s^{-1})	0.062	D_{50}	0.032	1.25	NO	NO	YES	YES
		D_{84}	0.356	13.95	NO	NO	NO	NO

Section Data					
ER_e (m)	0.55	ER stations L / R	-3.00	8.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	3.10	3.10
Lf_e (m)	-0.450	Lf stations L / R	1.25	2.00	
W_{fp} (m)	11.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.55	1.75	
E_g (m m^{-1})	0.0065				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.06	0.10	0.25	6.00	60.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				5.82	58.20
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	1.93		
τ_{calc} (N m^{-2})	18.95		
τ D_{crit} (gr-co) (mm)	19.53	Strickler	Limerinos
D_{50} V_c (vcs +) (m s^{-1})	0.08	0.15	
D_{84} V_c (vcs +) (m s^{-1})	0.38	0.76	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
12.8	66.7	20.5	0.0	0.0

Bank Data u/s L	u/s R
H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Bedload Transport Data	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0017	0.0022	T_*	195.3	78.1	3.3
C3	0.0001	0.0008	saltation	YES	YES	YES
C4	0.0055	0.0083	rolling	YES	YES	YES
			Ø	NO	NO	NO

Flow Regime Strickler method	
Q (cms)	0.689
V (m s^{-1})	0.72
n	0.050
Fr	0.40
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.27
D_c triangular (m)	0.40
D_c parabolic (m)	0.24
D_c mean (m)	0.27
flow type	SUBCRITICAL
Ω (watts m^{-1})	43.87
ω_a (watts m^{-2})	13.56
ω_a/TW (watts m^{-1})	4.52
Re^*	0.5
Re	186678
turbulence	LOW

Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-Section Analysis Models
Stable Conditions

Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)
Shellswell's Creek Tributary (5 Line S., Guthrie)
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)

Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan

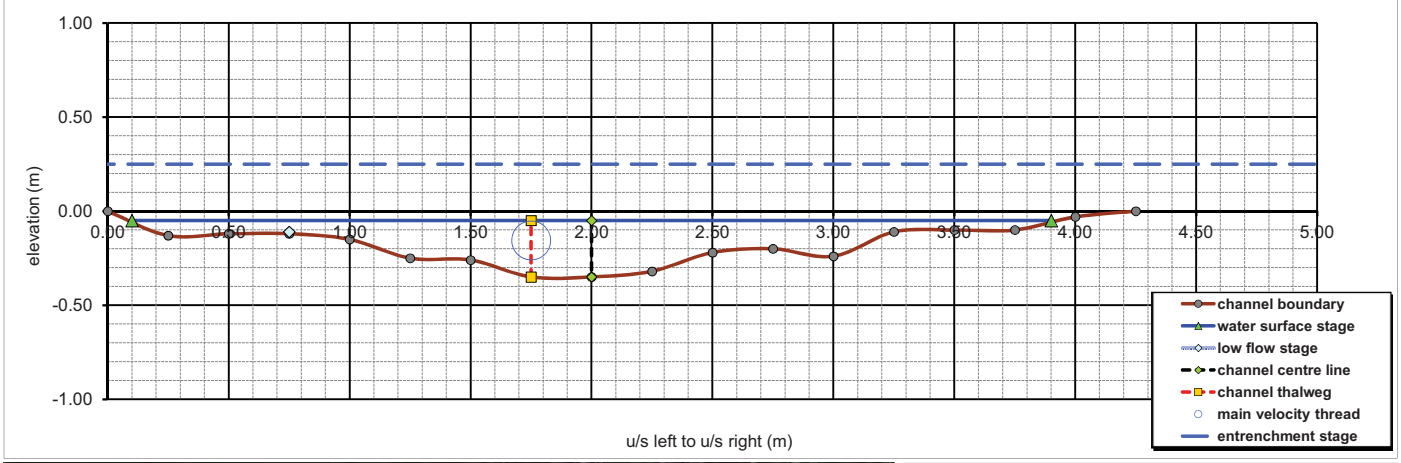
AquaLogic

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 Stability Test - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

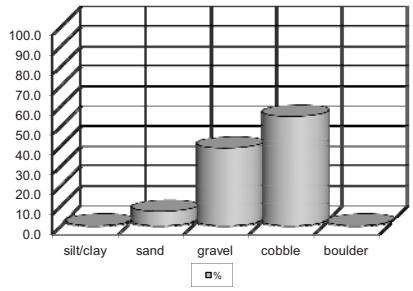
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.56
R (m)	0.14
TW (m)	3.83
WP (m)	3.95
max d (m)	0.30
mean d (m)	0.15
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.18
ff V mean/V*	4.39
ff D_{84}	3.33
ff mean	3.86
ROUGH BED	

Hydraulic Ratios	
ER max d	6.52
r_c / TW	
TW / Lf_w	
TW/max d	12.8
TW/mean d	26.1

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	24.77	NO	NO	NO	NO
V_* (m s^{-1})	0.079	D_{50}	1.183	36.48	NO	NO	NO	NO
		D_{84}	1.608	49.58	NO	NO	NO	NO

Section Data

ER_e (m)	0.25	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	-0.050	WS stations L / R	0.10	3.90	3.80
Lf_e (m)	-0.110	Lf stations L / R	0.75	0.75	
W_{fp} (m)	25.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.35	1.75	
E_g (m m^{-1})	0.0220				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0016	0.0014	saltation	NO	NO	NO
C3	0.0001	0.0000	rolling	YES	NO	NO
C4	0.0047	0.0040	Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	8.00	30.00	65.00	120.00	170.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		29.10	63.05	116.40	164.90
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	3.13		
τ_{calc} (N m^{-2})	30.64		
τ D_{crit} (gr-co) (mm)	31.59		
D_{50} V_c (vcs +) (m s^{-1})	1.25	2.00	
D_{84} V_c (vcs +) (m s^{-1})	1.70	2.72	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	6.8	38.6	54.5	0.0

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.501
V (m s^{-1})	0.89
n	0.045
Fr	0.74
D_c rectangular (m)	0.12
D_c trapezoidal (m)	0.24
D_c triangular (m)	0.36
D_c parabolic (m)	0.24
D_c mean (m)	0.24
flow type	SUBCRITICAL
Ω (watts m^{-1})	108.04
ω_a (watts m^{-2})	27.33
ω_a/TW (watts m^{-1})	7.13
*Re**	129.5
Re	111202
turbulence	HIGH

Flow Regime — Limerinos method

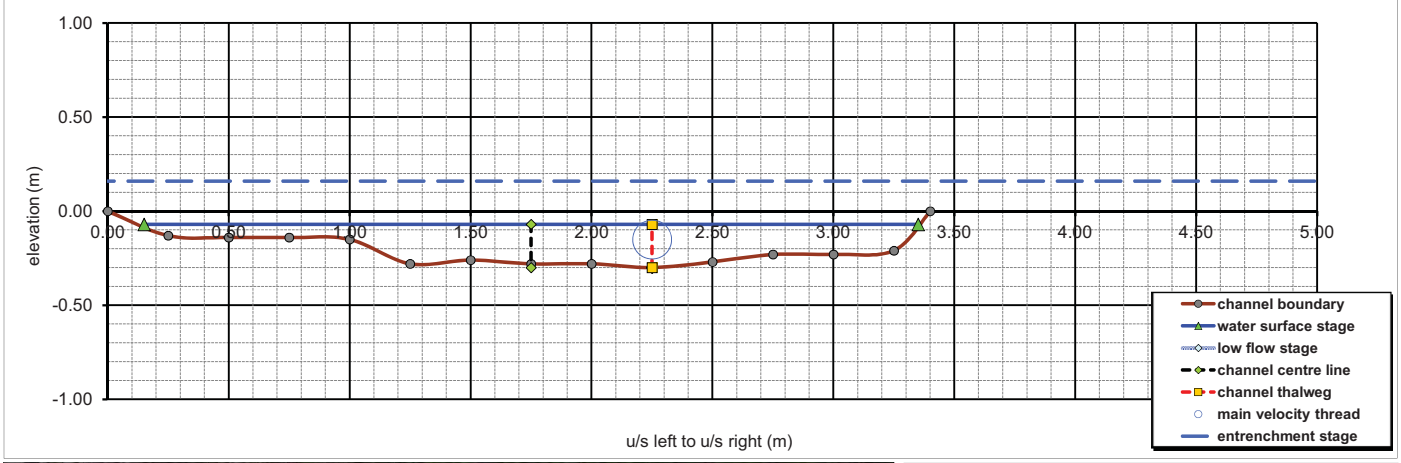
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 Stability Test - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

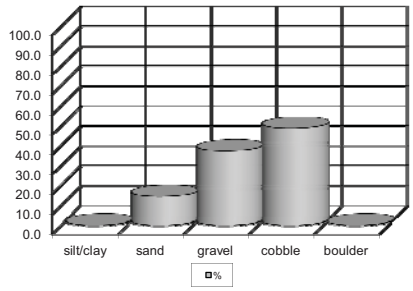
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.48
R (m)	0.14
TW (m)	3.22
WP (m)	3.34
max d (m)	0.23
mean d (m)	0.15
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.90
ff V mean/V*	4.08
ff D_{84}	2.67
ff mean	3.37
ROUGH BED	

Hydraulic Ratios	
ER max d	7.78
r_c / TW	
TW / Lf_w	
TW/max d	14.0
TW/mean d	21.4

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.462	14.46	NO	NO	NO	NO
V_* (m s^{-1})	0.078	D_{50}	1.183	37.03	NO	NO	NO	NO
		D_{84}	1.857	58.12	NO	NO	NO	NO

Section Data

ER_e (m)	0.16	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	-0.070	WS stations L / R	0.15	3.35	3.20
Lf_e (m)	-0.300	Lf stations L / R	2.25	2.25	
W_{fp} (m)	25.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.30	2.25	
E_g (m m^{-1})	0.0210				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0015	0.0013	T_*	3.1	0.5	0.2
C3	0.0001	0.0000	saltation	YES	NO	NO
C4	0.0043	0.0034	rolling	YES	NO	NO
			Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	2.00	10.00	65.00	160.00	180.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		9.70	63.05	155.20	174.60
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	3.03		
τ_{calc} (N m^{-2})	29.74	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	30.66		
D_{50} V_c (vcs +) (m s^{-1})	1.25	2.03	
D_{84} V_c (vcs +) (m s^{-1})	1.96	3.18	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	14.3	37.1	48.6	0.0

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.426
V (m s^{-1})	0.88
n	0.045
Fr	0.73
D_c rectangular (m)	0.12
D_c trapezoidal (m)	0.23
D_c triangular (m)	0.33
D_c parabolic (m)	0.22
D_c mean (m)	0.23
flow type	SUBCRITICAL
Ω (watts m^{-1})	87.57
ω_a (watts m^{-2})	26.20
ω_a/TW (watts m^{-1})	8.15
Re^*	129.6
Re	111671
turbulence	HIGH

Flow Regime — Limerinos method

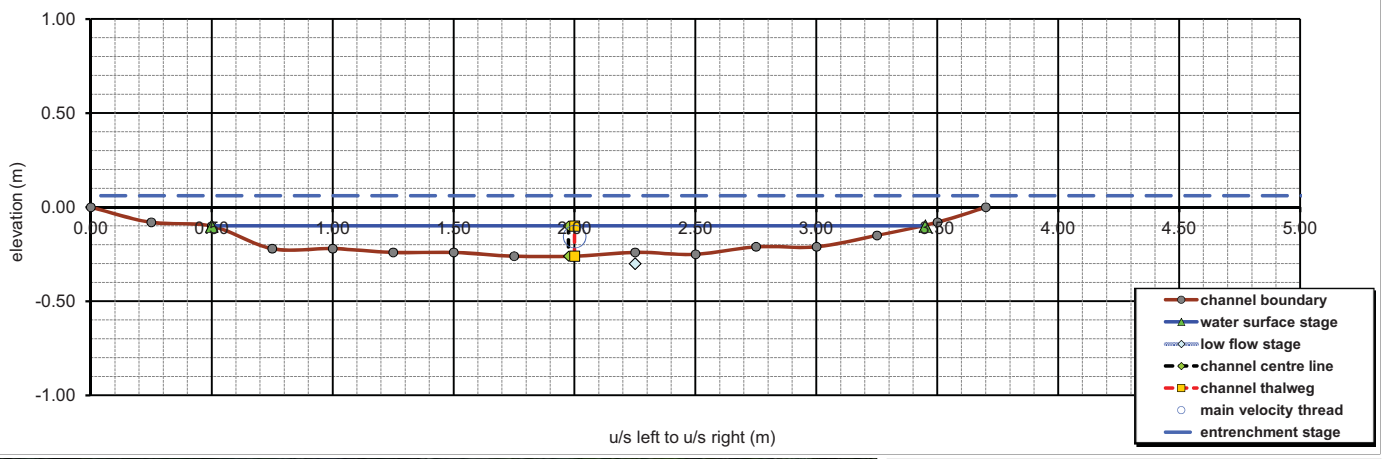
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 Stability Test - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

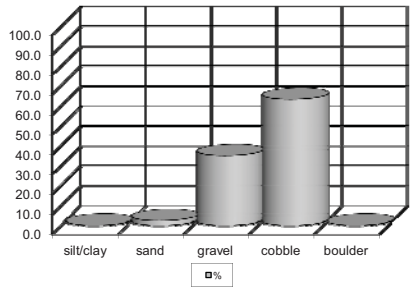
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.35
R (m)	0.12
TW (m)	2.93
WP (m)	2.98
max d (m)	0.16
mean d (m)	0.12
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.69
ff V mean/V*	3.63
ff D_{84}	1.95
ff mean	2.79
ROUGH BED	

Hydraulic Ratios	
ER max d	6.15
r_c / TW	
TW / Lf_w	
TW/max d	18.3
TW/mean d	24.6

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	1.038	32.43	NO	NO	NO	NO
V_* (m s^{-1})	0.078	D_{50}	1.468	45.88	NO	NO	NO	NO
		D_{84}	1.914	59.82	NO	NO	NO	NO

Section Data

ER_e (m)	0.06	ER stations L / R	-3.00	15.00	TW ck
WS_e (m)	-0.100	WS stations L / R	0.50	3.45	2.95
Lf_e (m)	-0.300	Lf stations L / R	2.25	2.25	
W_{fp} (m)	18.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.26	2.00	
E_g (m m^{-1})	0.0260				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0013	0.0011	saltation	NO	NO	NO
C3	0.0000	0.0000	rolling	NO	NO	NO
C4	0.0037	0.0026	Ø	YES	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	20.00	50.00	100.00	170.00	220.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	19.40	48.50	97.00	164.90	213.40
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	3.04		
τ_{calc} (N m^{-2})	29.82		
τ D_{crit} (gr-co) (mm)	30.74		
D_{50} V_c (vcs +) (m s^{-1})	1.55	2.60	
D_{84} V_c (vcs +) (m s^{-1})	2.02	3.39	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	2.2	34.8	63.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.296
V (m s^{-1})	0.85
n	0.045
Fr	0.79
D_c rectangular (m)	0.10
D_c trapezoidal (m)	0.20
D_c triangular (m)	0.29
D_c parabolic (m)	0.20
D_c mean (m)	0.20
flow type	SUBCRITICAL
Ω (watts m^{-1})	75.52
ω_a (watts m^{-2})	25.38
ω_a/TW (watts m^{-1})	8.67
Re^*	204.4
Re	87373
turbulence	HIGH

Flow Regime — Limerinos method

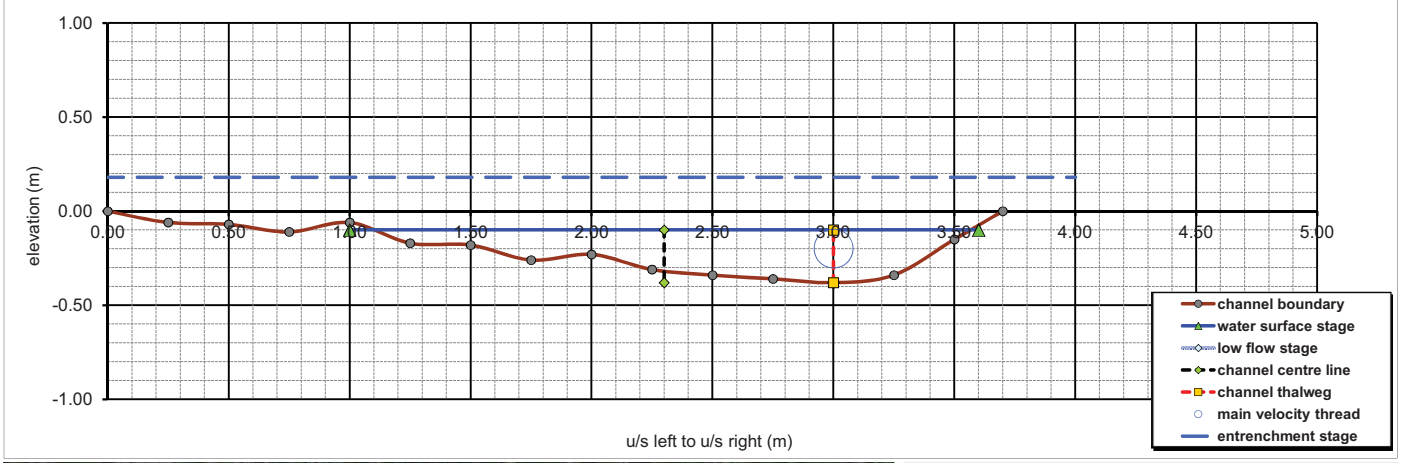
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 Stability Test - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

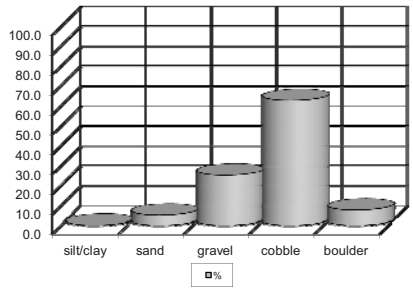
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.42
R (m)	0.16
TW (m)	2.59
WP (m)	2.72
max d (m)	0.28
mean d (m)	0.16
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.74
ff V mean/V*	3.41
ff D_{84}	2.21
ff mean	2.81
ROUGH BED	

Hydraulic Ratios	
ER max d	3.48
r_c / TW	
TW / Lf_w	
TW/max d	9.2
TW/mean d	15.8

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	1.137	28.70	NO	NO	NO	NO
V_* (m s^{-1})	0.097	D_{50}	1.737	43.84	NO	NO	NO	NO
		D_{84}	2.128	53.70	NO	NO	NO	NO

Section Data

ER_e (m)	0.18	ER stations L / R	-5.00	4.00	TW ck
WS_e (m)	-0.100	WS stations L / R	1.00	3.60	2.60
Lf_e (m)	-0.380	Lf stations L / R	3.00	3.00	
W_{fp} (m)	9.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.38	3.00	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0014	0.0012	saltation	NO	NO	NO
C3	0.0000	0.0000	rolling	NO	NO	NO
C4	0.0041	0.0033	Ø	YES	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	20.00	60.00	140.00	210.00	290.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	19.40	58.20	135.80	203.70	281.30
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	4.66		
τ_{calc} (N m^{-2})	45.72	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	47.13		
D_{50} V_c (vcs +) (m s^{-1})	1.83	2.89	
D_{84} V_c (vcs +) (m s^{-1})	2.25	3.55	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	5.0	25.0	62.5	7.5

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.383
V (m s^{-1})	0.91
n	0.055
Fr	0.72
D_c rectangular (m)	0.13
D_c trapezoidal (m)	0.22
D_c triangular (m)	0.32
D_c parabolic (m)	0.21
D_c mean (m)	0.22
flow type	SUBCRITICAL
Ω (watts m^{-1})	112.50
ω_a (watts m^{-2})	41.37
ω_a/TW (watts m^{-1})	15.99
*Re**	338.8
Re	123446
turbulence	HIGH

Flow Regime — Limerinos method

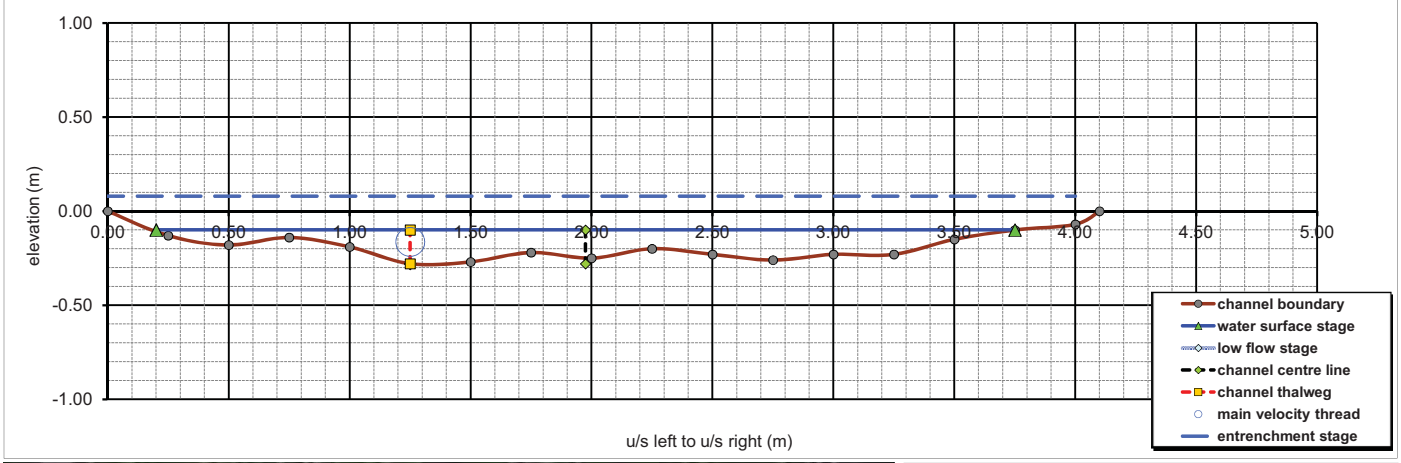
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 Stability Test - Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove) - Node S3

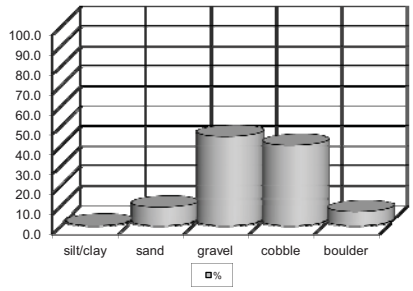
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Geometry	
A (m^2)	0.39
R (m)	0.11
TW (m)	3.56
WP (m)	3.63
max d (m)	0.18
mean d (m)	0.11
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.67
ff V mean/V*	3.12
ff D_{84}	1.88
ff mean	2.50
ROUGH BED	

Hydraulic Ratios	
ER max d	2.53
r_c / TW	
TW / Lf_w	
TW/max d	19.8
TW/mean d	32.7

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	17.28	NO	NO	NO	NO
V_* (m s^{-1})	0.080	D_{50}	1.038	31.62	NO	NO	NO	NO
		D_{84}	1.857	56.59	NO	NO	NO	NO

Section Data

ER_e (m)	0.08	ER stations L / R	-5.00	4.00	TW ck
WS_e (m)	-0.100	WS stations L / R	0.20	3.75	3.55
Lf_e (m)	-0.280	Lf stations L / R	1.25	1.25	
W_{fp} (m)	9.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.28	1.25	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0013	0.0011	T_*	2.2	0.6	0.2
C3	0.0000	0.0000	saltation	YES	NO	NO
C4	0.0035	0.0027	rolling	YES	NO	NO
			Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	5.00	15.00	50.00	160.00	300.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	4.85	14.55	48.50	155.20	291.00
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	3.20		
τ_{calc} (N m^{-2})	31.37	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	32.34		
D_{50} V_c (vcs +) (m s^{-1})	1.10	2.23	
D_{84} V_c (vcs +) (m s^{-1})	1.96	3.98	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	8.9	44.4	40.0	6.7

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.272
V (m s^{-1})	0.70
n	0.055
Fr	0.68
D_c rectangular (m)	0.09
D_c trapezoidal (m)	0.19
D_c triangular (m)	0.28
D_c parabolic (m)	0.19
D_c mean (m)	0.19
flow type	SUBCRITICAL
Ω (watts m^{-1})	80.02
ω_a (watts m^{-2})	22.05
ω_a/TW (watts m^{-1})	6.20
Re^*	127.1
Re	65802
turbulence	HIGH

Flow Regime — Limerinos method

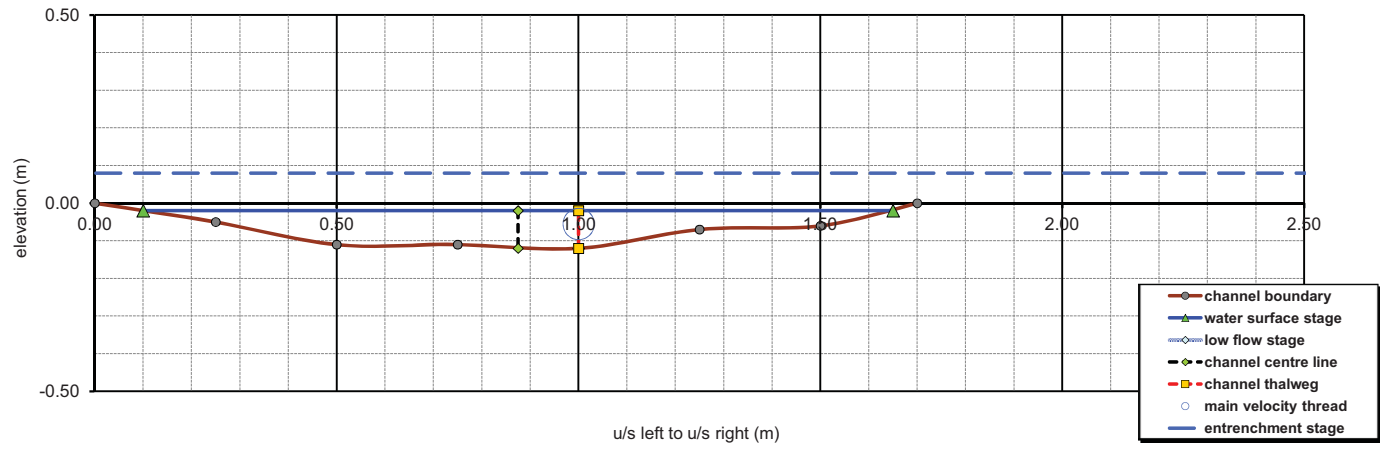
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

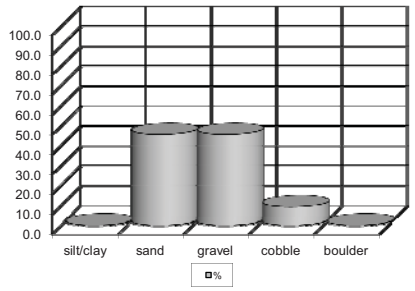
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.10
R (m)	0.06
TW (m)	1.53
WP (m)	1.55
max d (m)	0.10
mean d (m)	0.06
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.55
ff V mean/V*	4.12
ff D_{84}	3.94
ff mean	4.03
ROUGH BED	

Hydraulic Ratios	
ER max d	7.17
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	15.3
TW/mean d	24.4

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.040	1.30	NO	NO	YES	YES
V_* (m s^{-1})	0.075	D_{50}	0.247	7.97	NO	NO	NO	NO
		D_{84}	0.928	29.99	NO	NO	NO	NO

Section Data				
ER_e (m)	0.08	ER stations L / R	-6.00	5.00	TW ck
WS_e (m)	-0.020	WS stations L / R	0.10	1.65	1.55
Lf_e (m)	-0.120	Lf stations L / R	1.00	1.00	
W_{fp} (m)	11.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.12	1.00	
E_g (m m^{-1})	0.0460				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	0.30	3.00	40.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		0.29	2.91	38.80	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	2.85		
τ_{calc} (N m^{-2})	27.89	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	28.75		
D_{50} V_c (vcs +) (m s^{-1})	0.27	0.58	
D_{84} V_c (vcs +) (m s^{-1})	0.98	2.11	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	45.5	45.5	9.1	0.0

Bank Data u/s L	u/s R
H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Bedload Transport Data	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	95.8	9.6	0.7
B3	0.0009	0.0009	saltation	YES	YES	NO
C3	0.0000	0.0000	rolling	YES	YES	NO
C4	0.0018	0.0018	Ø	NO	NO	YES

Flow Regime Strickler method	
Q (cms)	0.064
V (m s^{-1})	0.66
n	0.050
Fr	0.85
D_c rectangular (m)	0.06
D_c trapezoidal (m)	0.11
D_c triangular (m)	0.16
D_c parabolic (m)	0.11
D_c mean (m)	0.11
flow type	SUBCRITICAL
Ω (watts m^{-1})	28.82
ω_a (watts m^{-2})	18.54
ω_a/TW (watts m^{-1})	12.09
*Re**	7.6
Re	36070
turbulence	LOW

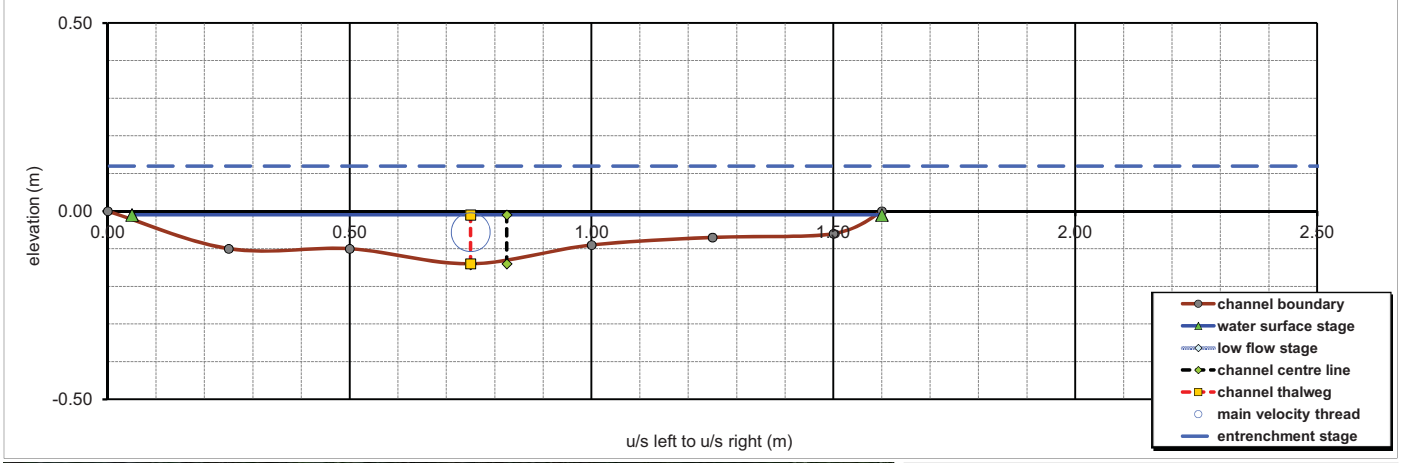
Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 - Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove) - Node S2

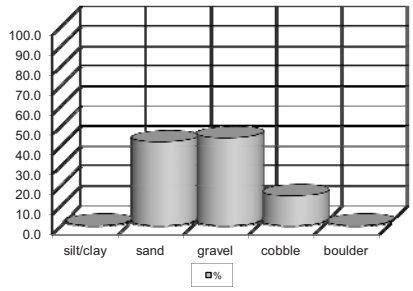
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.12
R (m)	0.07
TW (m)	1.56
WP (m)	1.60
max d (m)	0.13
mean d (m)	0.08
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.25
ff V mean/V*	4.17
ff D_{84}	3.44
ff mean	3.80
ROUGH BED	

Hydraulic Ratios	
ER max d	8.34
r_c / TW	
TW / Lf_w	#DIV/0!
TW/max d	12.0
TW/mean d	20.3

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.126	4.59	NO	NO	NO	YES
V_* (m s^{-1})	0.067	D_{50}	0.356	12.94	NO	NO	NO	NO
		D_{84}	1.137	41.35	NO	NO	NO	NO

Section Data

ER_e (m)	0.12	ER stations L / R	-8.00	5.00	TW ck
WS_e (m)	-0.010	WS stations L / R	0.05	1.60	1.55
Lf_e (m)	-0.140	Lf stations L / R	0.75	0.75	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.14	0.75	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0009	0.0009	T_*	22.7	3.8	0.4
C3	0.0000	0.0000	saltation	YES	YES	NO
C4	0.0020	0.0018	rolling	YES	YES	NO
			Ø	NO	NO	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.25	1.00	6.00	60.00	150.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		0.97	5.82	58.20	145.50
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	2.25		
τ_{calc} (N m^{-2})	22.02	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	22.70		
D_{50} V_c (vcs +) (m s^{-1})	0.38	0.80	
D_{84} V_c (vcs +) (m s^{-1})	1.20	2.53	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	41.7	43.8	14.6	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.081
V (m s^{-1})	0.68
n	0.045
Fr	0.78
D_c rectangular (m)	0.07
D_c trapezoidal (m)	0.12
D_c triangular (m)	0.17
D_c parabolic (m)	0.12
D_c mean (m)	0.12
flow type	SUBCRITICAL
Ω (watts m^{-1})	23.86
ω_a (watts m^{-2})	14.92
ω_a/TW (watts m^{-1})	9.58
Re^*	13.3
Re	44529
turbulence	HIGH

Flow Regime — Limerinos method

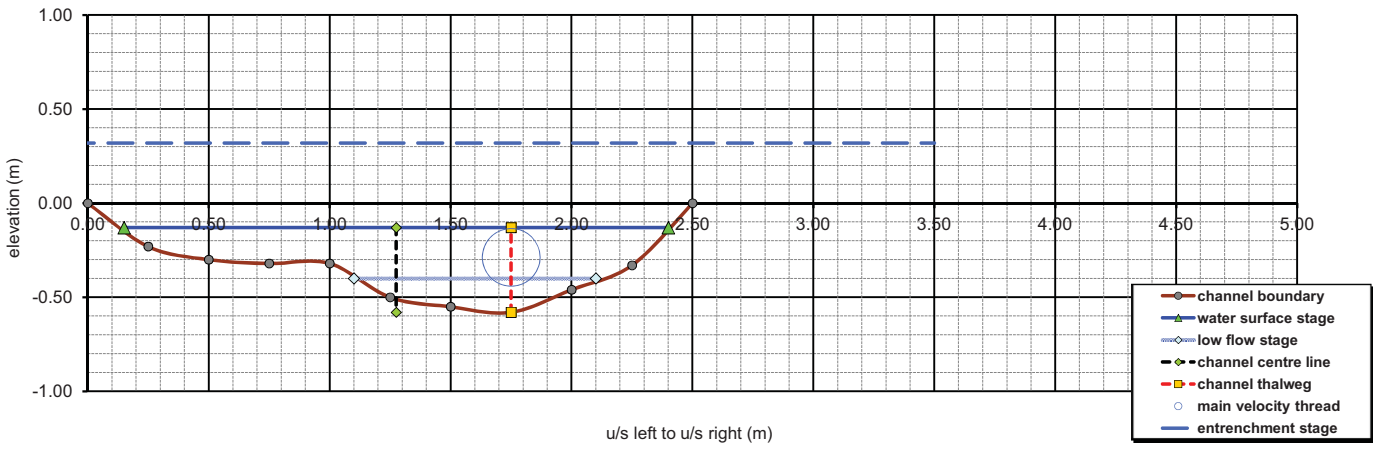
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 Stability Test - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

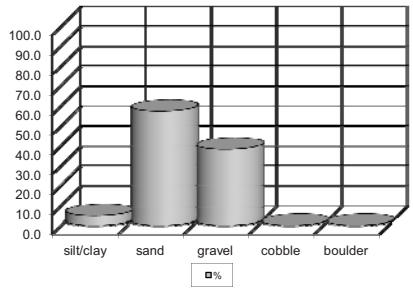
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.59
R (m)	0.23
TW (m)	2.26
WP (m)	2.53
max d (m)	0.45
mean d (m)	0.26
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr *R* /D_{84}	15.48
ff V mean/V*	7.46
ff D_{84}	9.89
ff mean	8.68
	SMOOTH BED

Hydraulic Ratios	
ER max d	5.97
r_c / TW	
TW / Lf_w	2.26
TW/max d	5.0
TW/mean d	8.7

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.023	0.89	NO	YES	YES	YES
V_* (m s^{-1})	0.064	D_{50}	0.071	2.72	NO	NO	NO	YES
		D_{84}	0.567	21.75	NO	NO	NO	NO

Section Data

ER_e (m)	0.32	ER stations L / R	-10.00	3.50	TW ck
WS_e (m)	-0.130	WS stations L / R	0.15	2.40	2.25
Lf_e (m)	-0.400	Lf stations L / R	1.10	2.10	
W_{fp} (m)	13.50	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.58	1.75	
E_g (m m^{-1})	0.0087				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0015	0.0018	T_*	102.0	40.8	1.4
C3	0.0001	0.0002	saltation	YES	YES	NO
C4	0.0043	0.0059	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	0.20	0.50	15.00	50.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				14.55	48.50
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	Limerinos
τ_{calc} (kg m^{-2})	2.02		
τ_{calc} (N m^{-2})	19.80		
τ D_{crit} (gr-co) (mm)	20.41		
D_{50} V_c (vcs +) (m s^{-1})	0.11	0.22	
D_{84} V_c (vcs +) (m s^{-1})	0.60	1.22	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
4.8	57.1	38.1	0.0	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.412
V (m s^{-1})	0.70
n	0.050
Fr	0.44
D_c rectangular (m)	0.15
D_c trapezoidal (m)	0.22
D_c triangular (m)	0.33
D_c parabolic (m)	0.19
D_c mean (m)	0.22
flow type	SUBCRITICAL
Ω (watts m^{-1})	35.16
ω_a (watts m^{-2})	13.88
ω_a/TW (watts m^{-1})	6.14
*Re**	1.1
Re	142825
turbulence	LOW

Flow Regime — Limerinos method

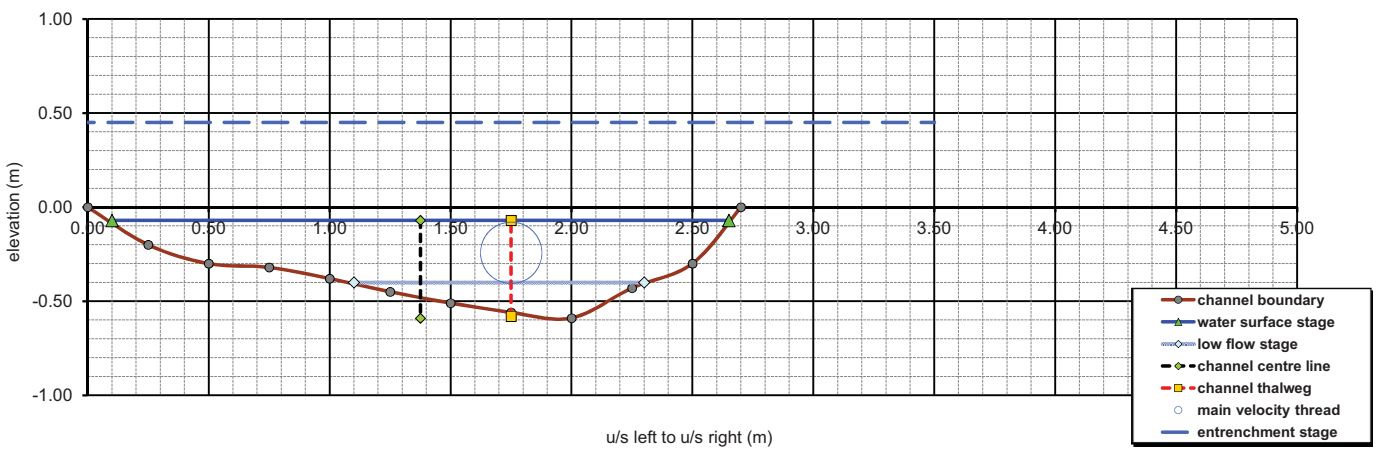
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 Stability Test - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

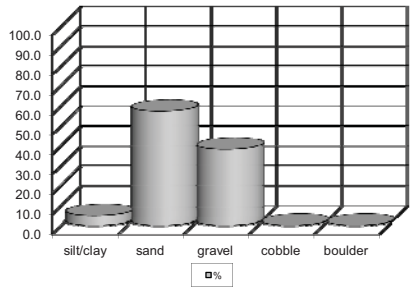
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.82
R (m)	0.29
TW (m)	2.57
WP (m)	2.86
max d (m)	0.52
mean d (m)	0.32
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	19.05
ff V mean/V*	7.81
ff D_{84}	10.40
ff mean	9.10
SMOOTH BED	

Hydraulic Ratios	
ER max d	5.26
r_c / TW	
TW / Lf_w	2.14
TW/max d	4.9
TW/mean d	8.0

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.023	0.92	NO	YES	YES	YES
V_* (m s^{-1})	0.061	D_{50}	0.071	2.82	NO	NO	NO	YES
		D_{84}	0.567	22.51	NO	NO	NO	NO

Section Data

ER_e (m)	0.45	ER stations L / R	-10.00	3.50	TW ck
WS_e (m)	-0.070	WS stations L / R	0.10	2.65	2.55
Lf_e (m)	-0.400	Lf stations L / R	1.10	2.30	
W_{fp} (m)	13.50	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.58	1.75	
E_g (m m^{-1})	0.0066				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0016	0.0020	T_*	95.3	38.1	1.3
C3	0.0001	0.0004	saltation	YES	YES	NO
C4	0.0050	0.0070	rolling	YES	YES	YES
			Ø	NO	NO	NO

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	0.20	0.50	15.00	50.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				14.55	48.50
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	1.89		
τ_{calc} (N m^{-2})	18.48	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	19.05		
D_{50} V_c (vcs +) (m s^{-1})	0.11	0.22	
D_{84} V_c (vcs +) (m s^{-1})	0.60	1.22	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
4.8	57.1	38.1	0.0	0.0

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.574
V (m s^{-1})	0.70
n	0.050
Fr	0.40
D_c rectangular (m)	0.18
D_c trapezoidal (m)	0.26
D_c triangular (m)	0.38
D_c parabolic (m)	0.22
D_c mean (m)	0.26
flow type	SUBCRITICAL
Ω (watts m^{-1})	37.14
ω_a (watts m^{-2})	12.97
ω_a/TW (watts m^{-1})	5.06
*Re**	1.0
Re	175910
turbulence	LOW

Flow Regime — Limerinos method

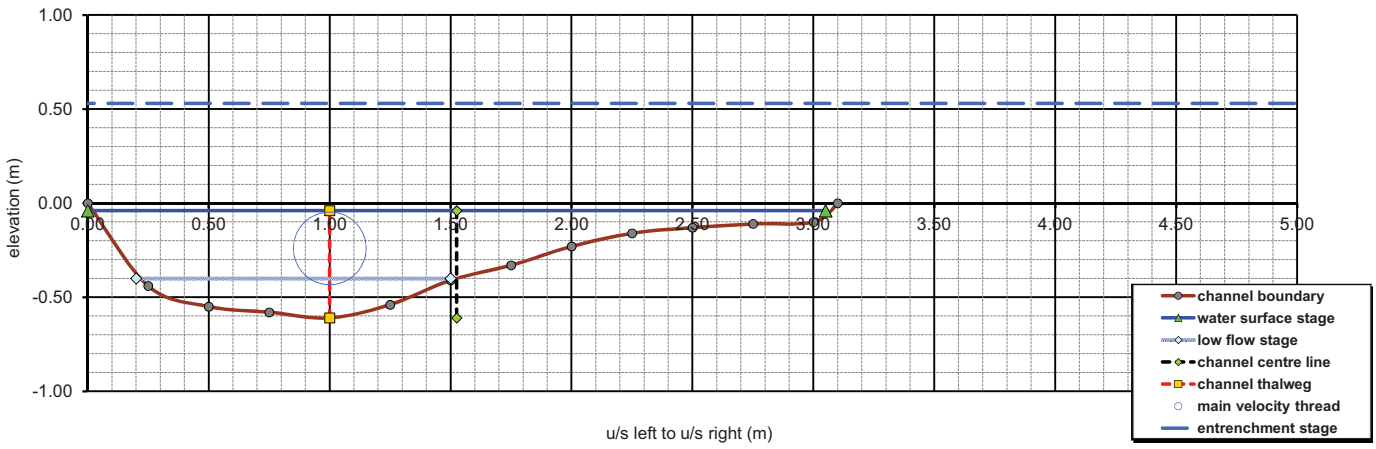
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 3 Stability Test - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

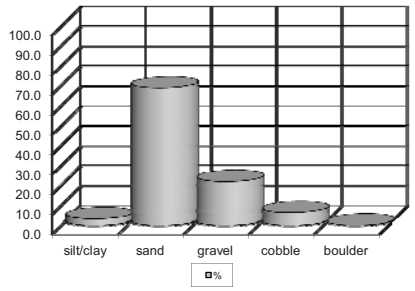
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Roughness	
rr R/D_{84}	33.65
ff V mean/V*	8.46
ff D_{84}	11.82
ff mean	10.14
	SMOOTH BED

Hydraulic Geometry	
A (m^2)	0.92
R (m)	0.27
TW (m)	3.04
WP (m)	3.41
max d (m)	0.57
mean d (m)	0.30
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Ratios	
ER max d	6.58
r_c / TW	
TW / Lf_w	2.34
TW/max d	5.3
TW/mean d	10.1

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.023	0.92	NO	YES	YES	YES
V_* (m s^{-1})	0.061	D_{50}	0.071	2.82	NO	NO	NO	YES
		D_{84}	0.412	16.37	NO	NO	NO	NO

Section Data

ER_e (m)	0.53	ER stations L / R	-10.00	10.00	TW ck
WS_e (m)	-0.040	WS stations L / R	0.00	3.05	3.05
Lf_e (m)	-0.400	Lf stations L / R	0.20	1.50	
W_{fp} (m)	20.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.61	1.00	
E_g (m m^{-1})	0.0070				

Bedload Transport Data

Rosgen	Strickler Q Q_{sb} (kg sec^{-1})	Limerinos Q Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
type			T_*	95.2	38.1	2.4
B3	0.0017	0.0021	saltation	YES	YES	YES
C3	0.0001	0.0006	rolling	YES	YES	YES
C4	0.0053	0.0078	Ø	NO	NO	NO

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.06	0.20	0.50	8.00	90.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				7.76	87.30
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	1.88		
τ_{calc} (N m^{-2})	18.47	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	19.04		
D_{50} V_c (vcs +) (m s^{-1})	0.11	0.23	
D_{84} V_c (vcs +) (m s^{-1})	0.44	0.90	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
3.1	68.8	21.9	6.3	0.0

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (m)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.637
V (m s^{-1})	0.69
n	0.050
Fr	0.40
D_c rectangular (m)	0.17
D_c trapezoidal (m)	0.26
D_c triangular (m)	0.39
D_c parabolic (m)	0.23
D_c mean (m)	0.26
flow type	SUBCRITICAL
Ω (watts m^{-1})	43.71
ω_a (watts m^{-2})	12.83
ω_a/TW (watts m^{-1})	4.22
*Re**	1.0
Re	164034
turbulence	LOW

Flow Regime — Limerinos method

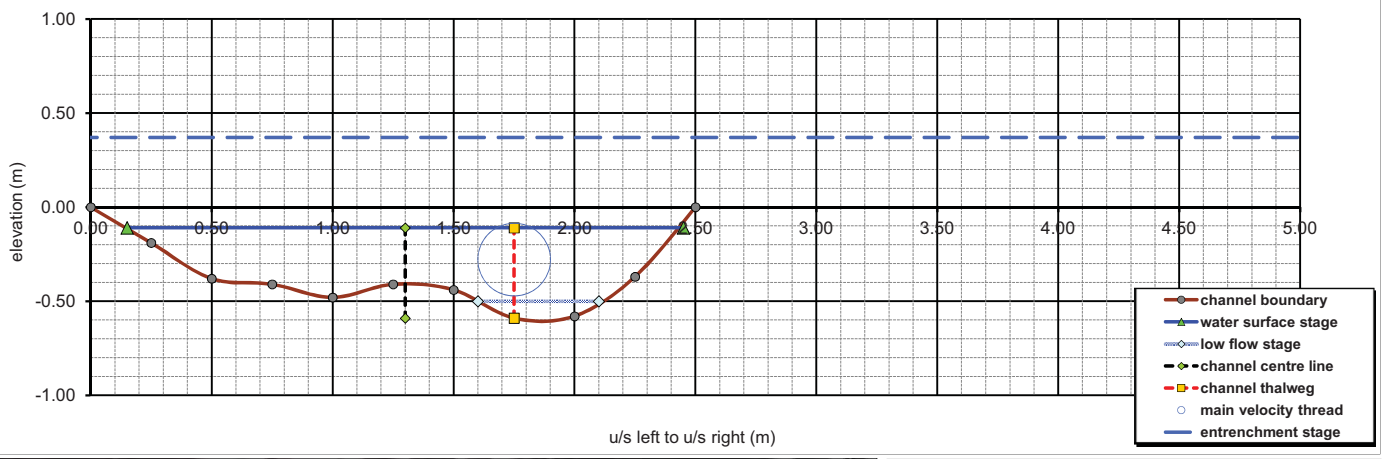
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 Stability Test - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

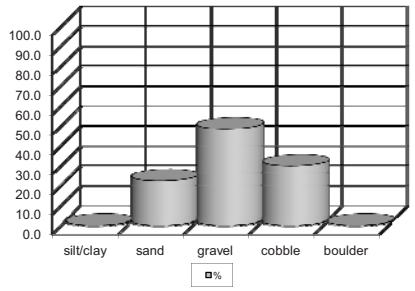
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type

cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry

A (m^2)	0.70
R (m)	0.26
TW (m)	2.28
WP (m)	2.65
max d (m)	0.48
mean d (m)	0.31
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness

rr *R* /D_{84}	3.10
ff V mean/V*	5.64
ff D_{84}	6.01
ff mean	5.82
	ROUGH BED

Hydraulic Ratios

ER max d	8.77
r_c / TW	
TW / Lf_w	4.56
TW/max d	4.8
TW/mean d	7.4

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.412	16.08	NO	NO	NO	NO
V_* (m s^{-1})	0.063	D_{50}	0.803	31.34	NO	NO	NO	NO
		D_{84}	1.353	52.80	NO	NO	NO	NO

Section Data

ER_e (m)	0.37	ER stations L / R	-10.00	10.00	TW ck
WS_e (m)	-0.110	WS stations L / R	0.15	2.45	2.30
Lf_e (m)	-0.500	Lf stations L / R	1.60	2.10	
W_{fp} (m)	20.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.59	1.75	
E_g (m m^{-1})	0.0074				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0015	0.0016	T_*	2.5	0.7	0.2
C3	0.0001	0.0001	saltation	YES	NO	NO
C4	0.0047	0.0051	rolling	YES	NO	NO
			Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	1.00	8.00	30.00	85.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				82.45	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	1.95		
τ_{calc} (N m^{-2})	19.14	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	19.73		
D_{50} V_c (vcs +) (m s^{-1})	0.85	1.72	
D_{84} V_c (vcs +) (m s^{-1})	1.43	2.90	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	22.2	48.1	29.6	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime Strickler method

Q (cms)	0.493
V (m s^{-1})	0.70
n	0.050
Fr	0.41
D_c rectangular (m)	0.17
D_c trapezoidal (m)	0.24
D_c triangular (m)	0.35
D_c parabolic (m)	0.20
D_c mean (m)	0.24
flow type	SUBCRITICAL
Ω (watts m^{-1})	35.75
ω_a (watts m^{-2})	13.48
ω_a/TW (watts m^{-1})	5.91
*Re**	63.5
Re	163108
turbulence	HIGH

Flow Regime Limerinos method

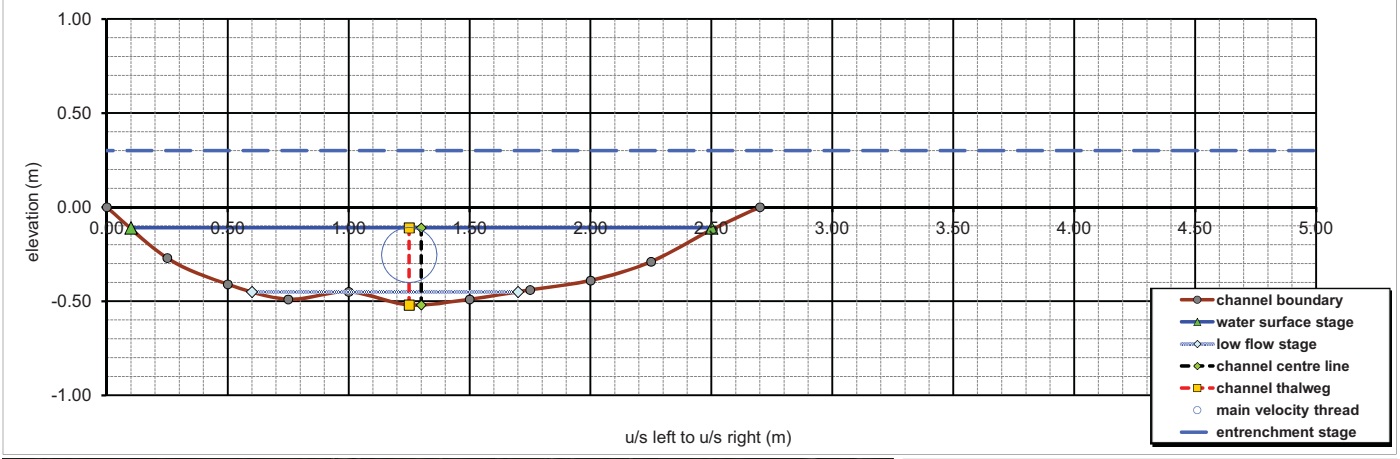
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 Stability Test - Shellswell's Creek Tributary (5 Line S., Guthrie) - Node G1

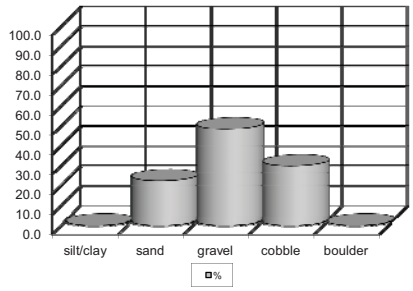
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	
run	●
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.68
R (m)	0.26
TW (m)	2.41
WP (m)	2.63
max d (m)	0.41
mean d (m)	0.28
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	3.05
ff V mean/V*	5.57
ff D_{84}	5.81
ff mean	5.69
ROUGH BED	

Hydraulic Ratios	
ER max d	10.35
r_c / TW	
TW / Lf_w	2.20
TW/max d	5.9
TW/mean d	8.5

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.412	16.11	NO	NO	NO	NO
V_* (m s^{-1})	0.062	D_{50}	0.803	31.39	NO	NO	NO	NO
		D_{84}	1.353	52.88	NO	NO	NO	NO

Section Data

ER_e (m)	0.30	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	-0.110	WS stations L / R	0.10	2.50	2.40
Lf_e (m)	-0.450	Lf stations L / R	0.60	1.70	
W_{fp} (m)	25.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.52	1.25	
E_g (m m^{-1})	0.0075				

Bedload Transport Data

	Strickler Q	Limerinos Q				
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
B3	0.0015	0.0016	T_*	2.5	0.7	0.2
C3	0.0001	0.0001	saltation	YES	NO	NO
C4	0.0046	0.0050	rolling	YES	NO	NO
			Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	1.00	8.00	30.00	85.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})				82.45	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b	
τ_{calc} (kg m^{-2})	1.95		
τ_{calc} (N m^{-2})	19.07	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	19.66		
D_{50} V_c (vcs +) (m s^{-1})	0.85	1.73	
D_{84} V_c (vcs +) (m s^{-1})	1.43	2.91	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	22.2	48.1	29.6	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime — Strickler method

Q (cms)	0.479
V (m s^{-1})	0.70
n	0.050
Fr	0.42
D_c rectangular (m)	0.16
D_c trapezoidal (m)	0.24
D_c triangular (m)	0.35
D_c parabolic (m)	0.20
D_c mean (m)	0.24
flow type	SUBCRITICAL
Ω (watts m^{-1})	35.23
ω_a (watts m^{-2})	13.38
ω_a/TW (watts m^{-1})	5.54
Re^*	61.6
Re	159697
turbulence	HIGH

Flow Regime — Limerinos method

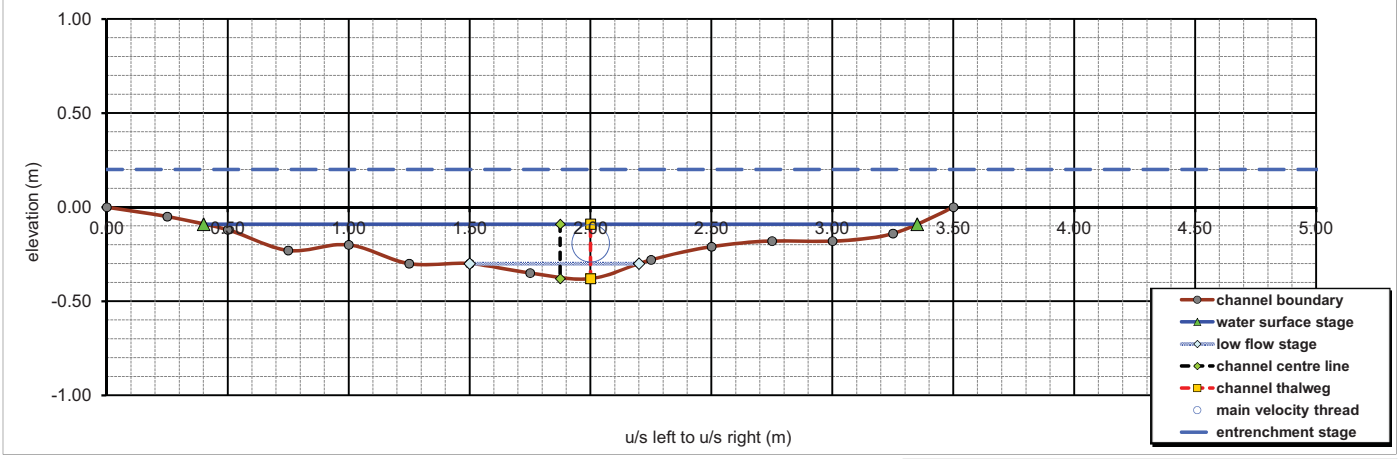
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
Re^*	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 1 Stability Test - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

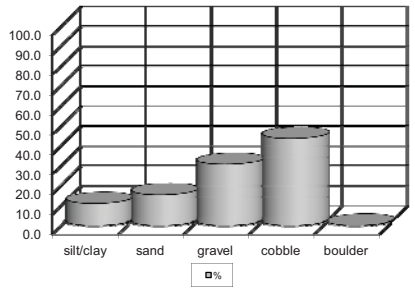
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.44
R (m)	0.14
TW (m)	2.95
WP (m)	3.05
max d (m)	0.29
mean d (m)	0.15
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.32
ff V mean/V*	4.06
ff D_{84}	3.59
ff mean	3.83
	ROUGH BED

Hydraulic Ratios	
ER max d	5.09
r_c / TW	
TW / Lf_w	4.21
TW/max d	10.2
TW/mean d	19.7

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.462	12.08	NO	NO	NO	NO
V_* (m s^{-1})	0.093	D_{50}	0.984	25.75	NO	NO	NO	NO
		D_{84}	1.540	40.27	NO	NO	NO	NO

Section Data

ER_e (m)	0.20	ER stations L / R	-5.00	10.00	TW ck
WS_e (m)	-0.090	WS stations L / R	0.40	3.35	2.95
Lf_e (m)	-0.300	Lf stations L / R	1.50	2.20	
W_{fp} (m)	15.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.38	2.00	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0014	0.0014	saltation	YES	NO	NO
C3	0.0000	0.0000	rolling	YES	NO	NO
C4	0.0041	0.0040	Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	0.10	10.00	45.00	110.00	220.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		9.70	43.65	106.70	213.40
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	4.34		
τ_{calc} (N m^{-2})	42.56		
τ D_{crit} (gr-co) (mm)	43.88		
D_{50} V_c (vcs +) (m s^{-1})	1.04	1.72	
D_{84} V_c (vcs +) (m s^{-1})	1.63	2.69	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
10.9	15.2	30.4	43.5	0.0

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime Strickler method

Q (cms)	0.381
V (m s^{-1})	0.86
n	0.055
Fr	0.71
D_c rectangular (m)	0.12
D_c trapezoidal (m)	0.22
D_c triangular (m)	0.32
D_c parabolic (m)	0.21
D_c mean (m)	0.22
flow type	SUBCRITICAL
Ω (watts m^{-1})	111.94
ω_a (watts m^{-2})	36.72
ω_a/TW (watts m^{-1})	12.46
*Re**	109.4
Re	109565
turbulence	HIGH

Flow Regime Limerinos method

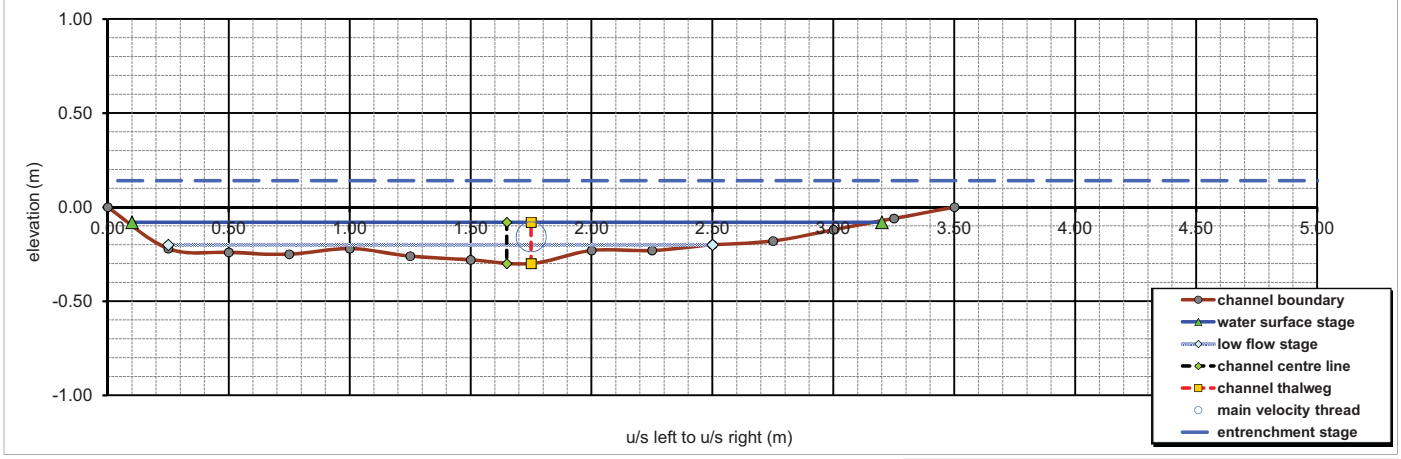
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 2 Stability Test - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

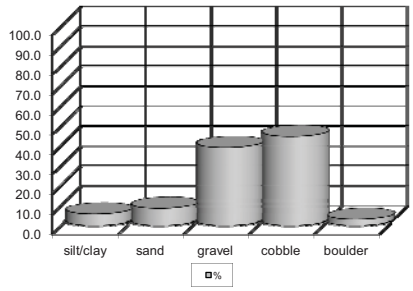
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type

cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	●

Hydraulic Roughness

rr R/D_{84}	1.06
ff V mean/V*	3.77
ff D_{84}	3.04
ff mean	3.40
	ROUGH BED

Hydraulic Geometry

A (m^2)	0.43
R (m)	0.14
TW (m)	3.08
WP (m)	3.16
max d (m)	0.22
mean d (m)	0.14
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Ratios

ER max d	4.23
r_c / TW	
TW / Lf_w	1.37
TW/max d	14.0
TW/mean d	21.8

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	14.09	NO	NO	NO	NO
V_* (m s^{-1})	0.098	D_{50}	1.038	25.79	NO	NO	NO	NO
		D_{84}	1.674	41.60	NO	NO	NO	NO

Section Data

ER_e (m)	0.14	ER stations L / R	-3.00	10.00	TW ck
WS_e (m)	-0.080	WS stations L / R	0.10	3.20	3.10
Lf_e (m)	-0.200	Lf stations L / R	0.25	2.50	
W_{fp} (m)	13.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.30	1.75	
E_g (m m^{-1})	0.0350				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0014	0.0014	saltation	YES	NO	NO
C3	0.0000	0.0000	rolling	YES	NO	NO
C4	0.0042	0.0038	Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	3.00	15.00	50.00	130.00	260.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		14.55	48.50	126.10	252.20
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	4.81		
τ_{calc} (N m^{-2})	47.16		
τ D_{crit} (gr-co) (mm)	48.61		
D_{50} V_c (vcs +) (m s^{-1})	1.10	1.74	
D_{84} V_c (vcs +) (m s^{-1})	1.77	2.80	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
5.6	8.3	38.9	44.4	2.8

Bank Data u/s L u/s R

H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Flow Regime Strickler method

Q (cms)	0.391
V (m s^{-1})	0.90
n	0.055
Fr	0.77
D_c rectangular (m)	0.12
D_c trapezoidal (m)	0.22
D_c triangular (m)	0.32
D_c parabolic (m)	0.22
D_c mean (m)	0.22
flow type	SUBCRITICAL
Ω (watts m^{-1})	134.14
ω_a (watts m^{-2})	42.45
ω_a/TW (watts m^{-1})	13.80
*Re**	122.2
Re	108552
turbulence	HIGH

Flow Regime Limerinos method

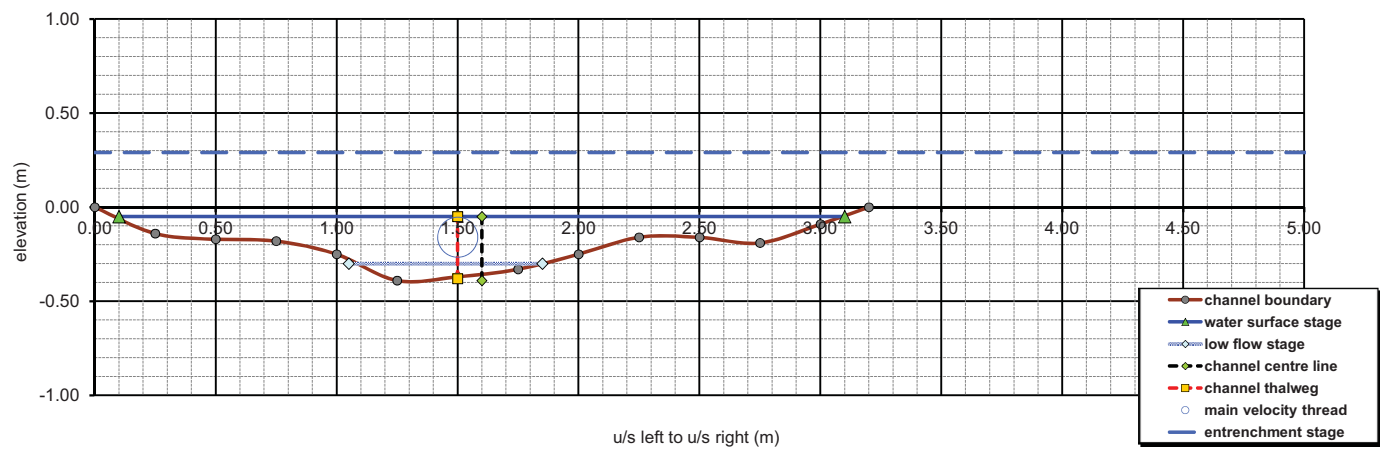
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 4 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

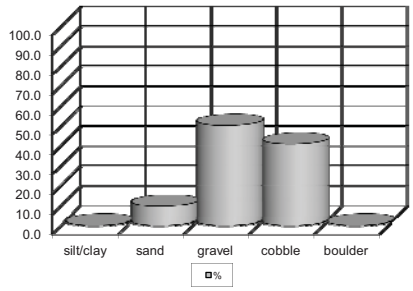
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.51
R (m)	0.16
TW (m)	3.00
WP (m)	3.13
max d (m)	0.34
mean d (m)	0.17
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	1.64
ff V mean/V*	4.59
ff D_{84}	4.16
ff mean	4.37
ROUGH BED	

Hydraulic Ratios	
ER max d	5.00
r_c / TW	
TW / Lf_w	3.75
TW/max d	8.8
TW/mean d	17.5

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	13.95	NO	NO	NO	NO
V_* (m s^{-1})	0.099	D_{50}	1.038	25.53	NO	NO	NO	NO
		D_{84}	1.468	36.12	NO	NO	NO	NO

Section Data

ER_e (m)	0.29	ER stations L / R	-5.00	10.00	TW ck
WS_e (m)	-0.050	WS stations L / R	0.10	3.10	3.00
Lf_e (m)	-0.300	Lf stations L / R	1.05	1.85	
W_{fp} (m)	15.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) / $T_{o/s}$ (m)	-0.38	1.50	
E_g (m m^{-1})	0.0300				

Bedload Transport Data

Rosgen type	Strickler Q_{sb} (kg sec^{-1})	Limerinos Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
B3	0.0016	0.0016	saltation	YES	NO	NO
C3	0.0001	0.0001	rolling	YES	NO	NO
C4	0.0048	0.0047	Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	4.00	15.00	50.00	100.00	130.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	3.88	14.55	48.50	97.00	126.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} (kg m^{-2})	4.91		
τ_{calc} (N m^{-2})	48.12		
τ D_{crit} (gr-co) (mm)	49.60		
D_{50} V_c (vcs +) (m s^{-1})	1.10	1.52	
D_{84} V_c (vcs +) (m s^{-1})	1.55	2.15	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	9.4	50.0	40.6	0.0

Bank Data u/s L u/s R

H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Flow Regime — Strickler method

Q (cms)	0.528
V (m s^{-1})	1.03
n	0.050
Fr	0.80
D_c rectangular (m)	0.15
D_c trapezoidal (m)	0.25
D_c triangular (m)	0.36
D_c parabolic (m)	0.24
D_c mean (m)	0.25
flow type	SUBCRITICAL
Ω (watts m^{-1})	155.31
ω_a (watts m^{-2})	49.57
ω_a/TW (watts m^{-1})	16.53
*Re**	108.7
Re	147904
turbulence	HIGH

Flow Regime — Limerinos method

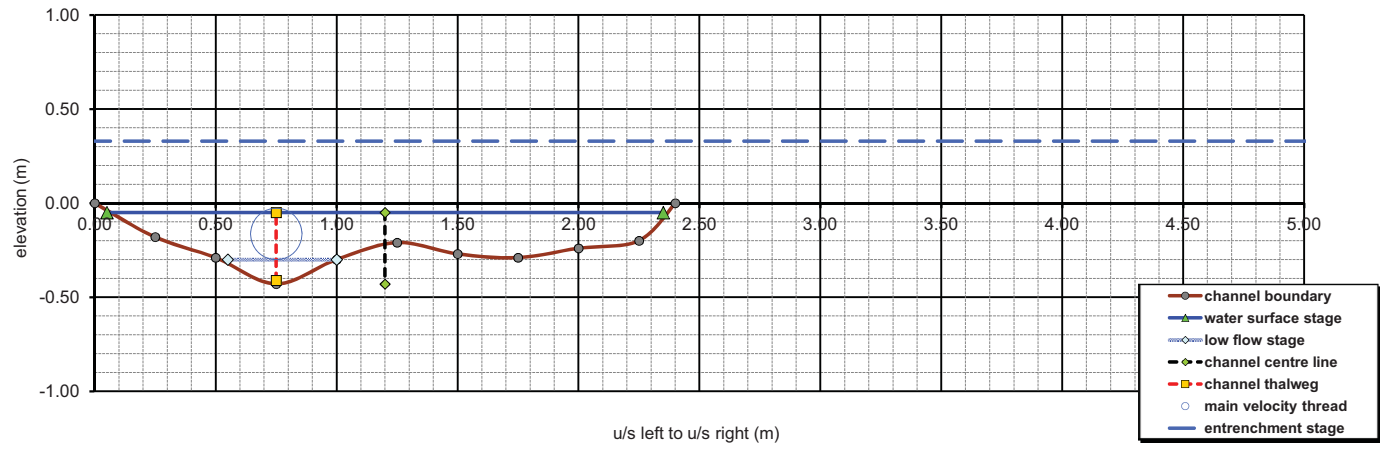
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Sec. 5 - Kempenfelt Bay Tributary C (Robertson St., Hawkestone) - Node H4

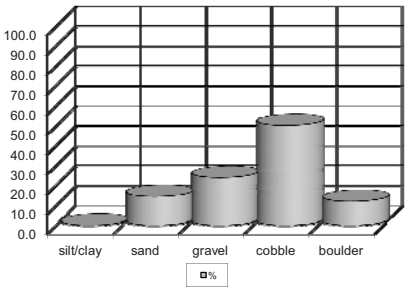
B. de Geus 05.11

Cross Section Plot





Substrate Type



Morphology Type	
cascade	
step	●
riffle	
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	0.48
R (m)	0.19
TW (m)	2.29
WP (m)	2.53
max d (m)	0.38
mean d (m)	0.21
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	0.82
ff V mean/V*	3.65
ff D_{84}	2.57
ff mean	3.11
ROUGH BED	

Hydraulic Ratios	
ER max d	6.54
r_c / TW	
TW / Lf_w	5.10
TW/max d	6.0
TW/mean d	11.1

Sediment Transport Mode			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	15.99	NO	NO	NO	NO
V_* (m s^{-1})	0.123	D_{50}	1.540	30.64	NO	NO	NO	NO
		D_{84}	2.227	44.31	NO	NO	NO	NO

Section Data					
ER_e (m)	0.33	ER stations L / R	-5.00	10.00	TW ck
WS_e (m)	-0.050	WS stations L / R	0.05	2.35	2.30
Lf_e (m)	-0.300	Lf stations L / R	0.55	1.00	
W_{fp} (m)	15.00	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.41	0.75	
E_g (m m^{-1})	0.0400				

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	3.00	30.00	110.00	230.00	340.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})		29.10	106.70	223.10	329.80
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Erosion Thresholds		V_c / V_b	
τ_{calc} (kg m^{-2})	7.50		
τ_{calc} (N m^{-2})	73.53	Strickler	Limerinos
τ D_{crit} (gr-co) (mm)	75.81		
D_{50} V_c (vcs +) (m s^{-1})	1.63	1.96	
D_{84} V_c (vcs +) (m s^{-1})	2.35	2.83	

Substrate Type (%)				
silt/clay	sand	gravel	cobble	boulder
0.0	14.3	23.8	50.0	11.9

Bank Data u/s L	u/s R
H_b (m)	
Bf_d (m)	
RDp (m)	
H_b/Bf_d	
RDp/H_b	
RDn (%)	
BA (°)	
BFP (%)	

Bedload Transport Data						
	Strickler Q	Limerinos Q		D_{30}	D_{50}	D_{84}
Rosgen type	Q_{sb} (kg sec^{-1})	Q_{sb} (kg sec^{-1})	T_*	2.5	0.7	0.3
B3	0.0016	0.0014	saltation	YES	NO	NO
C3	0.0001	0.0000	rolling	YES	NO	NO
C4	0.0050	0.0041	Ø	NO	YES	YES

Flow Regime Strickler method	
Q (cms)	0.563
V (m s^{-1})	1.18
n	0.055
Fr	0.83
D_c rectangular (m)	0.19
D_c trapezoidal (m)	0.27
D_c triangular (m)	0.37
D_c parabolic (m)	0.24
D_c mean (m)	0.27
flow type	SUBCRITICAL
Ω (watts m^{-1})	220.72
ω_a (watts m^{-2})	87.13
ω_a/TW (watts m^{-1})	38.00
*Re**	264.4
Re	194979
turbulence	HIGH

Flow Regime Limerinos method	
Q (cms)	
V (m s^{-1})	
n	
Fr	
D_c rectangular (m)	
D_c trapezoidal (m)	
D_c triangular (m)	
D_c parabolic (m)	
D_c mean (m)	
flow type	
Ω (watts m^{-1})	
ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	
*Re**	
Re	
turbulence	

GEO - ESUM v.1.3 Erosion Threshold Summary Models

Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)
Shellswell's Creek Tributary (5 Line S., Guthrie)
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)

Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan

AquaLogic

GEO - ESUM v.1.3 Erosion Threshold Summary Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Kempenfelt Bay Tributary A (Ridge Rd. W & O'Brien St., Shanty Cove)

B. de Geus 8.11

Existing Channel Capacity	Q $m^3 s^{-1}$	V $m s^{-1}$	veg control	D_{50} particle	D_{84}-D_{100} particle	τ_{calc} N m^{-2}	veg control	D_{50} particle*	D_{84}-D_{100} particle*	Ω watts m^{-1}	Ω threshold
Xsec. 1	0.776	1.02	Y	Y	Y	37.5	Y	Y	Y	168.0	Y
Xsec. 2	0.782	1.09	Y	Y	Y	41.1	N	Y	Y	160.0	Y
Xsec. 3	0.787	1.14	Y	Y	Y	46.4	N	Y	Y	200.0	Y
Xsec. 4	0.787	1.05	Y	Y	Y	56.8	N	Y	Y	231.0	Y
Xsec. 5	0.788	1.01	Y	Y	Y	54.1	N	Y	Y	231.0	Y
Dynamic Stability											
• Xsec. 1	0.501	0.89	Y	Y	Y	30.6	Y	Y	Y	108.0	Y
Xsec. 2	0.426	0.88	Y	Y	Y	29.7	Y	Y	Y	88.0	Y
Xsec. 3	0.296	0.85	Y	Y	Y	29.8	Y	Y	Y	76.0	Y
• Xsec. 4	0.383	0.91	Y	Y	Y	45.7	D	Y	Y	113.0	Y
• Xsec. 5	0.272	0.70	Y	Y	Y	31.0	Y	Y	Y	80.0	Y

Stability Criteria Met: Y - Yes, N - No, D - Dynamic

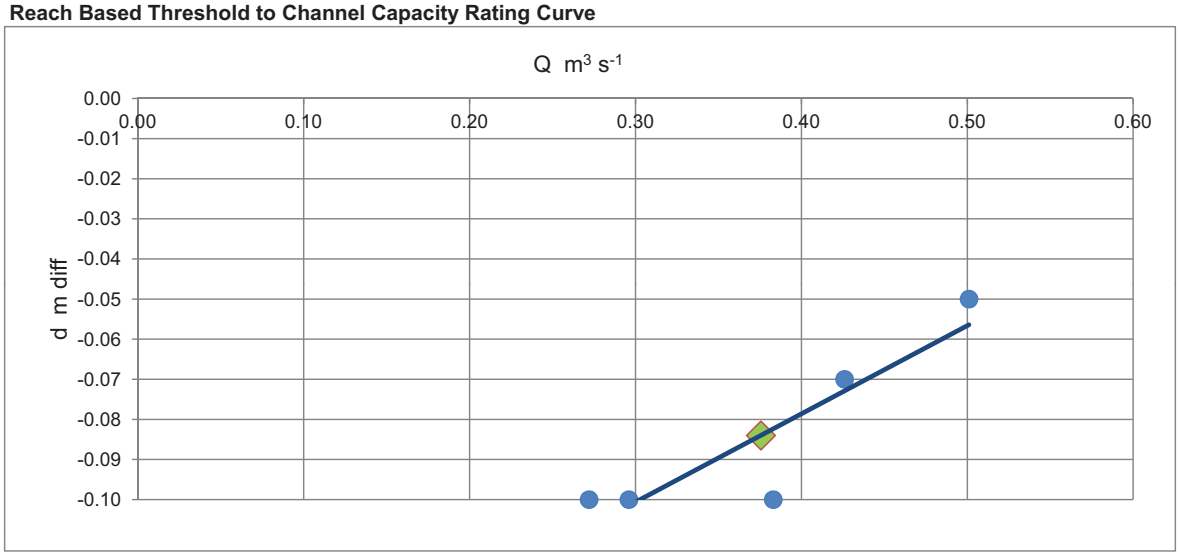
* - within 5 mm

Dynamic Stability
Dynamic Stability = Cautionary
Potentially Unstable

• additional adjustment made to flow stage to help confine flows over armoured bed

	Q $m^3 s^{-1}$ existing	Q $m^3 s^{-1}$ stable	Q $m^3 s^{-1}$ diff	d m diff
Xsec. 1	0.78	0.50	0.28	-0.05
Xsec. 2	0.78	0.43	0.36	-0.07
Xsec. 3	0.79	0.30	0.49	-0.10
Xsec. 4	0.79	0.38	0.40	-0.10
Xsec. 5	0.79	0.27	0.52	-0.10
mean	**0.78**	**0.38**	0.41	-0.08

Reach Based Threshold to Channel Capacity Rating Curve



GEO - ESUM v.1.3 Erosion Threshold Summary Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Kempenfelt Bay Tributary B (Ridge Rd. W & Line 3 S., Shanty Cove)

B. de Geus 8.11

Existing Channel Capacity	Q $m^3 s^{-1}$	V $m s^{-1}$	veg control	D_{50} particle	D_{84}-D_{100} particle	τ_{calc} N m^{-2}	veg control	D_{50} particle*	D_{84}-D_{100} particle*	Ω watts m^{-1}	Ω threshold
Xsec. 1	0.097	0.73	Y	Y	Y	30.2	Y	Y	Y	34.0	Y
Xsec. 2	0.097	0.75	Y	N	Y	33.6	Y	N	Y	44.0	Y
Xsec. 3	0.093	0.68	Y	D	Y	28.9	Y	D	Y	42.0	Y
Xsec. 4	0.094	0.70	Y	Y	Y	29.0	Y	Y	Y	37.0	Y
Xsec. 5	0.098	0.72	Y	N	Y	24.0	Y	D	Y	29.0	Y
Dynamic Stability											
Xsec. 1	0.097	0.73	Y	Y	Y	30.2	Y	Y	Y	34.0	Y
Xsec. 2	0.064	0.66	Y	D	Y	27.9	Y	D	Y	29.0	Y
Xsec. 3	0.093	0.68	Y	D	Y	28.9	Y	D	Y	42.0	Y
Xsec. 4	0.094	0.70	Y	Y	Y	29.0	Y	Y	Y	37.0	Y
Xsec. 5	0.081	0.68	Y	D	Y	22.0	Y	D	Y	24.0	Y

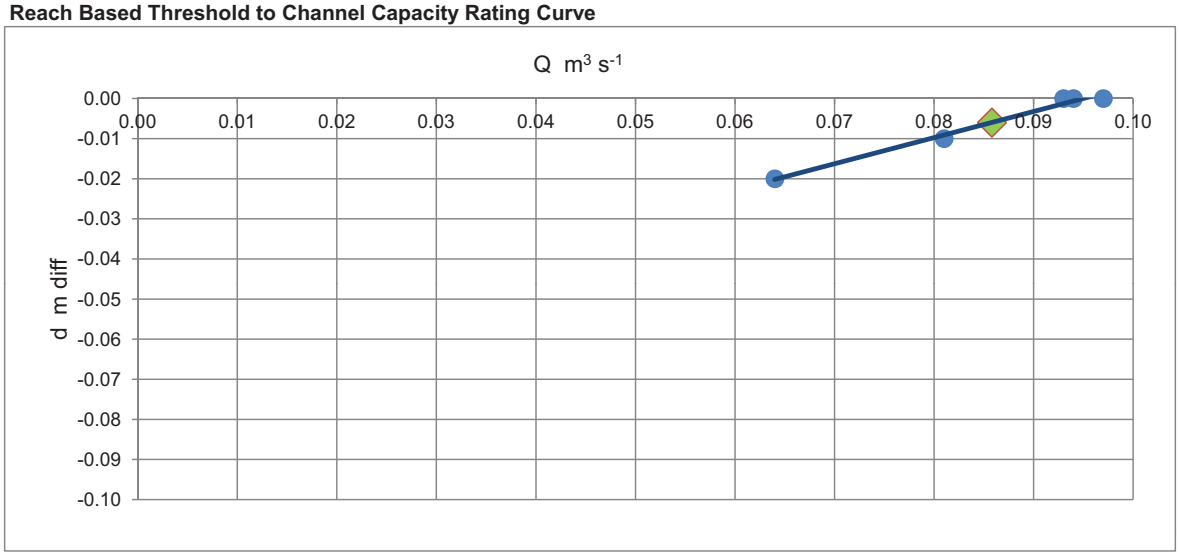
Stability Criteria Met: Y - Yes, N - No, D - Dynamic

* - within 5 mm

Dynamic Stability
Dynamic Stability = Cautionary
Potentially Unstable

	Q $m^3 s^{-1}$ existing	Q $m^3 s^{-1}$ stable	Q $m^3 s^{-1}$ diff	d m diff
Xsec. 1	0.10	0.10	0.00	0.00
Xsec. 2	0.10	0.06	0.03	-0.02
Xsec. 3	0.09	0.09	0.00	0.00
Xsec. 4	0.09	0.09	0.00	0.00
Xsec. 5	0.10	0.08	0.02	-0.01
mean	**0.10**	**0.09**	0.01	-0.01

Reach Based Threshold to Channel Capacity Rating Curve



GEO - ESUM v.1.3 Erosion Threshold Summary Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Shellswell's Creek Tributary (5 Line S., Guthrie)

B. de Geus 8.11

Existing Channel Capacity	Q $m^3 s^{-1}$	V $m s^{-1}$	veg control	D_{50} particle	D_{84}-D_{100} particle	τ_{calc} $N m^{-2}$	veg control	D_{50} particle*	D_{84}-D_{100} particle*	Ω watts m^{-1}	Ω threshold
Xsec. 1	0.765	0.85	Y	N	Y	26.5	Y	N	D	65.0	Y
Xsec. 2	0.771	0.77	Y	N	Y	21.2	Y	N	D	50.0	Y
Xsec. 3	0.770	0.74	Y	N	N	20.3	Y	N	D	53.0	Y
Xsec. 4	0.779	0.81	Y	Y	Y	23.5	Y	Y	Y	57.0	Y
Xsec. 5	0.782	0.81	Y	Y	Y	23.7	Y	Y	Y	57.0	Y
Dynamic Stability											
Xsec. 1	0.412	0.70	Y	D	Y	19.8	Y	N	D	35.0	Y
Xsec. 2	0.574	0.70	Y	D	Y	18.5	Y	Y	D	37.0	Y
Xsec. 3	0.637	0.69	Y	D	Y	18.5	Y	N	D	44.0	Y
• Xsec. 4	0.49	0.70	Y	Y	Y	19.1	Y	Y	Y	36.0	Y
• Xsec. 5	0.48	0.70	Y	Y	Y	19.1	Y	Y	Y	35.0	Y

Stability Criteria Met: Y - Yes, N - No, D - Dynamic

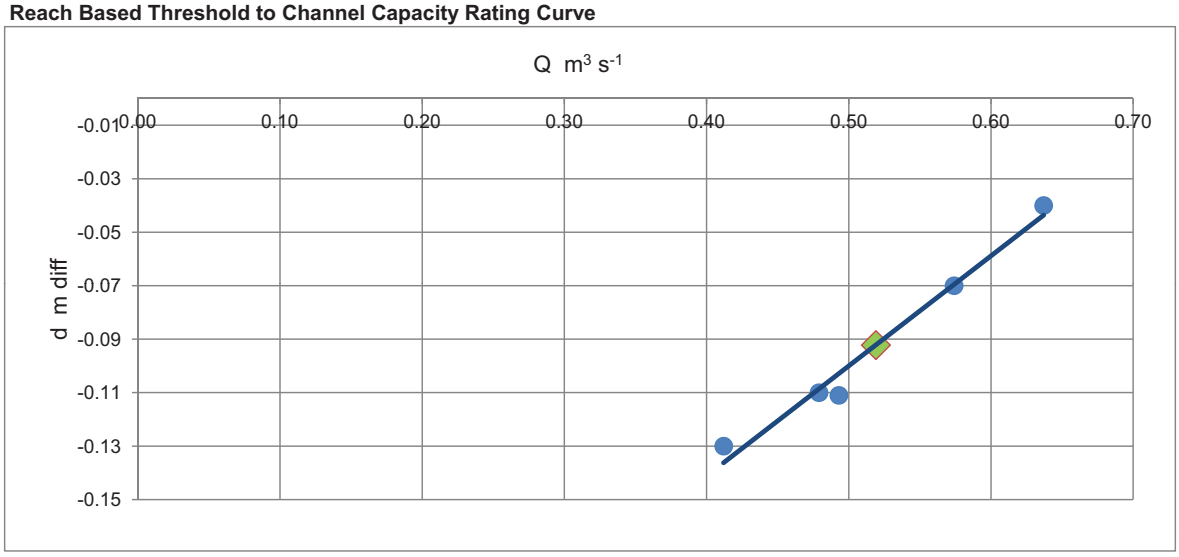
* - within 5 mm

Dynamic Stability
Dynamic Stability = Cautionary
Potentially Unstable

• additional adjustment made to flow stage to help confine flows over armoured bed and to address bank soil type for consistency with other sections

	Q $m^3 s^{-1}$ existing	Q $m^3 s^{-1}$ stable	Q $m^3 s^{-1}$ diff	d m diff
Xsec. 1	0.77	0.41	0.35	-0.13
Xsec. 2	0.77	0.57	0.20	-0.07
Xsec. 3	0.77	0.64	0.13	-0.04
Xsec. 4	0.78	0.49	0.29	-0.11
Xsec. 5	0.78	0.48	0.30	-0.11
mean	**0.77**	**0.52**	0.25	-0.09

Reach Based Threshold to Channel Capacity Rating Curve



GEO - ESUM v.1.3 Erosion Threshold Summary Model

Project: Erosion Threshold Analysis
Oro-Medonte Stormwater Management Master Plan
Kempenfelt Bay Tributary C (Robertson St., Hawkestone)

B. de Geus 8.11

Existing Channel Capacity	Q $m^3 s^{-1}$	V $m s^{-1}$	veg control	D_{50} particle	D_{84}-D_{100} particle	τ_{calc} $N m^{-2}$	veg control	D_{50} particle*	D_{84}-D_{100} particle*	Ω watts m^{-1}	Ω threshold
Xsec. 1	0.784	1.07	Y	Y	Y	59.0	D	N	Y	230.0	Y
Xsec. 2	0.787	1.13	Y	Y	Y	66.0	D	N	Y	270.0	Y
Xsec. 3	0.783	1.20	Y	Y	Y	72.4	D	Y	Y	269.0	Y
Xsec. 4	0.784	1.17	Y	Y	Y	58.5	D	N	Y	230.0	Y
Xsec. 5	0.784	1.32	N	Y	Y	86.6	N	Y	Y	307.0	Y
Dynamic Stability											
• Xsec. 1	0.381	0.86	Y	Y	Y	42.6	D	Y	Y	112.0	Y
• Xsec. 2	0.391	0.90	Y	Y	Y	47.2	D	Y	Y	134.0	Y
Xsec. 3	0.783	1.20	Y	Y	Y	72.4	D	Y	Y	269.0	Y
Xsec. 4	0.528	1.03	Y	Y	Y	48.1	D	Y	Y	155.0	Y
Xsec. 5	0.563	1.18	Y	Y	Y	73.5	D	Y	Y	221.0	Y

Stability Criteria Met: Y - Yes, N - No, D - Dynamic

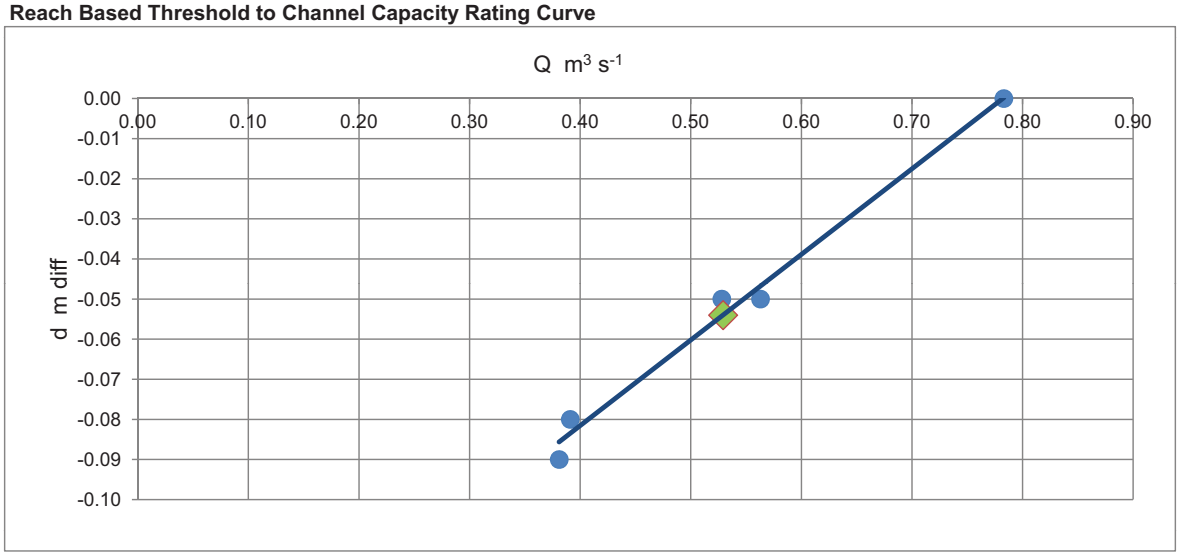
* - within 5 mm

Dynamic Stability
Dynamic Stability = Cautionary
Potentially Unstable

• additional adjustment made to flow stage to help confine flows over armoured bed

	Q $m^3 s^{-1}$ existing	Q $m^3 s^{-1}$ stable	Q $m^3 s^{-1}$ diff	d m diff
Xsec. 1	0.78	0.38	0.40	-0.09
Xsec. 2	0.79	0.39	0.40	-0.08
Xsec. 3	0.78	0.78	0.00	0.00
Xsec. 4	0.78	0.53	0.26	-0.05
Xsec. 5	0.78	0.56	0.22	-0.05
mean	**0.78**	**0.53**	0.26	-0.05

Reach Based Threshold to Channel Capacity Rating Curve



APPENDIX E:
PUBLIC INFORMATION CENTRE FEEDBACK

Township of Oro-Medonte
Proud Heritage, Exciting Future

TOWNSHIP OF ORO-MEDONTE
COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

NOTICE OF PUBLIC OPEN HOUSE

The Township of Oro-Medonte has initiated a Comprehensive Stormwater Management Master Plan (CSWM-MP) in compliance with the requirements of the Lake Simcoe Protection Plan and the Guidelines developed for the implementation of the CSWM-MP in the Lake Simcoe Watershed.

The primary goal of the CSWM-MP is to improve water quality in the Lake Simcoe watershed by reducing phosphorous loadings. The study will identify ways to improve the management of stormwater in the Township to achieve this goal through a detailed analysis of existing conditions and evaluation of stormwater management alternatives.

A Public Open House Meeting will be held on:

Date: **Thursday, September 18, 2014**
Time: **4:30 to 7:00 p.m.**
Location: **Township Administration Centre**
148 Line 7 South Oro-Medonte, Ontario L0L 2E0

This meeting will provide an opportunity for the public and stakeholders to review the alternatives under consideration and to provide input and comments.

Subsequent to the Public Open House, the Township will review the comments and recommend a preferred alternative(s). Those individuals and parties that request to be kept informed will be notified of the date that the preferred alternative(s) is presented to General Committee such that there is the opportunity for deputations to the next scheduled Council session, if required. Written comments and input are welcome and should be submitted to:

Jerry Ball, CRSS
Township of Oro-Medonte
148 Line 7 South P.O. Box 100
Oro, Ontario
L0L 2X0
Tel: 705-487-2171
Fax: 705-487-0133
e-mail: jball@oro-medonte.ca

or

Dan Hurley, B.A.Sc., P.Eng.
C.C. Tatham & Associates Ltd.
115 Sandford Fleming Drive, Suite 200
Collingwood, Ontario
L9Y 5A6
Tel: 705-444-2565, ext 228
Fax: 705-444-2327
e-mail: dhurley@cctatham.com

This Notice issued August 27, 2014.

Oro-Medonte

Comprehensive Stormwater Management Master Plan

September 18, 2014

4:30pm-7pm

SIGN-IN SHEET

Please Print Clearly

NAME, ORGANIZATION	ADDRESS	EMAIL ADDRESS	PHONE #	ADD TO MAILING LIST
L. McNiven	148 Line 7 S	———	705 487-2171	YES / NO
DIANE RICHARDS	72 WILLIAM	DIANERICHARDS2014 Chotmail.com	705-7347466	YES / NO
Steve Schaefer SCS Consulting Group	30 Centurian Drive Suite 100 Markham	sschaefer@scsconsultinggroup.com	905 475 1900	YES / NO
TIM CROOKS	133 BAY ST.	TVCROOKS@SYMPATICO.CA	416-961-8467	YES / NO
SANDY AGNEW	1305 SCARLETT LINE	sagnew@ecomedic.ca	705-835-6824	YES / NO
Bruce Quinn	26 Alpine Dr.	quinbj@live.ca	705 835-6706	YES / NO

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record. Questions regarding this collection should be directed to the project manager.

Thank you for your participation in this study

1: Please send copy of open house presentation -

SIGN-IN SHEET

Please Print Clearly

NAME, ORGANIZATION	ADDRESS	EMAIL ADDRESS	PHONE #	ADD TO MAILING LIST
SUE BENJAFIELD	267 Bay St.	sbenjafield@hotmail.com	705-727-0395	YES / NO
Ted Bigelow	115 Bay Cte	tebigelow@rogers.com	705-732-4576	YES / NO
✓ ANN TRUYENS COPY OF PRESENTATION EDGAIR		at@iglide.net	705-721-7898	YES / NO
Ann Budge	13 Oneida Sagtuk		705-835-3318	YES / NO
Chris Clark (CHASKE DIESEL LTD)	47 PATERSON ROAD FOREST HOME INDUSTRIAL PARK	RBIORILLIA	705-325-4013	YES / NO
Mary Jane Lajeunesse	2249 Ridge Rd. W.	mjslajeunesse@yahoo.ca	705 737 2618	YES / NO
Pat O'Malley	30 5th Line North	pomalley@ryder.com	705-321-8433	YES / NO
Mark Crafoord	1 Melville court	matlayt/zed@hotmail.com	705 457 1946	YES / NO
BARRY METZ	2418 Hwy 11 South	barrymetz@sympatico.ca	705-487-3765	YES / NO
				YES / NO

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record. Questions regarding this collection should be directed to the project manager.

Thank you for your participation in this study

SIGN-IN SHEET

Please Print Clearly

NAME, ORGANIZATION	ADDRESS	EMAIL ADDRESS	PHONE #	ADD TO MAILING LIST
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record. Questions regarding this collection should be directed to the project manager.

Thank you for your participation in this study

SIGN-IN SHEET

Please Print Clearly

NAME, ORGANIZATION	ADDRESS	EMAIL ADDRESS	PHONE #	ADD TO MAILING LIST
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO

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Thank you for your participation in this study

SIGN-IN SHEET

Please Print Clearly

NAME, ORGANIZATION	ADDRESS	EMAIL ADDRESS	PHONE #	ADD TO MAILING LIST
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO
				YES / NO

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record. Questions regarding this collection should be directed to the project manager.

Thank you for your participation in this study

Submission re the Stormwater Management Master Plan

Shanty Bay - Controlling surface water runoff to reduce the amount of phosphorus flowing into Lake Simcoe

Date: **September 12, 2014**
To: Dan Hurley, B.A.Sc., P.Eng., C.C. Tatham & Associates Ltd., Collingwood, Ontario.
Jerry Ball, Township of Oro-Medonte
From: **AWARE Oro-Medonte and The Rescue Lake Simcoe Coalition**

Introduction

We submit the following report in answer to the Township's offer to receive written suggestions from the public and other interested parties in preparation for the forthcoming public meeting on September 18, 2014 about the alternative proposals for a stormwater management master plan for Shanty Bay and other settlement areas in the Lake Simcoe watershed in Oro-Medonte. This report outlines some of the drainage problems in Shanty Bay and suggested recommendations to fix the problems.

We look forward the reviewing the draft stormwater management master plan from C.C. Tatum and Associates Limited.

Background

Policy 4.5-SA of the Lake Simcoe Protection Plan states that " within five years of the date the Plan came into effect, municipalities, in collaboration with the LSRCA, will prepare and implement comprehensive stormwater master plans for each settlement area in the Lake Simcoe watershed." The Policy goes on to state what must be included in the master plans.

Drainage Objectives

Prior to June 2009, planning the drainage infrastructure for the settlement area of Shanty Bay was a matter of controlling flooding and directing all surface water runoff into Lake Simcoe via stormwater retention or holding ponds or by culverts and ditches. Since the Lake Simcoe Protection Plan was established in 2009, the focus is on pollution prevention and reducing the amount of phosphorus flowing into Lake Simcoe.

As far as Shanty Bay is concerned, the purposes of stormwater master plans within the boundary of Shanty Bay are to:

- Prevent silt and phosphorus from flowing into Lake Simcoe. Note that silt contains phosphorus.
- Prevent erosion.
- Prevent e-coli and other pollutants for example, gas and oil spills from driveways, from flowing into Lake Simcoe.
- Prevent flooding.

Existing drainage systems

Within the village of Shanty Bay, there are four main catchment areas or watersheds:

1. The watershed including the land surrounding the houses in Arbourwood and Martine Crescent and the Church Woods, a wooded private conservation area owned by the Couchiching Conservancy. This catchment area has three drainage outlets; one into the two large stormwater ponds just south and west of the Arbourwood housing development, another into a stormwater treatment pond at northeast corner of Ridge Road and Martine Crescent and another into the Church Woods.

2. The watershed drained by the ditches that run along the second line and into the lake.

3. The watershed that includes the fields and house lots north of the fire hall and the Ridge Road and east of line 2 and drains into the lake via an ever-deepening ditch that runs through a wooded area parallel and east of the houses on the east side O'Brien Street.

4. The catchment area that drains into the storm water pond at the north east corner of the Ridge Road and Martine Crescent.

Problems

Three of the above three catchment are dumping tons of silt and large amounts of phosphorus into Lake Simcoe.

1 (a). Drainage into and from the Church Woods

Description of the stormwater runoff

Some of the runoff from the housing development (Arbourwood) north of the Rail Trail flows directly into a ditch that runs along the north side of the Rail Trail, then it flows west along the ditch, then the water flows underneath the Rail Trial via an old culvert, then it flows east for about 100 meters, then it flows south along a ditch, then it flows underneath the Ridge Road and into the Church Woods. Next, the water

meanders through the woods and finally goes underneath Bay Street and into Kempenfelt Bay beside 115 Bay Street. You can see this drainage pattern in the "Shanty Bay Drainage Study" report prepared by Skelton, Brumwell & Associates Limited dated August 1975.

The volume of water flowing through the woods has been increasing, especially during the annual spring thaw and during heavy rains. For example, on Friday, September 5, 2014 there a thunderstorm with heavy rain from 7:00 P.M. until midnight. At 9:15 P.M. during a lull in the storm, I walked through the woods to the north end where the culvert under Ridge Road empties into the woods. At about one bucketfull every 35 seconds, the water from the culvert flowed through the woods gathering silt as it went. The water plus the silt flowed through the woods, flowed underneath a culvert under Bay Street and emptied into Lake Simcoe. On Saturday morning, September 6, there was a puddle of silt lying is the shallow water just in front of the outfall into the bay. The silt puddle was four to five inches deep and about eight feet in diameter.

The Church Woods should act as a buffer between the lake and the developments north of the Ridge Road. The woods should be able to absorb any rain falling into the woods but the woods cannot absorb additional water flowing into the woods from the developments north of the Ridge Road.

On the positive side, I note that all the open drainage ditches leading into the culvert under the Ridge Road are all heavily vegetated with the result that the water flowing into the Church Woods from the culvert is crystal clear. Unfortunatley, as I indicated, by the time the water leaves the woods, it contains much silt.

Problem

There is too much water flowing into the Church Woods during the spring thaw and during heavy rainfall. The woods cannot absorb the rain and the additional water flowing into the woods from the culvert under the Ridge Road. The end result is too much phosphorus flowing into Lake Simcoe. Prior to 1980, there was barely a discernable drainage ditch through the woods. Every year, for the last fifteen to twenty years the drainage ditch through the Church Woods gets deeper and deeper and truckloads of silt have been and are continuing to be dumped into the lake in front of Mr. Ted Bigelow's property at 115 Bay Street.

Solution

We are looking for a solution that does not put silt and phosphorus into the lake from the Church Woods. One possible solution is for the township and/or house owners to plant bushes, shrubs and other vegetative matter other than grass along the drainage ditches and along the sloping banks that lead into the ditches in the housing development, known as Arbourwood, north of the Rail Trail. The advantage of this solution is that it is effective, the investment may be low compared with other alternatives and it is in keeping with low impact development practices.

1 (b). Maintenance of the two ponds just south west of the Arbourwood housing development.

Is there a maintenance plan for the two large stormwater ponds that drain part of Arbourwood?

2. Drainage Along the Second Line

The problem with this drainage is that there are neither silt catchments areas, nor holding ponds, nor any other method to remove silt, phosphorus and other pollutants from the rushing water. The spring snow melt and summer storm water runs directly into the lake. After heavy thunderstorms in the summer the waters

surrounding the outfall of the water in Kempenfelt Bay are dark with all the silt and pollutants washed into the bay. If we want a healthier Lake Simcoe, this source of phosphorus and pollution must be mitigated.

3. Drainage from the fields and house lots north of the fire hall and the Ridge Road and east of line 2.

The problem with this drainage is that the houses in the watershed were built before holding ponds were required. Consequently, there is no holding pond and the spring snow melt and summer storm waters are making a ditch south from the Ridge Road and behind the houses along the east side of O'Brien Street then into Kempenfelt Bay. This ditch gets deeper and wider every year and is dumping tons and tons of silt that contains phosphorus into the bay. You can see the ditch if you drive to the end of Bay Street and walk east until you see the gorge that the run-off water is gradually carving. This problem must be fixed.

4. Stormwater treatment pond at northeast corner of Ridge Road and Martine Crescent

It is clear that this pond is silted up. However, it is completely filled with bullrushes and other plants and shrubs that do a very good job of filtering out the silt that may run into the pond. We suggest that the township examine this pond to see if any remedial action is required.

Summary

No.	Catchment description	Problems	Possible Solutions
1 a	Church Woods	The woods cannot absorb additional water coming fom the culvert under the Ridge Road. Tons of silt get dumped into the lake.	Review all drainage into the Church Woods and take appropriate action to reduce the runoff into the woods.
1 b	Main stp's for Arbourwood	Is there a maintenance plan for these ponds?	
2	Line 2	Tons of silt dumped into lake every year. No pollution controls.	Install devices to trap silt, remove phosphorus and other pollutants. Use modern infiltration basins and other techniques.
3	Area north of the Ridge Road, the fire hall and east of line 2.	Tons of untreated silt and unknown amounts of pollution and phosphorus dumped into the lake.	Install new storm water holding pond.
4.	STP on northeast corner of Martine Crescent and the Ridge Road	The pond is silted up. This may not be a problem or it may be a low priority problem.	Investigate to determine if any remedial action is required.

Andre Moura - Re: Innisfil Mapleview and Friday Harbour WaterCAD and SewerCAD

From: Keith Shular
To: Andre Moura; Suzanne Troxler
Date: 11/13/2014 2:02 PM
Subject: Re: Innisfil Mapleview and Friday Harbour WaterCAD and SewerCAD

Suzanne, would this be similar in scope to previous reports?

>>> Suzanne Troxler 11/13/2014 1:57 PM >>>
Andre, Keith,

The Town gave us the go ahead on the Friday Harbour modelling and on the Innisfil Mapleview modelling.

For the Innisfil Mapleview, which is the block of land south west of 25th SR and Mapleview Dr., just north of Sandy Cove, they want a report by the end of November. Bryan will send me the FSR. The draft workplan letter is attached; the scope will be changed because the developer's engineers have done some of the work we were proposing to do. We will essentially only run the models and verify all is OK and identify any changes required. I will forward the revised work plan.
Keith, can you check if Josh has the time to run the SewerCAD model and report back in the next two weeks?
Andre, for WaterCAD, I think it will be fairly straightforward considering the work we just did for Sandy Cove.

For Friday Harbour, we said the work would be done in 4 weeks from authorization to proceed. Our work plan is attached. The work should be done after the Innisfil Mapleview assignment.

We can discuss further tomorrow.

Suzanne

Oro-Medonte

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

PUBLIC COMMENT SHEET

Public Open House
September 18, 2014
Oro-Medonte Town Hall, Council Chambers

NAME: Barry Metz

LAND OWNER/COMPANY: Barry Metz

ADDRESS: 2418 Highway 11 South, Oro-Medonte

PHONE: 705-487-3768 EMAIL: barrymetz@sympatico.ca

MY COMMENTS ARE AS FOLLOWS: Our Long Flooding Of Our Property Since Our House Was Built In 2000. Flooding Is Progressively Getting Worse. Early Spring Is Significantly The Worst As Water Has Back Up To Our Neighbours. I Have Attached Some Pictures.

Date: Sept. 19/14

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record. Questions regarding this collection should be directed to the project manager.

Please return this form to:

C.C. Tatham & Associates Ltd
115 Sandford Fleming Drive, Suite 200 Collingwood, ON L9Y 5A6
dhurley@cctatham.com





Township of Oro-Medonte
Proud Heritage, Exciting Future

TOWNSHIP OF ORO-MEDONTE
COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

NOTICE OF PUBLIC OPEN HOUSE

The Township of Oro-Medonte has initiated a Comprehensive Stormwater Management Master Plan (CSWM-MP) in compliance with the requirements of the Lake Simcoe Protection Plan and the Guidelines developed for the implementation of the CSWM-MP in the Lake Simcoe Watershed.

The primary goal of the CSWM-MP is to improve water quality in the Lake Simcoe watershed by reducing phosphorous loadings. The study will identify ways to improve the management of stormwater in the Township to achieve this goal through a detailed analysis of existing conditions and evaluation of stormwater management alternatives.

A Public Open House Meeting will be held on:

Date: **Thursday, September 18, 2014**
Time: **4:30 to 7:00 p.m.**
Location: **Township Administration Centre**
148 Line 7 South Oro-Medonte, Ontario L0L 2E0

This meeting will provide an opportunity for the public and stakeholders to review the alternatives under consideration and to provide input and comments.

Subsequent to the Public Open House, the Township will review the comments and recommend a preferred alternative(s). Those individuals and parties that request to be kept informed will be notified of the date that the preferred alternative(s) is presented to General Committee such that there is the opportunity for deputations to the next scheduled Council session, if required. Written comments and input are welcome and should be submitted to:

Jerry Ball, CRSS
Township of Oro-Medonte
148 Line 7 South P.O. Box 100
Oro, Ontario
L0L 2X0
Tel: 705-487-2171
Fax: 705-487-0133
e-mail: jball@oro-medonte.ca

or

Dan Hurley, B.A.Sc., P.Eng.
C.C. Tatham & Associates Ltd.
115 Sandford Fleming Drive, Suite 200
Collingwood, Ontario
L9Y 5A6
Tel: 705-444-2565, ext 228
Fax: 705-444-2327
e-mail: dhurley@cctatham.com

This Notice issued August 20, 2014.

Oro-Medonte

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

PUBLIC COMMENT SHEET

Public Open House
September 18, 2014
Oro-Medonte Town Hall, Council Chambers

NAME: CHRIS CLARKE

LAND OWNER/COMPANY: CLARKE DIESEL LIMITED

ADDRESS: 47 Paterson Rd., Forest Home Industrial Park, Oro-Medonte Twp.

PHONE: 705-325-4013 EMAIL: clarke.diesel@hotmail.com

MY COMMENTS ARE AS FOLLOWS: I was informed at the meeting that the study was only concerned with the drainage of existing and new sub-divisions and residential areas. The water from the community of Forest Home to the west flows through the Forest Home Industrial Park along with the water from the wetland area on the east of Line 15, south of Hwy 11, causing water levels to rise and creates more run-off from industrial and farm lands into Lake Simcoe. The wetland did **not** exist when the Industrial Park was developed and the CNR rail line was still in use. The higher water levels that exist in the area today causes damage to existing wells and property, expecially as the drains and ditches have not been properly maintained.

Chris Clarke

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Please return this form to:

C.C. Tatham & Associates Ltd
115 Sandford Fleming Drive, Suite 200 Collingwood, ON L9Y 5A6
dhurley@cctatham.com

Oro-Medonte

COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN

PUBLIC COMMENT SHEET

Public Open House
September 18, 2014
Oro-Medonte Town Hall, Council Chambers

NAME: Diane Richards

LAND OWNER/COMPANY: _____

ADDRESS: 72 William St.

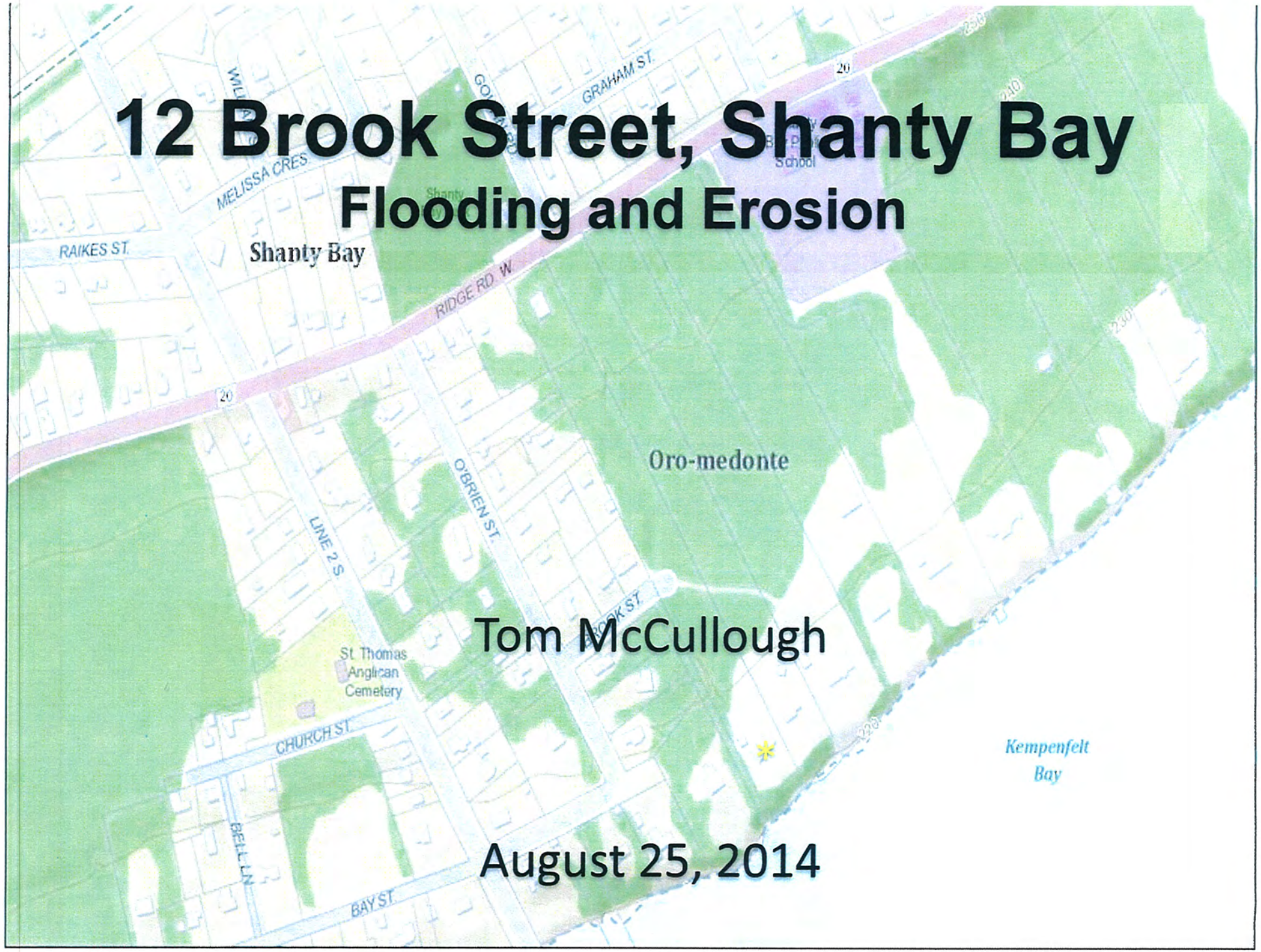
PHONE: 705-734-1466 EMAIL: dianerichards2014@hotmail.com

MY COMMENTS ARE AS FOLLOWS: My concerns are with the ditches + waterflow on Govan St. Shanty Bay.

Information will be collected in accordance with the Municipal Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record. Questions regarding this collection should be directed to the project manager.

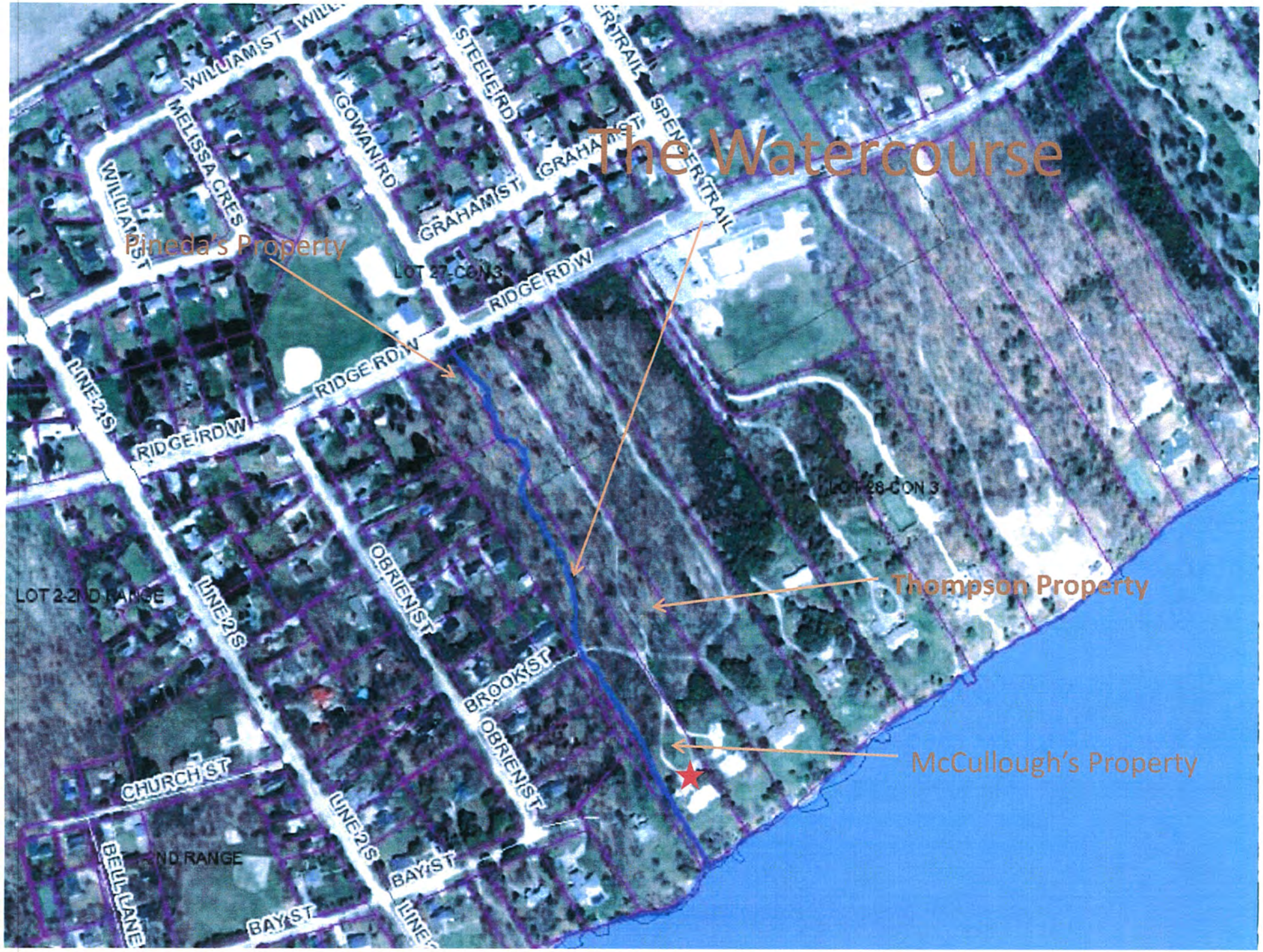
Please return this form to:

C.C. Tatham & Associates Ltd
115 Sandford Fleming Drive, Suite 200 Collingwood, ON L9Y 5A6
dhurley@cctatham.com


12 Brook Street, Shanty Bay
Flooding and Erosion
Shanty Bay
Oro-medonte
Tom McCullough
August 25, 2014
RAIKES ST.
MELISSA CRES.
GRAHAM ST.
RIDGE RD. W.
O'BRIEN ST.
LINE 2 S.
BROOK ST.
St. Thomas Anglican Cemetery
CHURCH ST.
BELL LN.
BAY ST.
Kempenfelt Bay
School
20
240
230
220

Overview

- Property Purchased in 2010
- Built in 2012
- Watercourse is on 3 properties. Eroding into 4th.
- ¾ of watercourse on McCullough's property
- Watercourse conveys storm water from Town's ditch system along and north of Ridge Road
- Watercourse is not part of the Storm water system


The Watercourse
Pineda's Property
Thompson Property
McCullough's Property
WILLIAM ST
MELISSA CRES
WILLIAM ST
GOWAN RD
STEELE RD
GRAHAM ST
GRAHAM ST
SPENCER TRAIL
LOT 27 CON 3
RIDGE RD W
RIDGE RD W
RIDGE RD W
LINE 2 S
LOT 28 CON 3
LOT 2 2ND RANGE
LINE 2 S
OBRIEN ST
BROOK ST
OBRIEN ST
CHURCH ST
LINE 2 S
BELL LANE
ND RANGE
BAY ST
BAY ST

Storm Water is from Ditches along and North of Ridge Road



Storm Water Flows through the Woodland on Neighbour's and McCullough's Property



The excess of water is causing erosion, flooding, and undermining trees.

Storm Water Passes under McCullough's Driveway through Twin Culverts







The excess of water carries debris, and is eroding under the culverts. The water can reach 20ft wide at times when the volumes exceed the capacity of the culverts.

Storm Water Enters Twin Culvert and flows past house underground







The bank erosion resulting from the water puts the nearby structures at risk

Storm Water discharges from the Twin Culverts down a steep bank into the lake with all of the upstream debris







The Excessive Water Results in flooding and erosion, and carries significant pollution to the lake



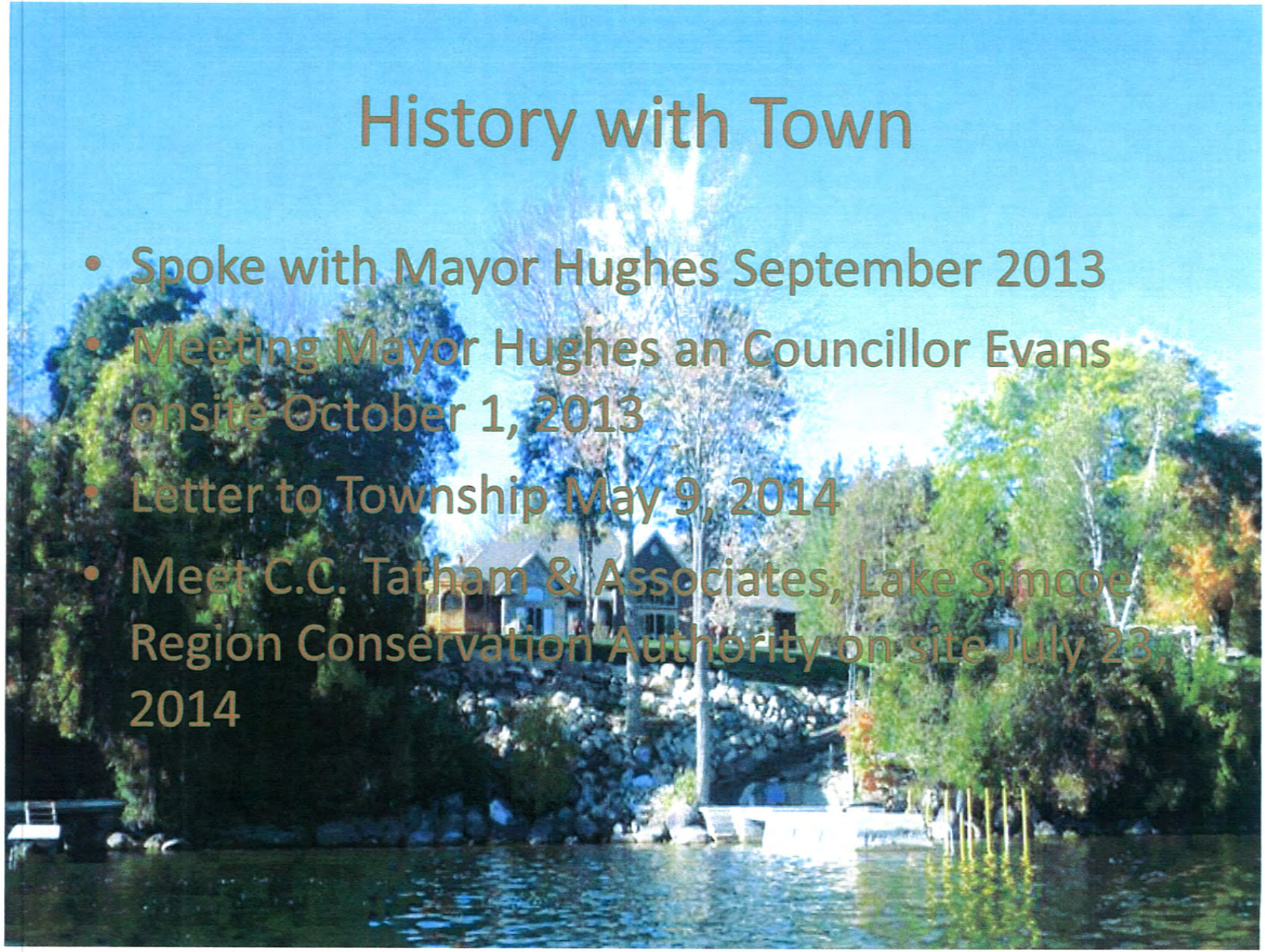


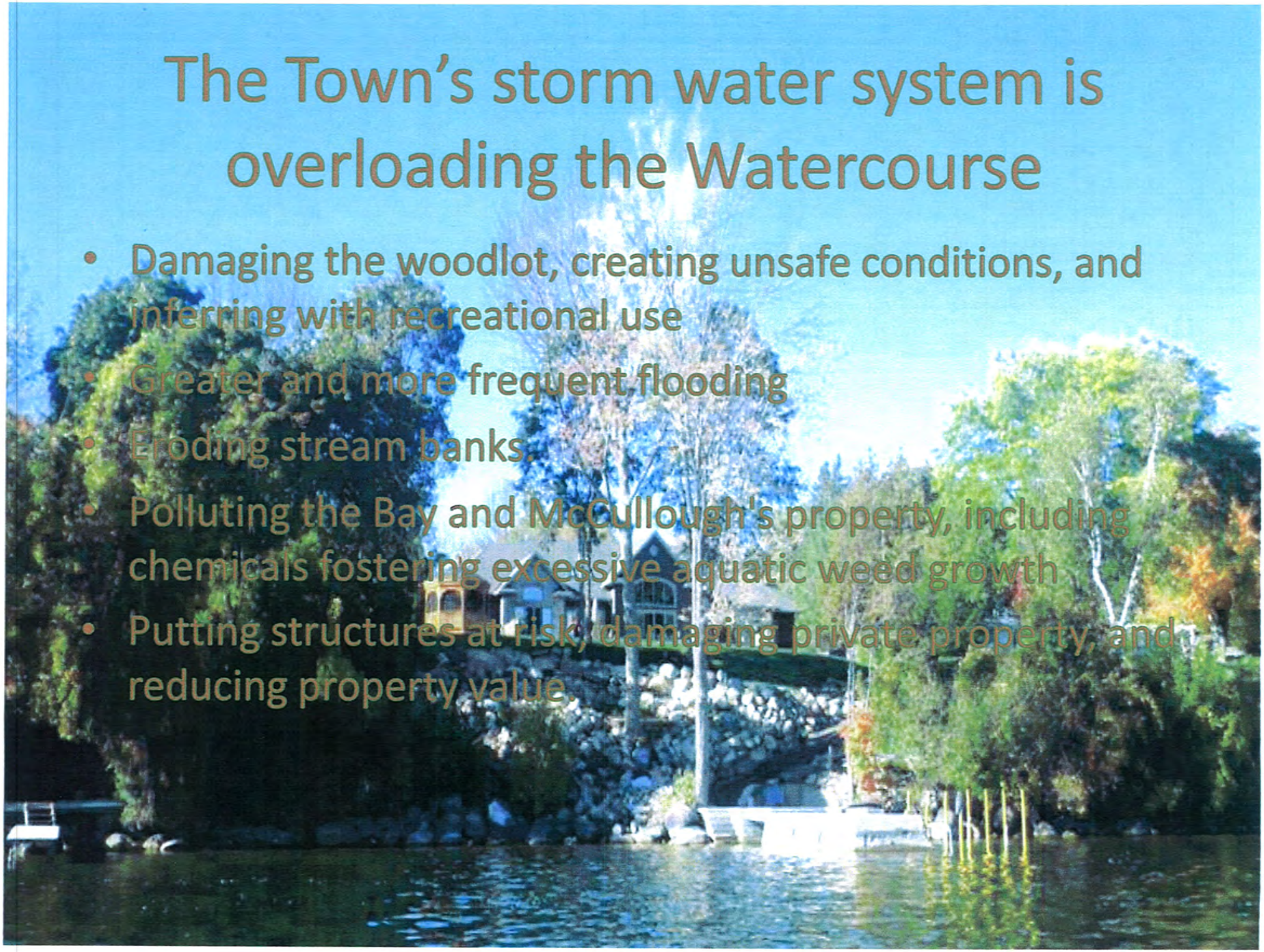


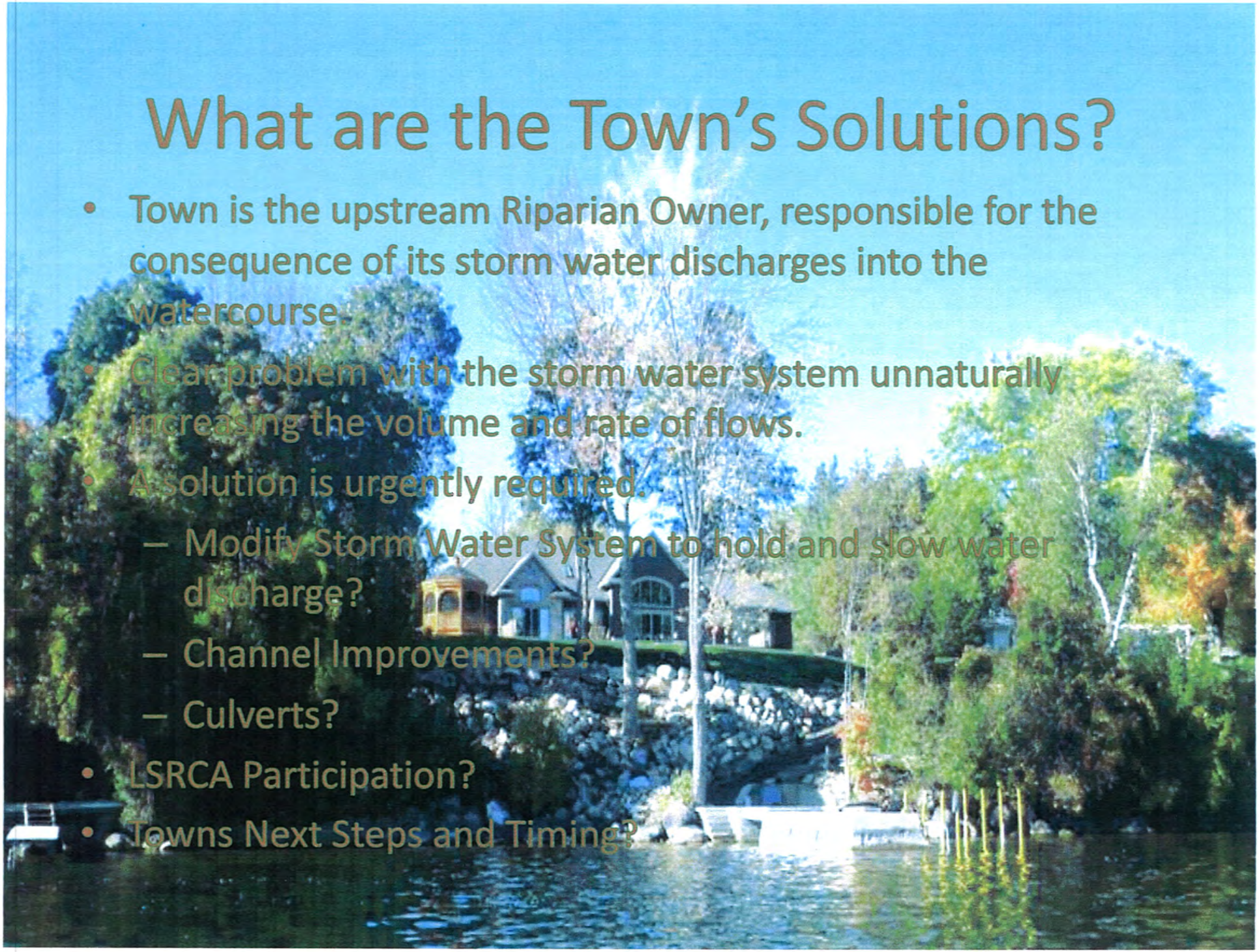




The upstream pollution flowing into the Bay from the watercourse has fostered the growth of weeds in that one isolated location.


History with Town
• Spoke with Mayor Hughes September 2013
• Meeting Mayor Hughes an Councillor Evans onsite October 1, 2013
• Letter to Township May 9, 2014
• Meet C.C. Tatham & Associates, Lake Simcoe Region Conservation Authority on site July 23, 2014


The Town's storm water system is overloading the Watercourse
• Damaging the woodlot, creating unsafe conditions, and inferring with recreational use
• Greater and more frequent flooding
• Eroding stream banks.
• Polluting the Bay and McCullough's property, including chemicals fostering excessive aquatic weed growth
• Putting structures at risk, damaging private property, and reducing property value.


What are the Town's Solutions?
• Town is the upstream Riparian Owner, responsible for the consequence of its storm water discharges into the watercourse.
• Clear problem with the storm water system unnaturally increasing the volume and rate of flows.
• A solution is urgently required.
– Modify Storm Water System to hold and slow water discharge?
– Channel Improvements?
– Culverts?
• LSRCA Participation?
• Towns Next Steps and Timing?