Garner Road/Rymal Road and Garth Street

Class Environmental Assessment

APPENDICES

FEBRUARY 2014

Prepared for:
City of Hamilton
400 - 77 James Street North
Hamilton, ON L8R 2K3

128039-4E-Rev 0

APPENDIX A
CONSULTATION

- **A.1 – Notice of Commencement and Public Information Centre #1 (PIC #1)**
- **A.2 – Public Information Centre #2 (PIC #2)**
- **A.3 – First Nations Consultation**
- **A.4 – Notice of Completion**

APPENDIX A.1

NOTICE OF COMMENCEMENT AND PUBLIC INFORMATION CENTRE #1 (PIC #1)

- **Notice of Commencement and PIC #1**
- **PIC Advertisement – April 15, 2011**
- **PIC #1 – Displays**
- **PIC #1 – Comment Sheet**
- **PIC #1 Summary – Comments and Responses**

Notice of Commencement and PIC #1

Notice of Study Commencement and Public Information Centre
Garner Road/Rymal Road and Garth Street Municipal Class Environmental Assessment & Shaver Estates Park and Trail

THE STUDY

The City of Hamilton has initiated a Municipal Class Environmental Assessment (EA) to address the transportation needs for Garner Road/Rymal Road and Garth Street in response to recent land use and transportation planning studies that have documented the justification for improvements in these corridors (see accompanying map for subject area). The purpose of this study is to develop and assess design alternatives that address the identified transportation issues along these roads.

THE PROCESS

This project is being carried out as a Schedule C project under the Municipal Engineers Association *Municipal Class Environmental Assessment* (October 2000, as amended in 2007). All requirements for Schedule C projects within the Study Area will be fulfilled.

PUBLIC INFORMATION CENTRE

Public consultation is an important component of the EA process. Accordingly, the first Public Information Centre (PIC) to receive public input will be held as follows:

DATE: Thursday, April 28, 2011
TIME: 6:00 p.m. – 8:00 p.m. (open house format)
LOCATION: Redeemer University College, Room 212 AD, 777 Garner Road E., Ancaster

The purpose of this information session is to present alternative design concepts that address the identified transportation needs, and the evaluation criteria that will be used to assess the alternative design concepts.

A second PIC will be held at a later date to present the evaluation of the alternative design concepts and identify the preferred design concept.

The study results will be documented in an Environmental Study Report, which will be available for public review and comment upon completion of the study. Another advertisement will be published at that time, indicating where the report can be viewed.

PUBLIC COMMENTS INVITED

There is an opportunity at any time during this process for interested persons to review outstanding issues and bring concerns to the attention of the Project Managers. If you have any questions or comments, or wish to be added to the study mailing list, please contact:

Lorissa Skrypniak, MCIP, RPP
Senior Project Manager
Transportation Planning
Environment & Sustainable Infrastructure
Public Works
City of Hamilton

Ian Upjohn, MCIP, RPP
Project Manager
SNC-Lavalin Inc.
195 The West Mall
Toronto, ON, M9C 5K1
Ian.Upjohn@snclavalin.com

ON, L8R 2K3
tplanning@hamilton.ca
Phone: 905-546-2424 ext. 2732
Fax: 905-546-4435

Phone: 416-679-6289
Fax: 416-231-5356

PARK PLANNING

The City of Hamilton is conducting a master plan for the Shaver Estates Park, located at 33 Brooking Court, Ancaster. The City is seeking public input regarding the proposed park development. In addition, the City is planning a trail to connect Shaver Estates Park with Tollgate Drive to the east, through the natural open space lands, to provide a pedestrian connection to the neighbourhood. Park and trail development panels will also be on display, and staff on hand to answer questions and receive comments.

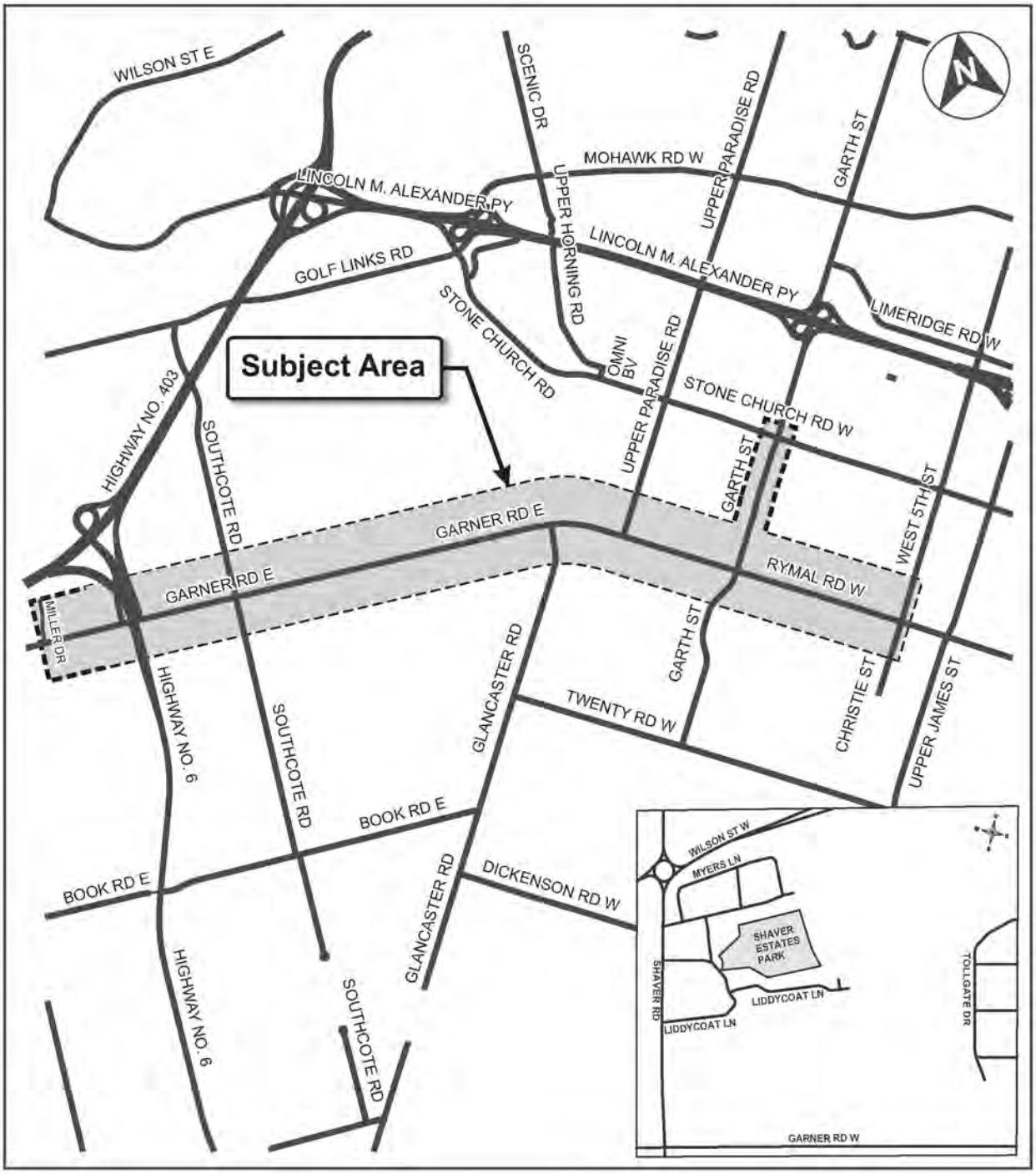
For park or trail related inquiries:

Cynthia Graham, MLA, OALA, CSLA
Landscape Architect
Landscape Architectural Services
Environment & Sustainable Infrastructure
Public Works
City of Hamilton ON, L8R 2K3
Cynthia.graham@hamilton.ca
Phone: 905-546-2424 ext. 2337
Fax: 905-546-4515

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.

If you have any accessibility requirements in order to participate in this program or event, please contact Cynthia Graham by January 7, 2011. Advance requests are highly encouraged to enable us to meet your needs adequately.

This Notice issued April 15 and 22, 2011.


Subject Area
WILSON ST E
SCENIC DR
MOHAWK RD W
UPPER PARADISE RD
GARTH ST
LINCOLN M. ALEXANDER PY
UPPER HORNING RD
LINCOLN M. ALEXANDER PY
GOLF LINKS RD
STONE CHURCH RD
LIMERIDGE RD W
OMNI BV
UPPER PARADISE RD
STONE CHURCH RD W
HIGHWAY NO. 403
SOUTHCOTE RD
GARTH ST
WEST 5TH ST
GARNER RD E
GARNER RD E
RYMAL RD W
MILLER DR
GARTH ST
GLANCASTER RD
CHRISTIE ST
UPPER JAMES ST
TWENTY RD W
HIGHWAY NO. 6
SOUTHCOTE RD
BOOK RD E
BOOK RD E
DICKENSON RD W
GLANCASTER RD
HIGHWAY NO. 6
SOUTHCOTE RD
WILSON ST W
MYERS LN
SHAVER ESTATES PARK
SHAVER RD
LIDDYCOAT LN
LIDDYCOAT LN
TOLLGATE DR
GARNER RD W

PIC Advertisement – April 15, 2011

Hamilton

at your Service

905-546-CITY (2489)
519 AREA RESIDENTS CALL 519-647-2577
CAMPBELLVILLE RESIDENTS CALL 905-634-2971

需要中文咨询，请打如下电话 • Pour des informations en français, s'il vous plaît composez le 905.546.2489 • Per informazioni in Italiano per favore chiama 905.546.2489 • Para Informações em português, por favor ligue 905.546.2489 • Po Informacje z jezyku polskim, prosze dzwonic 905.546.2489

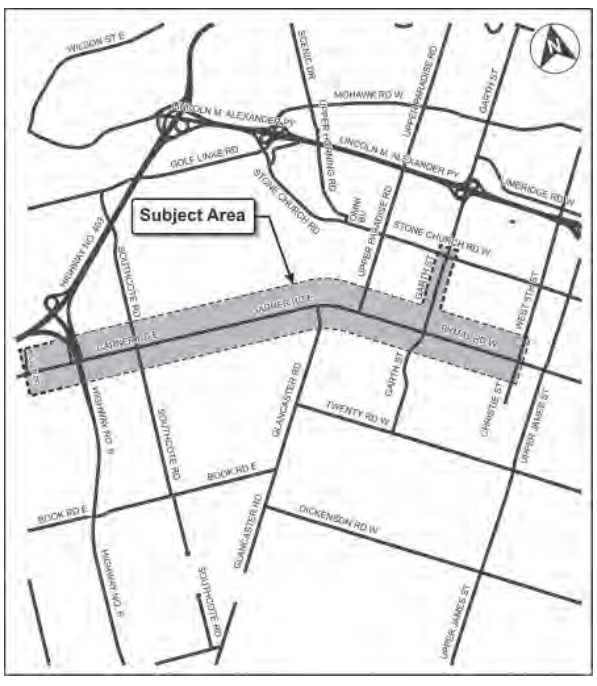
NOTICES

Notice of Study Commencement and Public Information Centre

Garner Road/Rymal Road and Garth Street Municipal Class Environmental Assessment

THE STUDY

The City of Hamilton has initiated a Municipal Class Environmental Assessment (EA) to address the transportation needs for Garner Road/Rymal Road and Garth Street in response to recent land use and transportation planning studies that have documented the justification for improvements in these corridors (see accompanying map for subject area). The purpose of this study is to develop and assess design alternatives that address the identified transportation issues along these roads.



THE PROCESS

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Lorissa Skrypniak, MCIP, RPP
Senior Project Manager
Transportation Planning
Environment & Sustainable Infrastructure
Public Works Dept., City of Hamilton
400 - 77 James Street North
Hamilton, ON, L8R 2K3
tplanning@hamilton.ca
Phone: 905-546-2424 ext. 2732
Fax: 905-546-4435

Ian Upjohn, MCIP, RPP
Project Manager
SNC-Lavalin Inc.
195 The West Mall
Toronto, ON, M9C 5K1
Ian.Upjohn@snclavalin.com
Phone: 416-679-6289
Fax: 416-231-5356

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.

This Notice issued April 15 and 22, 2011.

CITY OF HAMILTON
SALE OF LANDS FOR TAX ARREARS

TAKE NOTICE that tenders are invited for the purchase of the land(s) described below and will be received until 3:00 p.m. local time on Wednesday May 4, 2011 at the Information Desk 1st Floor City Hall, 71 Main Street West, Hamilton, On.

The tenders will then be opened in public on the same day at 3:10 p.m. local time in Room 192 of City Hall, 71 Main Street West, Hamilton, On.

Description of Land

1. **176 Kensington Avenue North**
   LT 151, PL 378; Hamilton;
   Subject to Execution 96-00518, If enforceable
   PIN # 17222-0207 (LT)
   25.00 feet X 100.00 feet more or less
   Assessed Value: Residential $ 95,750
   Serial No. 040.284.07160.0000
   Minimum Bid $ 18,946.25
2. **391 Victoria Avenue North**
   LTS 23, 24, 25, 26 & 27, PL 254;
   PT LTS 28 & 29, PL 254;
   North St. PL 254, (Closed by By-law HL75666 & HL 83010);
   As in HL 83171, HL 60613, HL 63136, HL 63137, AB 134028, HL 63138, HL 63139,
   HL 63140; S/T &T/W AB134028; Except the easement therein AB 134028; S/T CD 208507; City of Hamilton
   PIN # 17188-0012 (LT)
   Irregular 7.85 Acres
   Assessed Value: Commercial $ 489,815
   Industrial $ 987,935
   Serial No. 030.221.00400
   Minimum Bid $ 337,914.98
3. **390 Victoria Avenue North**
   LTS 1, 2 & 3 PL 163, PT LT 4, PL 163,
   As in AB136372, AB 139639, AB 137393;
   T/W AB 136372, AB 139639, AB 137393; Hamilton
   PIN # 17188-0040 (LT)
   200.00 feet X 132.00 feet more or less
   Assessed Value: Commercial Vacant $ 149,250
   Serial No. 030.221.00910
   Minimum Bid $ 46,788.56
4. **CANCELLED**
5. **187 Grace Avenue**
   LT 320, PL 573; Hamilton; Subject to Execution 94-00573, if Enforceable;
   Subject to Execution 94-03771, if Enforceable
   City of Hamilton
   PIN # 17293-0222 (LT)
   Corner, 25.00 feet X 100.00 feet more or less
   Assessed Value: Residential $ 142,500
   Serial No. 050.403.01030
   Minimum Bid $ 16,922.46
6. **741 Brighton Avenue**
   LT 17, PL 708;
   City of Hamilton
   PIN # 17923-0011 (LT)
   41.67 feet X 112.00 feet more or less
   Assessed Value: Residential $ 137,250
   Serial No. 050.402.04740
   Minimum Bid $ 27,409.33
7. **130 Robert Street**
   PT LTS 6 & 7, PL 287, As in CD 142329;
   City of Hamilton
   PIN # 17162-0145 (R)
   30.83 feet X 80.00 feet more or less
   Assessed Value: Residential $ 114,250
   Serial No. 020.156.52940
   Minimum Bid $ 11,997.80
8. **23 Nugent Drive**
   LT 38, PL 1280;
   City of Hamilton
   PIN # 17282-0076 (LT)
   Irregular, 50.03 feet X 101.02 feet more or less
   Assessed Value: Residential $ 204,250
   Serial No. 050.451.03010
   Minimum Bid $ 26,579.14
9. **629 – 631 Barton Street East**
   PT LT 58, PL 245, As in AB 109940
   City of Hamilton
   PIN # 17194-0210 (LT)
   Irregular, 42.50 feet X 125.00 feet more or less
   Assessed Value: Commercial $ 182,259
   Residential $ 50,491
   Serial No. 030.237.55760
   Minimum Bid $ 64,666.23
10. **129 Hillyard Street**
    PT LT 130, PL 32, As in AB 227593; Hamilton
    City of Hamilton
    PIN # 17576-0150 (R)
    22.75 feet X 132.00 feet more or less
    Assessed Value: Residential $ 88,250
    Serial No. 030.224.04840
    Minimum Bid $ 11,335.30
11. **CANCELLED**

Tenders must be submitted in the prescribed form and must be accompanied by a deposit in the form of a money order or of a bank draft or cheque certified by a bank or trust company payable to the City of Hamilton and representing at least 20 per cent of the tender amount.

The municipality makes no representation regarding the title to or any other matters including any environmental concerns relating to the land to be sold. Any existing Federal or Provincial liens or executions will remain on title and may become the responsibility of the potential purchaser. Responsibility for ascertaining these matters rests with the potential purchasers. **The municipality does not provide an opportunity for potential purchasers to view properties nor is it in a position to provide successful purchasers with a key or vacant possession.**

This sale is governed by Part XI of the Municipal Act, 2001 and as amended by The Municipal Statute Law Amendment Act, 2002. The successful purchaser will be required to pay the amount tendered plus the accumulated taxes (i.e. the property taxes that have accumulated since the first day of advertising of the land for sale until a successful purchaser is declared) and any relevant federal or provincial taxes that may apply (including land transfer tax and HST). **Failure to complete the transaction by the successful bidder (highest or if failed, second highest bidder) will result in the forfeiture of their deposit.**

For further information regarding this sale, including an updated list of properties still available for sale, and a copy of the prescribed form of tender documents, go to the City of Hamilton Web site at www.hamilton.ca, or contact:

Larry Friday, Director of Taxation
City of Hamilton
71 Main Street West,
Hamilton, Ontario L8P 4Y5
Attn: D. Kevin Beattie, Tax Sale Officer
Tel. (905) 546-2424 ext. 4538 / Fax (905) 546-2449
April 8, 2011

HamiltOn

Protecting Public Health, Property and the Environment

Municipal Class Environmental Assessment Centennial Parkway Bridge and Drainage Improvements

Notice of Study Commencement

THE STUDY

The City of Hamilton needs to make improvements to the Centennial Parkway Bridge structure, which the City owns, and is utilized by CN Rail for mainline traffic in the Lakeshore corridor. In addition, the drainage problems in the underpass need to be addressed. The bridge site is shown on the accompanying Location Map. In order to accomplish this, the City must complete an environmental assessment (EA).

THE PROCESS

Bridge Structure

The bridge improvements are being planned as a **Schedule C** project under the *Municipal Engineers Association's Municipal Class Environmental Assessment* (June 2000, as amended in October 2007). This will involve a process of problem/opportunity identification; identification and assessment of alternative planning solutions; preparation of an inventory of the natural, socio-economic and cultural environments; and development and evaluation of design concepts of the preferred solution.

Drainage

In addition to the structural and functional improvements being planned for the Centennial Parkway Bridge and roadway, it is also proposed as part of this project to evaluate various alternatives to reduce the flooding risk at the underpass. This evaluation is following the same MEA Class EA process and the Project Schedule will vary, depending on the preferred solution. For instance, should the drainage work involve sewer upgrades within the roadway right-of-way, the works would fall under Schedule A undertaking; however, if a pumping station is required, the works would constitute a Schedule B undertaking The ultimate determination of Project Schedule will be through this process.

During this process, Technical Memoranda will be prepared and will be available for review at various locations in the City. There is an opportunity at any time during this process for interested persons to review issues and bring concerns to the attention of the respective Project Manager.

Prior to implementing the preferred solution, a Notice of Completion will also be published in the At Your Service section of the Hamilton Spectator, and an Environmental Study Report (documenting the Municipal Class EA planning process) will be placed on the public record for review and comment.

PUBLIC COMMENTS INVITED

Public consultation is a key component of the Class Environmental Assessment process. As noted above, there will be Technical Memoranda available for review at various locations in the City at different times throughout the project. Information on the status of the project and the availability of the Technical Memoranda will be posted on the City's project website www.hamilton.ca/Centennial-Bridge-EA . If you would like to receive a copy of the Technical Memoranda, please contact one of the Project Managers noted below. If you have any questions or comments or wish to be added to the study mailing list, please contact:

Bridge Structure	Drainage
Margaret Fazio, B. Sc., C.C.E.P. Project Manager, Transportation Planning Strategic Planning & Rapid Transit Environment & Sustainable Infrastructure Public Works Dept., City of Hamilton 400 - 77 James Street North Hamilton, ON, L8R 2K3 tplanning@hamilton.ca Phone: 905 546 2424 ext. 2218 Fax: 905 546 4435	Nahed Ghbn Senior Project Manager, Infrastructure and Source Water Planning, Strategic Planning Environment & Sustainable Infrastructure Public Works Dept., City of Hamilton 400 -77 James Street North Hamilton, ON L8R 2K3 Nahed.Ghbn@hamilton.ca Phone: (905) 546-2424 Ext. 6413 Fax: (905) 546-4435
Ian Upjohn, MCIP, RPP Project Manager SNC-Lavalin Inc. 400 Carlingview Drive Toronto, ON, M9W 6N9 Ian.Upjohn@snclavalin.com Phone: 416-679-6289 Fax: 416-231-5356	Ron Scheckenberger, P.Eng. Principal Consultant AMEC Earth & Environmental 3215 North Service Road Burlington, ON, L7R 3G2 ron.scheckenberger@amec.com Phone: 905-335-2353 Fax: 905-335-1414 Website: www.amec.com

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.

This Notice issued on April 8 and April 15, 2011.

PIC #1 – Displays

GARNER ROAD / RYMAL ROAD AND GARTH STREET IMPROVEMENTS

SCHEDULE "C" CLASS ENVIRONMENTAL ASSESSMENT

Hamilton Public Works

Environment & Sustainable Infrastructure Division
Strategic Planning & Rapid Transit Group
www.hamilton.ca/cpi

SNC·LAVALIN

Welcome to Public Information Centre

PUBLIC INFORMATION CENTRE

Redeemer University College

Thursday, April 28, 2011

6:00 P.M. – 8:00 P.M.

The City of Hamilton and SNC-Lavalin Inc. (the Consultant) would like to welcome you and thank you for attending this evening.

Please sign the register for future mail-outs.

- Representatives from the City and the Consultant are available to answer your questions and to hear your comments and concerns.
- Background information and technical reports pertaining to the study are available to review with resource staff.
- We would like your comments. Please complete a Comment Sheet and drop it in the Comment Sheet box before leaving, or return it via mail/email by **May 12, 2011**.

Information for this study is being collected in accordance with the *Municipal Freedom of Information and Protection of Privacy Act* to assist the City of Hamilton in meeting the requirements of the Ontario *Environmental Assessment Act*. Comments and information will be maintained on file for use during the study and may be included in project documentation. With the exception of personal information, all comments will become part of the public record.

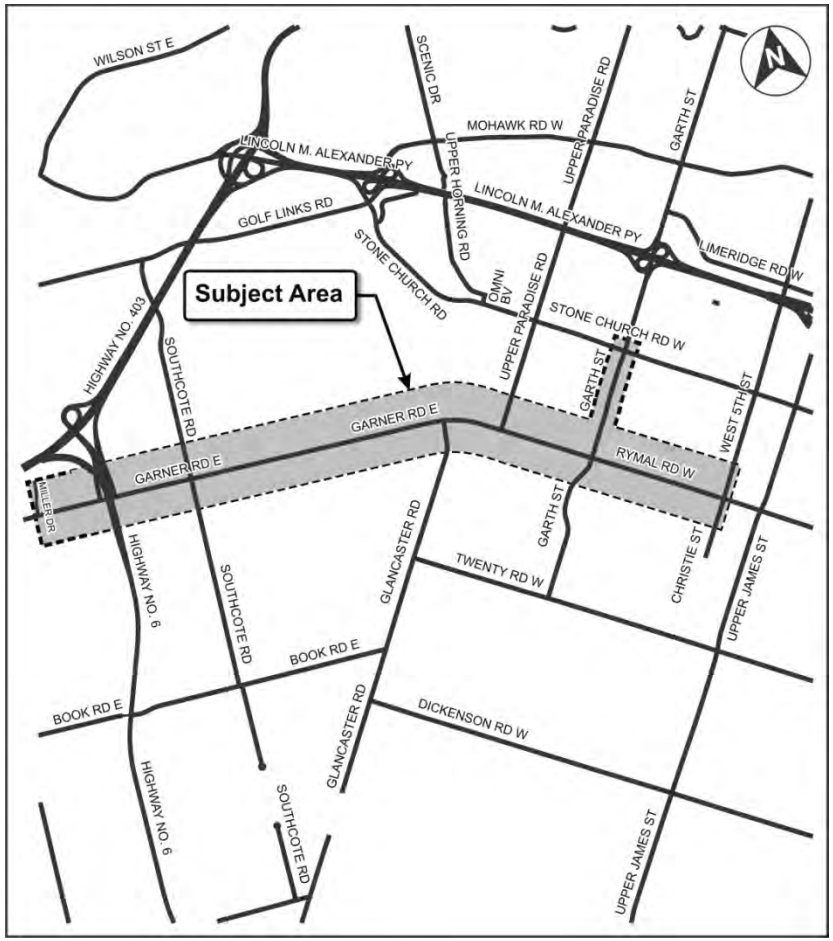
Study Background and Purpose

Land use and transportation planning studies completed within the last ten years have provided the rationale for addressing transportation needs and improving traffic carrying capacity in the Garner Road/Rymal Road and Garth Street corridors to accommodate future traffic demand. The City of Hamilton has initiated a Municipal Class Environmental Assessment (EA) in response to these needs. The accompanying map shows the subject area under consideration.

The purpose of this study is to develop and assess design alternatives that address the identified transportation issues along these roads.

The following displays present:

- An outline of the Class EA process;
- The need and justification for the roadway improvements;
- Alternative design concepts for widening the roadway corridors; and
- The proposed evaluation criteria for assessing the alternative design concepts.



Overview of Municipal Class EA Process

This study is being conducted in accordance with the Municipal Engineers Association *Municipal Class Environmental Assessment* (October 2000, as amended in 2007) ("Municipal Class EA") for Road Projects.

Under the Municipal Class EA, there are four types of projects or activities:

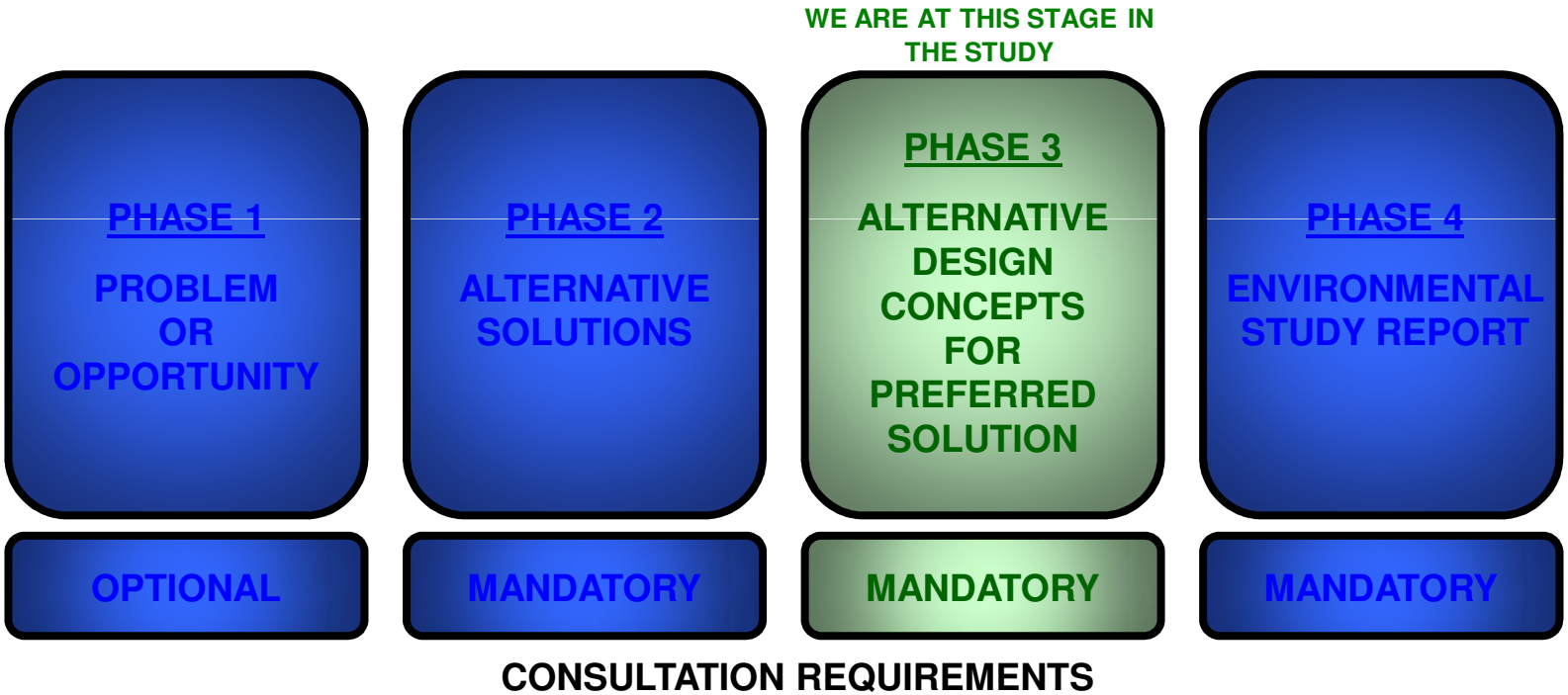
Schedule "A"	Municipal maintenance, operational and emergency activities. These projects are pre-approved and allow the municipality to proceed without further approval under the EA Act.
Schedule "A+"	The environmental effects are usually minimal. However, the public is to be advised prior to implementation. These projects are also pre-approved.
Schedule "B"	Projects may have minimal environmental effects on the environment. These projects are approved subject to a screening process, including consultation with directly affected public and agencies.
Schedule "C"	Projects may have significant effects on the environment and must proceed under the full planning and documentation procedures outlined in the Municipal Class EA document.

This study is being conducted as a **Schedule "C"** undertaking (please also refer to the accompanying display for information on the phased approach to the study process).

If, after reviewing the project proposals and discussing any concerns with the City of Hamilton, you still have concerns with the proposed project, you may request the Minister of the Environment to require the City to comply with Part II of the *Environmental Assessment Act* (which addresses individual Environmental Assessments), before proceeding with the proposed undertaking. This is known as a "Part II Order" request. The Minister determines whether or not this is necessary, with the Minister's decision being final.

Municipal Class EA Process for Schedule "C" Projects

Schedule "C" projects generally involve the construction of new facilities and the major expansion of existing facilities, and have the potential for significant environmental effects. Therefore, the study must complete Phases 1 through 4 as shown in the accompanying flow chart, culminating with the preparation of an Environmental Study Report, which will be made available for public comment. Phases 1 and 2 are deemed to have been completed through other (master planning) studies that included public review processes (please refer to subsequent display boards).



Results of Previous and Adjacent Planning Studies

The following planning studies have provided the rationale for widening the segments of Garner Road/Rymal Road and Garth Street under consideration, or otherwise exert some influence on the development of design concepts for transportation improvements in these corridors.

MEADOWLANDS (NEIGHBOURHOODS 3, 4 AND 5) CLASS EA (FEBRUARY 2000)

A study prepared for Meadowlands of Ancaster to satisfy Environmental Assessment Act master planning level requirements. Various recommendations came from this study.

Recommendations:

- Identified the need to widen Garner Road to 4 lanes, and include additional left-turn lanes, between Southcote Road and Glancaster Road.
- Consider an additional connection to Garner Road and/or Southcote Road, or increased left-turn storage lanes on Garner Road, if Ancaster Fairgrounds are developed.

The study was reviewed by Town of Ancaster staff, an independent Peer Review Team retained by the Town, Region of Hamilton-Wentworth staff, and a broad range of regulatory agency and interest group stakeholders. Also included two public meetings.

Results of Previous and Adjacent Planning Studies (Cont'd)

SOUTH MOUNTAIN AREA TRANSPORTATION MASTER PLAN STUDY (SMATMP) (MAY 2000)

Included the current Garner/Rymal corridor study area east of Southcote Road as part of a much broader study area extending from Southcote Road to Upper Centennial Parkway and from Twenty Road to the Niagara Escarpment. Focused on problems and opportunities associated with traffic carrying capacity, road and corridor safety, and road structural condition.

Problem/opportunity analysis identified Rymal Road as a congestion area based on 2006 and 2021 traffic forecasts and possible traffic diversions from the Lincoln Alexander Parkway (Linc) as it becomes congested. Stated the expectation that traffic volumes on Garth Street will double in the next 20 years (daily traffic of 16,000); would require reconstruction in 8-10 years; and would benefit from the addition of a left-turn lane for improved traffic operations and accessibility.

Assessed a range of transportation planning alternatives on a network basis and concluded that expanding and upgrading existing roadways to incorporate enhancements for all users is the preferred solution

Recommendations:

- Widen Rymal Road to 4 or 5 lanes from the limit of the 4-lane section recommended as part of the Meadowlands development to West 5th Street.
- Widen Garth Street south of Stone Church Road to 3 lanes, with Two-Way Left-Turn Lane (TWLTL).

The SMATMP was vetted through public consultation and endorsed by Regional Council with only minor changes.

Results of Previous and Adjacent Planning Studies (Cont'd)

AIRPORT EMPLOYMENT GROWTH DISTRICT (AEGD) STUDY (SEPTEMBER 2010)

This study presents a transportation system to guide the transportation infrastructure and strategic policies of the Hamilton International Airport area up to the 2031 planning horizon year. The study area was bounded by Garner Road and Twenty Road to the north, Fiddler's Green Road to the west, Upper James Street to the east and White Church and Carluke Road to the south.

The specific objectives of the study included:

- preparing a transportation strategy that supports development of the AEGD;
- identifying any problems or opportunities, including future transportation corridors; and
- developing a Transportation Master Plan for the AEGD area.

The study concluded that, with the ultimate build-out of the AEGD study area, the existing road network capacity will be constrained, especially on the east-west links within the AEGD. Other constraints include limited Highway 6 access and the location of the Hamilton International Airport relative to major municipal road access.

The study evaluated a number of alternatives for accommodating transportation demand, including the "Do Nothing" option.

Recommendations:

- Future transportation scenario included widening existing roads, enhancing transit service delivery, improving the bike lane network and implementing Transportation Demand Management measures.
- The road network improvements included widening Garner Road to 4-lanes between Fiddler's Green and Glancaster Road and extending Garth Street, as a 4-lane road, from Twenty Road to Dickenson Road.

Results of Previous and Adjacent Planning Studies (Cont'd)

CITY OF HAMILTON TRUCK ROUTE MASTER PLAN STUDY (APRIL 2010)

A City-wide study, initiated to develop a comprehensive truck route master plan, recognizing the City's role as a major transportation centre (road, rail, air, port) and the economic need for efficient goods movement.

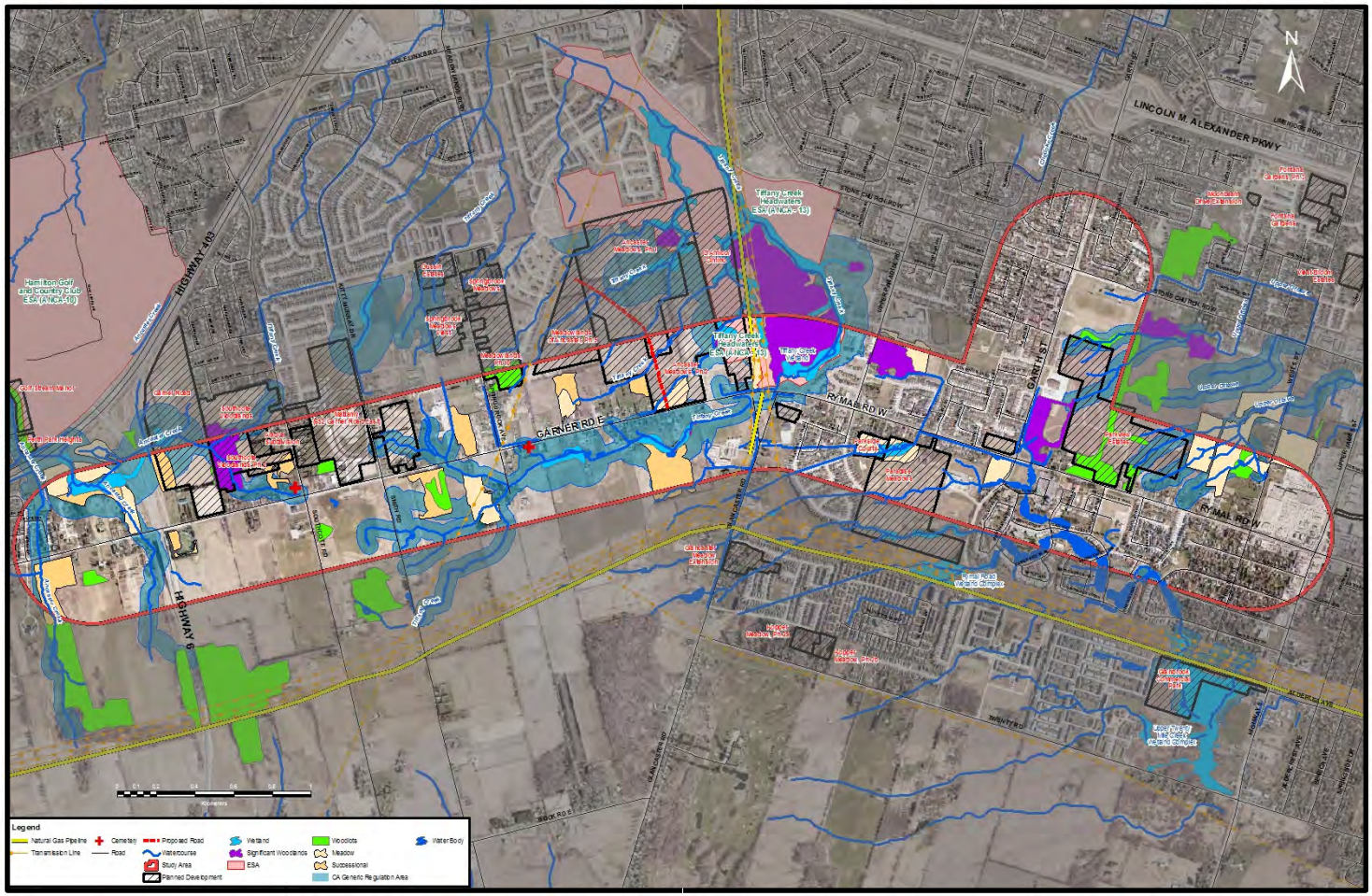
Recognized that King's Highway 53 (now Garner Road/Rymal Road), constructed in 1935 by the Province of Ontario and downloaded to the Regional Municipality of Hamilton Wentworth in 1997, has been a legal truck route from the day it officially opened for public use (1935). Also recognized that Garner Road/Rymal Road is a preferred corridor for over-sized loads.

Recommendations:

- Acknowledged concerns expressed by residents about through truck traffic on Garner Road/Rymal Road between Upper James Street and Highway 6, but still envisaged this corridor remaining a legal full-time truck route.
- Envisaged the section of Garth Street under consideration being part of a designated part-time truck route in the long term (after urbanization of the cross-section).

Existing Environmental Conditions and Constraints

Garner Road/Rymal Road and Garth Street Improvements
Schedule "C" Class Environmental Assessment
Public Information Centre No.1
April 28, 2011



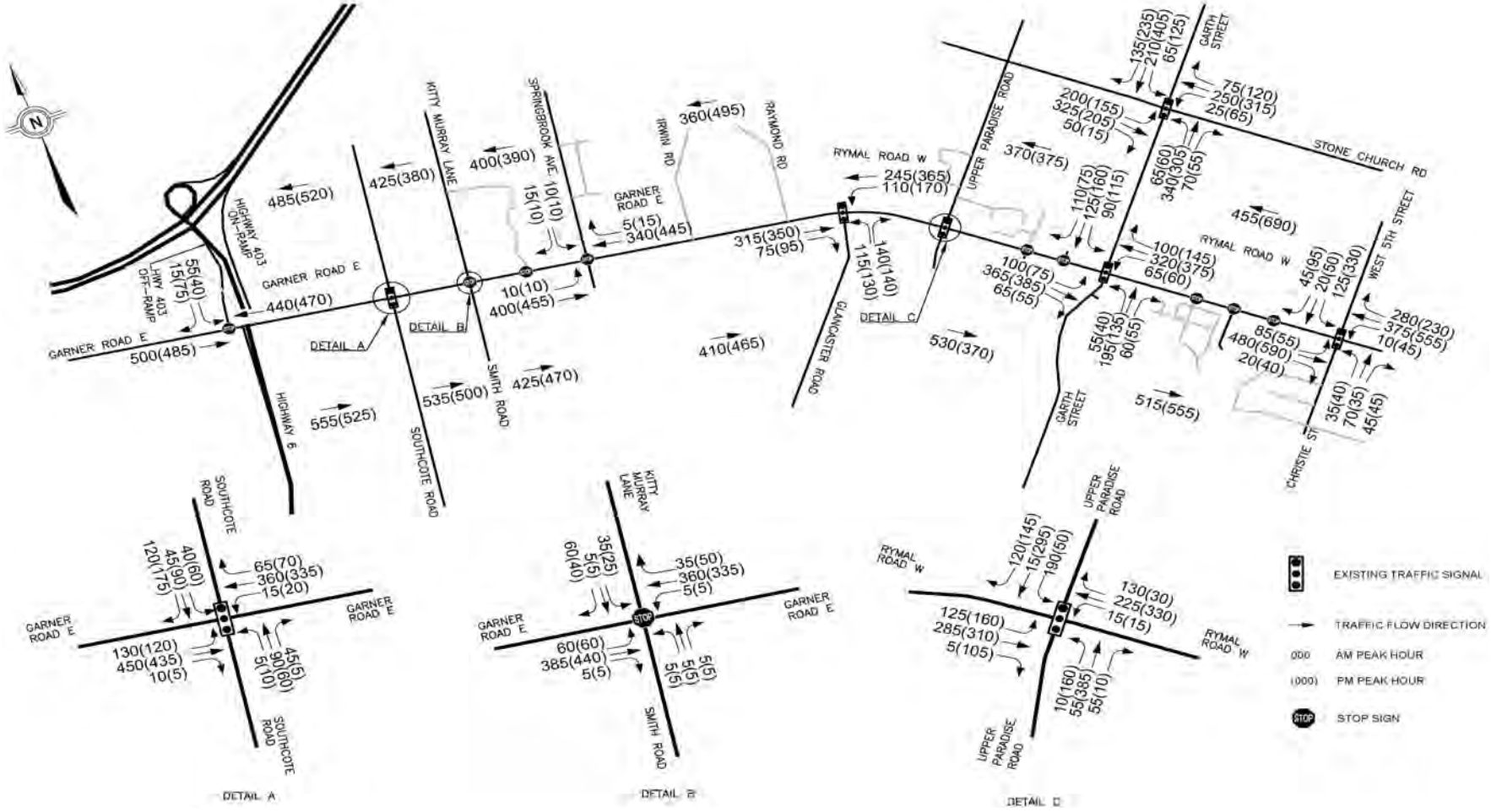
Hamilton Public Works

Environment & Sustainable Infrastructure Division
Strategic Planning & Rapid Transit Group
www.hamilton.ca/cpi

SNC·LAVALIN

Existing Peak Hour Traffic Conditions (2008)

Garner Road/Rymal Road and Garth Street Improvements
Schedule "C" Class Environmental Assessment
Public Information Centre No.1
April 28, 2011



Future Peak Hour Traffic Conditions (2031)

Welcome to Public Information Centre

PUBLIC INFORMATION CENTRE

St. Thomas More Catholic Secondary School

Tuesday April 3, 2012

6:00 P.M. – 8:00 P.M.

The City of Hamilton and SNC-Lavalin Inc. (the Consultant) would like to welcome you and thank you for attending this evening.

Please sign the register for future mail-outs.

- Representatives from the City and the Consultant are available to answer your questions and to hear your comments and concerns.
- Background information and technical reports pertaining to the study are available to review with resource staff.
- We would like your comments. Please complete a Comment Sheet and drop it in the Comment Sheet box before leaving, or return it via mail/email by **April 17, 2012**.

Information for this study is being collected in accordance with the *Municipal Freedom of Information and Protection of Privacy Act* to assist the City of Hamilton in meeting the requirements of the Ontario *Environmental Assessment Act*. Comments and information will be maintained on file for use during the study and may be included in project documentation. With the exception of personal information, all comments will become part of the public record.

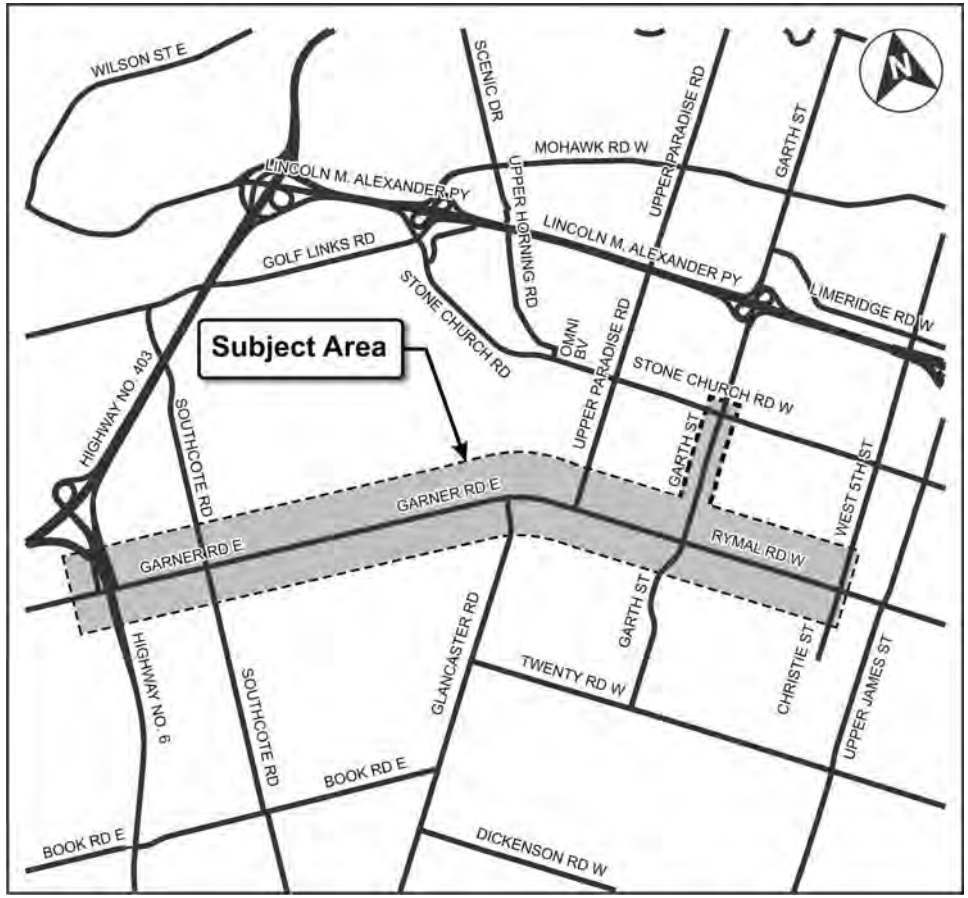
Study Background and Purpose

Land use and transportation planning studies completed within the last ten years have provided the rationale for addressing transportation needs and improving traffic carrying capacity in the Garner Road/Rymal Road and Garth Street corridors to accommodate future traffic demand. The City of Hamilton has initiated a Municipal Class Environmental Assessment (EA) in response to these needs. The accompanying map shows the subject area under consideration.

The purpose of this study is to develop and assess design alternatives that address the identified transportation issues along these roads.

The following displays present:

- ❑An outline of the Class EA process
- ❑Alternative design concepts for widening the roadway corridors
- ❑A summary assessment of the advantages and disadvantages of the alternative design concepts
- ❑Identification and rationale for the preferred design concepts



Overview of Municipal Class EA Process

This study is being conducted in accordance with the Municipal Engineers Association *Municipal Class Environmental Assessment* (October 2000, as amended in 2007) ("Municipal Class EA") for Road Projects.

Under the Municipal Class EA, there are four types of projects or activities:

Schedule "A" Municipal maintenance, operational and emergency activities. These projects are pre-approved and allow the municipality to proceed without further approval under the EA Act.

Schedule "A+" The environmental effects are usually minimal. However, the public is to be advised prior to implementation. These projects are also pre-approved.

Schedule "B" Projects may have minimal environmental effects on the environment. These projects are approved subject to a screening process, including consultation with directly affected public and agencies.

Schedule "C" Projects may have significant effects on the environment and must proceed under the full planning and documentation procedures outlined in the Municipal Class EA document.

This study is being conducted as a **Schedule "C"** undertaking (please also refer to the accompanying display for information on the phased approach to the study process).

If, after reviewing the project proposals and discussing any concerns with the City of Hamilton, you still have concerns with the proposed project, you may request the Minister of the Environment to require the City to comply with Part II of the *Environmental Assessment Act* (which addresses individual Environmental Assessments), before proceeding with the proposed undertaking. This is known as a "Part II Order" request. The Minister determines whether or not this is necessary, with the Minister's decision being final.

Municipal Class EA Process for Schedule "C" Projects

Schedule "C" projects generally involve the construction of new facilities and the major expansion of existing facilities, and have the potential for significant environmental effects. Therefore, the study must complete Phases 1 through 4 as shown in the accompanying flow chart, culminating with the preparation of an Environmental Study Report, which will be made available for public comment. Phases 1 and 2 are deemed to have been completed through other (master planning) studies that included public review processes.

WE ARE AT THIS STAGE IN THE PROJECT

PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5
PROBLEM OR OPPORTUNITY	ALTERNATIVE SOLUTIONS	ALTERNATIVE DESIGN CONCEPTS FOR PREFERRED SOLUTION	ENVIRONMENTAL STUDY REPORT	DETAIL DESIGN CONSTRUCTION MONITORING
OPTIONAL	MANDATORY	MANDATORY	MANDATORY	PTIONA

CONSULTATION REQUIREMENTS

Results of PIC No. 1 (April 18, 2011)

At the April 18, 2011 Public Information Centre, comments on the following project-related elements were received.

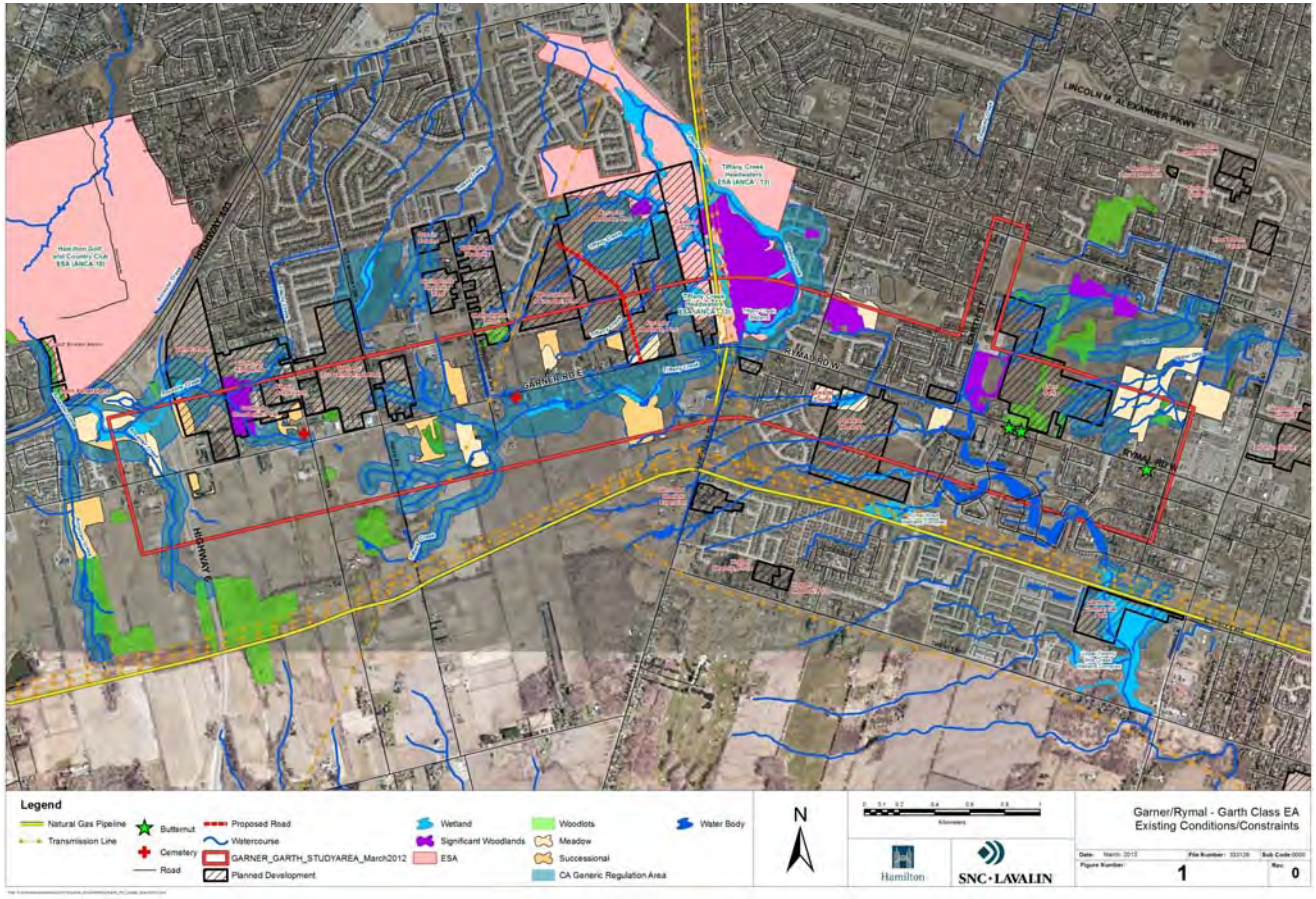
- Agreement with the incorporation of enhanced cycling and pedestrian facilities.
- Need for left-turn lanes for increased safety.
- The need for signalization and pedestrian crossing facilities at the entrance to Redeemer College.
- Provision of additional intersection improvements and pedestrian crossing facilities for St. Elizabeth Village.
- Potential impacts to Bowman United Church/Cemetery.
- Potential impacts to commercial/agricultural business operations (signage; parking; access).
- Potential impacts to individual properties (loss of frontage).
- Potential for use of roundabouts instead of stop signs at intersections.
- Staging and cost-sharing for municipal servicing (storm/sanitary sewers) in the Garner/Rymal corridor.
- Safety concerns associated with increased traffic speed and proximity of cyclists/pedestrians to travelled lanes on an approved truck route that is preferred by carriers with wide loads.
- Protection of Ancaster Creek and Tiffany Creek headwaters and associated natural areas.
- HSR bus stop locations and service provisions.

The Project Team addressed these comments and questions verbally, provided a written response to all written comments received, convened site meetings with a number of property owners, and posted information on the City's project website.

The comments received were considered by the Project Team in the development and assessment of the conceptual design alternatives.

Existing Environmental Conditions and Constraints

Garner Road/Rymal Road and Garth Street
Schedule "C" Class Environmental Assessment
Public Information Centre No. 2
April 3, 2012



Hamilton Public Works

Environment & Sustainable Infrastructure Division
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www.hamilton.ca/Garner-Rymal-Garth-EA

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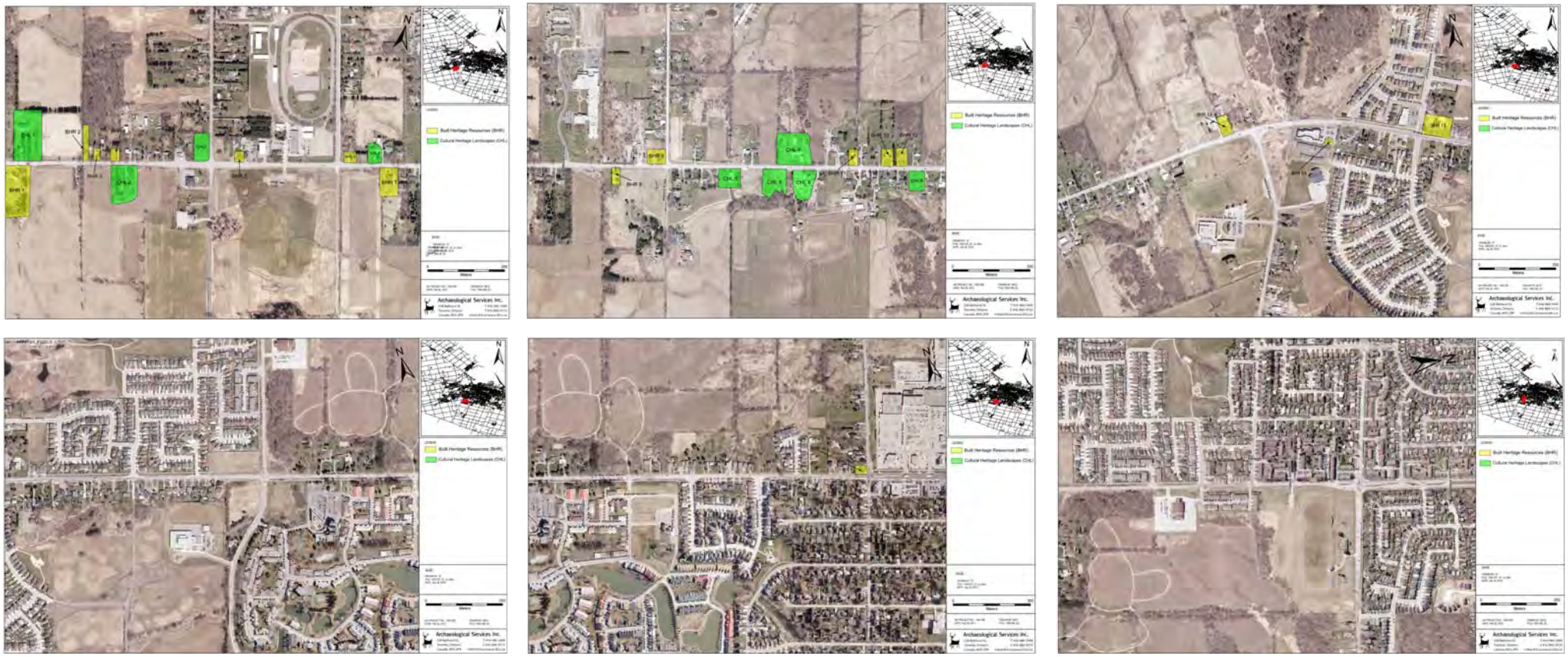
Cultural Heritage Resources

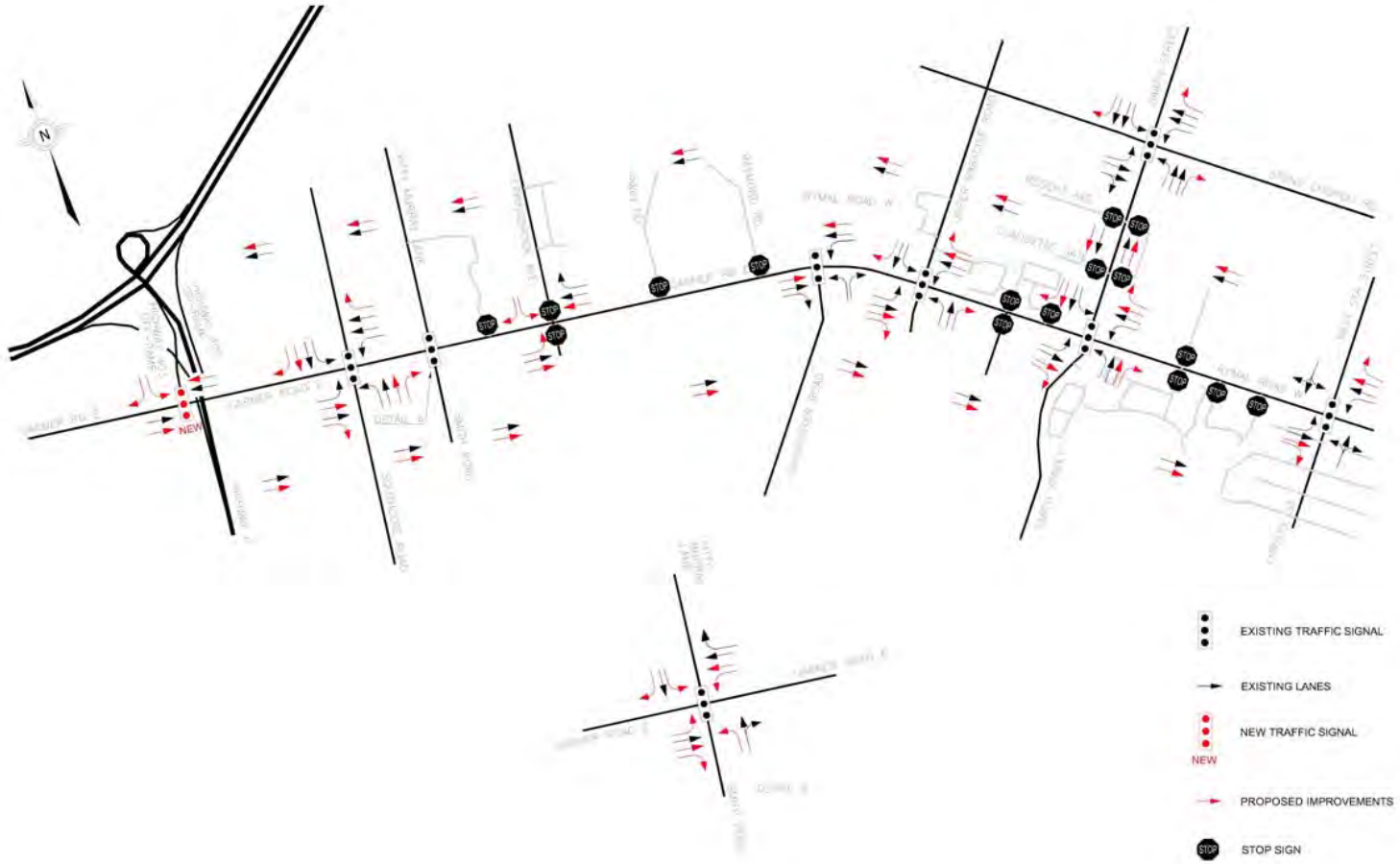


LEGEND:

Built Heritage Resources (BHR)

Cultural Heritage Landscapes (CHL)

Required Road/Intersection Improvements



Development and Assessment of Alternative Design Concepts

Following are the major considerations that have been incorporated in the development and assessment of the alternative design concepts for improving traffic operations in the Garner Road/Rymal Road and Garth Street corridors.

Natural Environment

- ❑Potential impacts to Upper Ottawa Creek, Upper Twenty Mile Creek, Ancaster Creek and Tiffany Creek subwatersheds and Tiffany Creek Environmentally Significant Area (ANCA-13).
- ❑Potential impacts to roadside vegetation, including significant individual tree specimens and Species at Risk.

Historical and Cultural Environment

- ❑Potential for discovery of archaeological resources and impacts to built heritage features and cultural landscapes if the roadway infrastructure is physically expanded onto previously undisturbed areas or improved properties.

Socio-Economic Environment

- ❑Garner Road/Rymal Road's economic function as an important intra- and inter-regional arterial road connector.
- ❑Compatibility with the City's broad-based growth management plan (GRIDS) and Official Plan land use designations.
- ❑Property requirements, and affects on the viability of adjacent existing and proposed land uses.
- ❑Access requirements for large approved/planned developments.
- ❑Need to accommodate social and recreational linkages in and across the corridor, including transit service, emergency services, school bus routes, and pedestrian and cycling networks.
- ❑Potential impacts to noise sensitive areas/receptors.

Development and Assessment of Alternative Design Concepts (Cont'd)

Technical Considerations

- Special design standards for truck traffic and future rapid transit operations (over-dimensional truck loads; transit stops, transit vehicle movement priority).
- Need to enhance existing intersections and incorporate new intersections for major planned development.
- MTO requirements governing operation of the Highway 6 interchange ramp terminals at Garner Road.
- Balance of cross-section requirements with respect to safety, drainage and relocation of existing utilities.
- Need to enhance and incorporate opportunities for active transportation (sidewalks, bike lanes, multi-use trails).
- Strategic implementation of a drainage and stormwater management plan in cooperation with approved planned developments, that also addresses Hamilton Conservation Authority and Niagara Peninsula Conservation Authority surface water management objectives.
- Existing or planned major municipal services (water, sewer) and private utilities that must also be located within the road right-of-way.
- How construction of the roadway expansion will be staged in relation to need (year of construction).
- How construction will be staged to ensure that traffic flows can be maintained in a manageable fashion.

Financial Implications

- Estimated construction and operations/maintenance costs in relation to the City of Hamilton's Capital and Operating Budgets (affordability).
- Relationship of the design schemes' benefits against their capital and operating costs (value for money).
- Project staging to facilitate other future infrastructure works and minimize throw-away costs.

Road Cross-Section Improvement Alternatives

Garner Road/Rymal Road and Garth Street
Schedule "C" Class Environmental Assessment
Public Information Centre No. 2
April 3, 2012

Alternative 1

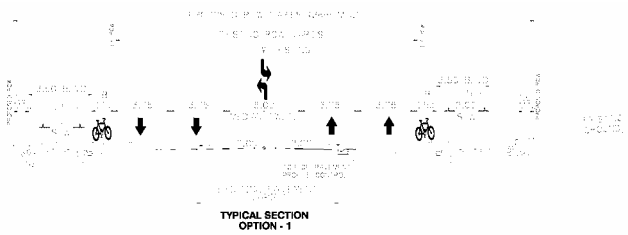
•Four 3.75 m through lanes
•Two 1.5 m bike lanes
•5.0 m continuous median that accommodates left turn lanes and raised medians at most intersections
•Exclusive right-turn lanes as per the recommendations from the Traffic Study report (SLI, 2010)
•Curb and gutter
•3.5 m continuous boulevard width

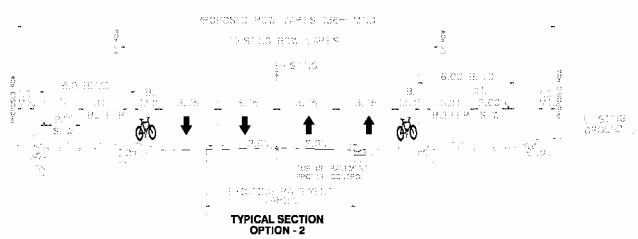
Alternative 2

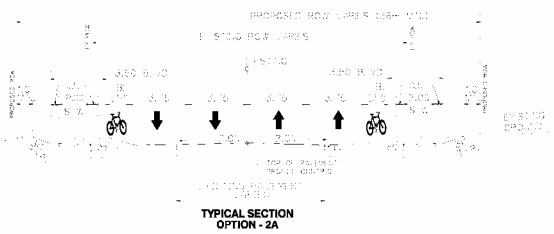
•Four 3.75 m through lanes
•Two 1.5 m bike lanes
•Exclusive right- and left-turn lanes, as per recommendations from Traffic Study report (SLI, 2010)
•Curb and gutter
•6.0 m continuous boulevard width except at two exceptions;
- Between Stations 1+100 to 1+200, the boulevard width has been reduced to 3.5 m on the north side with an offset of 0.5 m to sidewalk, eliminating impacts to the Garners Corners Cemetery (Garner Road/Southcote Road)
- Between Stations 2+330 to 2+570, the boulevard width has been reduced to 3.5 m on the south side with an offset of 0.5 m to sidewalk, eliminating property impacts to the Bowman United Church/Cemetery

Alternative 2A

•Four 3.75 m through lanes
•Two 1.5 m bike lanes
•Exclusive right- and left-turn lanes, as per the recommendations from Traffic Study report
•Curb and gutter
•3.5 m continuous boulevard width







Horizontal & Vertical Alignment

•The existing horizontal and vertical alignments have been maintained for all options, with the widening being symmetrical about the centerline, except at one location, where an alignment shift to the north has been implemented to mitigate property constraints at the Bowman United Church/Cemetery location.

•Alternative 1 has an alignment shift to the north at the Bowman United Church/Cemetery by a maximum of 8.0 m between Stations 2+076 to 2+784.

•Alternative 2 and 2A have an alignment shift to the north at the Bowman United Church/Cemetery of a maximum of 5.5 m between stations 2+130 to 2+730.

•The proposed standard 36.0 m right-of-way will be required within most of the project limits, with additional property being required at locations where there is an alignment shift or where the grading limit exceeds the 36.0 m.

Drainage

•Garner Road/Rymal Road and Garth Street currently have rural cross-sections, with drainage primarily by ditching with short sections of urban storm sewers. All options above include converting the existing rural cross-section from Highway 6 to West 5th Street to an urban one. This will eliminate the majority of the existing ditching, and drainage via storm sewer systems will be required. Some ditching may be retained/reinstated as required. In areas where there are existing sewers (between West Lawn Drive and West 5th Street), with adequate capacity, the existing drainage infrastructure may be retained and/or relocated/modified as needed.

Hamilton Public Works

Environment & Sustainable Infrastructure Division
Strategic Planning & Rapid Transit Group
www.hamilton.ca/Garner-Rymal-Garth-EA

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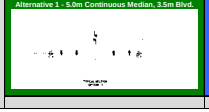
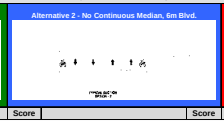
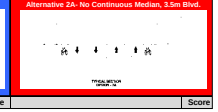
Evaluation Criteria

In consideration of the foregoing alternatives development and assessment consideration, following are the Evaluation Criteria against which the relative advantages and disadvantages of the alternative design concepts have been assessed and scored.

Evaluation Factor Group	Evaluation Criteria
Natural Environment	• Aquatic Habitat • Terrestrial Habitat/Roadside Vegetation • Designated Areas
Socio-Economic Environment	• Conformity with Planning/Development Policies • Impacts to Existing Adjacent Land Uses • Compatibility with Future Land Uses • Community Access and Linkages • Noise Impacts
Cultural Heritage Environment	• Archaeological Resources • Built Heritage Features • Cultural Landscapes
Technical Considerations	• Traffic Operations • Transit Operations • Provincial Highway Operations • Safety • Pedestrian/Cyclist Facilities • Drainage/Stormwater Management • Other Municipal Infrastructure / Utilities • Constructability (site-specific design issues) • Staging of Implementation to Meet Growth Needs
Financial Implications	• Construction Costs • Operations and Maintenance Costs

Summary Assessment of Alternative Design Concepts (Garner/Rymal)

Garner Road/Rymal Road and Garth Street
Schedule "C" Class Environmental Assessment
Public Information Centre No. 2
April 3, 2012

EVALUATION FACTOR	ALIGNMENT ALTERNATIVES		
	Alternative 1 - 5.0m Continuous Median, 3.5m Blvd.	Alternative 2 - No Continuous Median, 6m Blvd.	Alternative 2A- No Continuous Median, 3.5m Blvd.
			
	Score	Score	Score

Natural Environment

Aquatic Habitat	• Direct impact to fish and fish habitat with this alternative. • Key watercourse crossings include 0+340 (Ancaster Creek), 1+175 (Ancaster Creek Tributary), 1+960 Tiffany Creek Tributary), 2+840 (Tiffany Creek Tributary), 3+040 (Tiffany Creek Tributary), 3+270 (Tiffany Creek Tributary), 3+700 (Tiffany Creek Tributary and 5+080 (Upper Twenty Mile Creek Tributary). • There will be a loss of riparian vegetation at each crossing. • Culvert extensions will be required at all watercourse crossings, but no HADD is expected as result of the works with the application of mitigation.	2	• Direct impact to fish and fish habitat with this alternative. • Key watercourse crossings include 0+340 (Ancaster Creek), 1+175 (Ancaster Creek Tributary), 1+960 Tiffany Creek Tributary), 2+840 (Tiffany Creek Tributary), 3+040 (Tiffany Creek Tributary), 3+270 (Tiffany Creek Tributary), 3+700 (Tiffany Creek Tributary and 5+080 (Upper Twenty Mile Creek Tributary). • There will be a loss of riparian vegetation at each crossing. • Culvert extensions will be required at all watercourse crossings, but no HADD is expected as result of the works with the application of mitigation.	2	• Direct impact to fish and fish habitat with this alternative. • Key watercourse crossings include 0+340 (Ancaster Creek), 1+175 (Ancaster Creek Tributary), 1+960 Tiffany Creek Tributary), 2+840 (Tiffany Creek Tributary), 3+040 (Tiffany Creek Tributary), 3+270 (Tiffany Creek Tributary), 3+700 (Tiffany Creek Tributary and 5+080 (Upper Twenty Mile Creek Tributary). • There will be a loss of riparian vegetation at each crossing. • Culvert extensions will be required at all watercourse crossings, but no HADD is expected as result of the works with the application of mitigation. • This alignment has slightly lower impacts to the watercourses, as there is a slightly narrower footprint.	3
Terrestrial Habitat/Roadside Vegetation	• Moderate impacts to roadside trees in ditches and boulevard. • Key areas include: Garner/Rymal Road – 0+775-1+200, 1+650-1+850, 2+700-3+100, 5+150-5+500. • Impacts to four butternut trees (protected Species at Risk under Ontario Endangered Species Act) on south side between Garth Street and West 5th Street.	2	• Moderate impacts to roadside trees in ditches and boulevard. • Key areas include: Garner/Rymal Road – 0+775-1+200, 1+650-1+850, 2+700-3+100, 5+150-5+500. • Impacts to four butternut trees (protected Species at Risk under Ontario Endangered Species Act) on south side between Garth Street and West 5th Street.	2	• Lower impacts to roadside trees in ditches and boulevard compared to other options. • Key areas include: Garner/Rymal Road – 0+775-1+200, 1+650-1+850, 2+700-3+100, 5+150-5+500. • Impacts to four butternut trees (protected Species at Risk under Ontario Endangered Species Act) on south side between Garth Street and West 5th Street.	3
Designated Areas	• Minor impacts to roadside ditch wetland vegetation associated with Tiffany Creek (ESA) headwaters crossing of Garner/Rymal Road. This portion of the ESA has been previously impacted by original construction of the road and entrances for the hydro corridor.	3	• Minor impacts to roadside ditch wetland vegetation associated with Tiffany Creek (ESA) headwaters crossing of Garner/Rymal Road. This portion of the ESA has been previously impacted by original construction of the road and entrances for the hydro corridor.	3	• Minor impacts to roadside ditch wetland vegetation associated with Tiffany Creek (ESA) headwaters crossing of Garner/Rymal Road. This portion of the ESA has been previously impacted by original construction of the road and entrances for the hydro corridor.	3
Total Score	7		7		9 ***Preferred Alternative***	
Summary	• Alternatives 1 and 2 scored the same for each evaluation criteria and had slightly more impacts than Alternative 2A. • Alternative 2A is the preferred option with respect to Natural Environment, since impacts to watercourses are slightly lower due to the narrower footprint, and there are fewer impacts to roadside trees in ditches and boulevard areas compared to other options.					

Historical/Cultural Environment

Archaeological Resources	• Presence of known archaeological sites adjacent to the study area. • Presence of other features indicating archaeological potential. • Potential of the proposed road widening to impact identified areas containing archaeological potential.	2	• Presence of known archaeological sites adjacent to the study area. • Presence of other features indicating archaeological potential. • Potential of the proposed road widening to impact identified areas containing archaeological potential.	2	• Presence of known archaeological sites adjacent to the study area. • Presence of other features indicating archaeological potential. • Potential of the proposed road widening to impact identified areas containing archaeological potential.	2
Built Heritage Features and Cultural Landscapes	• Alternative 1 presents the most number of direct/ adverse impacts to both built heritage features and to cultural heritage landscapes. It is the least desirable alternative. • Removal: Five (5) cultural heritage resources were shown to be impacted through removal. • Encroachment (Proximity): Five (5) cultural heritage resources would be impacted by work being undertaken within proximity of the resource. An additional (1) resource could be subject to removal. • Encroachment (Frontage): Ten (10) cultural heritage resources could be subject to encroachment along the frontage of the property possibly resulting in impacts to mature plantings and an alteration to the integrity of the landscape. A further two (2) may be impacted depending on the extent of the western limits of the study area. • No Impact: Analysis showed that four (4) cultural heritage resources would not be impacted by the work proposed.	2	• Although the work undertaken Alternative 2 also requires removals, it presents slightly fewer adverse impacts to the built heritage resources and to the cultural heritage landscapes than Alternative 1. It is the second choice of the three alternatives. • Removal: Five (5) cultural heritage resources were shown to be impacted through removal. • Encroachment (Proximity): Six (6) cultural heritage resources would be impacted by work being undertaken within proximity of the resource. Of the total of six (6) resources, four (4) were deemed to be subject to impacts through encroachment (proximity). Of the two remaining cultural heritage resources one (1) presented reduced impacts (than Alternative 1) while the other (1) cultural heritage resource showed greater impacts than those assessed in Alternative 1. • Encroachment (Frontage): Seven (7) cultural heritage resources could be subject to encroachment along the frontage of the property possibly resulting in impacts to mature plantings and an alteration to the integrity of the landscape. Comparing these impacts with those assessed in Alternative 1 shows that one (1) cultural heritage resource was assessed as resulting in greater impacts and two (2) other resources returned impacts that were less than those assessed in Alternative 1. The final two (2) resources may be impacted depending on the extent of the western limits of the study area. • No Impact: Analysis showed that four (4) cultural heritage resources would not be impacted by the work proposed.	2	• Alternative 2A is the preferred alternative in terms of presenting fewer direct/ adverse impacts than Alternative 1. This alternative not only presents with reduced impacts (in the two categories of encroachment) it also potentially requires one less removal of an identified cultural heritage resource than both Alternatives 1 and 2. • Removal: Four (4) cultural heritage resources were shown to be impacted through removal. • Encroachment (Proximity): Seven (7) cultural heritage resources would be impacted by work being undertaken within proximity of the resource. Of the total of seven (7) cultural heritage resources, five (5) were deemed to be subject to impacts through encroachment (proximity). Comparing these impacts to those assessed in Alternative 1, one (1) cultural heritage resource showed reduced impacts and another (1) showed greater impacts than Alternative 1. • Encroachment (Frontage): Seven (7) cultural heritage resources could be subject to encroachment along the frontage of the property possibly resulting in impacts to mature plantings and an alteration to the integrity of the landscape. Three (3) other resources returned impacts that were less than those assessed in Alternative 1. The remaining two (2) resources may be impacted depending on the extent of the western limits of the study area • No Impact: Analysis showed that four (4) cultural heritage resources would not be impacted by the work proposed	2
Total Score	4		4		4 ***Preferred Alternative***	
Summary	• All Alternatives impact areas of archaeological potential. • Alternative 1 presents the most number of direct/adverse impacts to both built heritage features and to cultural heritage landscapes. It is the least desirable alternative. • Alternative 2 also requires removal of cultural heritage features. However, it imposes slightly fewer adverse impacts to the built heritage resources and to the cultural heritage landscapes than Alternative 1. It is the second choice of the three alternatives. • Alternative 2A is the preferred alternative in terms of imposing fewer direct/adverse impacts than Alternative 1. This alternative not only results in reduced impacts (in the two categories of encroachment), it also potentially requires one less removal of an identified cultural heritage resource than both Alternatives 1 and 2.					

Socio-Economic Environment

Conformity with Planning/ Development Policies	• This design option is compatible with the City's broad based growth management plan (GRIDS) and Official Plan land use designations.	5	• This design option is compatible with the City's broad based growth management plan (GRIDS) and Official Plan land use designations.	5	• This design option is compatible with the City's broad based growth management plan (GRIDS) and Official Plan land use designations.	5
Existing Adjacent Land Uses	• Majority (2/3) of the parking lot across the street from the Bowman United Church/Cemetery will be acquired. Approximately 587 m2 of property required. • The drilled well in front of the barn at 927 Garner Road East would be displaced with this option. Access used on the south side of barn from the east side to blow grain into upper level granary could be lost, but an alternative access is available via the barn bridge on the east-side. • Effects to local businesses - Bennett's Apple and Cider Ltd. (944 and 954 Garner Road East) may lose one or two parking spots in front of their store. The main store sign will need to be relocated southerly onto the site. Requires a complete buyout of commercial property (service station at 523 Garner) for all options. • Requires a total of 5.7 ha of property, which may require a complete buyout of 6 properties. • Avoids impacts to Garners Corners Cemetery and Bowman United Church/Cemetery.	2	• Approximately half (1/2) of the parking lot across the street from the Bowman United Church/Cemetery will be acquired. Approximately 455 m2 of property required. • Displacement of drilled well in front of the barn at 927 Garner Road could be avoided with this option. Access used on the south side of barn from the east side to blow grain into upper level granary could be maintained. • Effects to local businesses - Bennett's Apple and Cider Ltd. (944 and 954 Garner Road East) may lose one or two parking spots in front of their store. The main store sign will need to be relocated southerly onto the site. Requires a complete buyout of commercial property (service station at 523 Garner) for all options. • Option 2 requires a total of 5.9 ha of property, which may require a complete buyout of 8 properties. • Avoids impacts to Garners Corners Cemetery and Bowman United Church/Cemetery.	2	• Approximately half (1/2) of the parking lot across the street from the Bowman United Church/Cemetery will be acquired. Approximately 379 m2 of property required. • Displacement of drilled well in front of the barn at 927 Garner Road could be avoided with this option. Access used on the south side of barn from the east side to blow grain into upper level granary could be maintained. • Effects to local businesses - Bennett's Apple and Cider Ltd. (944 and 954 Garner Road East) may lose one or two parking spots in front of their store. The main store sign will need to be relocated southerly onto the site. Requires a complete buyout of commercial property (service station at 523 Garner) for all options. • Option 2A requires a total of 4.1 ha of property, which may require a complete buyout of 6 properties. • Avoids impacts to Garners Corners Cemetery and Bowman United Church/Cemetery.	3
Compatibility with Approved Future Land Uses	• A number of approved Draft Plans for large land parcels already include dedicated blocks for the roadway expansion. Future approved land use types include: Residential (single family detached, low density residential, medium density residential use and 3-storey retirement home), commercial, neighbourhood parks, and open space). It is expected that all future development lands will be graded to be compatible with the future road widening.	3	• A number of approved Draft Plans for large land parcels already include dedicated blocks for the roadway expansion. Future approved land use types include: Residential (single family detached, low density residential, medium density residential use and 3-storey retirement home), commercial, neighbourhood parks, and open space). It is expected that all future development lands will be graded to be compatible with the future road widening.	3	• A number of approved Draft Plans for large land parcels already include dedicated blocks for the roadway expansion. Future approved land use types include: Residential (single family detached, low density residential, medium density residential use and 3-storey retirement home), commercial, neighbourhood parks, and open space). It is expected that all future development lands will be graded to be compatible with the future road widening.	3
Community Access and Linkages	• This design option maintains/enhances pedestrian and cycling movement in the Garner/Rymal corridor and provides opportunities for connection to proposed north/south cycling routes (West 5th Street to Upper James Street; Garth Street; Upper Paradise Road; Glancaster; Kitty Murray Drive; Southcote Road; numerous points southerly into the planned Airport Employment Growth District).	4	• This design option maintains/enhances pedestrian and cycling movement in the Garner/Rymal corridor and provides opportunities for connection to proposed north/south cycling routes (West 5th Street to Upper James Street; Garth Street; Upper Paradise Road; Glancaster; Kitty Murray Drive; Southcote Road; numerous points southerly into the planned Airport Employment Growth District). • Provides highest level of comfort for pedestrians due to buffer between edge of pavement and sidewalk.	5	• This design option maintains/enhances pedestrian and cycling movement in the Garner/Rymal corridor and provides opportunities for connection to proposed north/south cycling routes (West 5th Street to Upper James Street; Garth Street; Upper Paradise Road; Glancaster; Kitty Murray Drive; Southcote Road; numerous points southerly into the planned Airport Employment Growth District).	4
Noise	• The impacts due to increasing traffic range from 3 dB to 4 dB. In cases where the future road centerline is offset from the existing road centerline (asymmetrical widening), there will be increases or decreases in the impacts noted above. Moving the centerline away from the sensitive receptors will decrease the impact, while moving the centerline closer will increase the impact. • For the sections on Garner Road, it is unlikely that a 5 dB impact will be reached due to asymmetrical widening, as the distance between the receptors and the roadway is large enough that small changes to the location of the centerline will not have a great effect. • All three road alignment options share a common centerline; therefore, the acoustic differences between the various options will not be significant.	3	• The impacts due to increasing traffic range from 3 dB to 4 dB. In cases where the future road centerline is offset from the existing road centerline (asymmetrical widening), there will be increases or decreases in the impacts noted above. Moving the centerline away from the sensitive receptors will decrease the impact, while moving the centerline closer will increase the impact. • For the sections on Garner Road it is unlikely that a 5 dB impact will be reached due to asymmetrical widening, as the distance between the receptors and the roadway is large enough that small changes to the location of the centerline will not have a great effect. • All three road alignment options share a common centerline; therefore, the acoustic differences between the various options will not be significant.	3	• The impacts due to increasing traffic range from 3 dB to 4 dB. In cases where the future road centerline is offset from the existing road centerline (asymmetrical widening), there will be increases or decreases in the impacts noted above. Moving the centerline away from the sensitive receptors will decrease the impact, while moving the centerline closer will increase the impact. • For the sections on Garner Road it is unlikely that a 5 dB impact will be reached due to asymmetrical widening, as the distance between the receptors and the roadway is large enough that small changes to the location of the centerline will not have a great effect. • All three road alignment options share a common centerline; therefore, the acoustic differences between the various options will not be significant	3
Total Score	18		18		18	
Summary	• Alternative 1 has the most impacts to existing adjacent land uses, including virtual displacement of the Bowman United Church north side parking lot and impacts to the barn at 927 Garner Road East (access restrictions and displacement of well). • Alternative 2 requires the most buyout of properties (8 complete buyouts) and the most property requirements of all three options. • Alternative 2A is the preferred alternative in regards to socio-economic environment, since this option has the lowest property requirements and the least impact to existing adjacent land uses.					

Impact Assessment Scoring Scheme

1	Major negative effect / No positive effect	2	Some negative effect/very little positive effect	3	Fair (little negative or positive effect)	4	Very little negative effect/ some positive effect	5	No negative effect/ Major positive effect

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Strategic Planning & Rapid Transit Group
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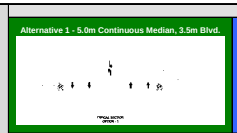
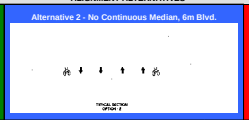
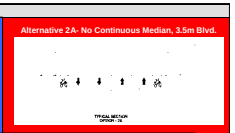
Summary Assessment of Alternative Design Concepts (Garner/Rymal) (Cont'd)

EVALUATION FACTOR	ALIGNMENT ALTERNATIVES					
	Alternative 1 - 5.0m Continuous Median, 3.5m Blvd.		Alternative 2 - No Continuous Median, 6m Blvd.		Alternative 2A- No Continuous Median, 3.5m Blvd.	
						
		Score		Score		Score
Technical Considerations						
Traffic Operations	• Continuous median lane provides more storage for left turns and access points for entrances and side roads. • Continuous median lane may be used for queue jumping.	5	• Left-turn storage lanes designed as per the traffic study report dated April 2011. Increasing storage lengths, if required, will have significant traffic operations and staging impacts.	2	• Left-turn storage lanes designed as per the traffic study report dated April 2011. Increasing storage lengths, if required, will have significant traffic operations and staging impacts.	2
Transit Operations	• Extra lane in each direction improves bus transit operations. • Continuous widened cross-section provides for easier future incorporation of alternate transit technologies.	4	• Extra lane in each direction improves bus transit operations.	3	• Extra lane in each direction improves bus transit operations.	3
Provincial Highway Operations	• Minor reconfiguration required at the Highway 6 interchange.	5	• Minor reconfiguration required at the Highway 6 interchange.	5	• Minor reconfiguration required at the Highway 6 interchange.	5
Safety	• Continuous median lane provides more storage for left turns and access points for entrances and side roads. • Continuous median lane may be used for queue jumping.	5	• Left-turn storage lanes designed as per the traffic study report dated April 2011. • Incorporating future intersections/side roads for development will require significant reconstruction and will disrupt traffic.	2	• Left-turn storage lanes designed as per the traffic study report dated April 2011. • Incorporating future intersections/side roads for development will require significant reconstruction and will disrupt traffic.	2
Pedestrian/ Cyclist Facilities	• 1.5 m Bicycle Lane provided on both sides of Garner/Rymal Road between the travelled edge of pavement and the curb. Refer also to Community Access and Linkages.	5	• 1.5 m Bicycle Lane provided on both sides of Garner/Rymal Road between the travelled edge of pavement and the curb. Refer also to Community Access and Linkages.	5	• 1.5 m Bicycle Lane provided on both sides of Garner/Rymal Road between the travelled edge of pavement and the curb. Refer also to Community Access and Linkages.	5
Drainage/ Stormwater Management	• The existing rural ditch cross-section on Garner/Rymal Road will be replaced by an urban cross-section with catch basins and storm sewers within the project limits. From Highway 6 to Glancaster Road, the urban storm system will outlet to existing Tiffany Creek. From Glancaster Road to West 5th Street, the storm sewer system will tie into an existing urban system outletting to Upper Twenty Mile Creek and Upper Ottawa Creek. • Construction of the storm sewer system has least impact on traffic staging because of increased overall pavement width.	4	• The existing rural ditch cross-section on Garner/Rymal Road will be replaced by an urban cross-section with catch basins and storm sewers within the project limits. From Highway 6 to Glancaster Road, the urban storm system will outlet to existing Tiffany Creek. From Glancaster Road to West 5th Street, the storm sewer system will tie into an existing urban system outletting to Upper Twenty Mile Creek and Upper Ottawa Creek. • Construction of the storm sewer system will require additional traffic and construction staging compared to Alternative 1 due to no median.	2	• The existing rural ditch cross-section on Garner/Rymal Road will be replaced by an urban cross-section with catch basins and storm sewers within the project limits. From Highway 6 to Glancaster Road, the urban storm system will outlet to existing Tiffany Creek. From Glancaster Road to West 5th Street, the storm sewer system will tie into an existing urban system outletting to Upper Twenty Mile Creek and Upper Ottawa Creek. • Construction of the storm sewer system will require additional traffic and construction staging compared to Alternative 1 due to no median.	2
Other Municipal Infrastructure/ Utilities	• Hydro, Bell, Gas and other utilities will require relocation. Extent of relocations is the largest for this option.	2	• Hydro, Bell, Gas and other utilities will require relocation. Extent of relocations is the least of all options. Wider boulevard can accommodate utilities.	4	• Hydro, Bell, Gas and other utilities will require relocation. Extent of relocations is the median of all options.	3
Constructability (site-specific design issues)	• Easiest alternative to construct. 5 m median provides for greater flexibility in shifting traffic lanes to facilitate storm sewer and the widening. • Impact on side roads and residential and commercial entrances is the largest of all of the options.	4	• More complicated alternative to construct with respect to shifting traffic lanes to facilitate storm sewer and the widening. • Fewer impacts on side roads and residential and commercial entrances than Alternative 1.	2	• More complicated alternative to construct with respect to shifting traffic lanes to facilitate storm sewer and the widening. • Fewer impacts on side roads and residential and commercial entrances than Alternative 1.	2
Staging of Implementation to Meet Growth Needs	• Continuous median provides for easier future incorporation of alternate transit technologies and other infrastructure to meet growth needs.	5	• Incorporating future growth/development will require significant reconstruction and will disrupt traffic.	2	• Incorporating future growth/development will require significant reconstruction and will disrupt traffic.	2
Total Score	**39** ***Preferred Alternative***		**27**		**26**	
Summary	• Alternative 1 is the preferred alternative since it allows for incorporating future development and could accommodate future plans for Rapid Transit. • Alternative 1 is also the easiest to construct.					

Financial Implications						
Construction Costs	• Approximately $25.4M construction costs (this estimate includes grading, drainage, and electrical works).	2	• Approximately $22.7M construction costs (this estimate includes grading, drainage, and electrical works).	3	• Approximately $22.2M construction costs (this estimate includes grading, drainage, and electrical works).	3
Utility Relocation Costs	• Approximately $800,000 for all utility relocation work.	2	• Approximately $800,000 for all utility relocation work.	2	• Approximately $800,000 for all utility relocation work.	2
Total Score	**4**		**5**		**5** ***Preferred Alternative***	
Summary	• Alternative 2A is the preferred alternative from a financial perspective, with the lowest construction costs, mainly resulting from lower earth excavation quantities.					

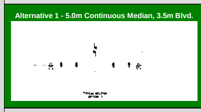
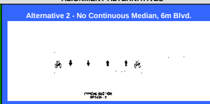
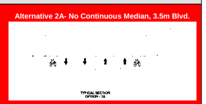
COMPREHENSIVE SUMMARY COMMENTS (Total Scores)	**PREFERRED ALTERNATIVE ALTERNATIVE 1**	**71**	**NOT RECOMMENDED FOR FURTHER STUDY**	**61**	**NOT RECOMMENDED FOR FURTHER STUDY**	**62**

Impact Assessment Scoring Scheme

1	Major negative effect/ No positive effect	**2**	Some negative effect/very little positive effect	**3**	Fair (little negative or positive effect)	**4**	Very little negative effect/ some positive effect	**5**	No negative effect/ Major positive effect

Summary Assessment of Alternative Design Concepts (Garth)

Garner Road/Rymal Road and Garth Street
Schedule "C" Class Environmental Assessment
Public Information Centre No. 2
April 3, 2012

EVALUATION FACTOR	ALIGNMENT ALTERNATIVES					
	Alternative 1 - 5.0m Continuous Median, 3.5m Blvd.		Alternative 2 - No Continuous Median, 6m Blvd.		Alternative 2A- No Continuous Median, 3.5m Blvd.	
						
		Score		Score		Score

Natural Environment

Aquatic Habitat	• Indirect impact to fish and fish habitat of Upper Twenty Mile Creek tributary with this alternative. • There will be a loss of some riparian vegetation.	2	• Indirect impact to fish and fish habitat of Upper Twenty Mile Creek tributary with this alternative. • There will be a loss of some riparian vegetation.	2	• Indirect impact to fish and fish habitat of Upper Twenty Mile Creek tributary with this alternative. • There will be a loss of some riparian vegetation.	2
Terrestrial Habitat/Roadside Vegetation	• Moderate impacts to roadside trees in ditches and boulevard. • Key areas include: Garth Street – 0+[illegible]-1+[illegible].	2	• Moderate impacts to roadside trees in ditches and boulevard. • Key areas include: Garth Street – 0+[illegible]-1+[illegible].	2	• Lesser impacts to roadside trees in ditches and boulevard compared to other options. • Key areas include: Garth Street – 0+[illegible]-1+[illegible]	3
Designated Areas	• Minor impacts to Significant woodlot on the east side of Garth Street (~0+[illegible]-0+[illegible]). Based on the Official Plan, site alterations, including grading and filling, are not permitted within these areas.	2	• Minor impacts to Significant woodlot on the east side of Garth St. (~0+[illegible]-0+[illegible]). Based on the Official Plan, site alterations, including grading and filling, are not permitted within these areas.	2	• Minor impacts to Significant woodlot on the east side of Garth St. (~0+[illegible]-0+[illegible]). [illegible] impact than other options. Based on the Official Plan, site alterations, including grading and filling, are not permitted within these areas.	3
Total Score	6		6		7 *Preferred Alternative*	
Summary	• Alternatives 1 and 2 scored the same for each evaluation criteria and had slightly more impacts than Alternative 2A. • Alternative 2A is the preferred option with respect to Natural Environment since there are fewer impacts to roadside trees (in ditches and boulevard) and Significant woodlot areas compared to other options.					

Historical/Cultural Environment

Archaeological Resources	• Potential for the proposed road widening to impact identified areas containing archaeological potential in Significant woodlot.	2	• Potential for the proposed road widening to impact identified areas containing archaeological potential in Significant woodlot.	2	• Potential for the proposed road widening to impact identified areas containing archaeological potential in Significant woodlot.	2
Built Heritage Features and Cultural Landscapes	• No cultural heritage resources were identified on Garth Street and, as such, no impacts are anticipated.	N/A	• No cultural heritage resources were identified on Garth Street and, as such, no impacts are anticipated.	N/A	• No cultural heritage resources were identified on Garth Street and, as such, no impacts are anticipated.	N/A
Total Score	**2**		**2**		**2**	
Summary	• There are no significant differences amongst the alternatives with respect to the Historical/Cultural Environment.					

Socio-Economic Environment

Conformity with Planning/ Development Policies	• This design option is compatible with the City's broad based growth management plan (GRIDS) and Official Plan land use designations.	5	• This design option is compatible with the City's broad based growth management plan (GRIDS) and Official Plan land use designations.	5	• This design option is compatible with the City's broad based growth management plan (GRIDS) and Official Plan land use designations.	5
Existing Adjacent Land Uses	• Requires a total of 0.08 ha of property, and does not require any property buyouts.	3	• Requires a total of 0.11 ha of property, and does not require any property buyouts.	2	• Requires a total of 0.05 ha of property, and does not require any property buyouts.	3
Compatibility with Approved Future Land Uses	• There is a conditionally approved site plan (DA-07-169) for 460 Rymal Road West (northwest corner of Rymal and Garth). The proposal is for a 3-storey retirement home with a total of 114 units and 100 parking spaces (75 above and 25 below). This option does not conflict with the development proposal.	3	• There is a conditionally approved site plan (DA-07-169) for 460 Rymal Road West (northwest corner of Rymal and Garth). The proposal is for a 3-storey retirement home with a total of 114 units and 100 parking spaces (75 above and 25 below). This option does not conflict with the development proposal.	3	• There is a conditionally approved site plan (DA-07-169) for 460 Rymal Road West (northwest corner of Rymal and Garth). The proposal is for a 3-storey retirement home with a total of 114 units and 100 parking spaces (75 above and 25 below). This option does not conflict with the development proposal.	3
Community Access and Linkages	• This option maintains/enhances pedestrian and cycling movement in the Garth Street corridor and provides opportunities for connection to the proposed east/west pedestrian and cycling facilities on Garner/Rymal.	4	• This option maintains/enhances pedestrian and cycling movement in the Garth Street corridor and provides opportunities for connection to the proposed east/west pedestrian and cycling facilities on Garner/Rymal. • Provides highest level of comfort for pedestrians due to buffer between edge of pavement and sidewalk.	5	• This option maintains/enhances pedestrian and cycling movement in the Garth Street corridor and provides opportunities for connection to the proposed east/west pedestrian and cycling facilities on Garner/Rymal.	4
Noise	• The impacts due to increasing traffic range from 3 dB to 4 dB. In cases where the future road centerline is offset from the existing road centerline (asymmetrical widening), there will be increases or decreases in the impacts noted above. Moving the centerline away from the sensitive receptors will decrease the impact, while moving the centerline closer will increase the impact. • For the sections on Garth Street, it is unlikely that a 5 dB impact will be reached due to asymmetrical widening, as the distance between the receptors and the roadway is large enough that small changes to the location of the centerline will not have a great effect. • All three road alignment options share a common centerline; therefore, the acoustic differences between the various options will not be significant.	3	• The impacts due to increasing traffic range from 3 dB to 4 dB. In cases where the future road centerline is offset from the existing road centerline (asymmetrical widening), there will be increases or decreases in the impacts noted above. Moving the centerline away from the sensitive receptors will decrease the impact, while moving the centerline closer will increase the impact. • For the sections on Garth Street it is unlikely that a 5 dB impact will be reached due to asymmetrical widening, as the distance between the receptors and the roadway is large enough that small changes to the location of the centerline will not have a great effect. • All three road alignment options share a common centerline; therefore, the acoustic differences between the various options will not be significant.	3	• The impacts due to increasing traffic range from 3 dB to 4 dB. In cases where the future road centerline is offset from the existing road centerline (asymmetrical widening), there will be increases or decreases in the impacts noted above. Moving the centerline away from the sensitive receptors will decrease the impact, while moving the centerline closer will increase the impact. • For the sections on Garth Street it is unlikely that a 5 dB impact will be reached due to asymmetrical widening, as the distance between the receptors and the roadway is large enough that small changes to the location of the centerline will not have a great effect. • All three road alignment options share a common centerline; therefore, the acoustic differences between the various options will not be significant	3
Total Score	**18**		**18**		**18**	
Summary	• Alternative 2 requires the most private property of all three options. • Alternative 2A is the preferred alternative in regards to socio-economic environment, since this option has the least property requirements.					

Technical Considerations

Traffic Operations	• Continuous median lane provides more storage for left turns and access points for entrances and side roads. • Continuous median lane may be used for queue jumping.	5	• Left-turn storage lanes designed as per the traffic study report dated April 2011. Increasing storage lengths, if required, will have significant traffic operations and staging impacts.	2	• Left-turn storage lanes designed as per the traffic study report dated April 2011. Increasing storage lengths, if required, will have significant traffic operations and staging impacts.	2
Transit Operations	• Extra lane in each direction improves bus transit operations. • Continuous widened cross-section provides for easier future incorporation of alternate transit technologies.	4	• Extra lane in each direction improves bus transit operations.	3	• Extra lane in each direction improves bus transit operations.	3
Provincial Highway Operations	• No impact to provincial highway operations.	5	• No impact to provincial highway operations.	5	• No impact to provincial highway operations.	5
Safety	• Continuous median lane provides more storage for left turns and access points for entrances and side roads. • Continuous median lane may be used for queue jumping.	5	• Left-turn storage lanes designed as per the traffic study report dated April 2011. • Incorporating future intersections/side roads for development will require significant reconstruction and will disrupt traffic.	2	• Left-turn storage lanes designed as per the traffic study report dated April 2011. • Incorporating future intersections/side roads for development will require significant reconstruction and will disrupt traffic.	2
Pedestrian/ Cyclist Facilities	• 1.5 m Bicycle Lane provided on both sides of Garner/Rymal Road between the travelled edge of pavement and the curb. Refer also to Community Access and Linkages.	5	• 1.5 m Bicycle Lane provided on both sides of Garner/Rymal Road between the travelled edge of pavement and the curb. Refer also to Community Access and Linkages.	5	• 1.5 m Bicycle Lane provided on both sides of Garner/Rymal Road between the travelled edge of pavement and the curb. Refer also to Community Access and Linkages.	5
Drainage/ Stormwater Management	• The storm sewer system will tie into an existing urban system outletting to Upper Twenty Mile Creek and Upper Ottawa Creek. • Construction of the storm sewer system has least impact on traffic staging because of increased overall pavement width.	4	• The storm sewer system will tie into an existing urban system outletting to Upper Twenty Mile Creek and Upper Ottawa Creek. • Construction of the storm sewer system will require additional traffic and construction staging compared to Alternative 1 due to no median.	2	• The storm sewer system will tie into an existing urban system outletting to Upper Twenty Mile Creek and Upper Ottawa Creek. • Construction of the storm sewer system will require additional traffic and construction staging compared to Alternative 1 due to no median.	2
Other Municipal Infrastructure/ Utilities	• Hydro, Bell, Gas and other utilities will require relocation. Extent of relocations is the largest for this option. • Total property required 0.08ha.	2	• Hydro, Bell, Gas and other utilities will require relocation. Extent of relocations is the least of all options. Wider boulevard can accommodate utilities. • Total property required 0.11ha.	4	• Hydro, Bell, Gas and other utilities will require relocation. Extent of relocations is the median of all options. • Total property required 0.05ha.	3
Constructability (site-specific design issues)	• Easiest alternative to construct. 5 m median provides for greater flexibility in shifting traffic lanes to facilitate storm sewer and the widening. • Impact on side roads and residential and commercial entrances is the largest of all of the options.	4	• More complicated alternative to construct with respect to shifting traffic lanes to facilitate storm sewer and the widening. • Fewer impacts on side roads and residential and commercial entrances than Alternative 1.	2	• More complicated alternative to construct with respect to shifting traffic lanes to facilitate storm sewer and the widening. • Fewer impacts on side roads and residential and commercial entrances than Alternative 1.	2
Staging of Implementation to Meet Growth Needs	• Continuous median provides for easier future incorporation of alternate transit technologies and other infrastructure to meet growth needs.	5	• Incorporating future growth/development will require significant reconstruction and will disrupt traffic.	2	• Incorporating future growth/development will require significant reconstruction and will disrupt traffic.	2
Total Score	**39** ***Preferred Alternative***		**27**		**26**	
Summary	• Alternative 1 is the preferred alternative since it allows for incorporating future development and is the easiest to construct.					

Financial Implications

Construction Costs	• Approximately $6.1M construction costs (this estimate includes grading, drainage, and electrical works).	2	• Approximately $5.4M construction costs (this estimate includes grading, drainage, and electrical works).	3	• Approximately $5.4M construction costs (this estimate includes grading, drainage, and electrical works).	3
Utility Relocation Costs	• Approximately $200,000 for all utility relocation work.	2	• Approximately $200,000 for all utility relocation work.	2	• Approximately $200,000 for all utility relocation work.	2
Total Score	**4**		**5**		**5** ***Preferred Alternative***	
Summary	• Alternative 2A is the preferred alternative from a financial perspective, with the lowest construction costs mainly resulting from lower earth excavation quantities.					

COMPREHENSIVE SUMMARY COMMENTS (Total Scores)	**PREFERRED ALTERNATIVE ALTERNATIVE 1**	**69**	**NOT RECOMMENDED FOR FURTHER STUDY**	**58**	**NOT RECOMMENDED FOR FURTHER STUDY**	**58**

Impact Assessment Scoring Scheme

1	Major negative effect/ No positive effect	**2**	Some negative effect/very little positive effect	**3**	Fair (little negative or positive effect)	**4**	Very little negative effect/ some positive effect	**5**	No negative effect/ Major positive effect

Hamilton Public Works

Environment & Sustainable Infrastructure Division
Strategic Planning & Rapid Transit Group
www.hamilton.ca/Garner-Rymal-Garth-EA

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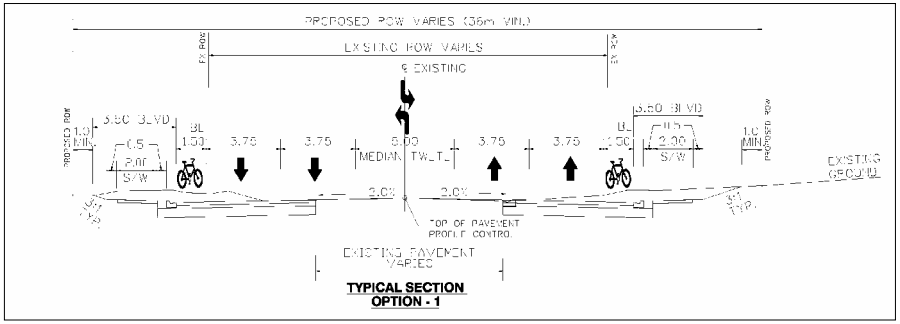
Rationale for Technically Preferred Design Concepts

Alternative 1 (4-lane Widening with Two-Way Left-Turn Lane) received the highest overall scores and has been identified as the technically preferred design concept for both the Garner Road/Rymal Road and Garth Street corridors for the following reasons:



- The continuous median lane provides the maximum storage lengths for left turns and access points for entrances and side roads, including the flexibility to accommodate future developments (e.g., Airport Employment Growth District).
- The widened cross-section as a result of the continuous median facilitates bus transit operations, current and anticipated truck traffic and provides for easier future incorporation of alternate transit technologies.
- Provides the necessary room for locating municipal services within the road cross-section and clearances to other utilities and appurtenances.
- Is the easiest alternative to construct, as the 5 m median provides the greatest flexibility to shift traffic lanes to facilitate the road widening and storm sewer installation, with the fewest impacts to traffic operations.
- Provides opportunities for potential streetscaping in median areas and replacement of roadside trees on boulevards.
- Potential property requirements can be reduced through strategic modification of grading requirements.

Next Steps

Thank you for attending this information session.

The Project Team will conduct the following activities to complete the requirements of Phase 3 and Phase 4 of the Municipal Class Environmental Assessment process:

- ❑ Public Information Centre No. 2 material will be placed on the City's project website (www.hamilton.ca/Garner-Rymal-Garth-EA).
- ❑ Consider all input from Public Information Centre No. 2.
- ❑ Conduct additional consultation as follow-up to PIC No. 2, if required, to refine the assessment of the alternative design concepts and confirm or alter the choice of the technically preferred design concepts accordingly.
- ❑ Refine the selected alternative design concepts for incorporation in the Environmental Study Report.
- ❑ The ESR will be prepared, presented to Council and filed in the Public Record for review and comment.
- ❑ Place other project information updates on the project website, including the Environmental Study Report (ESR) once it has been filed in the Public Record.
- ❑ The Project Team will respond to comments received during the ESR public review period and attempt to resolve any outstanding issues.

PIC #2 – Comment Sheet

PUBLIC INFORMATION CENTRE NO. 2

St. Thomas More Catholic Secondary School
Tuesday April 3, 2012
6:00 P.M. – 8:00 P.M.

COMMENT SHEET
(Please Print)

COMMENTS:

Comments and information regarding this study are being collected to assist the City of Hamilton in meeting the requirements of the *Environmental Assessment Act*. They will be maintained on file for use during the study and may be included in study documentation. With the exception of personal information, all comments will become part of the public record.

Please drop these comments in the box provided or forward them by **Tuesday, April 17, 2012** to either:

Lorissa Skrypniak, MCIP, RPP
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Ian Upjohn, MCIP, RPP
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Ph.: 1-416-679-6289
Fax: 1-416-231-5356
Email: Ian.Upjohn@snclavalin.com

Name:

Mailing Address:

Telephone:

Email:

Property Location: (if different from mailing address):

PIC #2 Summary – Comments and Responses

NO.	COMMENT	RESPONSE
1	▪ Concern with expansion of Rymal/Garner Road and Garth Street - damaging trees and increased traffic. Suggest to widen Rymal Road without damaging/removing trees	As summarized in the background information presented at the April 2011 public information session, land use and transportation planning studies completed within the last ten years have provided the rationale for widening Garner Road/Rymal Road to accommodate future traffic demand. Most recently, the Airport Employment Growth District (AEGD) Transportation Master Plan indicated that Garner Road will require 4 through lanes, and additional turning lanes at intersections. In particular, these studies drew attention to future potential traffic carrying capacity problems associated with: • Additional trip-making resulting from the intensification of existing land uses immediately adjacent to the Garner Road/Rymal Road corridor; • Additional trip-making resulting from new development on vacant lands surrounding the John C. Munro Hamilton International Airport (i.e., the AEGD lands); • Increased longer term travel demand in the corridor as a result of other major transportation corridors (e.g., the Linc) reaching their carrying capacity; and • Retention of the Garner/Rymal corridor as a designated/preferred full-time truck route. Daily traffic volumes in the Garner/Rymal corridor are expected to increase from approximately 10,000 vehicles in 2008 to approximately 25,000 vehicles by 2031, subject to full build-out of the AEGD area and proposed developments to the north of Garner Road East/Rymal Road West. If the roadway is not widened to provide additional traffic carrying capacity, the Garner/Rymal corridor will not operate efficiently. The overall traffic volumes at major intersections on Garner Road will approach or exceed double the available capacity, resulting in much higher waiting times, and the respective level of service will drop well below the acceptable level. Implementation of the three-lane cross-section you have suggested for use in the Garner/Rymal corridor would not be consistent with the projected requirements and recommendations for improving traffic operations. The incorporation of bike lanes and sidewalks in the Garner/Rymal corridor is consistent with the City's Cycling Master Plan (*Shifting Gears 2009* - proposed bike lane from the City's west limit to West 5th Street). The proposed design option for widening the road maintains and/or enhances cycling movement/connectivity in the Garner/Rymal corridor and provides opportunities for connection to proposed north/south cycling routes (West 5th Street to Upper James Street; Garth Street; Upper Paradise Road; Glancaster; Kitty Murray Drive; Southcote Road; numerous points southerly into the planned Airport Employment Growth District).

		The inclusion/addition of sidewalks on both sides of the road will improve the pedestrian environment in the corridor and assist the City in meeting its active transportation goals and objectives, as established in the *Step Forward: Pedestrian Mobility Master Plan* (i.e., to create pedestrian environments throughout the City that are safe, attractive, accessible to community institutions, recreation/leisure opportunities, employment, and retail services; to increase the number of people walking in the City; to improve public health; and to create a walkable City to attract new residents and employers). It is acknowledged that the proposed road widening scheme will displace, and has the potential to damage, a number of roadside trees, as you have suggested. The City is committed to the protection and preservation of such resources, where possible. The following mitigation measures will be considered to minimize the effects of construction of the road widening on those natural and/or semi-natural vegetative assemblages found within the project area: ▪ Minimize encroachment on, or avoid remnant woodlots and large healthy trees where possible. Individual specimens to be saved will be marked on the ground before construction takes place; ▪ Trees and areas to be preserved within and adjacent to the ROW will be identified in a Tree Protection Plan and protected with snow fence defining Tree Protection Zone(s); ▪ Inclusion of hard and soft landscaping in the corridor, including planting of additional street trees, where opportunities present themselves; ▪ Where practicable, use only native species for landscaping efforts along the road right-of-way; ▪ Provide dense edge plantings in areas of fresh forest edge exposure to protect from drying winds, sun exposure (desiccation and spread of invasive sun-tolerant plant species), and salt spray. These plantings may constitute an exception to the native species mandate, since non-native conifers may provide better screening/protection than native options. ▪ Approval will be obtained, and compensation/reimbursement will be provided, as required, for displacement of publicly owned roadside trees on public property, in compliance with City of Hamilton's Public Tree Removal Policy, the Forest Management Plan (Reforestation Policy) and By-Law 06-151 (Public Trees By-Law), as amended. ▪ Designated staging and construction vehicle maintenance/refuelling areas will be identified and enforced; ▪ Siltation control in areas where sedimentation could potentially affect vegetation not scheduled

		for removal; ▪ Stormwater management to maximize runoff water quality, and provide some peak flow controls, which will benefit nearby natural features; ▪ The movement of construction machinery will be limited to within the boundaries of the ROW and operated in a manner that minimizes damage to adjacent vegetation; ▪ Roots and branches, if damaged, will be treated using approved horticultural methods; ▪ Tree management, as needed, to remove any potentially hazardous trees along new wooded edges, and maintain forest health and balance; ▪ Trees felled will be dropped to fall within the ROW to avoid damage to the remaining vegetation, where practicable; and ▪ Wherever possible, construction activities will be restricted within the dripline of all trees not scheduled for removal.
2	▪ Concern of southbound traffic on Garth Street at Stonechurch in the right turn lane.	With respect to your concern over southbound traffic on Garth Street at Stonechurch Road, the outside lane on the north leg of the intersection is not marked as right-turn only, and southbound through traffic must merge with the inside lane prior reaching the one-lane section of Garth Street south of Stonechurch Road, near the townhouse entrance. This requirement is signed south of Stonechurch. The proposed widening of Garth Street south of Stonechurch Road will add one through lane in each direction, plus a centre two-way turning lane, which will eliminate the current merge requirement and facilitate right-turns into the townhouse complex. This is expected to alter the type of drive behavior and confusion you have cited. These improvements will also provide additional roadway capacity and the flexibility for through traffic to pass vehicles stopped in the curb lane (buses, emergency response vehicles, garbage trucks), thereby reducing delays and associated unsafe manoeuvres by impatient drivers. The City has a management plan and budget for regular maintenance and repair of its capital assets, including road infrastructure. With respect to your suggestion that City repair the section of Garth Street in front of the Highland Baptist Church, we can advise you that this portion of road is proposed to be reconstructed in 2015.

3	▪ Suggest to incorporate both cyclists and pedestrian traffic into the re-design of the transportation corridor to make it save and user friendly.	Your support for reconstruction of the Garner/Rymal corridor is noted and appreciated. You have expressed a desire to see the introduction of a multi-modal corridor, including facilities for both cyclist and pedestrian traffic. I can advise you that, in addition to the 5-lane vehicular section of the roadway, the corridor cross-section includes bicycle lanes and sidewalks on both sides. This will enhance cycling movement/connectivity in the Garner/Rymal corridor and provide opportunities for connection to proposed north/south cycling routes (West 5th Street to Upper James Street; Garth Street; Upper Paradise Road; Glancaster; Kitty Murray Drive; Southcote Road; numerous points southerly into the planned Airport Employment Growth District). The inclusion/addition of sidewalks on both sides of the road will improve the pedestrian environment in the corridor and assist the City in meeting its active transportation goals and objectives, as established in the *Step Forward: Pedestrian Mobility Master Plan* (i.e., to create pedestrian environments throughout the City that are safe, attractive, accessible to community institutions, recreation/leisure opportunities, employment, and retail services; to increase the number of people walking in the City; to improve public health; and to create a walkable City to attract new residents and employers).
4	▪ Is there any plan to maintain and repair the existing road specifically between West 5th and Garth? ▪ Are any traffic lights being contemplated in this area as well?	Your comments supporting the plan for widening the road to two lanes, with an additional turning lane are noted and appreciated. The City has a management plan and budget for regular maintenance and repair of its capital assets, including road infrastructure. With respect to your question on the City's plans to maintain and repair the section of Rymal Road between West 5th Street and Garth Street, I can advise you that this portion of road is proposed to be replaced in 2016. In response to your question on whether the City is contemplating the introduction of any traffic lights, the results of the consultant's traffic analysis suggest that new traffic signals are only required at the intersection of Garner Road and the Highway 403 access/egress ramps at the west end of the project. This information was presented at the April 3 Public Information Centre as part of the display showing the required road/intersection improvements, and is currently available on the City's website for this project (www.hamilton.ca/Garner-Rymal-Garth-EA).
5	▪ Concern with Garner expansion and the	The Project Team appreciates the character of the Garner Road-Rymal Road corridor, as you have described it. The road widening alternatives have been developed in a manner that

	removal of trees. ▪ Concern for accidents on the road.	generally avoids a number of the features you have cited (cemeteries, farm markets, Bowman United Church, St. Elizabeth Village). It is acknowledged that the proposed road widening scheme will displace a number of roadside trees, as you have suggested. The City is committed to the protection and preservation of such resources, where possible. The following mitigation measures will be considered to minimize the effects of construction of the road widening on those natural and/or semi-natural vegetative assemblages found within the project area: ▪ Minimize encroachment on, or avoid remnant woodlots and large healthy trees where possible. Individual specimens to be saved will be marked on the ground before construction takes place; ▪ Trees and areas to be preserved within and adjacent to the ROW will be identified in a Tree Protection Plan and protected with snow fence defining Tree Protection Zone(s); ▪ Inclusion of hard and soft landscaping in the corridor, including planting of additional street trees, where opportunities present themselves; ▪ Where practicable, use only native species for landscaping efforts along the road right-of-way; ▪ Provide dense edge plantings in areas of fresh forest edge exposure to protect from drying winds, sun exposure (desiccation and spread of invasive sun-tolerant plant species), and salt spray. These plantings may constitute an exception to the native species mandate, since non-native conifers may provide better screening/protection than native options. ▪ Approval will be obtained, and compensation/reimbursement will be provided, as required, for displacement of publicly owned roadside trees on public property, in compliance with City of Hamilton's Public Tree Removal Policy, the Forest Management Plan (Reforestation Policy) and By-Law 06-151 (Public Trees By-Law), as amended. ▪ Designated staging and construction vehicle maintenance/refuelling areas will be identified and enforced; ▪ Siltation control in areas where sedimentation could potentially affect vegetation not scheduled for removal; ▪ Stormwater management to maximize runoff water quality, and provide some peak flow controls, which will benefit nearby natural features;

		▪ The movement of construction machinery will be limited to within the boundaries of the ROW and operated in a manner that minimizes damage to adjacent vegetation; ▪ Roots and branches, if damaged, will be treated using approved horticultural methods; ▪ Tree management, as needed, to remove any potentially hazardous trees along new wooded edges, and maintain forest health and balance; ▪ Trees felled will be dropped to fall within the ROW to avoid damage to the remaining vegetation, where practicable; and ▪ Wherever possible, construction activities will be restricted within the dripline of all trees not scheduled for removal. Therefore, it is expected that the significant landscape impacts that you have described can be avoided. With respect to the need for the accommodating increased traffic in the corridor, I would refer you to the project need and justification described in my June 13, 2011 response to your comments from the April 2011 Public Information Centre. Traffic projections suggest that the three-lane configuration that you have suggested would not adequately serve future travel demand (i.e., 4-lanes of through traffic plus a centre two-way turning lane and additional turning lanes at intersections are required). It is the City's intent to retain the corridor as a designated full-time truck route based on current and project use by heavy commercial vehicles and recommendations in the Hamilton Truck Route Master Plan. I would also refer you to my June 13, 2011 response to your concerns over the potential for increased speeds in the corridor. Further in this regard, the introduction of additional signalized intersection controls in the corridor, both in association with this project and the introduction of intersecting roads to serve the Airport Employment Growth District (which will be bounded on the north by the Garner Road corridor), should serve to reduce the potential for excessive vehicular speeds.

APPENDIX A.3
FIRST NATIONS CONSULTATION

Assembly of First Nations
473 Albert Street, Suite 810
Ottawa, Ontario K1R 5B4
Telephone: (613) 241-6789 Fax: (613) 241-5808
www.afn.ca

Assemblée des Premières Nations
473 rue Albert, pièce 810
Ottawa, Ontario K1R 5B4
Téléphone: (613) 241-6789 Télécopieur: (613) 241-5808
www.afn.ca

April 21, 2011

Lorissa Skrypniak, MCIP, RPP
Senior Project Manager
Transportation Planning
Environmental & Sustainable Infrastructure
Public Works
City of Hamilton
400-77 James Street North
Hamilton ON L8R 2K3

Re: "Notice of Study Commencement and Public Information Centre Garner Road/Rymal Road and Garth Street Municipal Class Environment Assessment"

The Assembly of First Nations (AFN) is in receipt of your notice postmarked April 11, 2011 regarding the Notice of Study Commencement. The AFN is a national representative organization of over 630 First Nations communities in Canada. The AFN is designed to present the views of various First Nations through their leaders in areas such as: Aboriginal and Treaty Rights, Economic Development, Education, Languages and Literacy, Health, Housing, Social Development, Justice, Taxation, Land Claims, Environment, and a whole array of issues that are of common concern which arise from time to time. The First Nation Leaders meet quarterly to set national policy and direction through resolution.

Please be advised that the AFN functions only as a representation organization. As such the organization cannot be construed as a government, agent, principal, administrator and/or contractor for any of the First Nation Communities who are members of the AFN. As AFN does not have any entitlement to the lands in question and cannot speak on behalf of the First Nations communities in your area, nor are we in a position to provide any comments on the Municipal Class Environmental Assessment.

I would recommend that you provide the information you have given the AFN to the First Nation communities in the vicinity of the Hamilton area. You should also personally contact the First Nation communities in the area to provide them with more detailed information. It is these First Nation communities who may be impacted by the management plan or who may have outstanding claims in within your area. I have provided a list of the First Nation communities in your area for your reference now and in the future as an attachment to this letter.

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Please be advised that the Supreme Court of Canada has recently issued a number of judgments that provides clarity on the duty to consult and accommodate. In *Haida Nation v. British Columbia (Minister of Forests) and Weyerhaeuser* the Supreme Court held that there is a duty to consult and accommodate where there is knowledge of the potential existence of an Aboriginal right to title and conduct that may adversely affect it. Furthermore, the Supreme Court held in *Taku River Tlingit First Nation v. British Columbia* that where the potential for negative derivative impact on aboriginal claims is high, First Nations are entitled to something significantly deeper than minimal consultation and to a level of responsiveness that can be characterized as accommodation.

It is in the nature of respect for the first peoples that consultation and accommodation should be pursued. I commend Hamilton Public Works for being proactive in attempting to inform us of your plans. I would strongly recommend that you please extend this courtesy to the First Nation Communities in your area for now and any future projects your office undertakes that has the potential to involve local First Nations communities.

Sincerely,

Donald Sharp, Dr.P.H.
A/Director, Environmental Stewardship Unit
Assembly of First Nations

c.c.:
I. Upjohn, MCIP, RPP
Project manager
SNC Lavalin Inc.

Head Office/Siège Social
Territory of Akwesasne, RR#3, Cornwall Island, Ontario K6H 5R7 Telephone: (613) 932-0410 Fax: (613) 932-0415
Territoire de Akwesasne, RR#3, Ile de Cornwall K6H 5R7 Téléphone: (613) 932-0410 Télécopieur: (613) 932-0415

First Nations Communities in the Hamilton Region

Mississaugas of Scugog First Nation
Administration Building
22521 Island Road
Port Perry, ON
L9L 1b6

Six Nations Band Administration Office
1695 Chiefswood, Ohsweken,
ON N0A 1M0 (519) 445-2201

APPENDIX A.4
NOTICE OF COMPLETION

Hamilton

Garner Road/Rymal Road and Garth Street
Municipal Class Environmental Assessment
Notice of Project Completion

THE PROJECT AND PROCESS

The City of Hamilton has completed a Municipal Class Environmental Assessment (EA), Schedule C to develop and assess design alternatives that address the identified transportation issues along the following streets, Garner Road, Rymal Road and Garth Street.

The EA identified Alternative 1 as preferred alternative for all of these streets:

- Four (4) – through lanes
- Two (2) – bike lanes (off road for Rymal and Garner Roads – on road for Garth St)
- A continuous median that accommodates left turn lanes and raised medians at most intersections
- Exclusive right-turn lanes as per the recommendations for the Traffic Study report
- Curb and gutter
- A continuous boulevard

PUBLIC REVIEW PERIOD

The study has met the Municipal Class EA requirements and the Environmental Study Report has been completed. The study has been placed on public record for a review period starting **March 7, 2014 to April 11, 2014**. It will be available for public review at:

1. **Terryberry Library** at 100 Mohawk Road West; Tel: 905-546-3921
2. **Westmount Recreation Centre** at 35 Lynbrook Drive; Tel: 905-546-4932
3. **Ancaster Municipal Service Centre**, at 300 Wilson St. East; 905-546-1708
4. **Redeemer College University**, at 777 Garner Road E, Library main building, 905-648-2131
5. **City Centre Public Works Dept.** at 77 James St. N., Suite 400 Reception; Tel: 905-546-CITY
6. **City Hall Clerk's Dept.** at 71 Main St. E.; Tel: 905-546-CITY

Please check on line to confirm hours of operation. The Report is also available online at: http://www.hamilton.ca/Garner-Rymal-Garth-EA

If you have any outstanding concerns about this project, please address them to the City staff people below:

Lorissa Skrypniak, BA, MCIP, RPP
Project Manager
Transportation Planning
Public Works
City of Hamilton
Phone: 905-546-2424 ext. 2732
tplanning@hamilton.ca

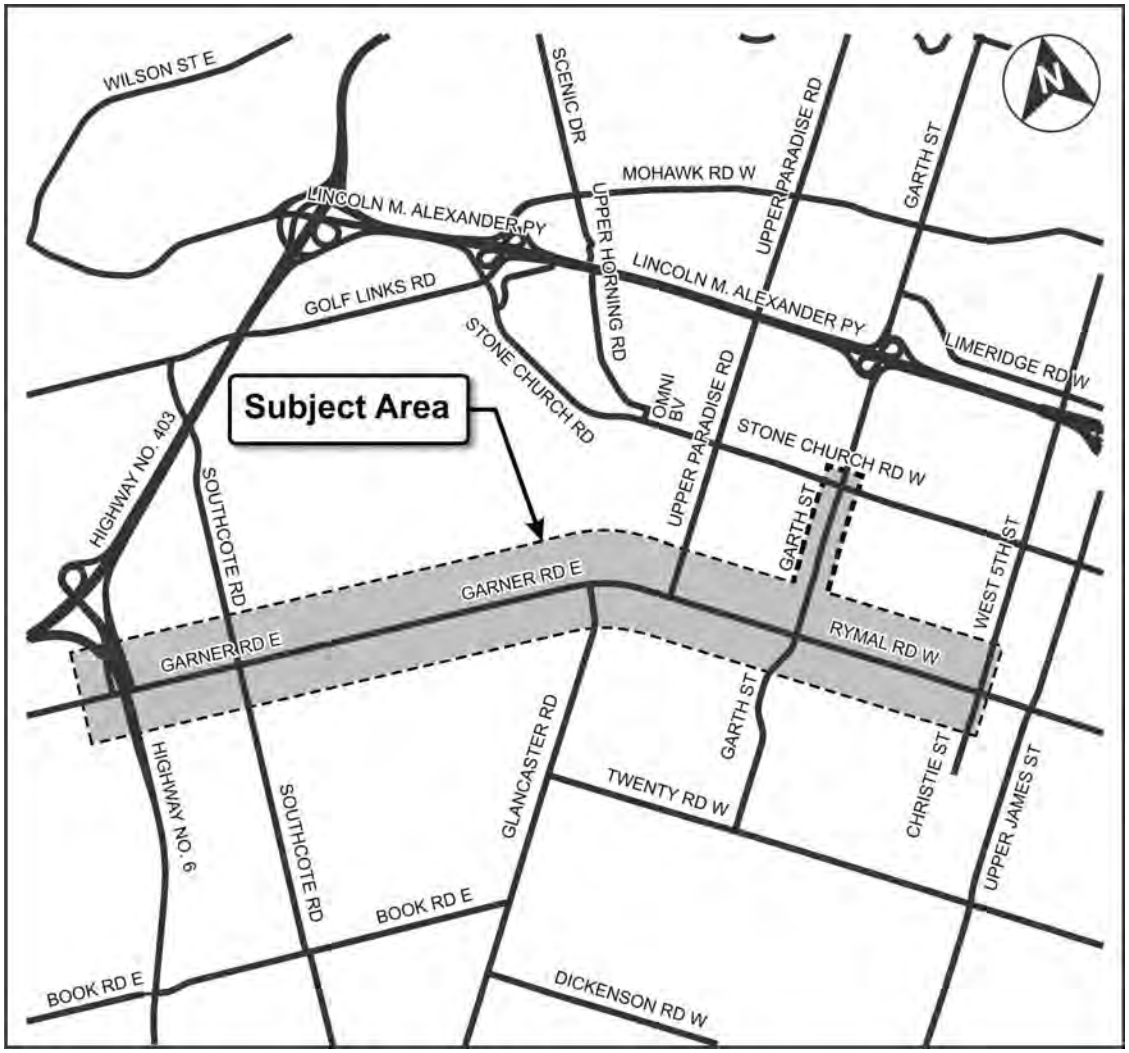
Susan Jacob
Project Manager
Engineering Services, Design
Public Works
City of Hamilton
Phone: 905-546-2424 ext. 2621

If concerns arise regarding this project, which cannot be resolved in discussion with the City, a person or party may request that the Minister of the Environment make a Part II Order (appeal). Requests must be received by the Minister of the Environment (address provided below) within the public review period. A copy of the request must also be sent to the City of Hamilton to the attention of Lorissa Skrypniak (address provided above). If there is no request received by **April 11, 2014**, the project will proceed to design and construction as presented in the planning documentation.

Minister of the Environment
77 Wellesley Street West
11th Floor, Ferguson Block
Toronto, Ontario
M7A 2T5

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.

This Notice issued on March 7 and 14, 2014.



APPENDIX B

CORRESPONDENCE AND MINUTES OF MEETINGS

Hamilton Conservation Authority

Healthy Streams...Healthy Communities!

March 2, 2012

CEA-MUN/11-03

Lorissa Skrypniak, MCIP, RPP
Senior Project Manager
Transportation Planning
Public Works Department
City of Hamilton
77 James Street North, Suite 400
Hamilton, Ontario
L8R 2K3

Dear Mrs. Skrypniak:

Re: Garner Road/Rymal Road and Garth Street
Municipal Class Environmental Assessment

Thank you for meeting with Lisa Jennings and me on February 29, 2012 to review the above noted issue.

It is our understanding that the Environmental Assessment is being conducted to review road improvements and upgrade options for Garner Road, Rymal Road and Garth Street within the study area. It was outlined in this meeting that based on studies done for adjacent development that the road upgrades would involve a 5 lane width for the road with urban cross sections. We have reviewed the information provided to us at the meeting and provide the following information for your reference and use.

a) Portions of the study area are located within lands regulated by *the Hamilton Conservation Authority's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation 161/06 under Ontario Regulation 97/04.* These lands are associated with the headwater areas of Ancaster Creek, Tiffany Creek and the Red Hill Creek. A permit from the HCA will be required for any works proposed within these regulated areas. It is noted that this project will be phased in two sections over a period of time. As such, a permit for each phase will be required.

b) Portions of the study area are located within the Niagara Peninsula Conservation Authority's (NPCA) watershed. In this regard, the NPCA should be contacted regarding this project. It was indicated in the meeting that it was proposed to divert flows from the Red Hill Creek watershed to the Twenty Mile Creek watershed. It is noted that as a general policy, these watershed diversions are not supported by the HCA. We do note however, that the West Central Mountain Drainage Assessment has been completed by AMEC Environment & Infrastructure and submitted to the City of Hamilton for this area as part of the Mewburn and Sheldon

RECEIVED MAR 12 2012

P.O. Box 81067, 838 Mineral Springs Road, Ancaster, Ontario L9G 4X1 ◆ Phone: 905-525-2181 or 905-648-4427
Office Fax: 905-648-4622 ◆ Shop Fax: 905-525-2214 ◆ E-mail: nature@conservationhamilton.ca ◆ Website: www.conservationhamilton.ca

Neighbourhood Master Servicing Plan and should be consulted as it relates to the drainage plans for this area. This report should also provide catchment area information about this area.

c) As part of our review of this proposal, we would request that a drainage and stormwater management report be provided to us for consideration. As Ancaster Creek, Tiffany Creek and the Red Hill Creek all drain into Hamilton Harbour, the Enhanced (Level 1) quality control for stormwater is required. We would suggest that low impact development methods be utilized to address water quality as opposed to stormceptors.

d) There are a number of significant natural heritage features located within the study area. In order to ensure that the new development complies with other legislative approvals, we recommend that you contact Graham Buck of the Ministry of Natural Resources-Guelph District Office at 519-826-4505 or graham.buck@ontario.ca regarding the Endangered Species Act, and investigate the requirements of the Migratory Birds Convention Act. Should you require additional information regarding the Migratory Birds Convention Act, please visit the Environment Canada website at http://www.ec.gc.ca/paom-itmb, or contact Christian Friis of the Canadian Wildlife Service at 416-739-4908 or christian.friis@ec.gc.ca to discuss the matter further.

e) While we have concerns regarding the entire study area specifically as it relates to the proposed watershed diversion and stormwater management, the western end of the study area is of particular concern as it contains the headwater areas of Ancaster Creek and Tiffany Creek. Maintaining these features in their natural state and maintaining the hydrology of the area is a paramount concern. The study should provide direction on how the proposed road and transportation upgrades will maintain and enhance the natural features in and adjacent to the study area. In this regard we would recommend the completion of an environmental impact study as part of the environmental assessment.

We appreciate the opportunity to comment on this proposal and would request that we be circulated on future correspondence regarding this issue. Should you have any questions, please contact the undersigned at (905)525-2181, ext. 133.

Sincerely,

T. Scott Peck, B.A., DPA, MCIP, RPP
Manager, Watershed Planning Services

TSP/tsp

Pc: Ian Upjohn, SNC – Lavalin Inc.

Hamilton District
Christian High

July 11, 2011

Ms Lorissa Skrypniak, MCIP, RPP

Senior Project Manager

City of Hamilton Public Works Department

400 – 77 James Street North

Hamilton ON L8R 2K3

RE: **GARNER ROAD / RYMAL ROAD AND GARTH STREET**

SCHEDULE C MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

Dear Ms Skrypniak,

Thank you for your detailed response dated June 13, 2011 to my initial comments to you. I had raised a number of questions and concerns with respect to student safety and transit service near Hamilton District Christian High.

I have discussed your reply with our school administration and have advised our Property Committee. As well, our campus strategic planning group has taken your comments under advisement.

We are encouraged by the plans to relocate the #44 Rymal bus stops at the northwest and southwest corners of the Rymal/Glancaster/Garner intersection. As well, we are encouraged by the plan to include a connecting concrete sidewalk from the intersection to the existing bus loop on the west side of Glancaster Road.

We have considered the possibility of bringing the #34 Upper Paradise closer to HDCH by relocating the bus loop facility on our campus, per your proposal. In the 1990s we negotiated an agreement with ORC to maintain and develop the existing fully landscaped walking path to the current bus loop facility on Glancaster Road. Our current administration believes that from a cost / benefit analysis there is little to be gained by relocating the bus loop.

Thank you for your careful attention to our concerns. I look forward to seeing the forthcoming refinement and assessment at the second Public Information Centre.

Kind regards,

Harry Meester

Director of Recruitment & Advancement

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t. 905-648-6655 | f. 905-648-3139 | www.hdch.org | 92 Glancaster Road, Ancaster ON L9G 3K9

Hamilton District
Christian High

May 2, 2011

Ian Upjohn, MCIP, RPP

Project Manager

SNC-Lavalin Inc.

195 The West Mall

Toronto ON M9C 5K1

Re: Garner Road / Rymal Road EA

Dear Mr Upjohn,

Further to my email, I would like to express the interest of Hamilton District Christian High to participate in the EA process related to the development of Garner and Rymal Roads.

HDCH is situated on a 20 acre parcel near the centre of the EA Study area. The school has been at this location since 1989 and will likely remain and develop here for the foreseeable future. Currently, 484 students and 50 staff travel here daily.

While most arrive by car and school bus, and significant number of students cycle, walk and travel by HSR. We would like to encourage these sustainable practices. However, particularly with the new poorly-placed Route 44 HSR bus stops, our students are forced to walk on narrow, unlit gravel shoulders near traffic which often passes pedestrians at fairly high speed. Especially in winter, we perceive this as a very real pedestrian safety hazard. If it takes years for this hazard to be remedied, we fear the risk of delay.

As well, as stakeholders we may wish to have input on other aspects of road development. Kindly add us to the study mailing list.

Kind regards,

Harry Meester

Director of Recruitment & Advancement

t. 905-648-6655 | f. 905-648-3139 | www.hdch.org | 92 Glancaster Road, Ancaster ON L9G 3K9

Affaires indiennes et du Nord Canada
Indian and Northern Affairs Canada

www.ainc-inac.gc.ca

Votre référence - Your file

0 9 JUIN 2010
Notre référence - Our file

Lorissa Srypniak
Senior Project Manager
Capital Planning and Implementation,
Public Works Department
320-77 James St., N.
Hamilton ON, L8R 2K3

Dear Ms. Srypniak:

Re: Notice of Study Commencement Garner Road/ Rymal Road and Garth Street schedule C Municipal Class Environment Assessment

I am writing in response to your letter of May 3, 2010 addressed to Franklin Roy inquiring about any claims that may affect the subject property. I regret that we were unable to respond earlier.

We can inform you that our inventory includes active litigation (cases) in the vicinity of this property. It is ***Six Nations of the Grand River Band of Indians v. Attorney General for Canada and Her Majesty the Queen in Right of Ontario, Ontario Superior Court of Justice, filed in Brantford, court reference number 406/95.***

I am unable to comment with respect to the possible effect of this claim as the case has not yet been adjudicated and any statement regarding the outcome of the litigation would be speculative at this point. It is recommended that you consult legal counsel as to the effect this action could have on the lands you are concerned with.

If you are interested in further details about this claim, copies of the pleadings can be obtained from the Court for a fee. Please contact the appropriate Court Registry Office and make reference to the court file number listed above.

We cannot make any comments regarding claims filed under other departmental policies. For information on any claims you should also contact Don Boswell of the Specific Claims Branch at (819) 953-1940 to inquire about any Specific Claims. To inquire about any current Comprehensive Claims, please contact

.../2

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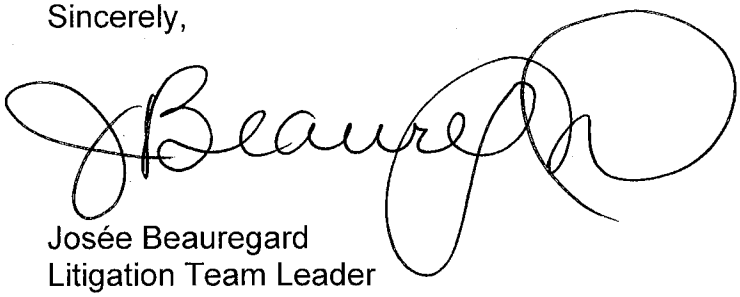
Nicole Cheechoo of Treaty and Aboriginal Government Central Operations at (819) 997-3499.

If you have any further questions please do not hesitate to contact me at (819)994-1947. (Also, please note that all future requests of this nature should no longer be addressed to Franklin Roy. Instead, could you kindly modify your distribution list to send these requests to the following destination:

Josée Beauregard, Ontario/Nunavut Team
Indian and Northern Affairs
LITIGATION MANAGEMENT AND RESOLUTION BRANCH
25 Eddy Street
Gatineau, Quebec
K1A 0H4)

Sincerely,



Josée Beauregard
Litigation Team Leader
Eastern Litigation Directorate
Litigation Management and Resolution Branch

DISCLAIMER: In this Disclaimer, "Canada" means Her Majesty the Queen in right of Canada and the Minister of Indian Affairs and Northern Development and their servants and agents. Canada does not warrant or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any data or information disclosed with this correspondence or for any actions in reliance upon such data or information or on any statement contained in this correspondence. Data and information is based on information in departmental records and is disclosed for convenience of reference only. Canada does not act as a representative for any Aboriginal group for the purpose of any claim. Information from other government sources and private sources (including Aboriginal groups) should be sought, to ensure that the information you have is accurate and complete.

Ministry of the Environment
West Central Region

119 King Street West
12th Floor
Hamilton, Ontario L8P 4Y7
Tel.: 905 521-7640
Fax: 905 521-7820

Ministère de l'Environnement

119 rue King ouest
12e étage
Hamilton (Ontario) L8P 4Y7
Tél. : 905 521-7640
Téléc. : 905 521-7820

Ontario

June 15, 2010

Ms L. Skrypniak
Public Works Department
City of Hamilton
Capital Planning and Implementation
320-77 James Street North
Hamilton, Ontario
L8R 2K3

Dear Ms Skrypniak:

Re: Notice of Study Commencement
Garner Road/Rymal Road and Garth Street
Schedule C Municipal Class Environmental Assessment

Thank you for your Notice advising of the commencement of a class EA for the above-noted road project. It is understood that the City is proceeding in accordance with the requirements for Schedule "C" undertakings under the MEA Class Environmental Assessment. This project has been initiated to evaluate options for the widening of Garner/Rymal Road and Garth Street in the vicinity of the Garth Street and Rymal Road intersection.

Schedule "C" projects require preparation of a Environmental Study Report (ESR) that is prepared when the preferred design has been selected and design work has progressed to the point where the details of any environmental protection measures to be incorporated in the construction package have been finalized. A suggested outline for an ESR is presented in the MEA Class EA document. Once the ESR is finalized a Notice of Completion is issued, allowing the public at least a 30 calendar day period for documentation review and comment. You are also reminded that when concerns are raised during the public comment period, the concerned party should be consulted in an attempt to resolve the concerns. Discussions may result in the 30-day review period being exceeded. The concerned party must be advised that if discussions are unsuccessful at resolving the concerns, they can submit a Part II Order request if they have not already done so to the Minister within a further seven calendar days following the end of discussions.

Please note that as part of the required stakeholder and agency consultation, proponents are advised to contact the following agencies to determine potentially affected Aboriginal communities in the project area. You are encouraged to visit the ministry's website at http://www.ene.gov.on.ca/envision/env_reg/ea/english/General_info/GRTList.htm for the most up to date contact list in this regard. Once identified, you are advised to provide notification directly to the Aboriginal communities who may be affected by the project and provide them with an opportunity to participate in any planned public consultation sessions and comment on the project.

RECEIVED JUN 18 2010

Should you have any questions regarding the Class EA process, please contact me at (905) 521-7864 or at Barbara.slattery@ontario.ca.

Thank you,

Barbara Slattery

Barbara Slattery
EA/Planning Coordinator

May 31, 2010

Ms. Lorissa Skrypniak, MCIP, RPP
Senior Project Manager
The City of Hamilton
320-77 James Street North
Hamilton, ON
L8R 2K3

Via email: lorissa.skrypniak@hamilton.ca

Dear Ms. Skrypniak:

Re: Garner Road / Rymal Road and Garth Street
Environmental Assessment
Our File No. PAR 16904

We have received notice of the EA to widen Garner Road. TransCanada has one high pressure natural gas pipeline crossing Garner Road on the east side of Glancaster Rd. TransCanada reviews all development/construction within 200 metres of its facilities to ensure that it does not affect the safety and integrity of those facilities.

Please forward additional study details as they become available. Upon receipt of this information we will provide site-specific comments.

Until such time, please be advised of the following TransCanada and National Energy Board requirements for any construction in close proximity to the pipeline:

1. All crossings of the pipeline right-of-way by any facility as defined by the National Energy Board (NEB) Regulation 112 must have TransCanada's prior written authorisation. A crossing facility may include but is not limited to driveways, roads, access ramps, trails, pathways or utilities. In accordance with the NEB Act, the owner may be required to enter into a crossing agreement with TransCanada prior to the construction of any facility. The owner agrees to meet all clearances and design requirements outlined in the crossing agreement and the NEB Pipeline Crossing Regulations.

2. Any grading not otherwise permitted by the NEB Act or Crossing Regulations, that will affect the right-of-way or drainage onto it, regardless of whether or not the grading is conducted on the right-of-way, must receive TransCanada's prior written approval. Grading

activities on the right-of-way will only be permitted when a TransCanada representative is present to inspect and supervise them.

3. Section 112 of the NEB Act requires that anyone excavating with power-operated equipment or explosives within 30m of the pipeline right-of-way must obtain leave from the pipeline company before starting any work. To satisfy this NEB requirement, you may send your request for leave directly to TransCanada with supporting information explaining how the work will be carried out. Once you obtain written approval for your excavation request, you must notify TransCanada at 1-800-827-5094 or Ontario One Call at 1-800-400-2255 15 business days before the start of any excavation using power-operated equipment and 30 business days before the use of explosives within 30m of the pipeline right-of-way limits.

4. Notice must be given to TransCanada directly (1-800-827-5094) or through Ontario One Call (1-800-400-2255) a minimum of 15 business days before the start of any construction on or within 30m of the pipeline right-of-way and 30 business days before conducting any work involving explosives.

5. No fill or building material may be stored on the pipeline right-of-way before, during or after construction unless prior written approval is obtained from TransCanada.

6. The Owner shall ensure through all contracts entered into, that all contractors and subcontractors are aware of and observe the foregoing terms and conditions.

If you have any questions, please contact our office.

Sincerely,

Darlene Presley

May 16, 2011

Mr. Ian Upjohn, MCIP, RPP
Project Manager
SNC Lavalin Inc.
195 The West Mall
Toronto, ON
M9C 5K1

Via email: Ian.Upjohn@snclavalin.com

Dear Mr. Upjohn:

Re: Garner Rd./Rymal Rd. & Garth Street Municipal Class Environmental Assessment
Our File No. PAR 19595

We have received notice of commencement for the study noted above. TransCanada has one high pressure natural gas pipeline crossing Garner Rd. just west of Glancaster Rd. TransCanada reviews all development within 200 metres of its facilities to ensure that it does not affect the safety and integrity of those facilities.

We request the following TransCanada and National Energy Board requirements are included in the Environmental Study Report:

1. All crossings of the pipeline right-of-way by any facility as defined by the National Energy Board (NEB) Regulation 112 must have TransCanada's prior written authorisation. A crossing facility may include but is not limited to driveways, roads, access ramps, trails, pathways or utilities. In accordance with the NEB Act, the owner may be required to enter into a crossing agreement with TransCanada prior to the construction of any facility. The owner agrees to meet all clearances and design requirements outlined in the crossing agreement and the NEB Pipeline Crossing Regulations.

2. Any grading not otherwise permitted by the NEB Act or Crossing Regulations, that will affect the right-of-way or drainage onto it, regardless of whether or not the grading is conducted on the right-of-way, must receive TransCanada's prior written approval. Grading activities on the right-of-way will only be permitted when a TransCanada representative is present to inspect and supervise them.

3. Section 112 of the NEB Act requires that anyone excavating with power-operated equipment or explosives within 30m of the pipeline right-of-way must obtain leave from the pipeline company before starting any work. To satisfy this NEB

requirement, you may send your request for leave directly to TransCanada with supporting information explaining how the work will be carried out. Once you obtain written approval for your excavation request, you must notify TransCanada at 1-800-827-5094 or Ontario One Call at 1-800-400-2255 15 business days before the start of any excavation using power-operated equipment and 30 business days before the use of explosives within 30m of the pipeline right-of-way limits.

4. Notice must be given to TransCanada directly (1-800-827-5094) or through Ontario One Call (1-800-400-2255) a minimum of 15 business days before the start of any construction on or within 30m of the pipeline right-of-way and 30 business days before conducting any work involving explosives.

If you have any questions, please contact our office.

Sincerely,

Darlene Presley,
Project Manager

APPENDIX C

GARNER ROAD/RYMAL ROAD AND GARTH STREET DESIGN PLATES

PUBLIC WORKS DEPARTMENT

Hamilton

SNC·LAVALIN

GARNER ROAD EAST/RYMAL ROAD WEST AND GARTH STREET

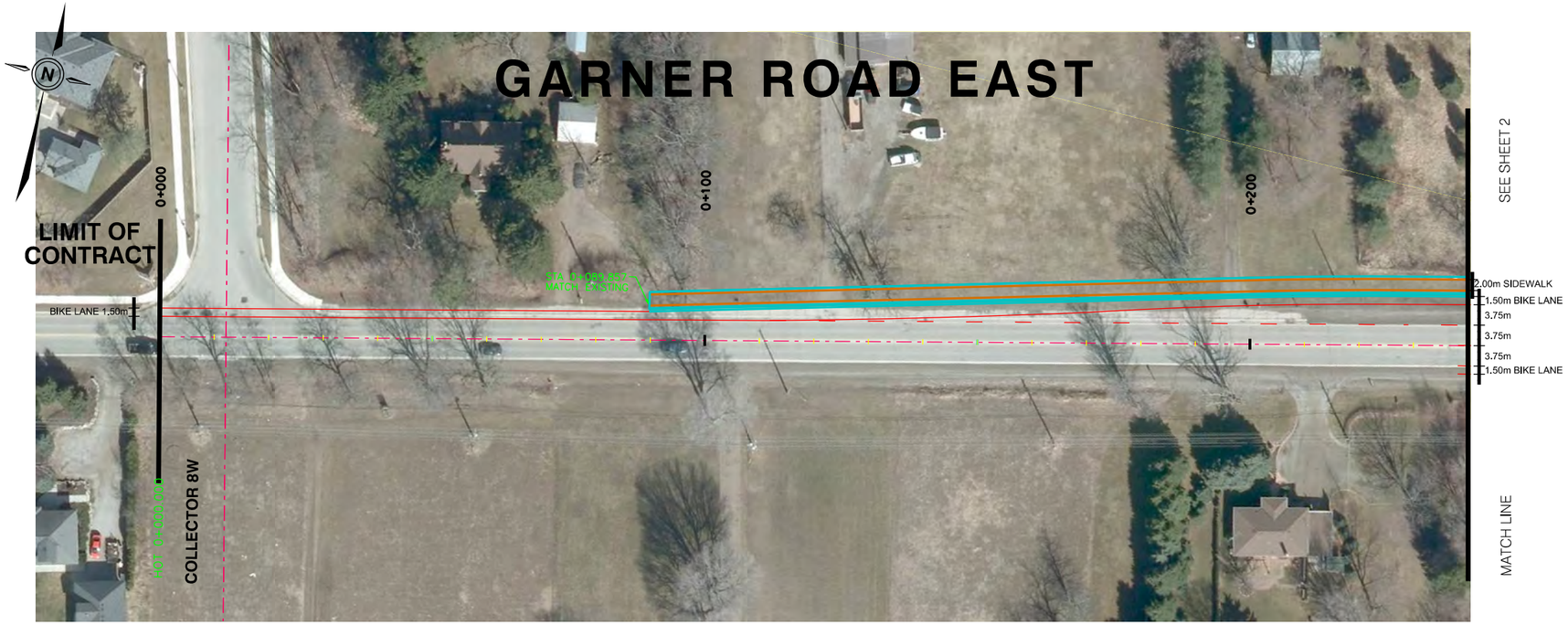
DESIGN PLATES - PREFERRED ALTERNATIVE

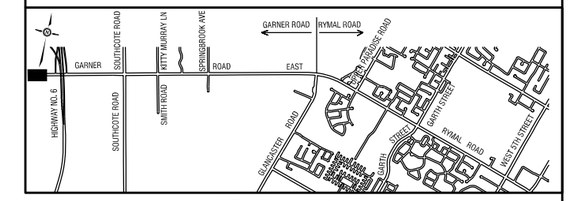
City of Hamilton

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 1 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED





KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET

250
245
240

SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS																		*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS																		EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+000	0+015	0+030	0+045	0+060	0+075	0+090	0+105	0+120	0+135	0+150	0+165	0+180	0+195	0+210	0+225	0+240	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

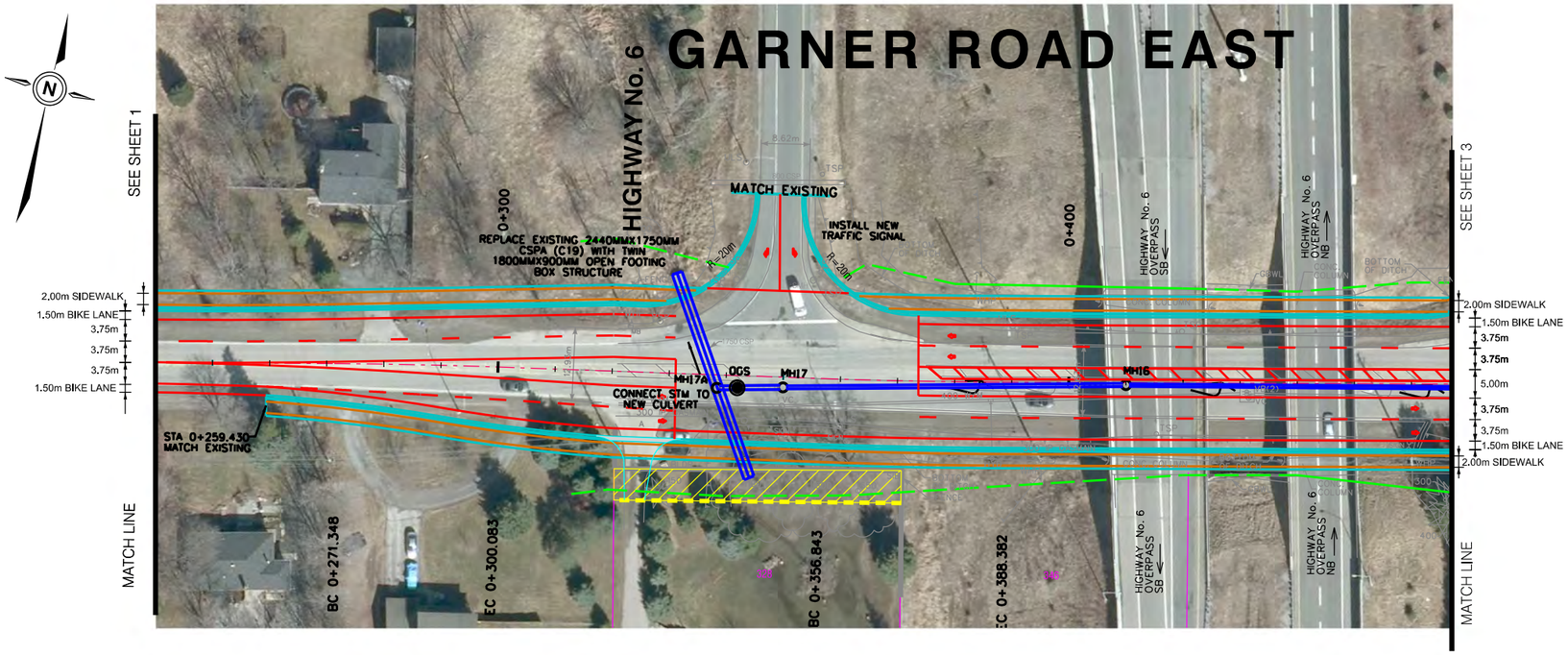
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

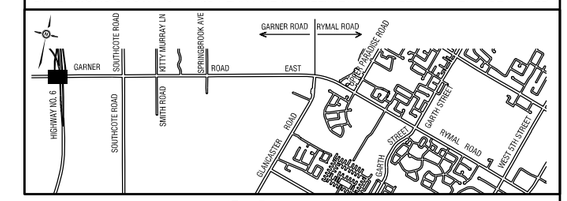
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 2 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

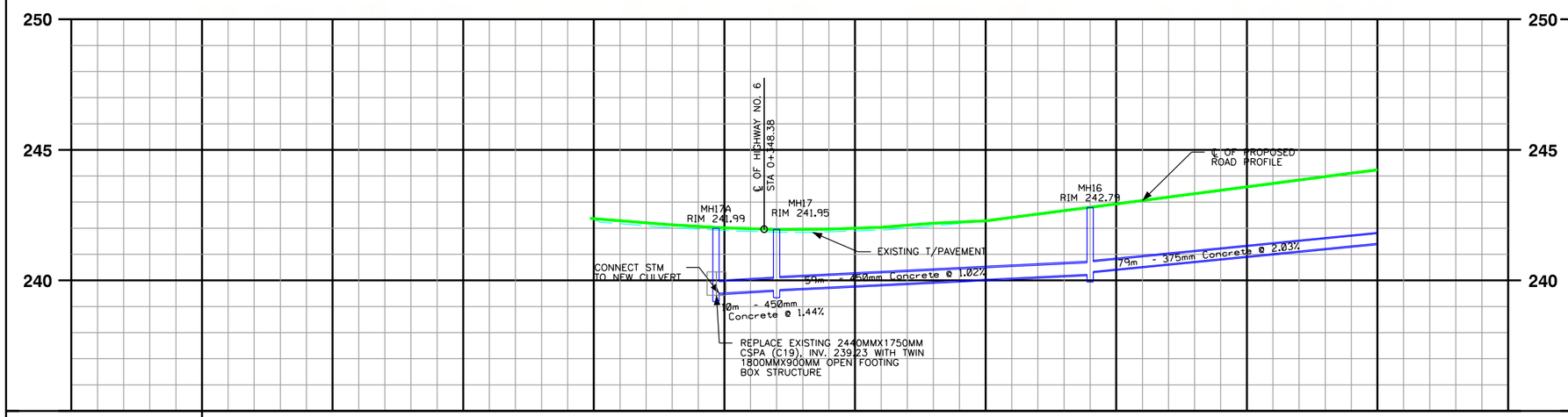




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS

C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS						242.13	241.98	241.96	242.11	242.28	242.67	243.06	243.45	243.85	244.23			*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS						242.03	241.88	241.86	242.00	242.28	242.64	243.06	243.42	243.82	244.22			EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+240	0+255	0+270	0+285	0+300	0+315	0+330	0+345	0+360	0+375	0+390	0+405	0+420	0+435	0+450	0+465		EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON

Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

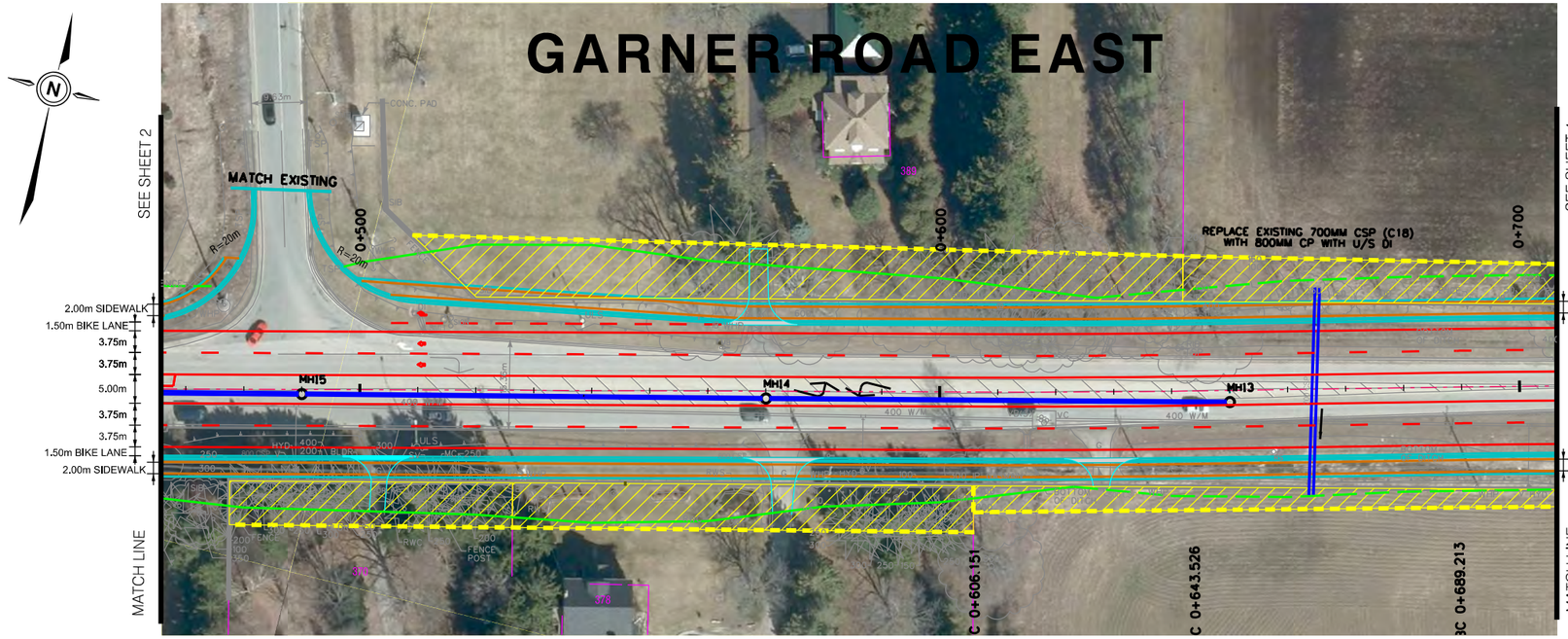
From : Highway No 6

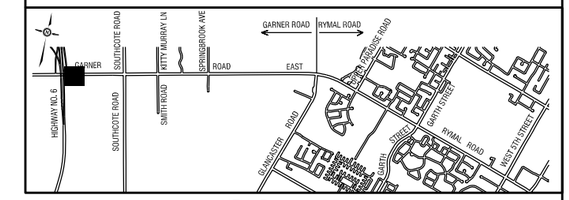
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 3 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

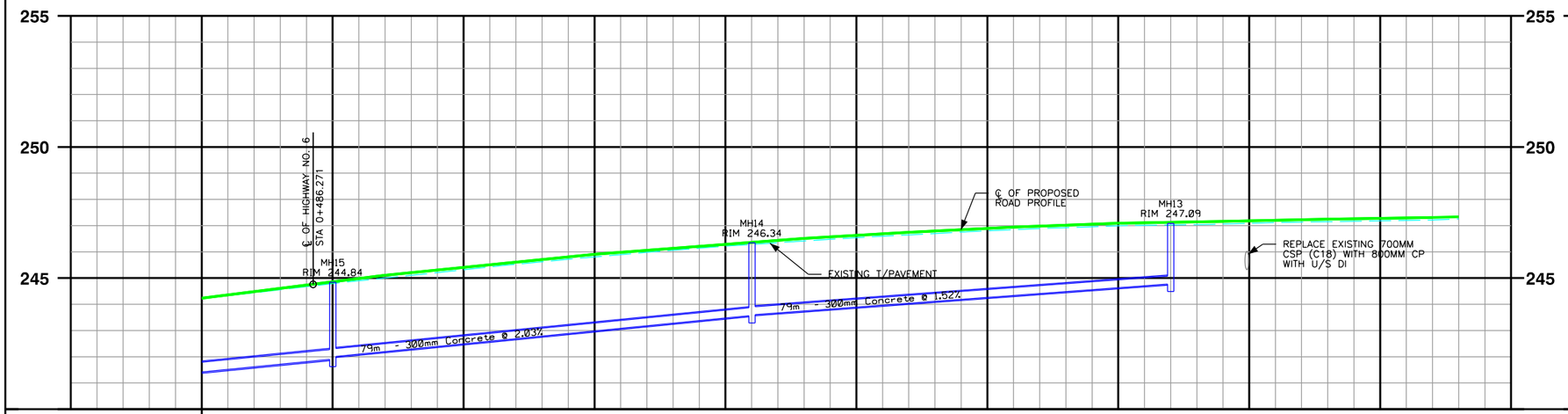




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	244.23	244.61	244.98	245.31	245.61	245.91	246.14	246.36	246.57	246.75	246.90	247.02	247.11	247.16	247.23	247.28	247.34	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	244.22	244.56	244.90	245.21	245.53	245.81	246.06	246.28	246.48	246.65	246.80	246.92	247.01	247.06	247.13	247.18	247.25	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+465	0+480	0+495	0+510	0+525	0+540	0+555	0+570	0+585	0+600	0+615	0+630	0+645	0+660	0+675	0+690	0+705	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

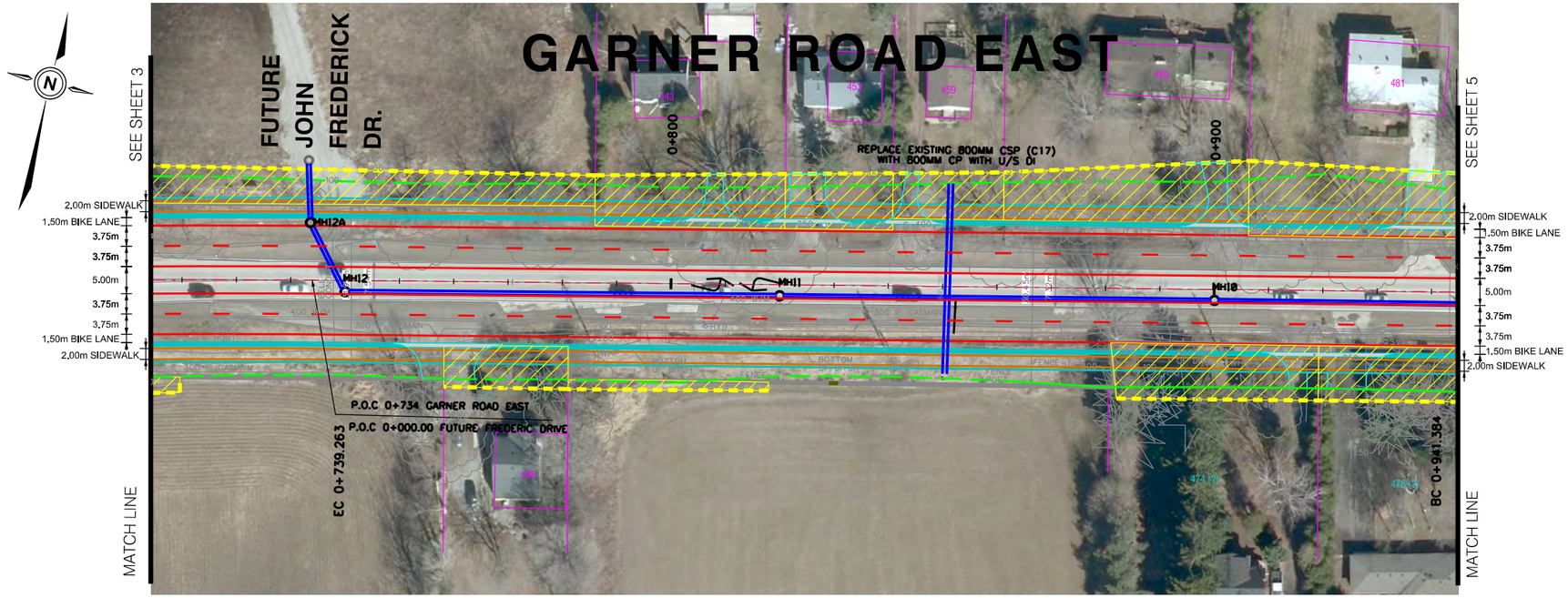
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

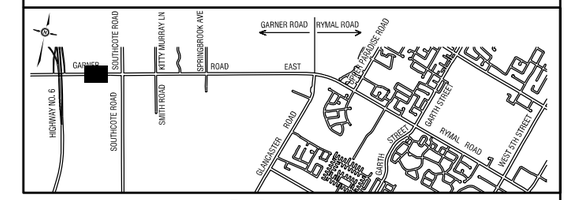
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 4 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

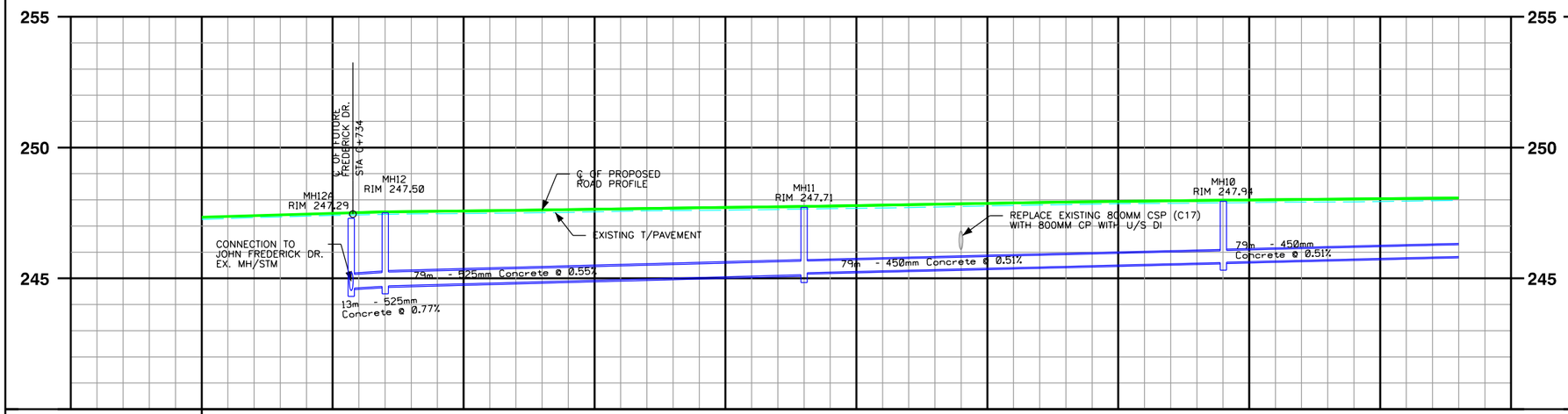




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		PROPOSED SANITARY SEWER
PROPOSED STORM SEWER																		PROPOSED STORM SEWER
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	247.34	247.43	247.51	247.57	247.60	247.64	247.69	247.73	247.77	247.82	247.87	247.92	247.95	247.98	248.01	248.04	248.07	PROPOSED ℄ OF ROAD PROFILE ELEVATIONS
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	247.25	247.35	247.43	247.47	247.50	247.55	247.59	247.62	247.66	247.71	247.77	247.82	247.86	247.88	247.91	247.94	247.98	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+705	0+720	0+735	0+750	0+765	0+780	0+795	0+810	0+825	0+840	0+855	0+870	0+885	0+900	0+915	0+930	0+945	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

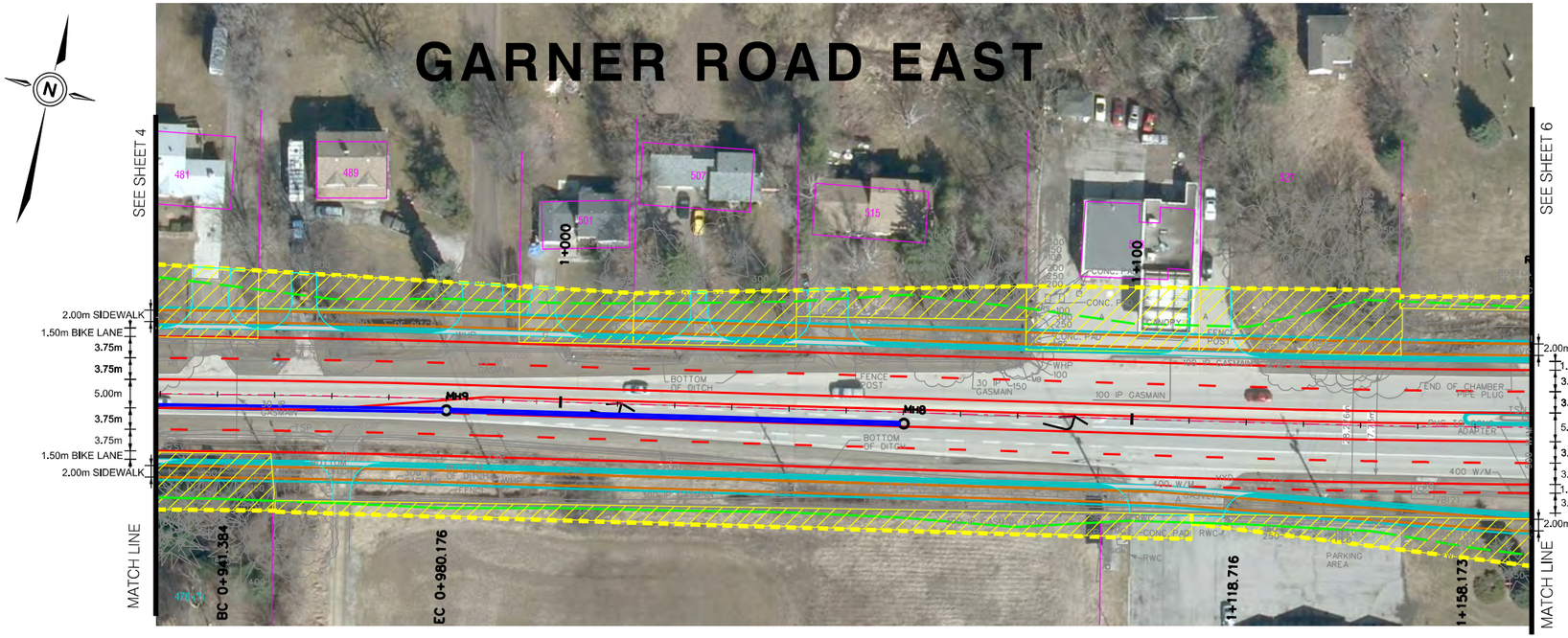
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

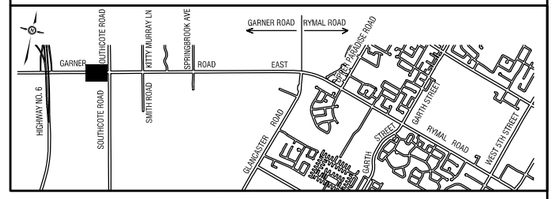
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 5 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

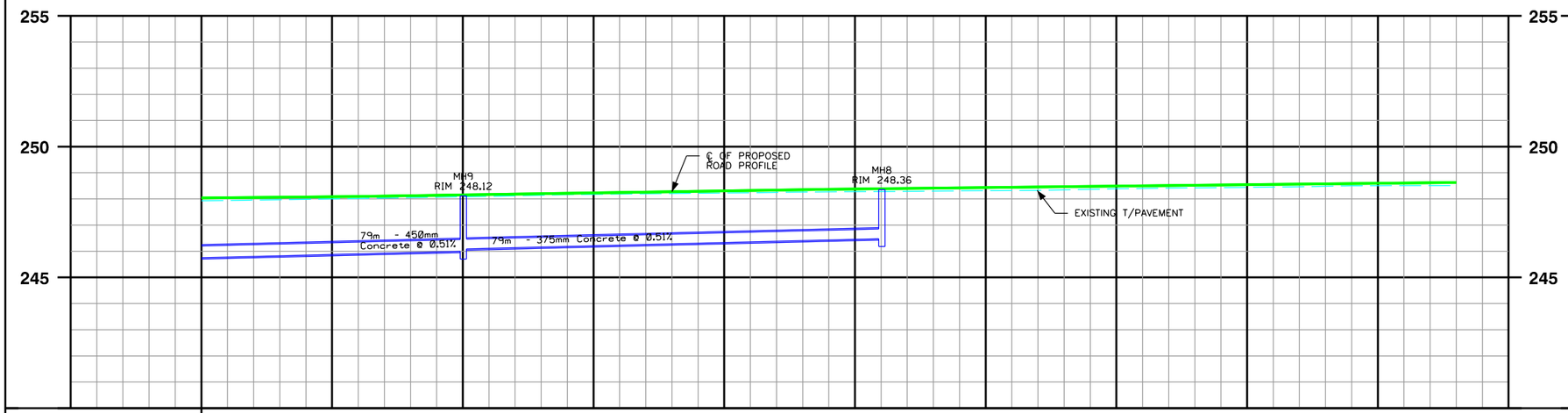




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	248.04	248.07	248.10	248.15	248.19	248.24	248.28	248.33	248.38	248.41	248.44	248.47	248.51	248.54	248.57	248.60	248.64	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	247.94	247.98	248.02	248.08	248.13	248.18	248.22	248.25	248.28	248.30	248.32	248.35	248.41	248.44	248.48	248.51	248.52	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+930	0+945	0+960	0+975	0+990	1+005	1+020	1+035	1+050	1+065	1+080	1+095	1+110	1+125	1+140	1+155	1+170	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

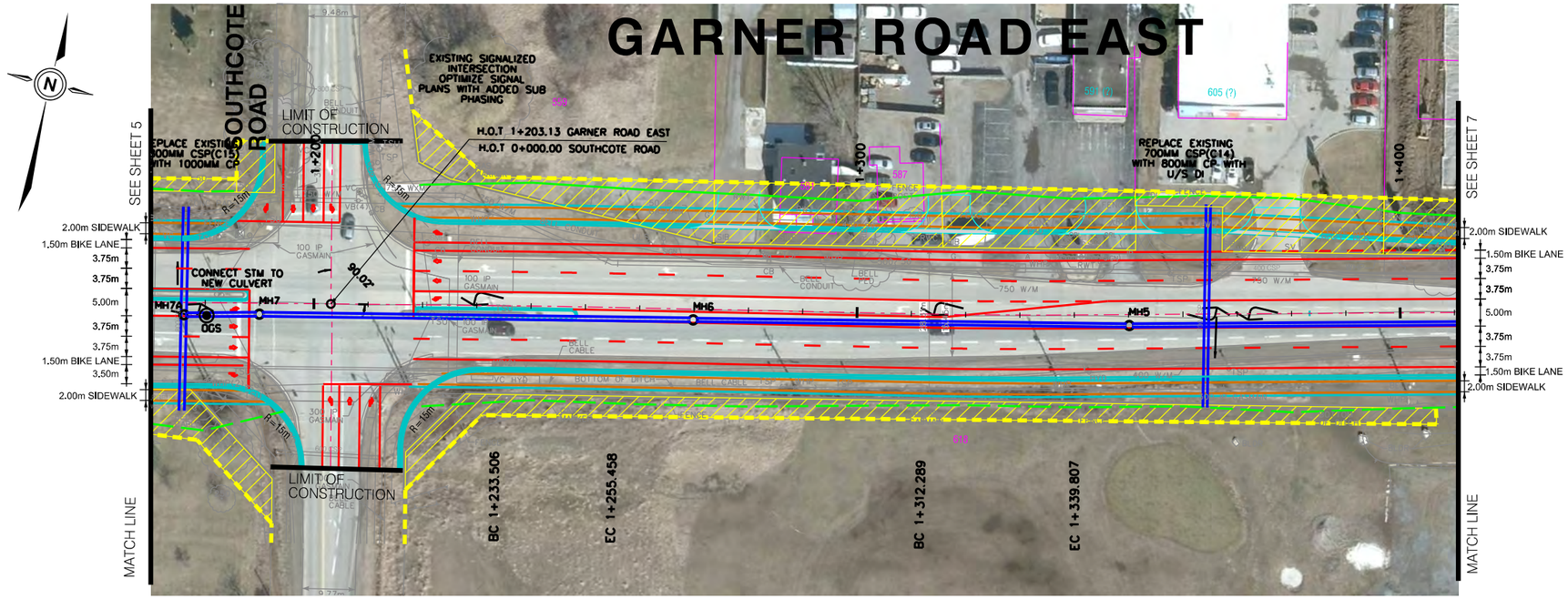
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

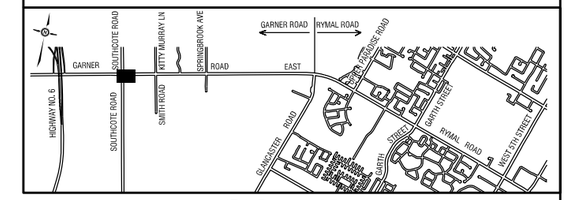
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 6 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

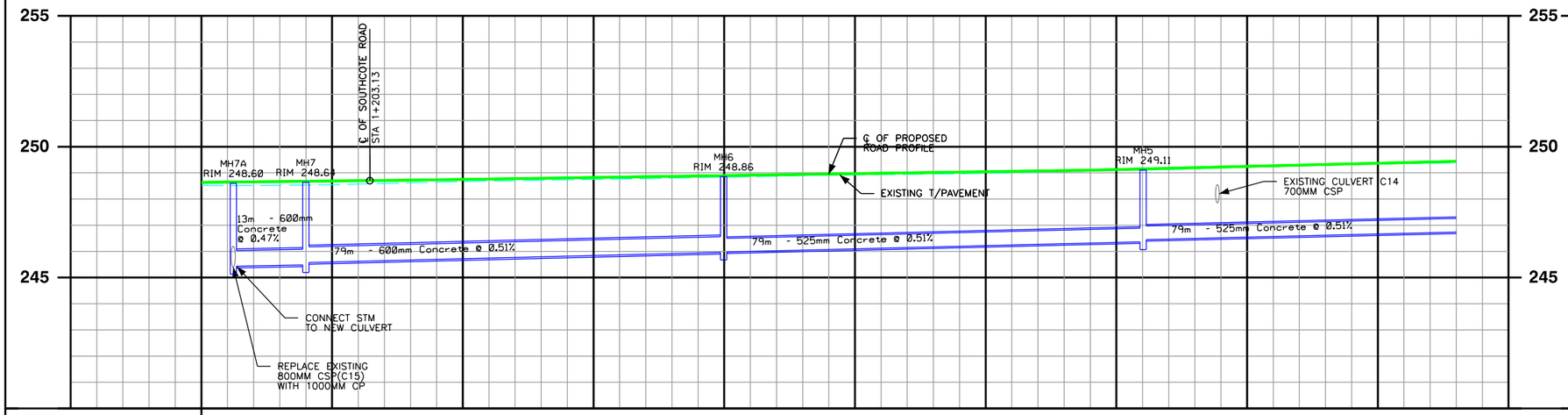




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	248.64	248.67	248.70	248.74	248.78	248.82	248.87	248.91	248.95	249.00	249.04	249.09	249.15	249.22	249.30	249.37	249.44	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	248.52	248.53	248.57	248.64	248.70	248.75	248.80	248.86	248.91	248.94	248.98	249.04	249.11	249.19	249.28	249.34	249.38	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	1+170	1+185	1+200	1+215	1+230	1+245	1+260	1+275	1+290	1+305	1+320	1+335	1+350	1+365	1+380	1+395	1+410	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

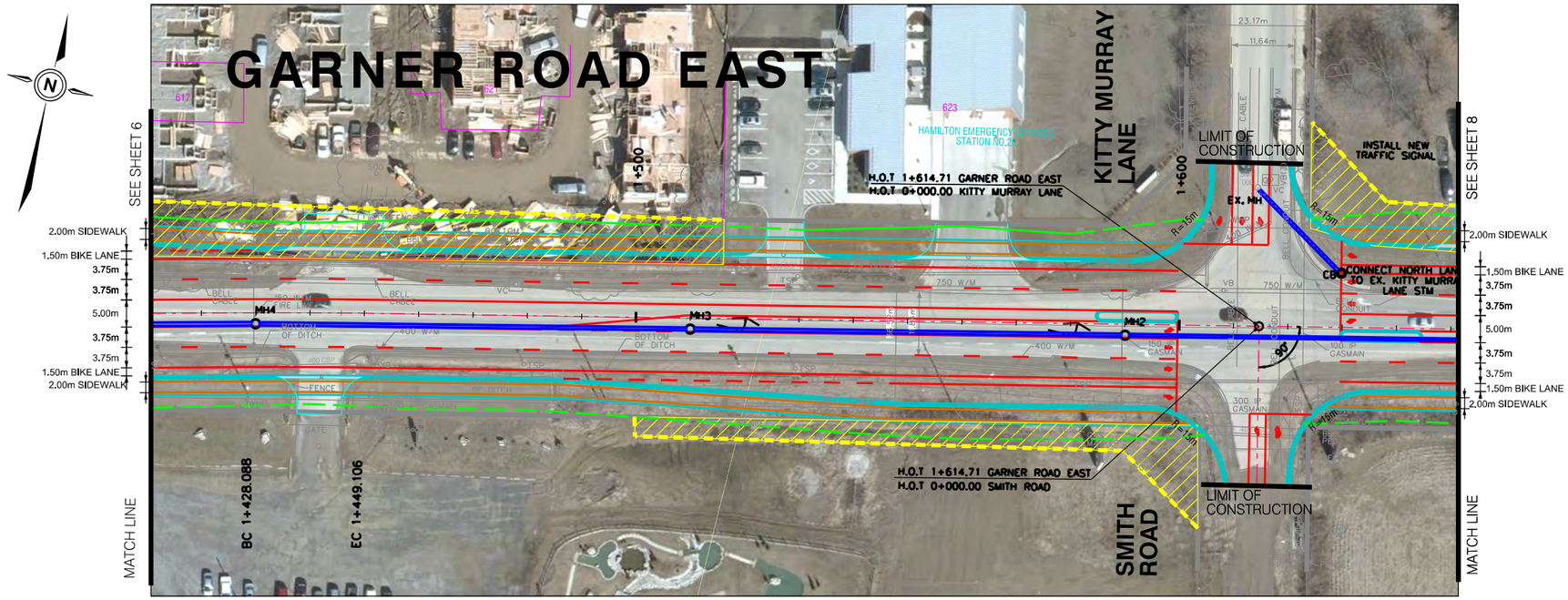
CITY OF HAMILTON
Public Works Department

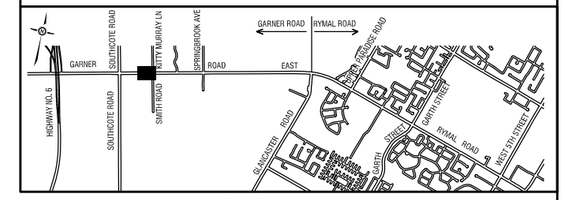
GARNER ROAD/RYMAL ROAD AND GARTH STREET
SCHEDULE C CLASS EA
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 7 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

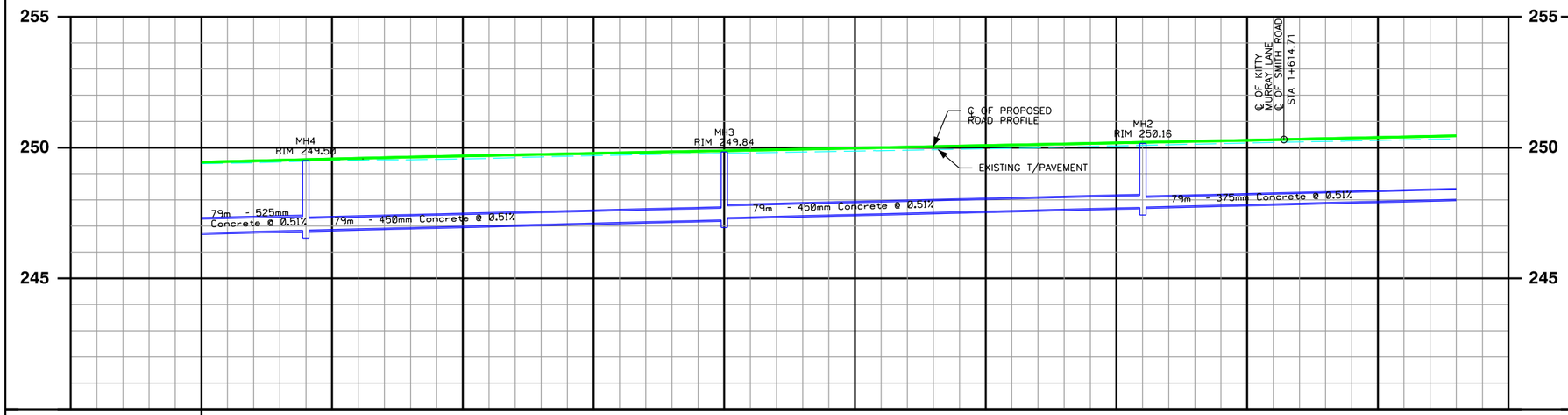




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																	*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																	*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	249.44	249.51	249.59	249.66	249.72	249.78	249.84	249.90	249.96	250.02	250.08	250.14	250.20	250.26	250.32	250.38	250.45	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	249.38	249.45	249.52	249.55	249.61	249.69	249.75	249.80	249.85	249.90	249.96	250.02	250.09	250.15	250.22	250.27	250.33	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	1+410	1+425	1+440	1+455	1+470	1+485	1+500	1+515	1+530	1+545	1+560	1+575	1+590	1+605	1+620	1+635	1+650	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.
SNC•LAVALIN

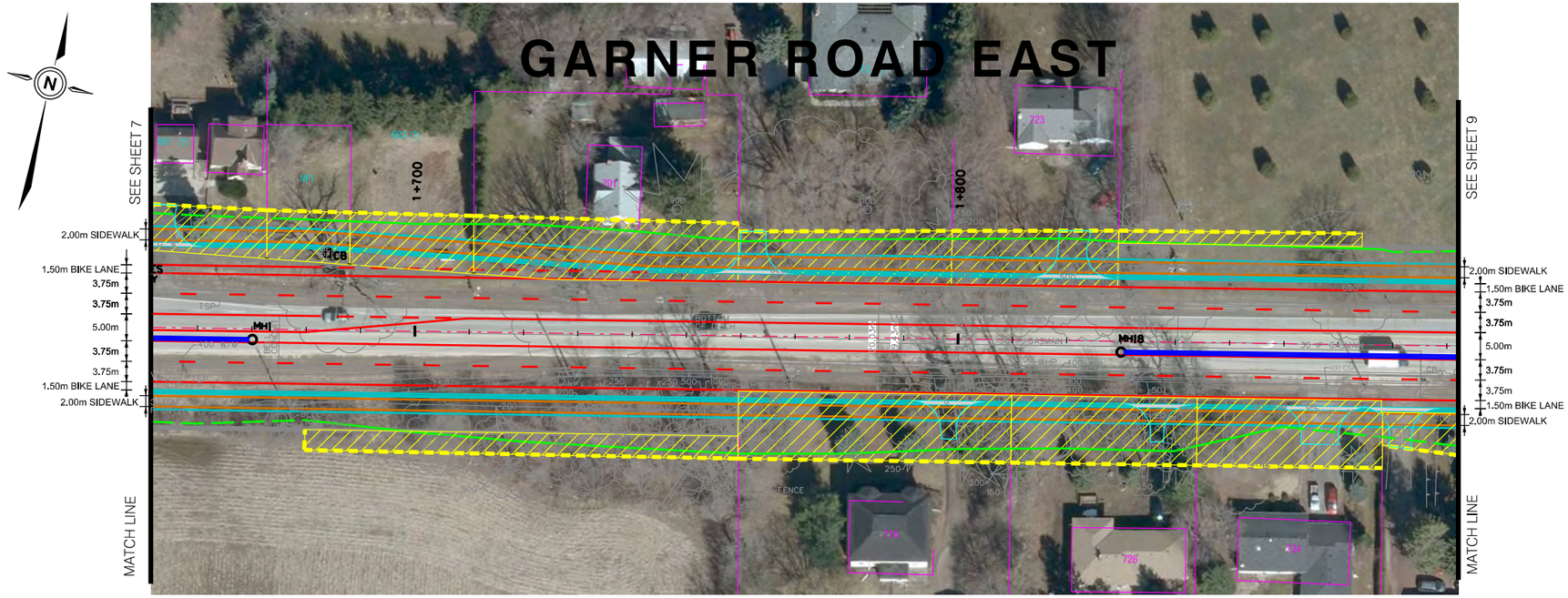
CITY OF HAMILTON
Public Works Department

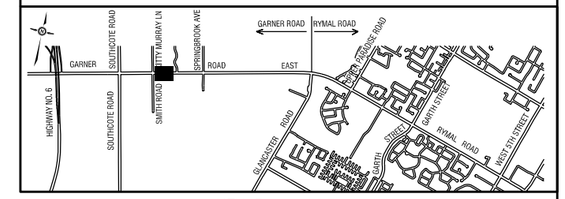
GARNER ROAD/RYMAL ROAD AND GARTH STREET
SCHEDULE C CLASS EA
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 8 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

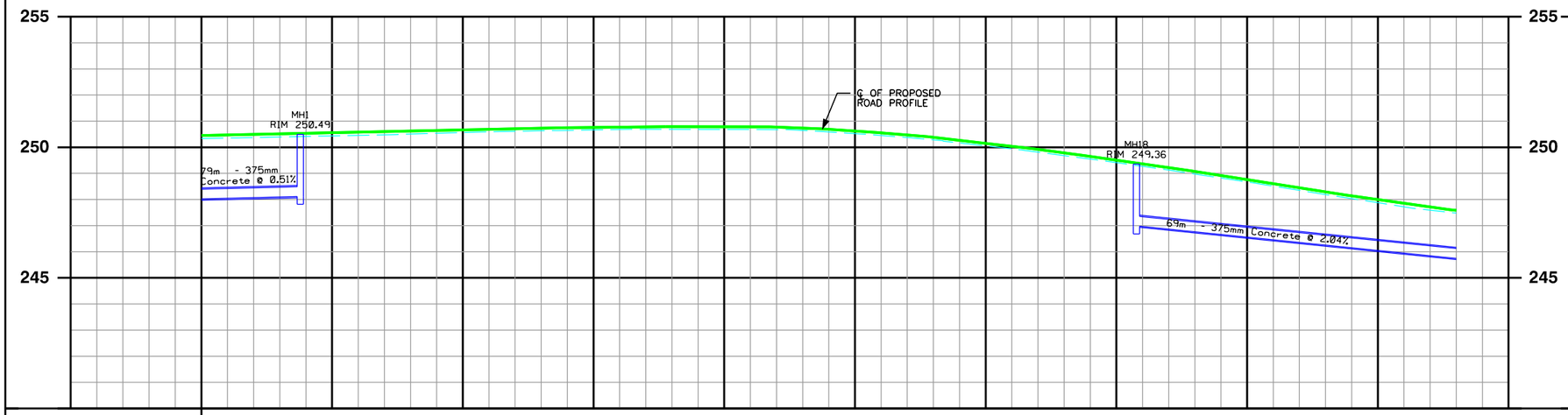




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	250.45	250.51	250.57	250.64	250.70	250.76	250.79	250.78	250.70	250.49	250.18	249.81	249.40	248.96	248.49	248.03	247.61	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	250.33	250.39	250.45	250.53	250.61	250.66	250.69	250.69	250.60	250.39	250.08	249.71	249.30	248.86	248.39	247.91	247.51	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	1+650	1+665	1+680	1+695	1+710	1+725	1+740	1+755	1+770	1+785	1+800	1+815	1+830	1+845	1+860	1+875	1+890	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

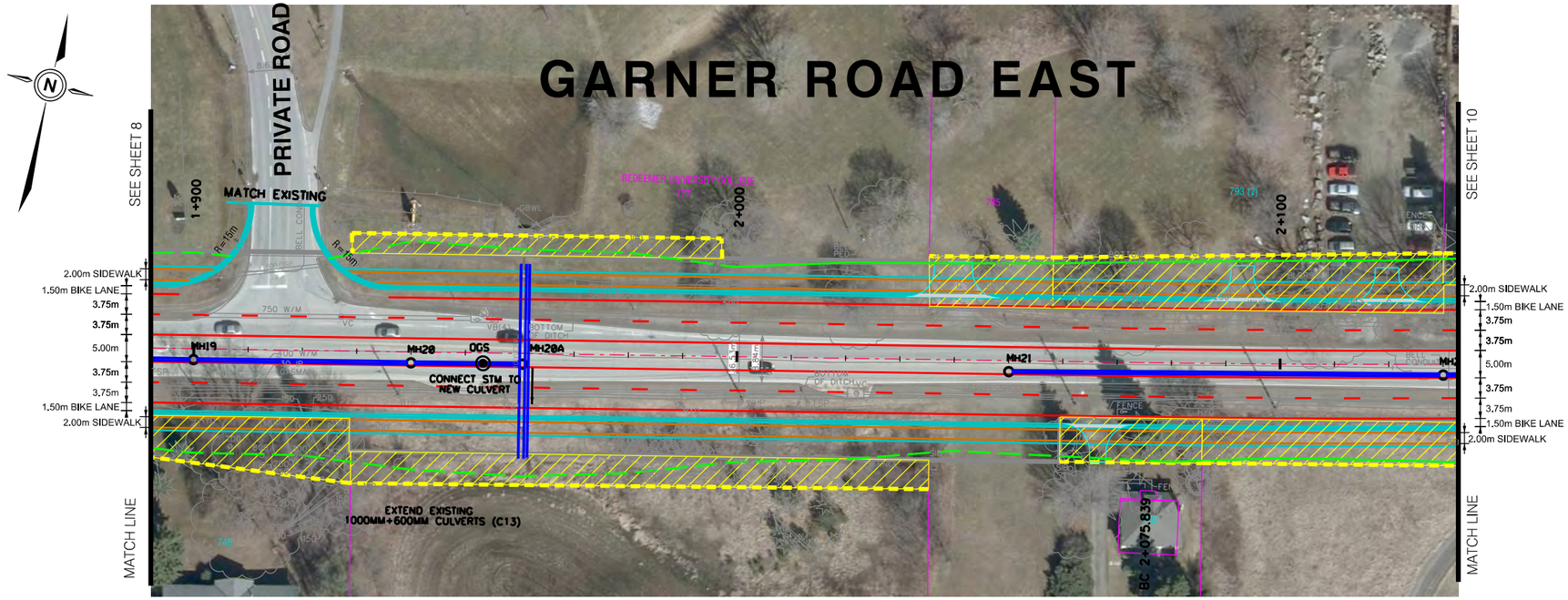
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

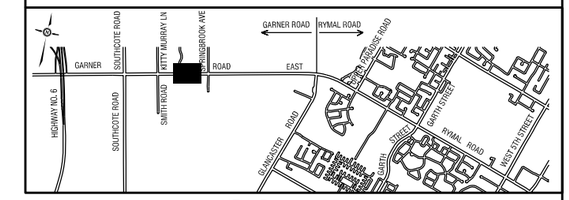
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 9 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

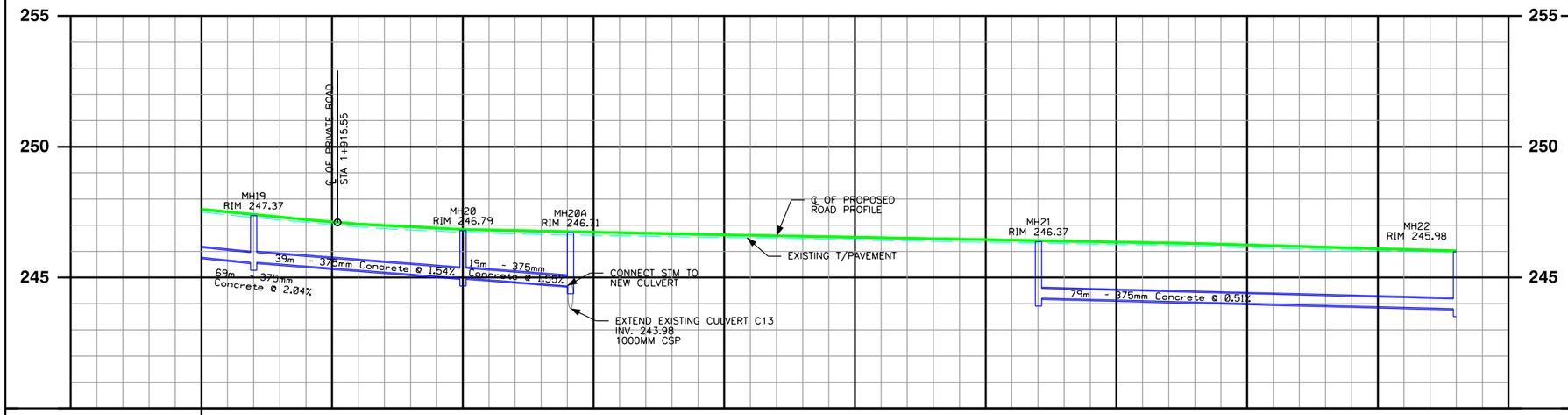




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	247.61	247.31	247.04	246.89	246.79	246.73	246.67	246.62	246.56	246.51	246.45	246.40	246.34	246.28	246.19	246.11	246.02	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	247.51	247.20	246.94	246.78	246.67	246.62	246.57	246.52	246.46	246.40	246.35	246.30	246.25	246.17	246.09	246.03	245.97	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	1+890	1+905	1+920	1+935	1+950	1+965	1+980	1+995	2+010	2+025	2+040	2+055	2+070	2+085	2+100	2+115	2+130	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

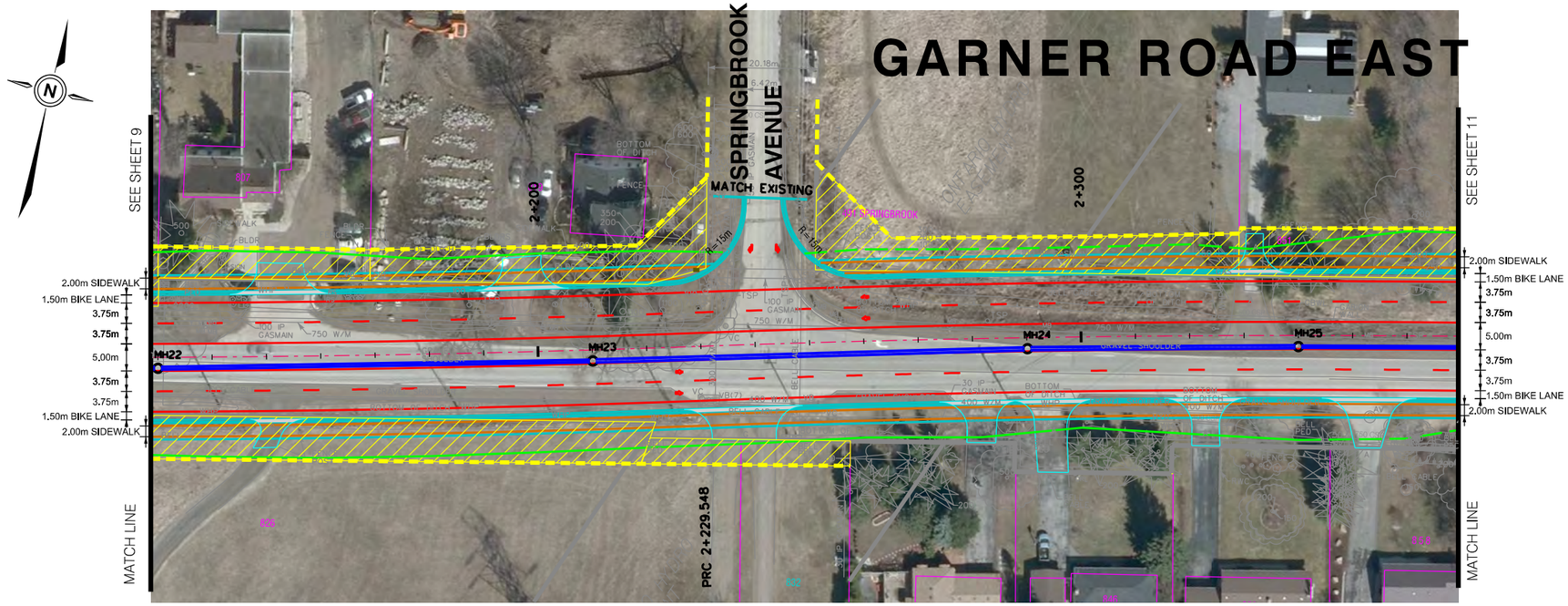
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

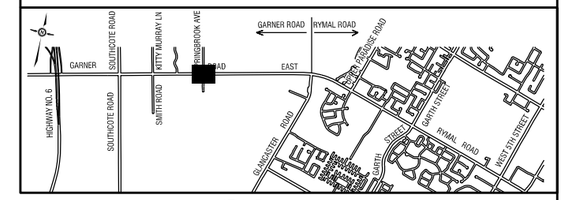
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 10 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

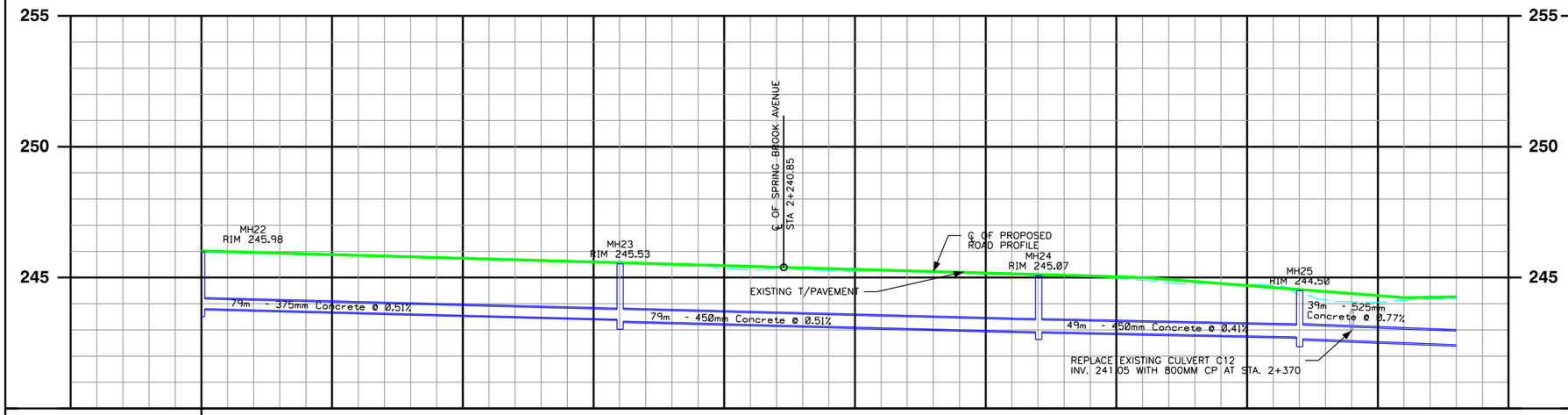




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	246.02	245.94	245.85	245.77	245.68	245.60	245.51	245.43	245.34	245.26	245.17	245.09	245.00	244.77	244.54	244.31	244.26	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	245.97	245.90	245.83	245.77	245.70	245.60	245.52	245.29	245.26	245.24	245.19	245.08	244.90	244.76	244.35	244.05	244.19	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	2+130	2+145	2+160	2+175	2+190	2+205	2+220	2+235	2+250	2+265	2+280	2+295	2+310	2+325	2+340	2+355	2+370	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

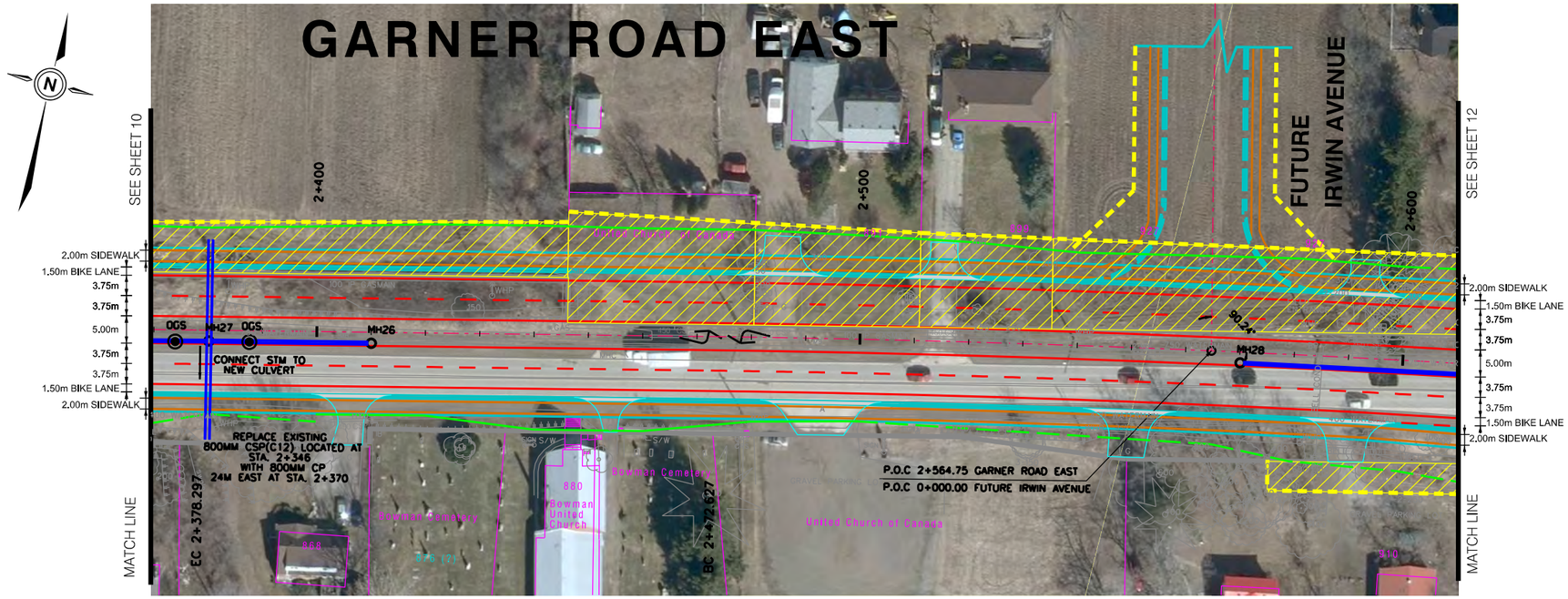
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

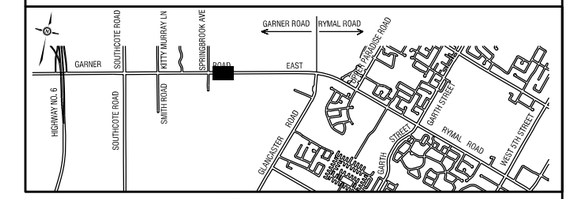
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 11 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

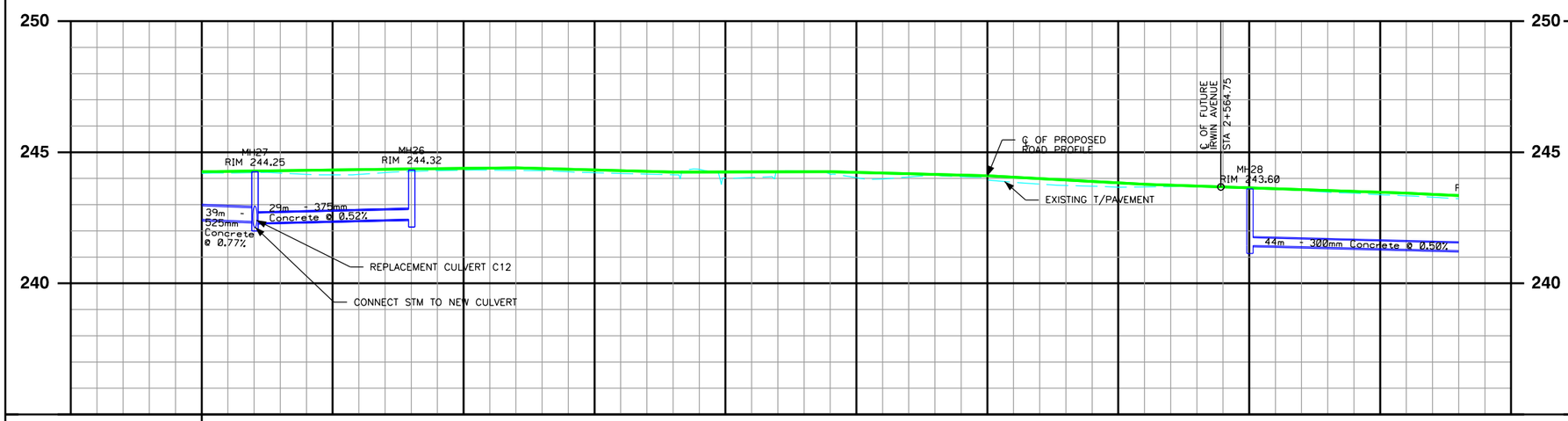




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS

C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		PROPOSED SANITARY SEWER
PROPOSED STORM SEWER																		PROPOSED STORM SEWER
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	244.26	244.30	244.34	244.38	244.41	244.32	244.24	244.25	244.26	244.18	244.10	243.94	243.78	243.67	243.57	243.47	243.35	PROPOSED ℄ OF ROAD PROFILE ELEVATIONS
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	244.19	244.21	244.15	244.30	244.31	244.22	244.14	244.04	244.16	244.06	243.95	243.73	243.67	243.67	243.54	243.38	243.23	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	2+370	2+385	2+400	2+415	2+430	2+445	2+460	2+475	2+490	2+505	2+520	2+535	2+550	2+565	2+580	2+595	2+610	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON

Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

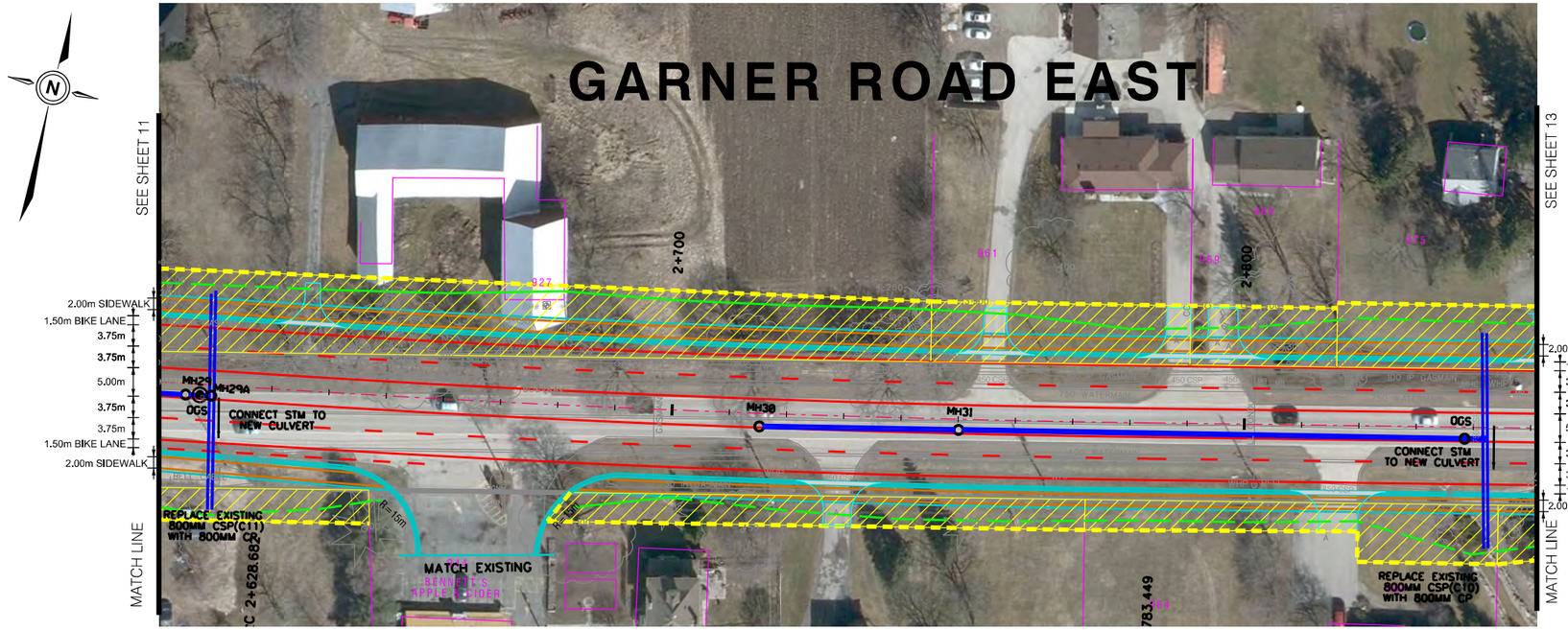
From : Highway No 6

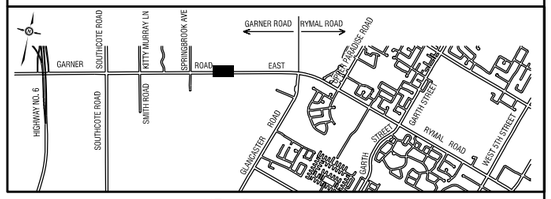
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 12 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

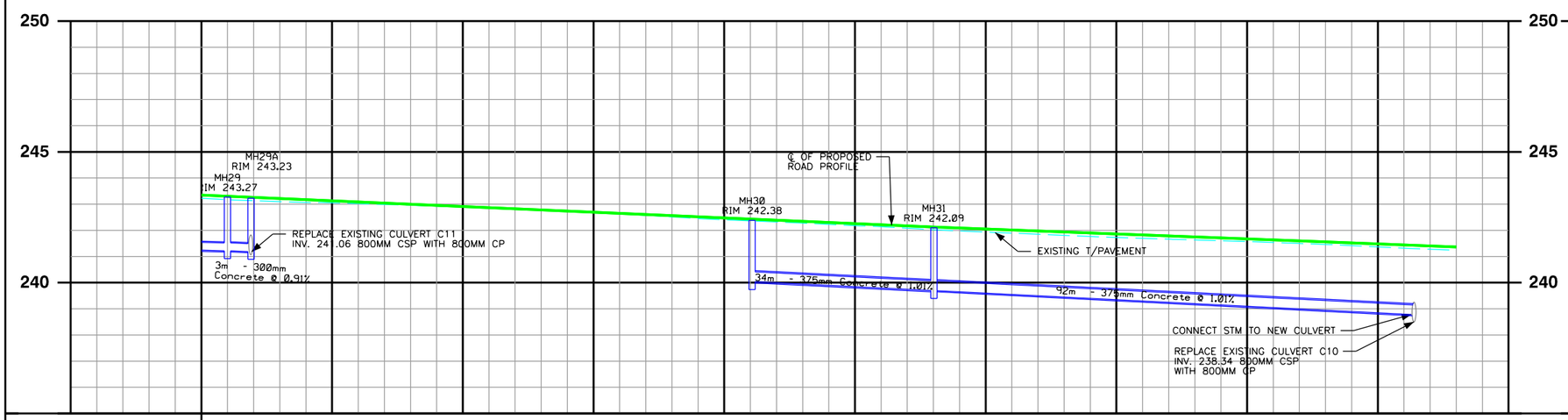




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		PROPOSED SANITARY SEWER
PROPOSED STORM SEWER																		PROPOSED STORM SEWER
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	243.35	243.22	243.09	242.96	242.83	242.69	242.56	242.43	242.30	242.17	242.05	241.94	241.83	241.71	241.60	241.48	241.37	PROPOSED ℄ OF ROAD PROFILE ELEVATIONS
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	243.23	243.10	243.02	242.93	242.83	242.69	242.51	242.36	242.23	242.08	241.94	241.81	241.69	241.60	241.50	241.36	241.24	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	2+610	2+625	2+640	2+655	2+670	2+685	2+700	2+715	2+730	2+745	2+760	2+775	2+790	2+805	2+820	2+835	2+850	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

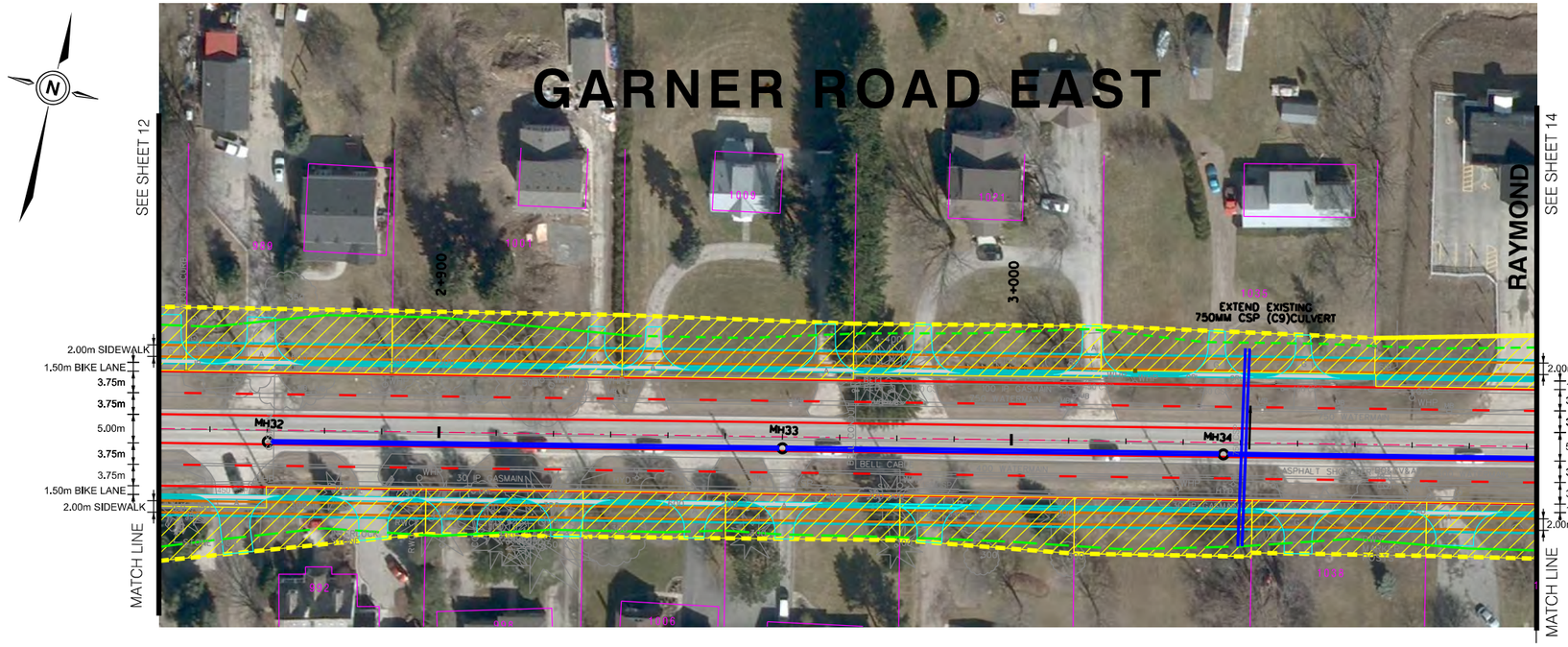
From : Highway No 6
To : West 5th Street

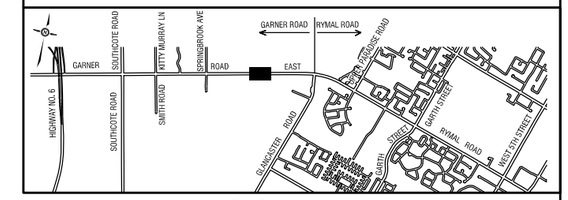
09-H-36 (12)

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 13 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

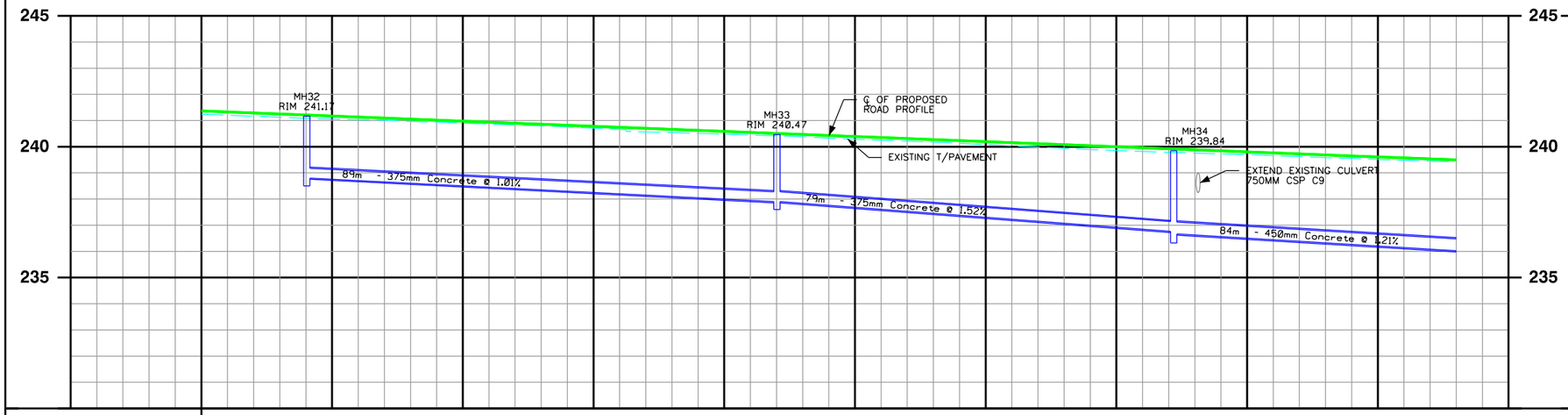




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS

C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	241.37	241.25	241.13	241.01	240.90	240.78	240.66	240.55	240.43	240.31	240.19	240.08	239.96	239.84	239.73	239.61	239.49	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	241.24	241.12	241.03	240.94	240.83	240.71	240.54	240.45	240.33	240.21	240.08	239.94	239.82	239.73	239.62	239.51	239.43	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	2+850	2+865	2+880	2+895	2+910	2+925	2+940	2+955	2+970	2+985	3+000	3+015	3+030	3+045	3+060	3+075	3+090	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON

Public Works Department

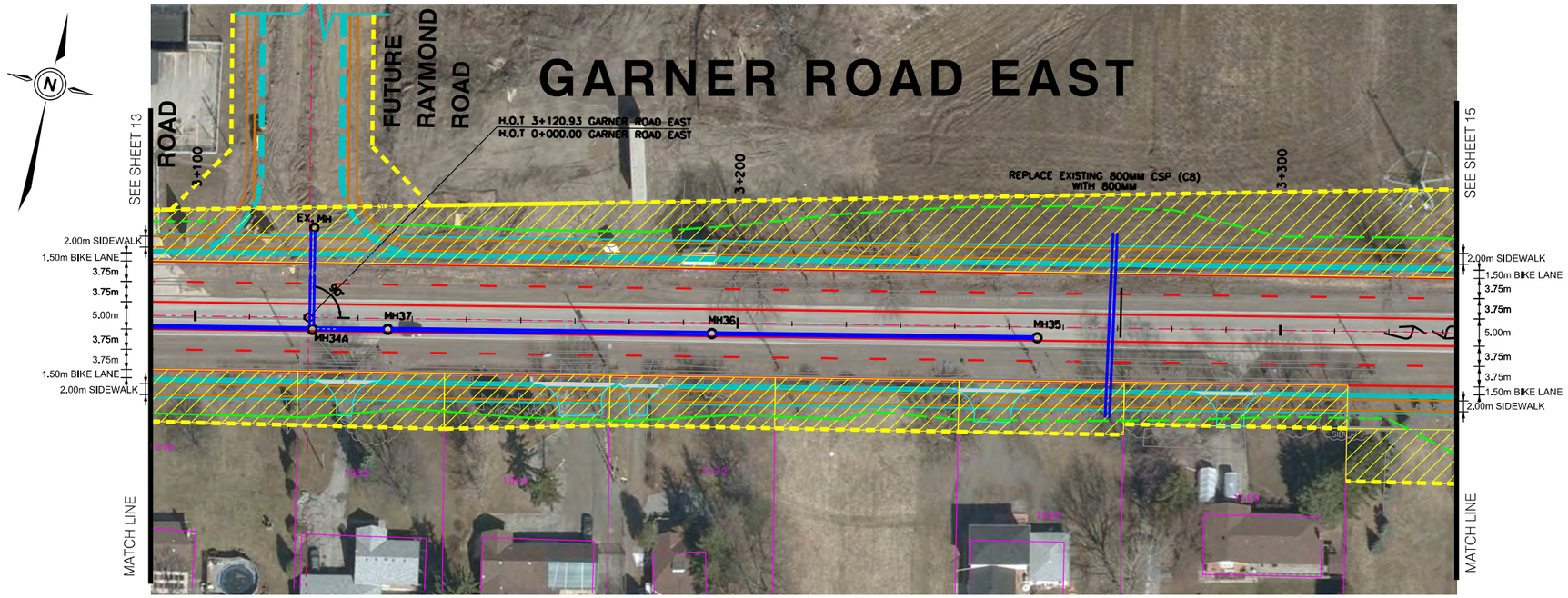
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

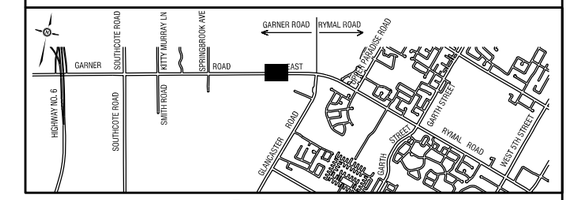
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 14 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

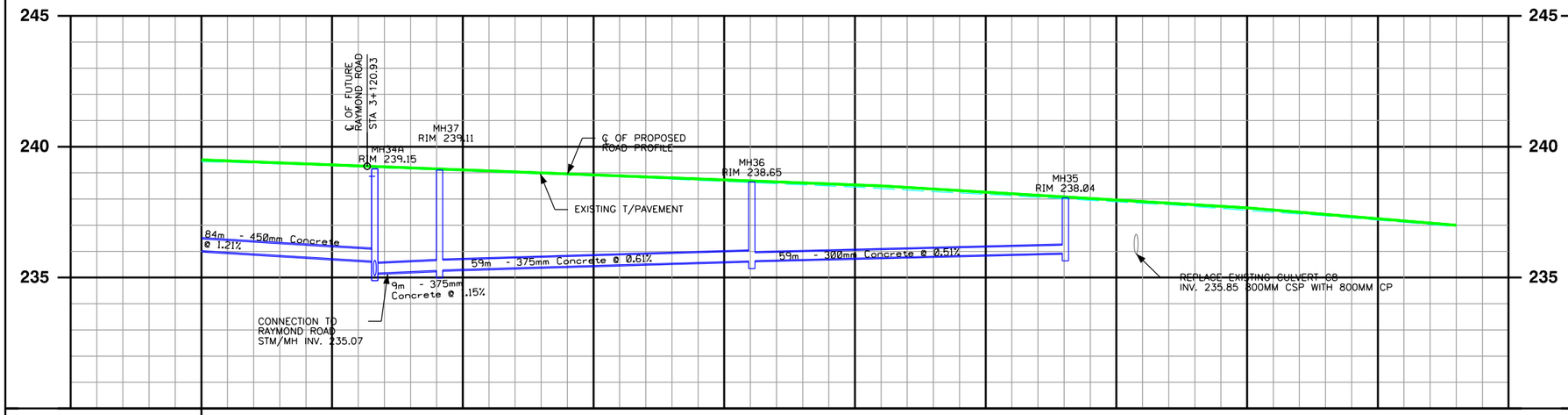




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS

C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	239.49	239.38	239.27	239.15	239.04	238.92	238.81	238.69	238.58	238.44	238.26	238.08	237.90	237.73	237.50	237.25	236.99	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	239.43	239.34	239.23	239.11	239.00	238.89	238.76	238.63	238.50	238.34	238.18	238.01	237.84	237.64	237.43	237.19	236.94	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	3+090	3+105	3+120	3+135	3+150	3+165	3+180	3+195	3+210	3+225	3+240	3+255	3+270	3+285	3+300	3+315	3+330	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON

Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

From : Highway No 6

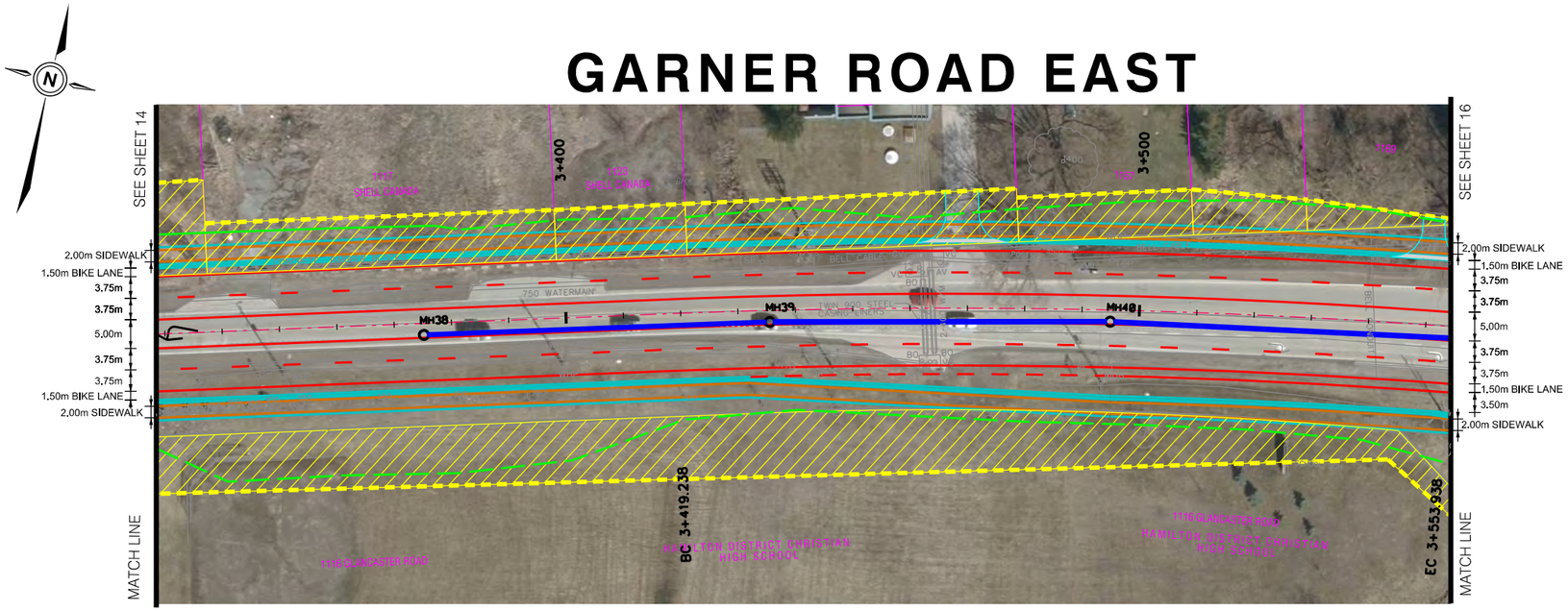
To : West 5th Street

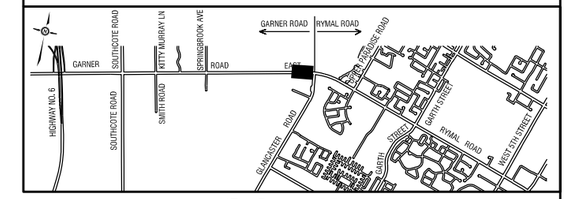
GARNER ROAD EAST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 15 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

GARNER ROAD EAST

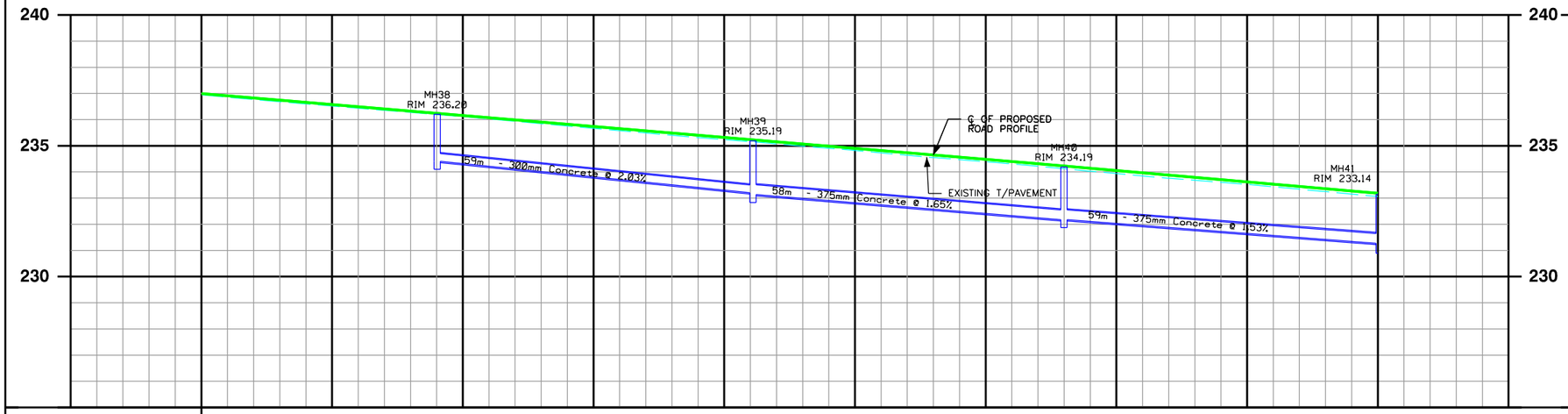




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	236.99	236.74	236.49	236.24	235.99	235.74	235.49	235.23	234.98	234.73	234.48	234.23	233.96	233.70	233.44	233.18		*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	236.94	236.68	236.43	236.19	235.93	235.67	235.40	235.16	234.90	234.63	234.39	234.12	233.84	233.60	233.34	233.06		EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	3+330	3+345	3+360	3+375	3+390	3+405	3+420	3+435	3+450	3+465	3+480	3+495	3+510	3+525	3+540	3+555		EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

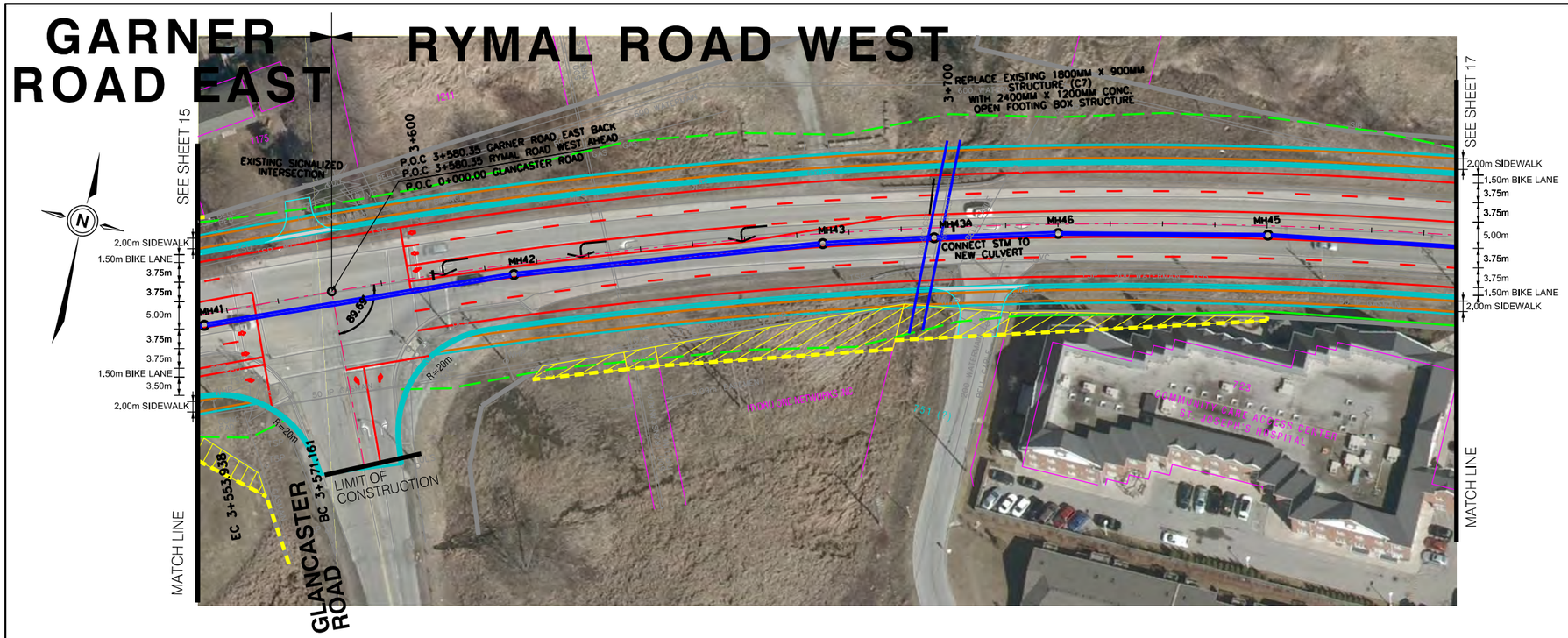
GARNER ROAD/RYMAL ROAD AND GARTH STREET
SCHEDULE C CLASS EA

From : Highway No 6
To : West 5th Street

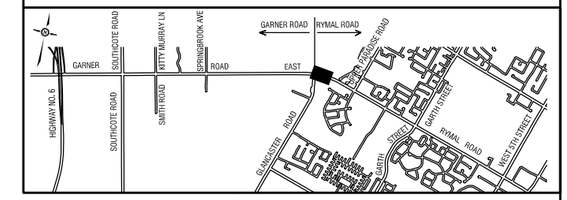
RYMAL ROAD WEST

FILE No.	CONTRACT No.	SHEET No.
	DRAWING No.	16 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

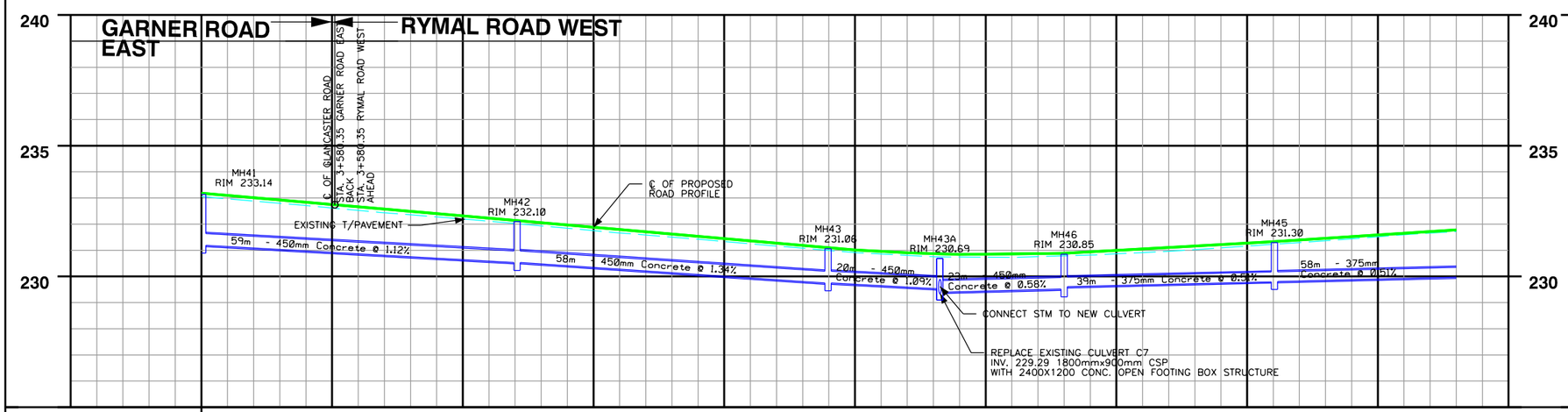


KEY PLAN INDEX



LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	233.18	232.92	232.66	232.40	232.14	231.88	231.62	231.36	231.10	230.91	230.85	230.89	231.05	231.22	231.39	231.59	231.78	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	233.06	232.80	232.53	232.28	232.02	231.76	231.51	231.25	231.00	230.81	230.74	230.79	230.91	231.09	231.30	231.52	231.72	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	3+555	3+570	3+585	3+600	3+615	3+630	3+645	3+660	3+675	3+690	3+705	3+720	3+735	3+750	3+765	3+780	3+795	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

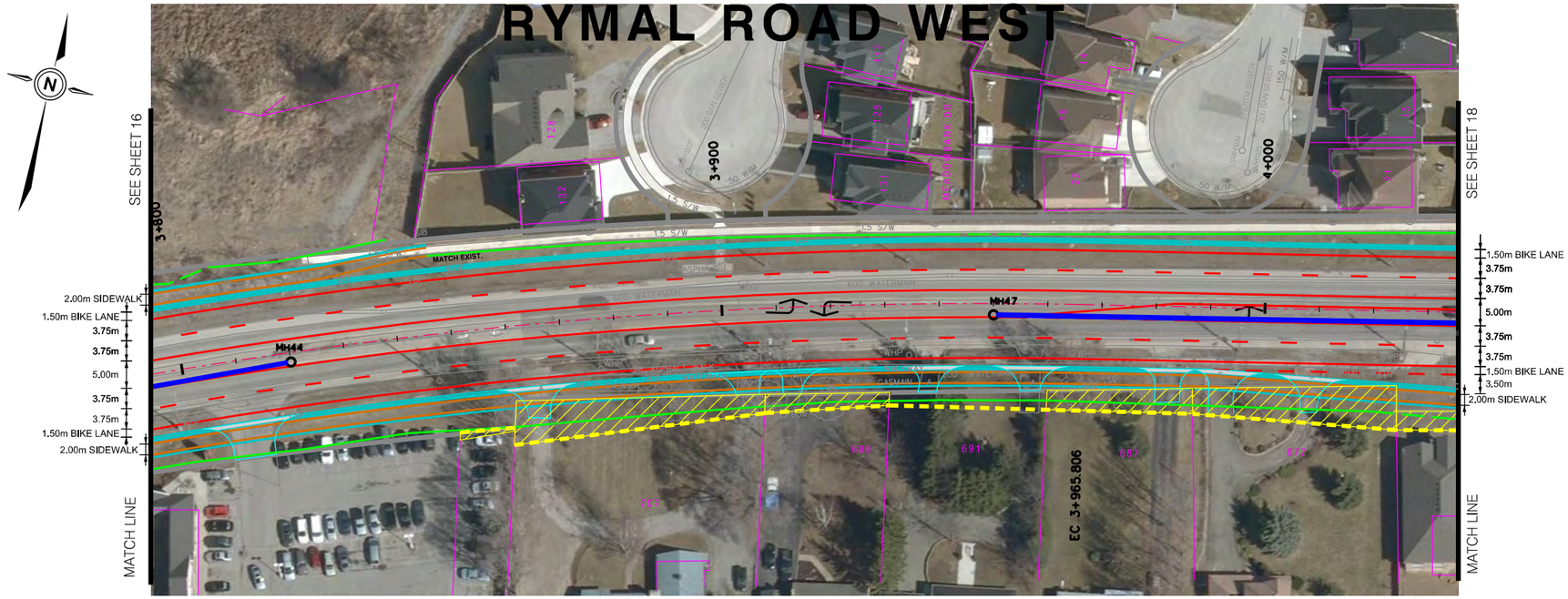
CITY OF HAMILTON
Public Works Department

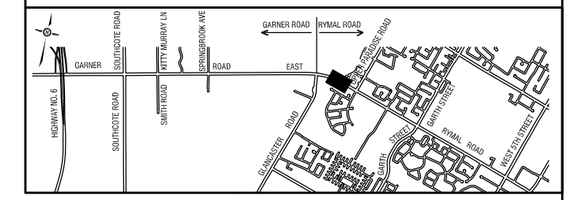
GARNER ROAD/RYMAL ROAD AND GARTH STREET
SCHEDULE C CLASS EA
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 17 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

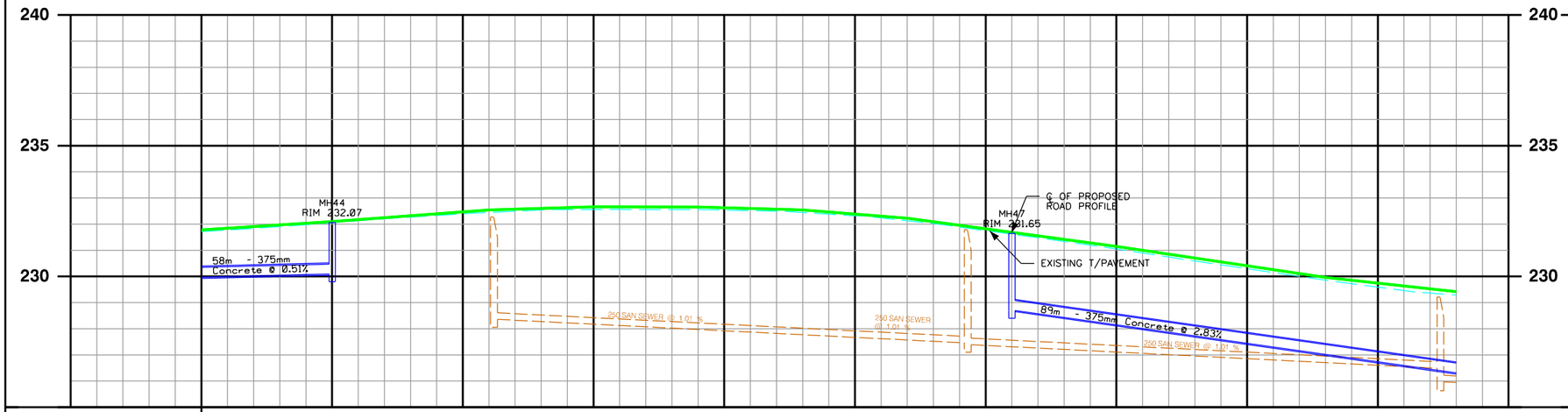




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	231.78	231.97	232.17	232.40	232.57	232.66	232.66	232.60	232.46	232.23	231.83	231.42	231.00	230.56	230.11	229.74	229.42	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	231.72	231.91	232.13	232.33	232.49	232.56	232.56	232.52	232.38	232.13	231.75	231.34	230.90	230.45	230.00	229.59	229.29	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	3+795	3+810	3+825	3+840	3+855	3+870	3+885	3+900	3+915	3+930	3+945	3+960	3+975	3+990	4+005	4+020	4+035	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

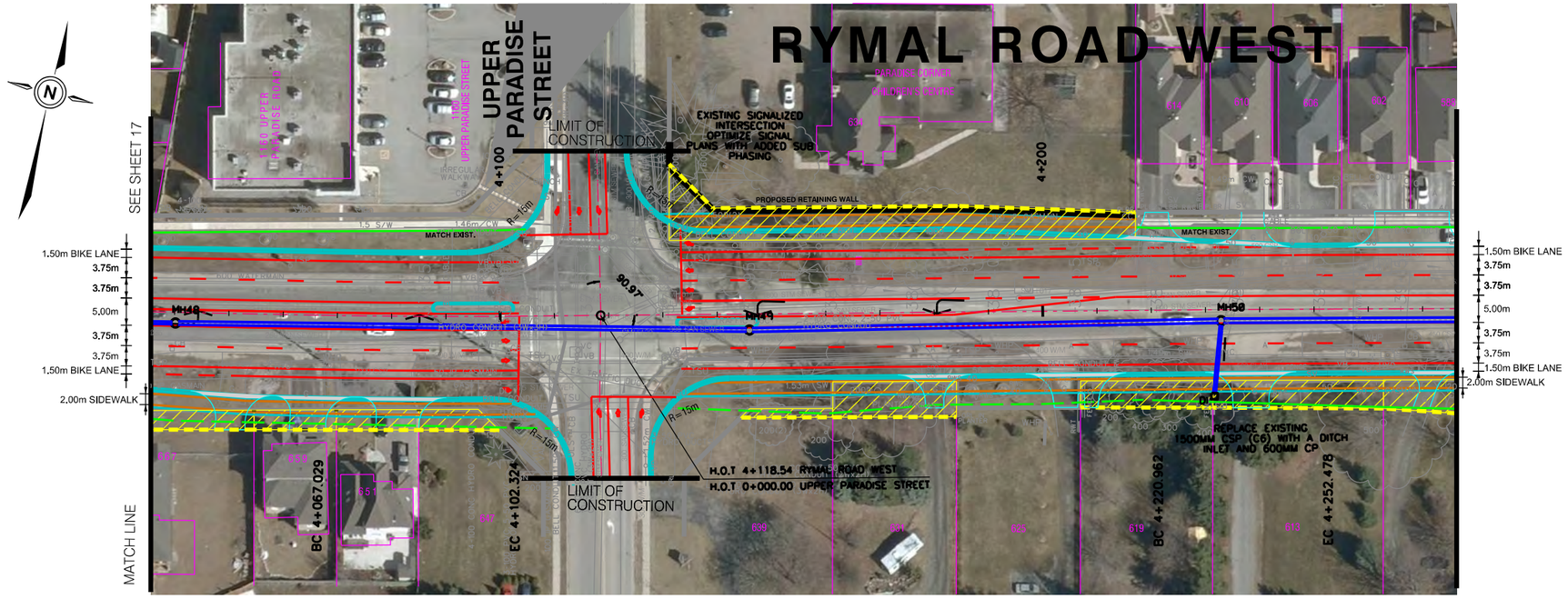
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

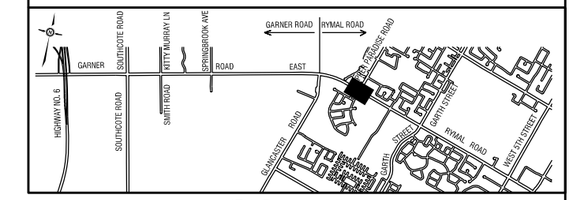
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 18 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

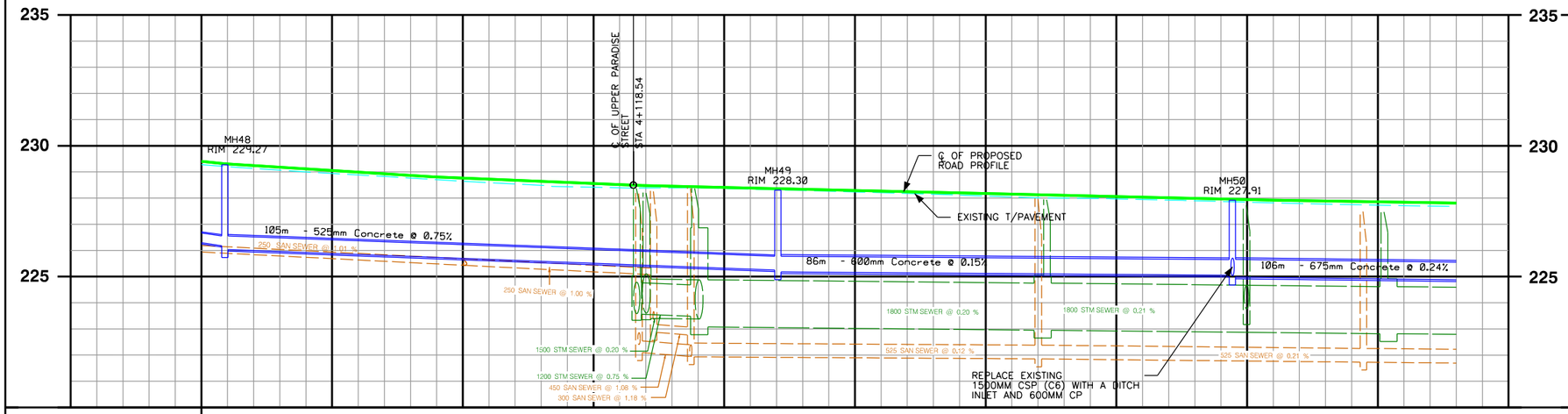




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	229.42	229.19	229.00	228.81	228.69	228.57	228.46	228.39	228.32	228.25	228.18	228.11	228.04	227.97	227.91	227.86	227.81	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	229.29	229.08	228.89	228.71	228.55	228.42	228.39	228.35	228.27	228.18	228.08	228.00	227.95	227.88	227.80	227.73	227.69	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	4+035	4+050	4+065	4+080	4+095	4+110	4+125	4+140	4+155	4+170	4+185	4+200	4+215	4+230	4+245	4+260	4+275	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

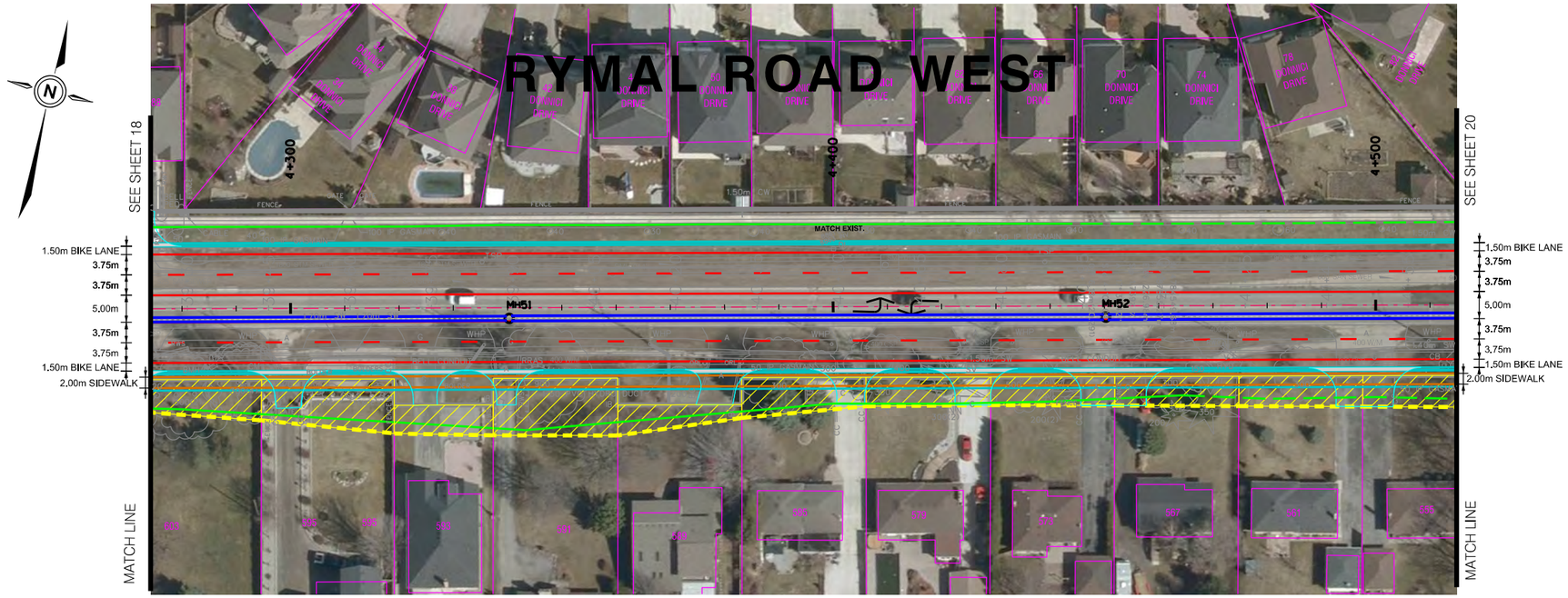
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

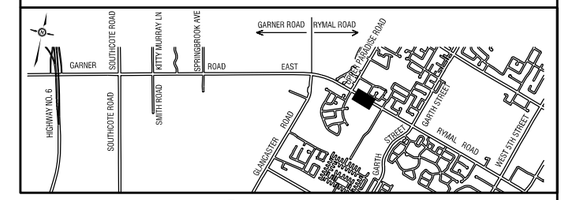
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 19 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

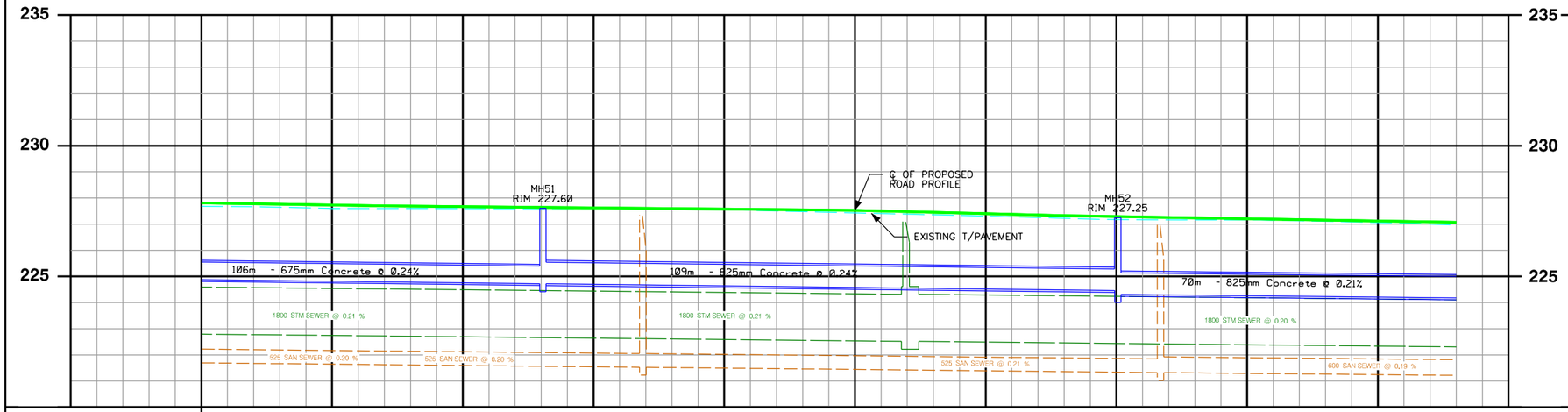




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	227.81	227.76	227.72	227.68	227.65	227.63	227.60	227.57	227.54	227.48	227.40	227.32	227.27	227.22	227.17	227.12	227.07		*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	227.69	227.64	227.60	227.60	227.59	227.59	227.58	227.53	227.45	227.38	227.31	227.22	227.17	227.16	227.12	227.06	226.96		EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	4+275	4+290	4+305	4+320	4+335	4+350	4+365	4+380	4+395	4+410	4+425	4+440	4+455	4+470	4+485	4+500	4+515		EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

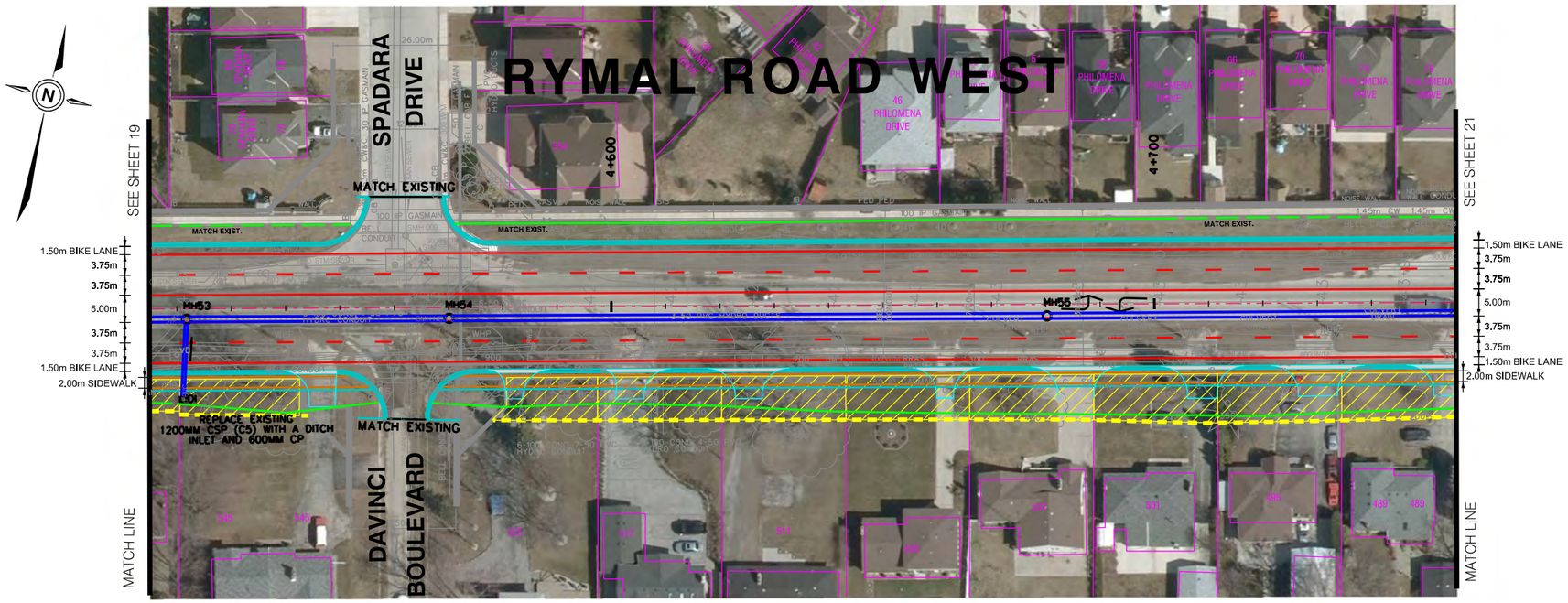
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

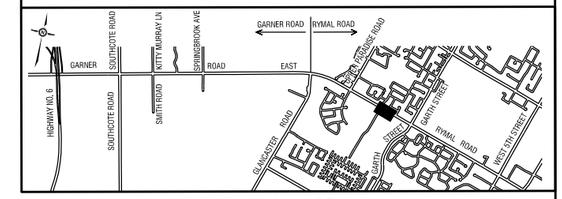
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 20 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

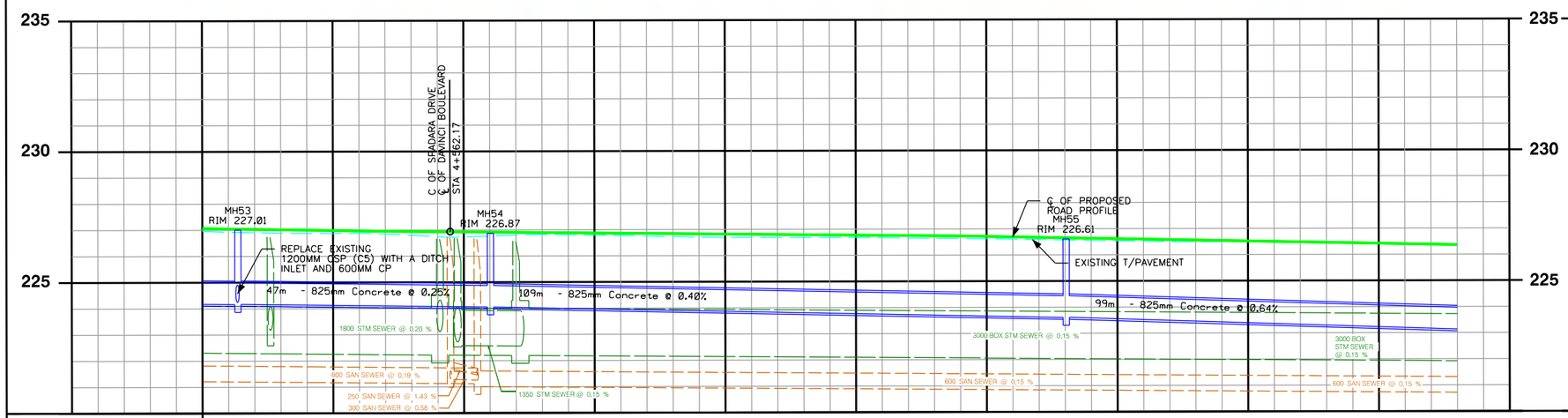




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS

C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																			*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																			*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	227.07	227.02	226.97	226.93	226.90	226.87	226.84	226.81	226.78	226.75	226.71	226.65	226.60	226.54	226.48	226.42	226.37		*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	226.96	226.89	226.88	226.75	226.79	226.79	226.73	226.69	226.68	226.66	226.62	226.57	226.52	226.49	226.46	226.42	226.37		EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	4+515	4+530	4+545	4+560	4+575	4+590	4+605	4+620	4+635	4+650	4+665	4+680	4+695	4+710	4+725	4+740	4+755		EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL: 1:1000 (0, 5m, 10m, 20m)
VERTICAL: 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

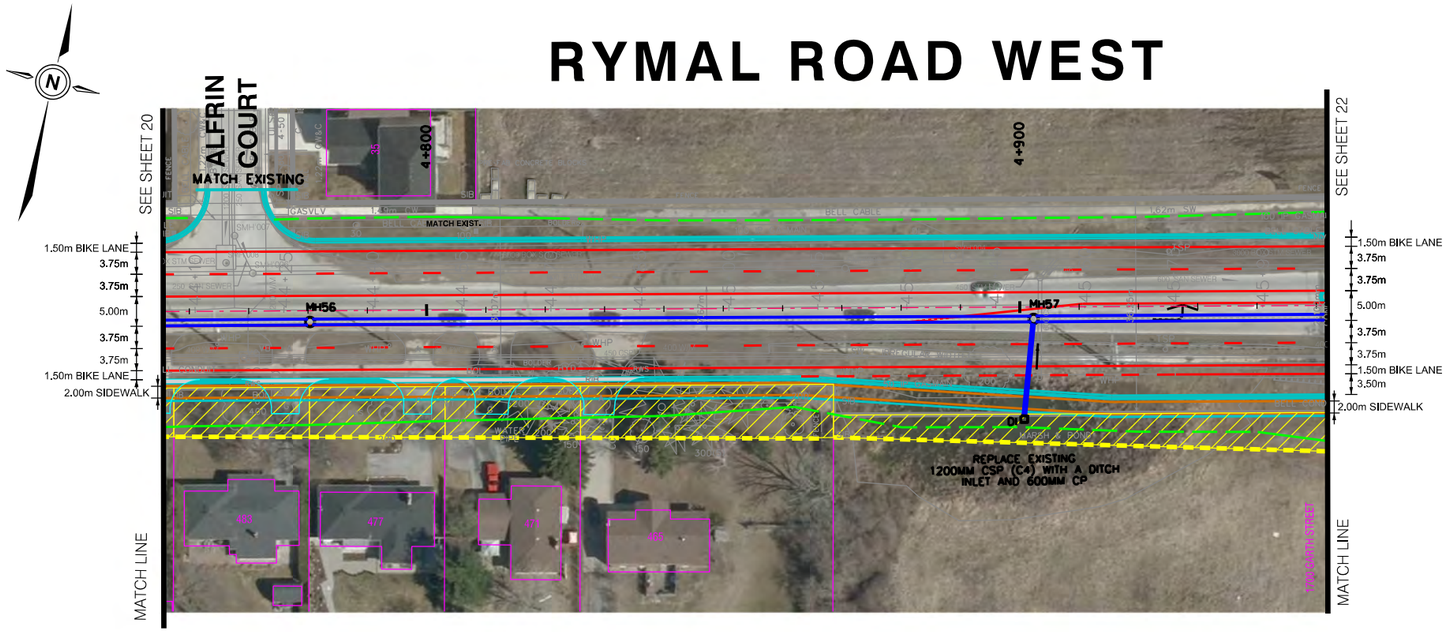
From : Highway No 6
To : West 5th Street

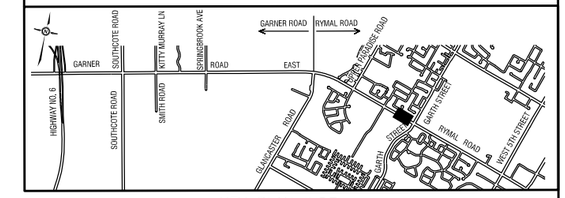
RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 21 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

RYMAL ROAD WEST

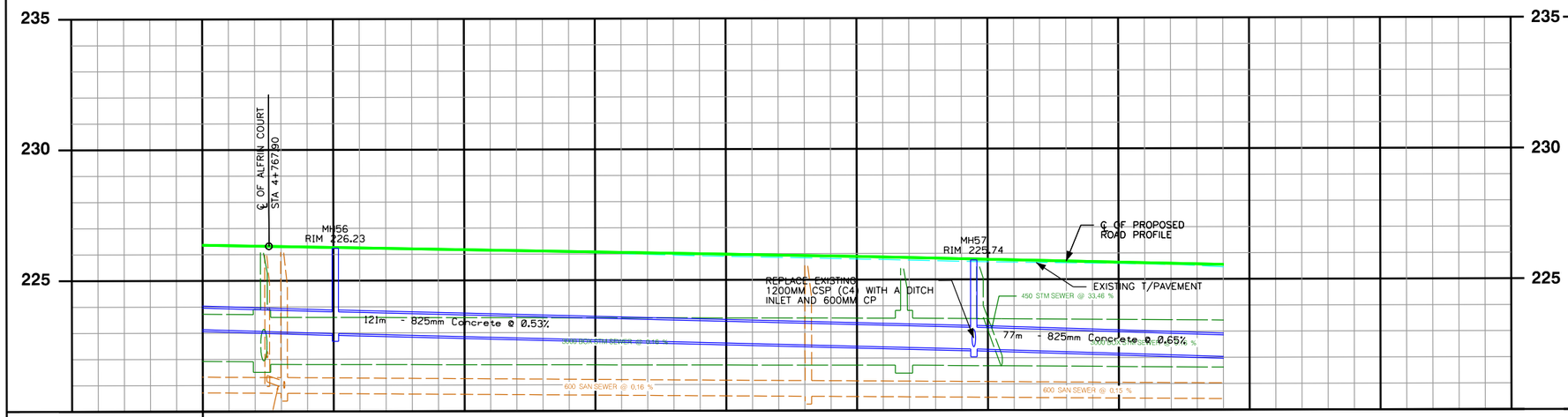




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	226.37	226.31	226.25	226.20	226.14	226.08	226.02	225.97	225.91	225.84	225.77	225.70	225.62	225.55				*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	226.37	226.29	226.24	226.19	226.12	226.04	225.95	225.88	225.81	225.74	225.67	225.63	225.58	225.46				EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	4+755	4+770	4+785	4+800	4+815	4+830	4+845	4+860	4+875	4+890	4+905	4+920	4+935	4+950				EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC·LAVALIN

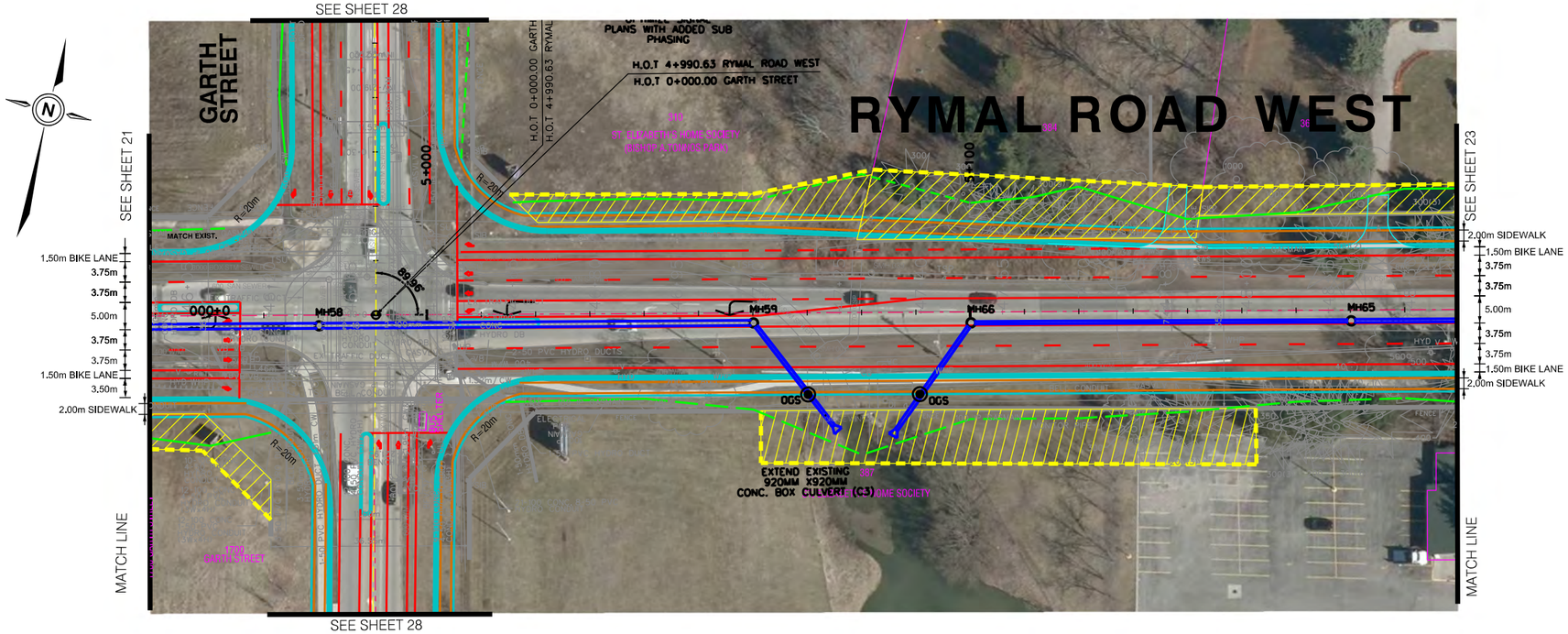
CITY OF HAMILTON
Public Works Department

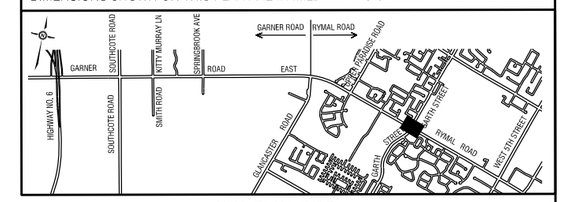
GARNER ROAD/RYMAL ROAD AND GARTH STREET
SCHEDULE C CLASS EA
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 22 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

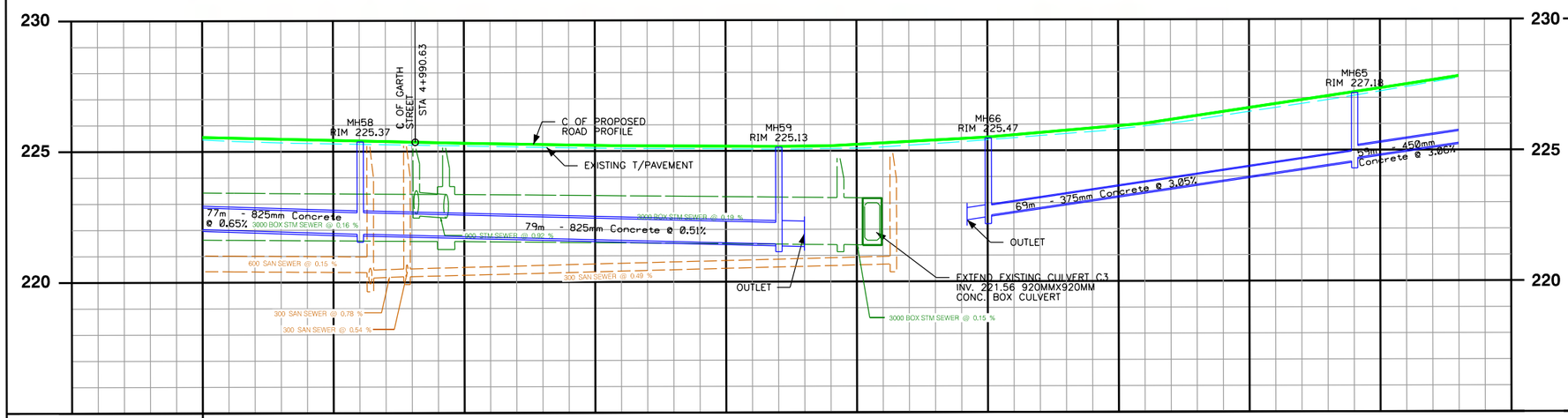




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	225.55	225.48	225.41	225.33	225.27	225.22	225.19	225.17	225.19	225.35	225.51	225.77	226.02	226.47	226.92	227.37	227.83	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	225.46	225.34	225.28	225.23	225.17	225.12	225.09	225.07	225.09	225.21	225.41	225.64	225.92	226.32	226.77	227.24	227.76	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	4+950	4+965	4+980	4+995	5+010	5+025	5+040	5+055	5+070	5+085	5+100	5+115	5+130	5+145	5+160	5+175	5+190	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL: 0 5m 10m 20m — 1:1000
VERTICAL: 0 1m 2m 4m — 1:50

Project Manager (Design)
Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

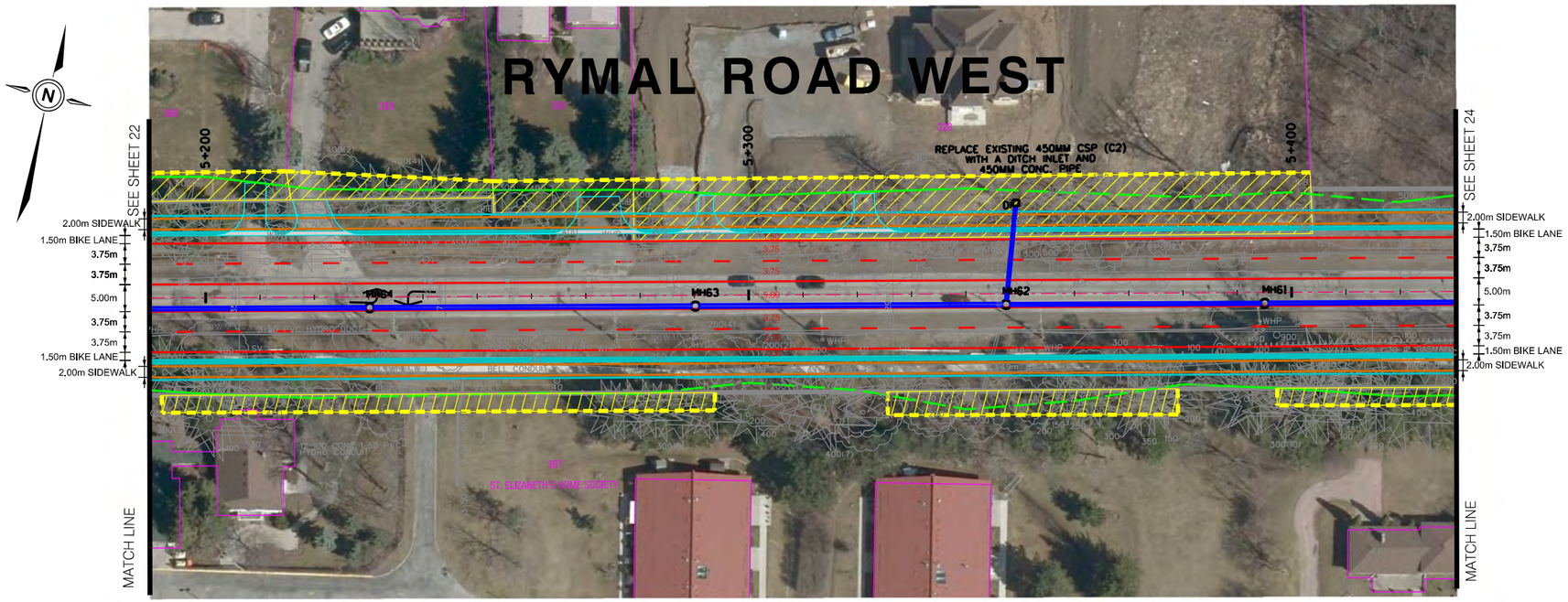
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

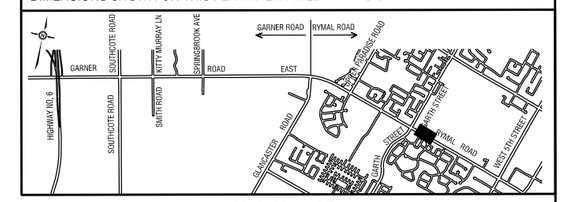
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 23 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

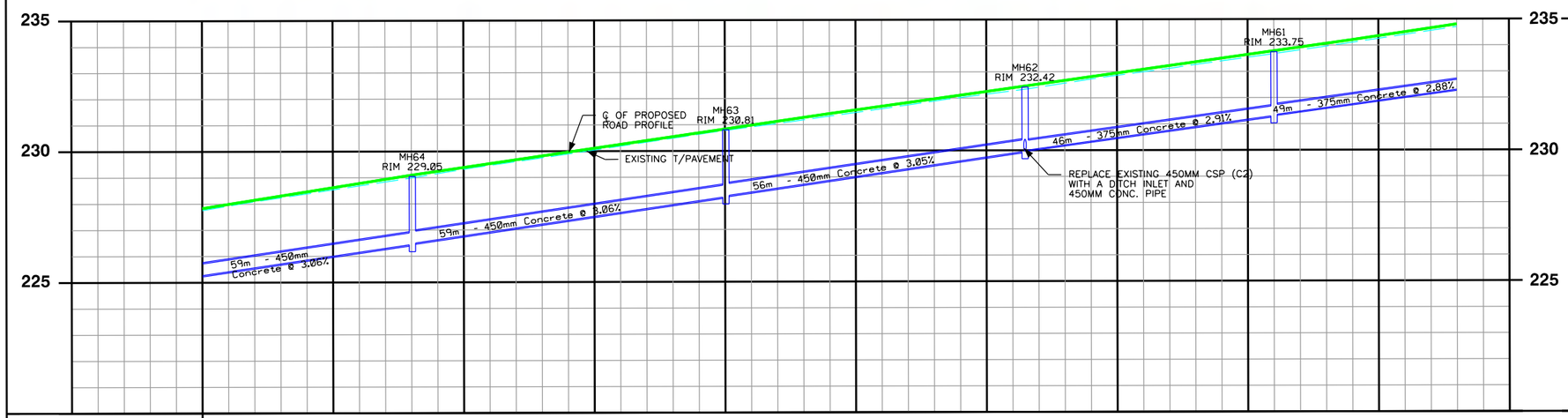




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	227.83	228.30	228.78	229.24	229.68	230.11	230.55	230.99	231.42	231.84	232.25	232.67	233.09	233.51	233.93	234.36	234.80	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	227.76	228.24	228.69	229.15	229.61	230.04	230.49	230.91	231.32	231.74	232.15	232.57	232.99	233.40	233.82	234.26	234.70	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	5+190	5+205	5+220	5+235	5+250	5+265	5+280	5+295	5+310	5+325	5+340	5+355	5+370	5+385	5+400	5+415	5+430	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL: 0 5m 10m 20m — 1:1000

VERTICAL: 0 1m 2m 4m — 1:50

Project Manager (Design)

Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

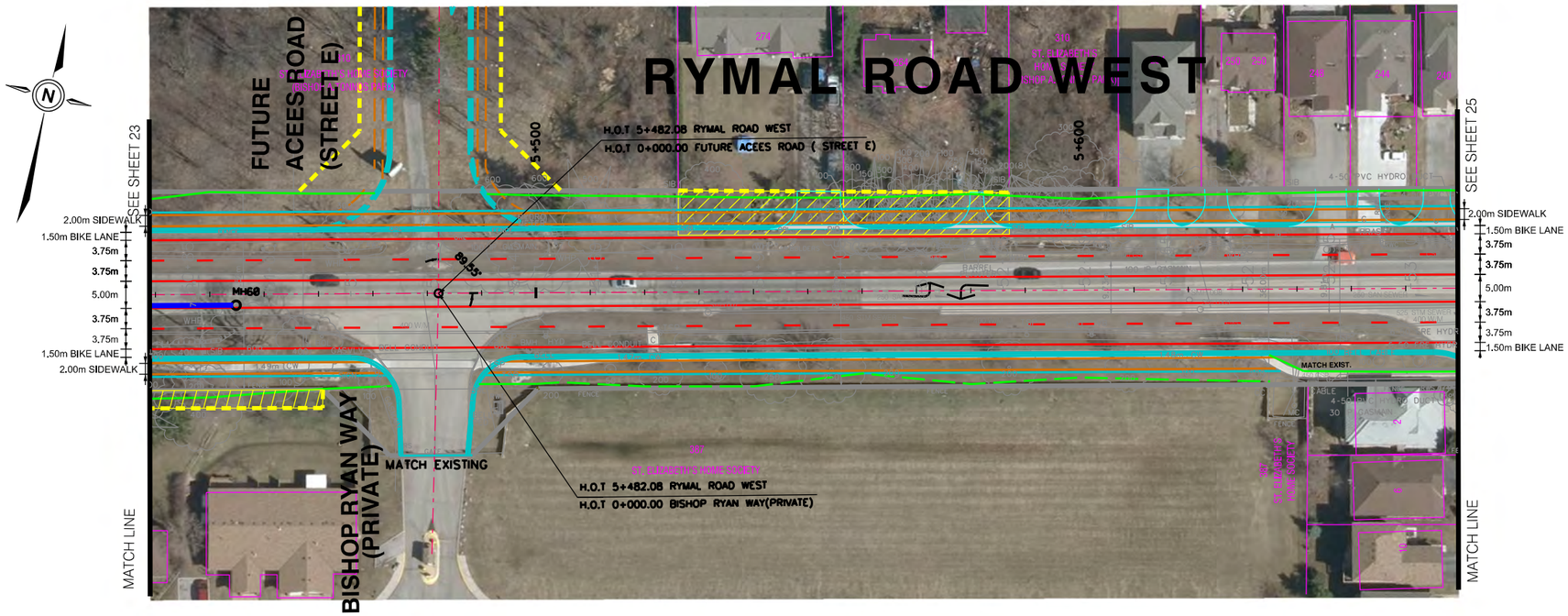
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

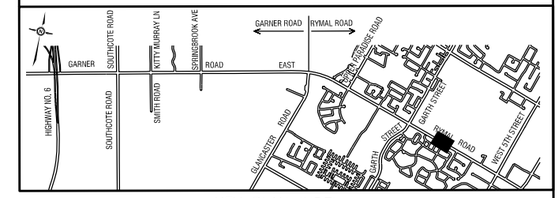
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 24 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

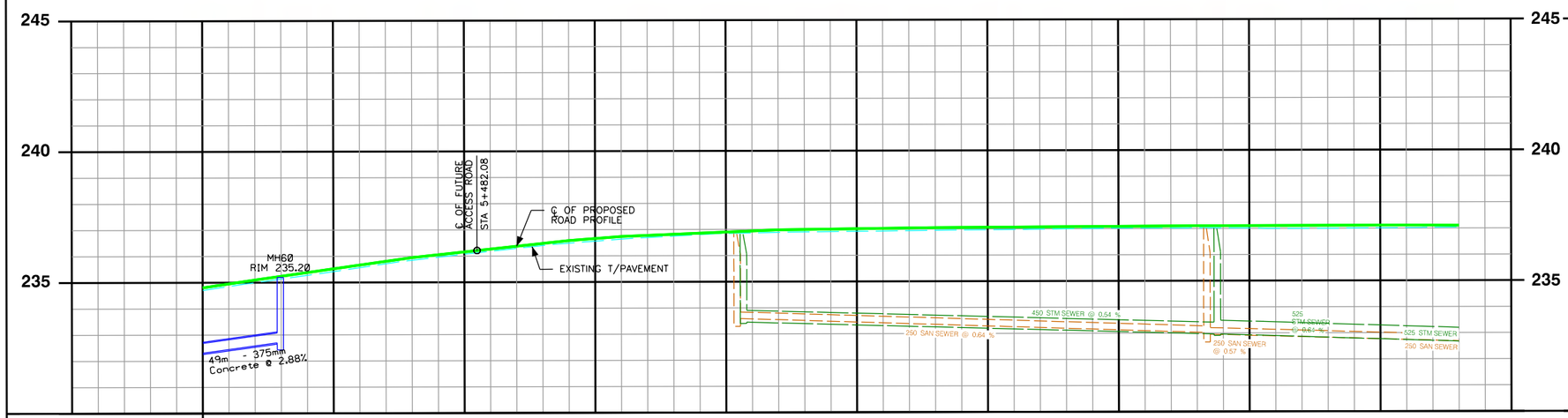




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	234.80	235.24	235.66	236.05	236.37	236.66	236.82	236.94	237.00	237.04	237.06	237.08	237.09	237.10	237.11	237.11	237.10	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	234.70	235.14	235.56	235.96	236.29	236.56	236.75	236.86	236.91	236.94	236.97	236.99	237.02	237.01	237.00	237.01	237.04	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	5+430	5+445	5+460	5+475	5+490	5+505	5+520	5+535	5+550	5+565	5+580	5+595	5+610	5+625	5+640	5+655	5+670	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL: 0 5m 10m 20m — 1:1000

VERTICAL: 0 1m 2m 4m — 1:50

Project Manager (Design)

Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

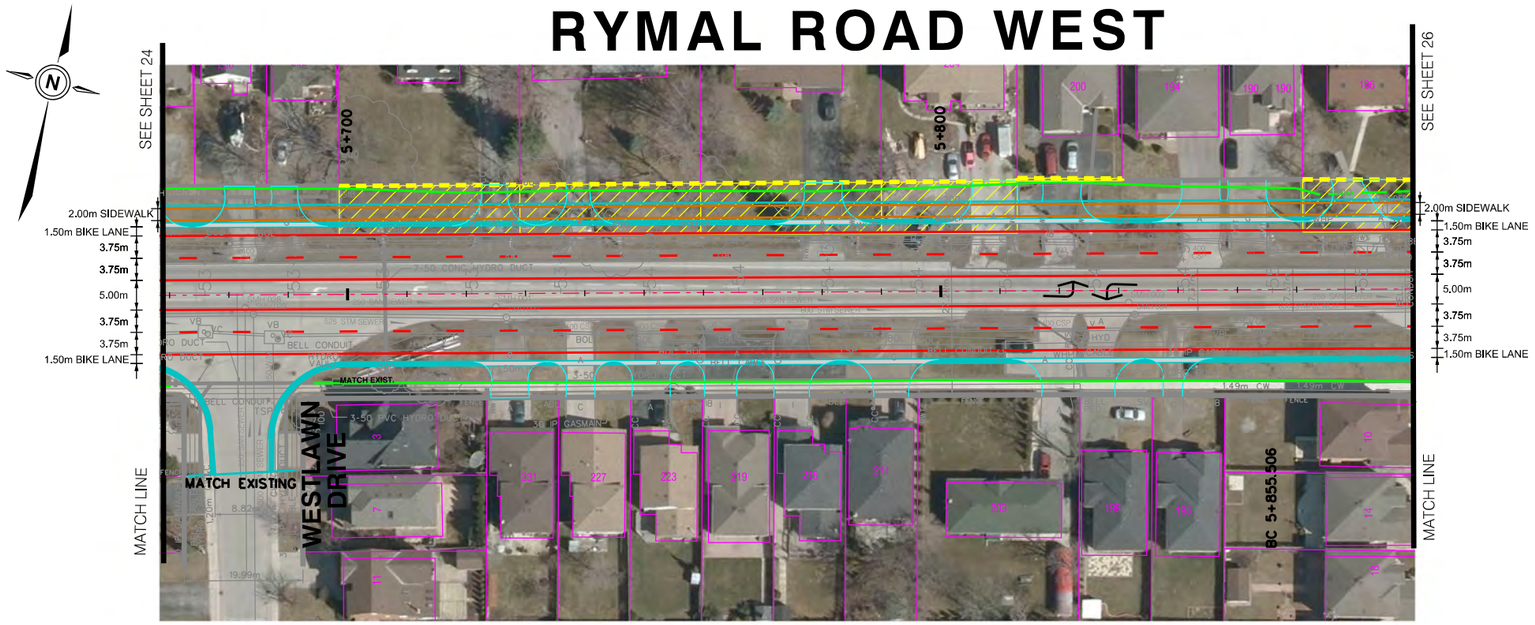
From : Highway No 6
To : West 5th Street

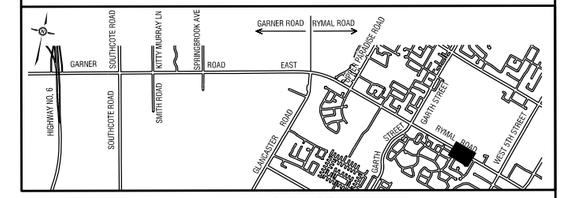
RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 25 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

RYMAL ROAD WEST

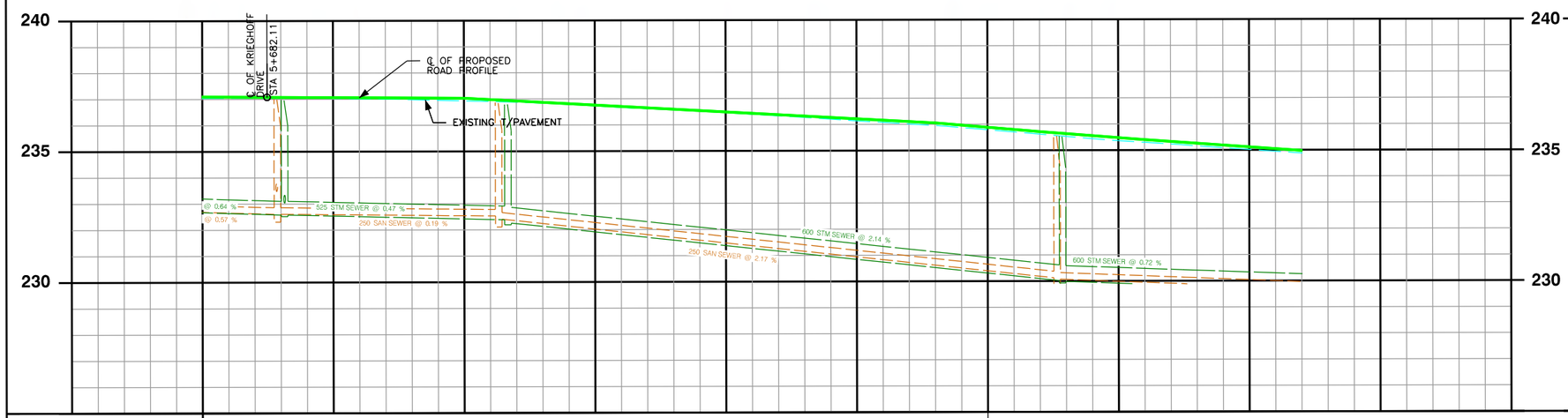




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS

C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																			*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																			*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	237.10	237.08	237.06	237.04	236.92	236.76	236.60	236.43	236.27	236.11	235.88	235.64	235.40	235.19	234.97				*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	237.04	237.05	237.02	236.96	236.87	236.73	236.57	236.40	236.21	236.01	235.79	235.53	235.30	235.09	234.87				EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	5+670	5+685	5+700	5+715	5+730	5+745	5+760	5+775	5+790	5+805	5+820	5+835	5+850	5+865	5+880				EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

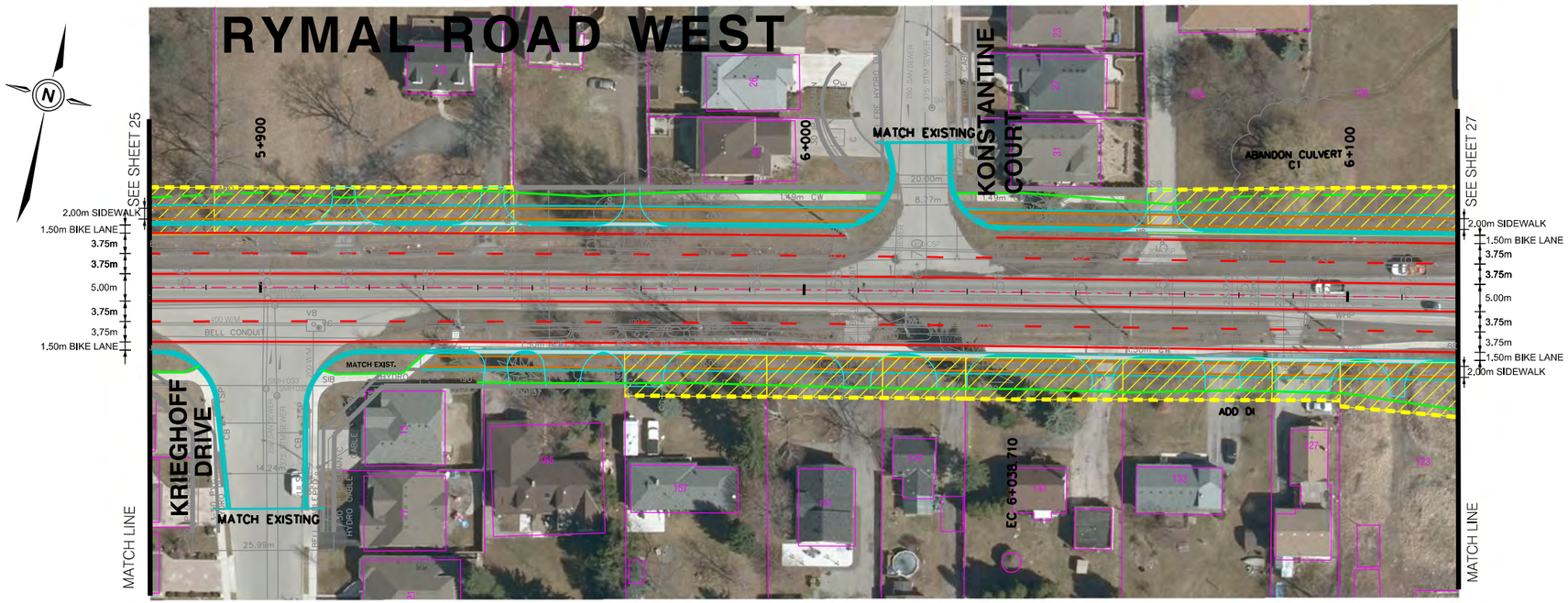
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

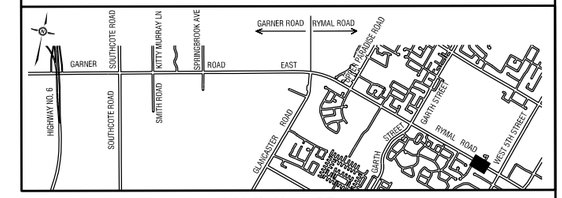
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 26 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

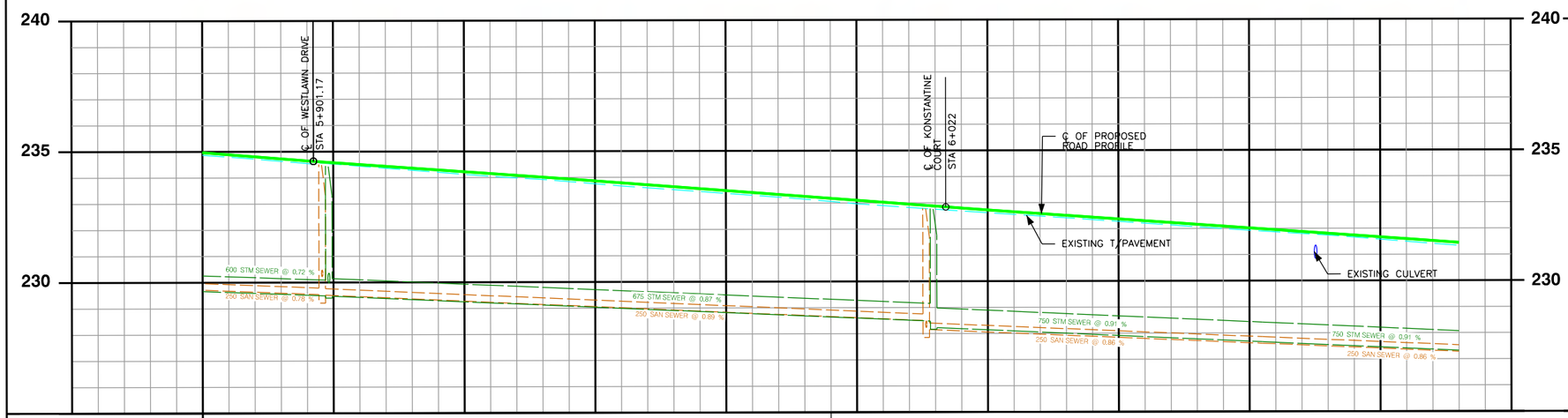




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																			*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																			*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	234.97	234.73	234.51	234.30	234.08	233.86	233.63	233.41	233.18	232.95	232.72	232.51	232.30	232.09	231.88	231.67	231.45		*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	234.87	234.64	234.45	234.20	233.98	233.75	233.53	233.30	233.06	232.83	232.62	232.42	232.21	232.00	231.80	231.58	231.33		EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	5+880	5+895	5+910	5+925	5+940	5+955	5+970	5+985	6+000	6+015	6+030	6+045	6+060	6+075	6+090	6+105	6+120		EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL: 1:1000 (0, 5m, 10m, 20m)
VERTICAL: 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

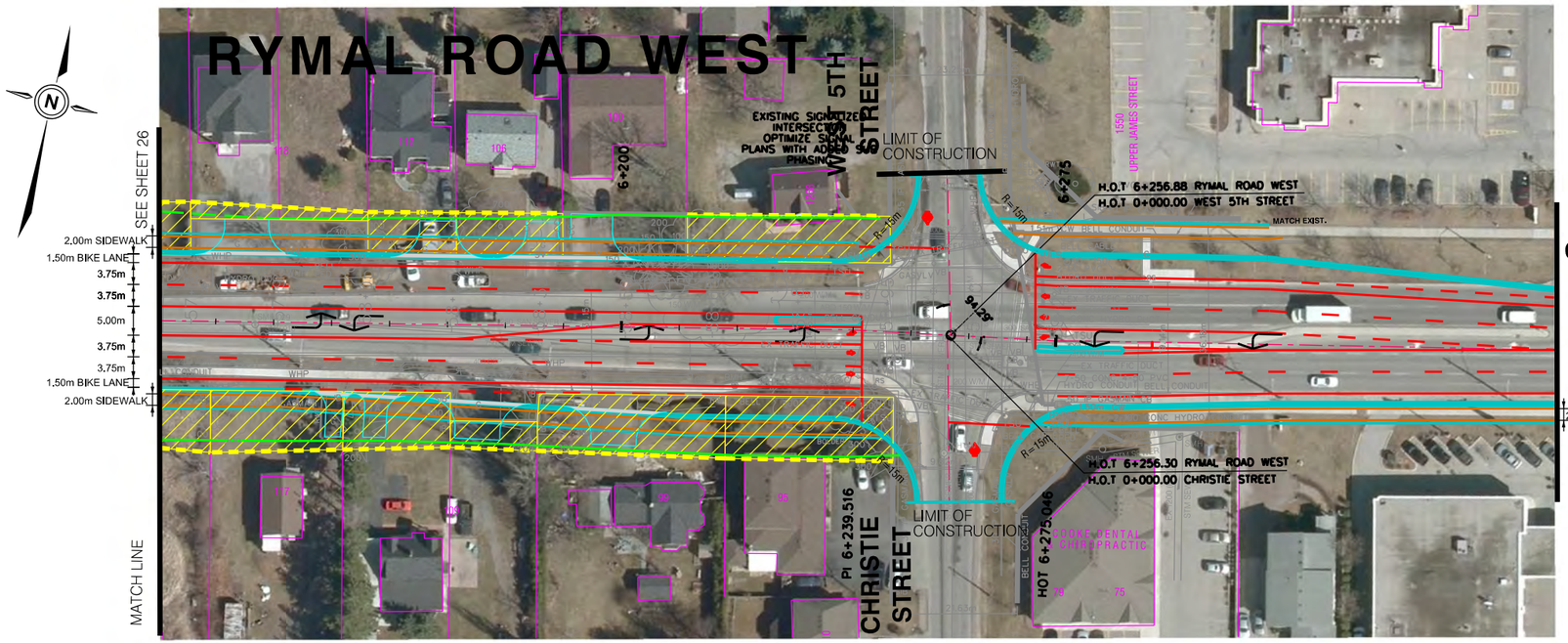
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

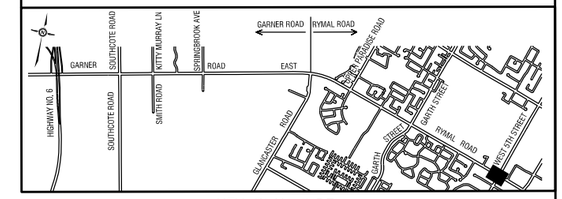
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 27 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

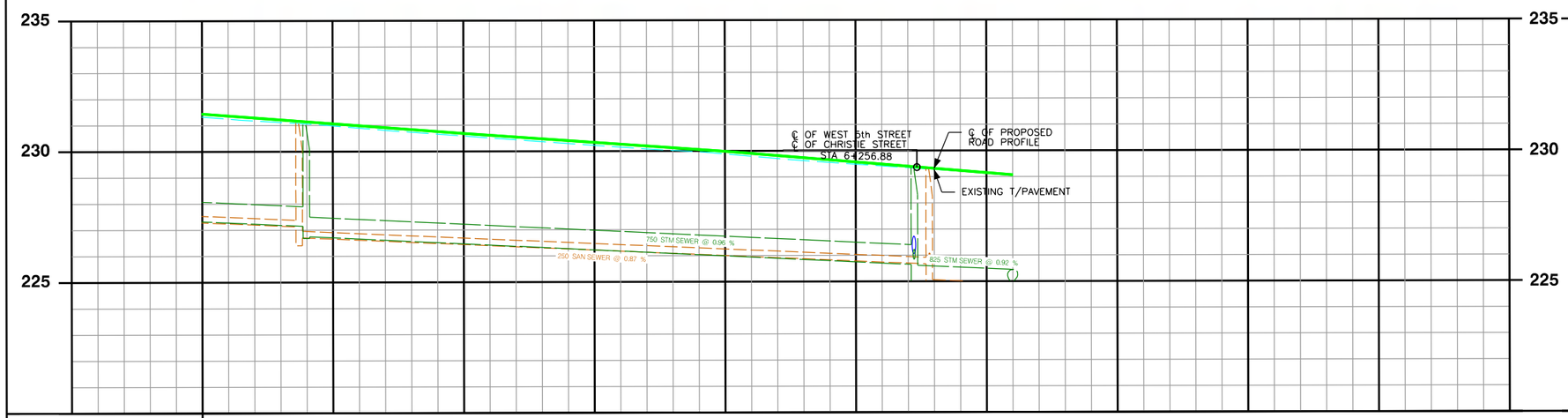




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	231.45	231.22	230.99	230.76	230.55	230.34	230.13	229.90	229.65	229.40	229.15							*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	231.33	231.12	230.90	230.66	230.44	230.22	230.02	229.80	229.55	229.35	229.14							EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	6+120	6+135	6+150	6+165	6+180	6+195	6+210	6+225	6+240	6+255	6+270	6+285	6+300					EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL: 0 5m 10m 20m — 1:1000

VERTICAL: 0 1m 2m 4m — 1:50

Project Manager (Design)

Peter Wowk, P. Eng.

SNC·LAVALIN

CITY OF HAMILTON
Public Works Department

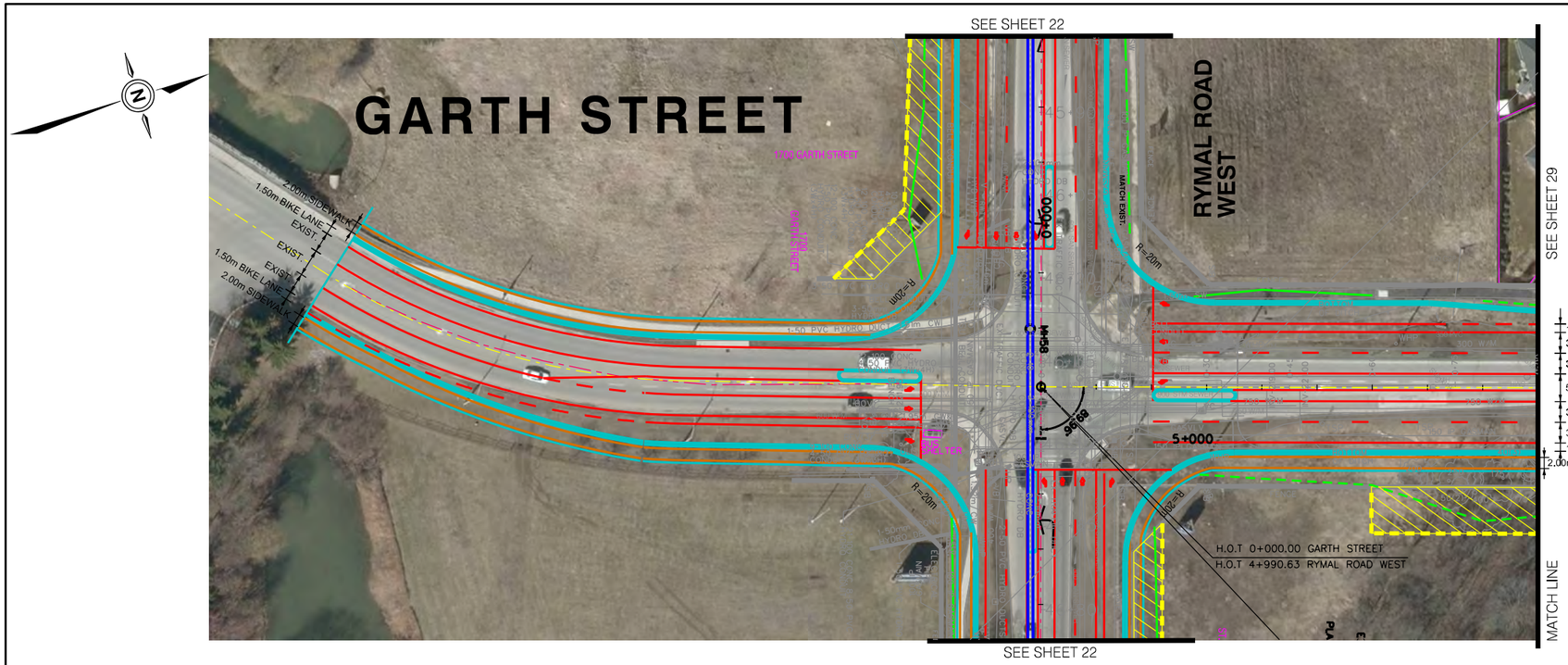
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

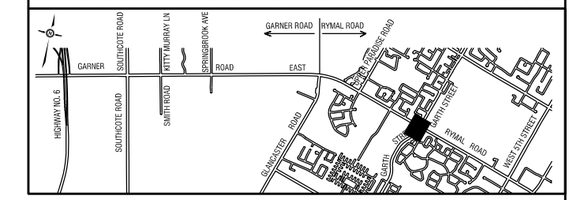
From : Highway No 6
To : West 5th Street

GARTH STREET

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 28 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

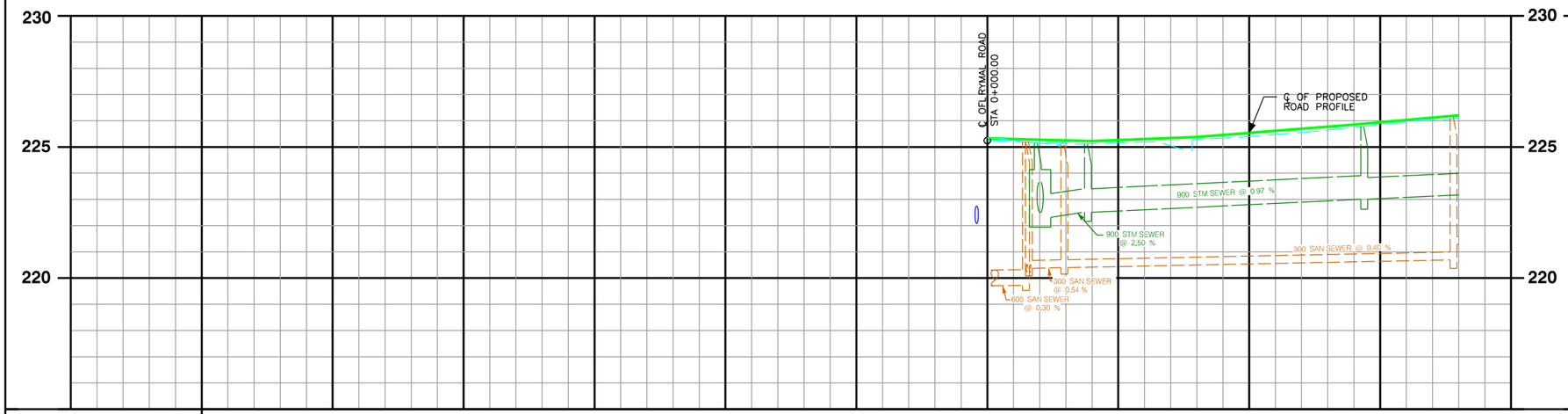




KEY PLAN INDEX

LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
- STORM SEWER
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																	PROPOSED SANITARY SEWER
PROPOSED STORM SEWER																	PROPOSED STORM SEWER
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS								-		225.33	225.23	225.30	225.46	225.70	225.94	226.21	PROPOSED ℄ OF ROAD PROFILE ELEVATIONS
EXISTING ℄ OF ROAD PROFILE ELEVATIONS										225.24	225.13	225.19	225.33	225.55	225.85	226.11	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION								-		0+000	0+015	0+030	0+045	0+060	0+075	0+090	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

From : Highway No 6
To : West 5th Street

GARTH STREET

FILE No.	CONTRACT No. / DRAWING No.	SHEET No. 29 OF 35

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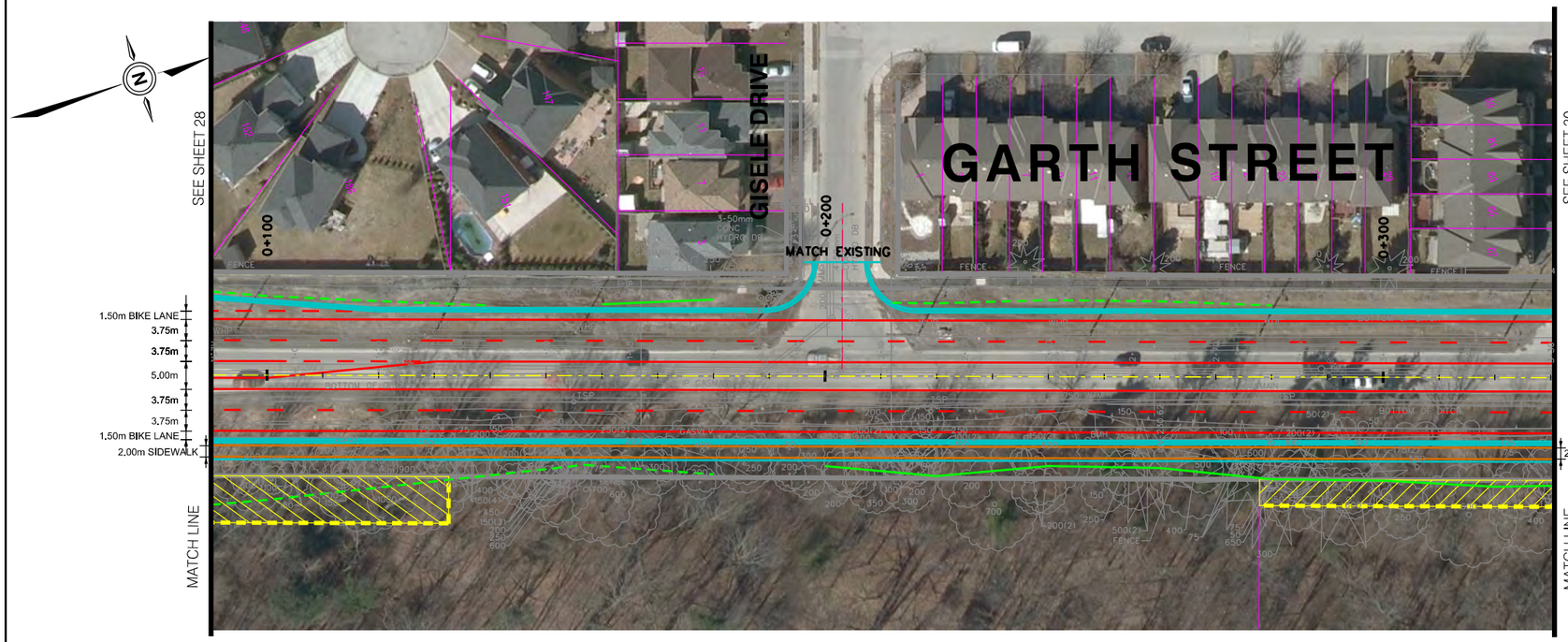

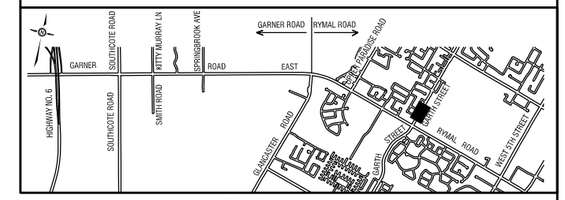

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LEGEND:

- PROPERTY REQUIRED
- PROPOSED C&G
- TRAFFIC MARKING
- PROPOSED GRADING LIMIT – FILL
- PROPOSED GRADING LIMIT – CUT
- EXISTING PROPERTY LINE
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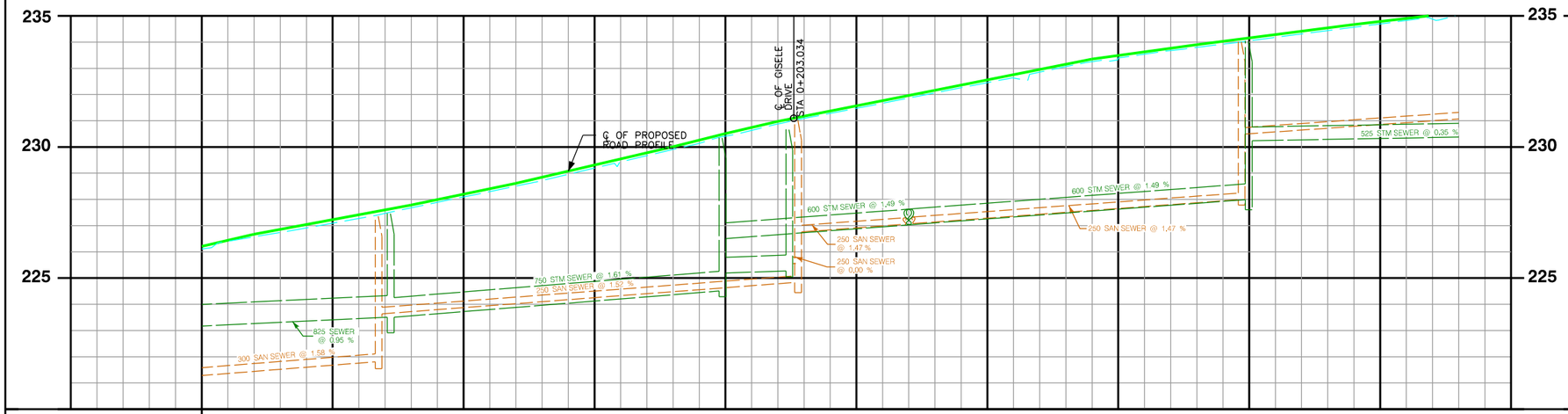
- MH
- OGS
- MAJOR SYSTEM OUTLET



SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	226.21	226.86	227.41	227.99	228.61	229.31	230.01	230.75	231.37	231.97	232.56	233.16	233.63	234.03	234.41	234.79	235.13	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	226.11	226.74	227.27	227.89	228.51	229.19	229.91	230.63	231.28	231.87	232.45	233.06	233.54	233.92	234.31	234.69	235.04	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+090	0+105	0+120	0+135	0+150	0+165	0+180	0+195	0+210	0+225	0+240	0+255	0+270	0+285	0+300	0+315	0+330	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

From : Highway No 6
To : West 5th Street

GARTH STREET

FILE No.	CONTRACT No.	SHEET No.
	DRAWING No.	30 OF 35

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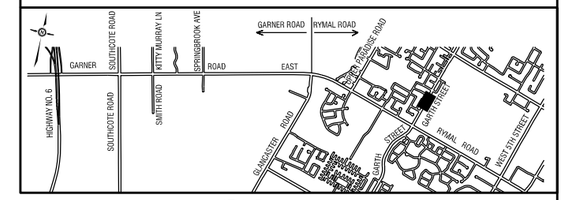

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LEGEND:

- PROPERTY REQUIRED
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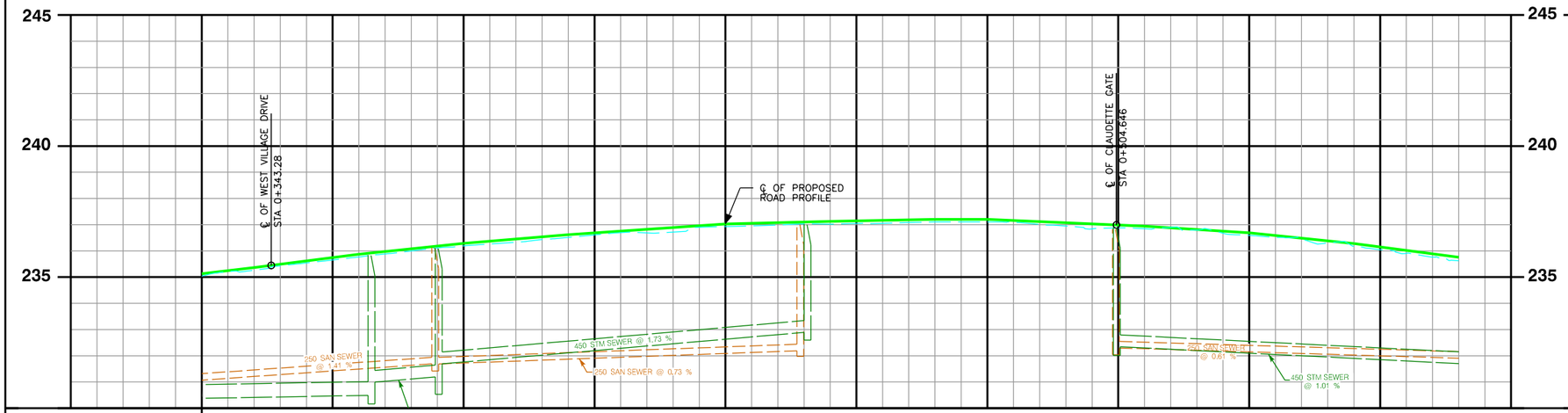

SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	235.13	235.49	235.87	236.19	236.45	236.69	236.89	237.05	237.13	237.18	237.21	237.08	236.95	236.75	236.49	236.15	235.76	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	235.04	235.43	235.77	236.11	236.33	236.61	236.72	236.96	237.03	237.08	237.11	236.95	236.85	236.67	236.41	236.05	235.63	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+330	0+345	0+360	0+375	0+390	0+405	0+420	0+435	0+450	0+465	0+480	0+495	0+510	0+525	0+540	0+555	0+570	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

From : Highway No 6
To : West 5th Street

GARTH STREET

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 31 OF 35

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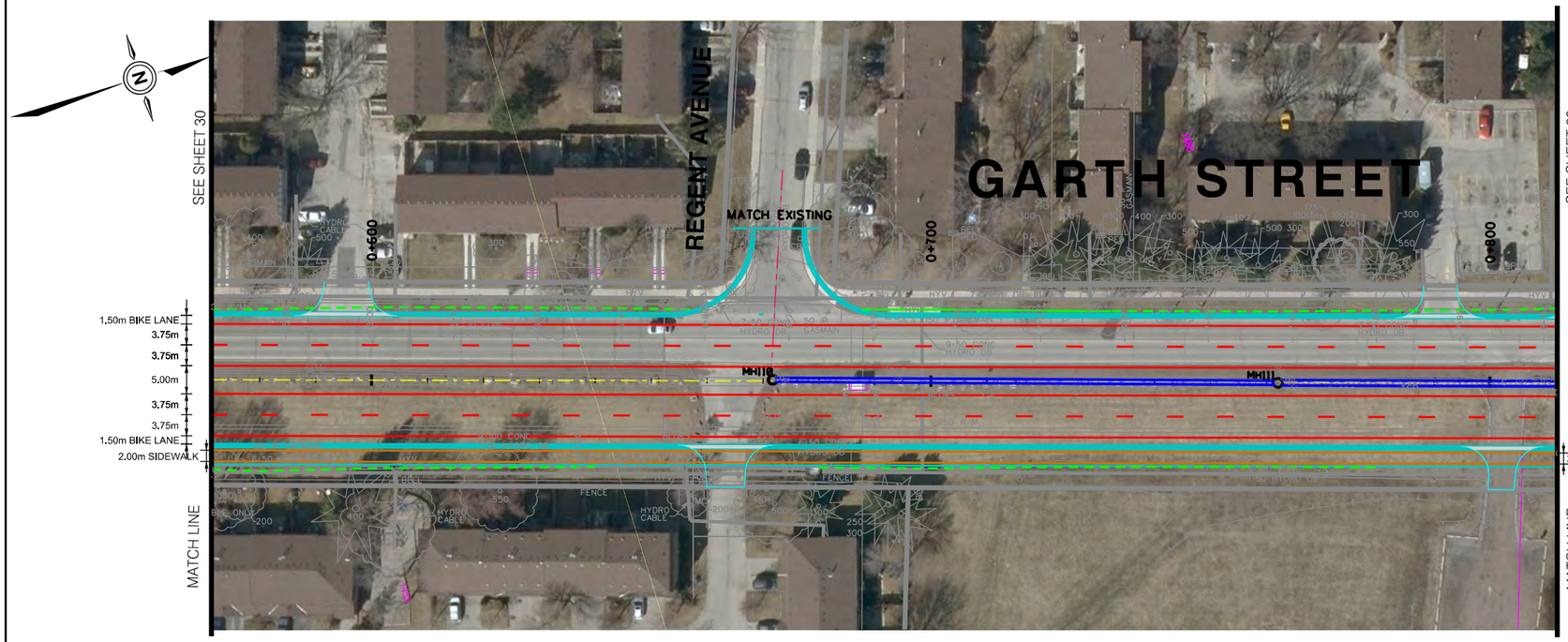

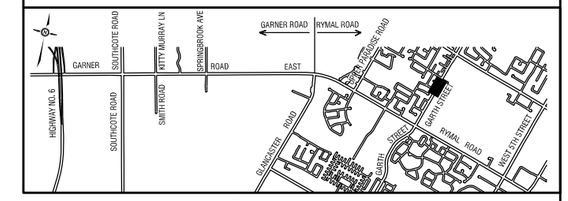

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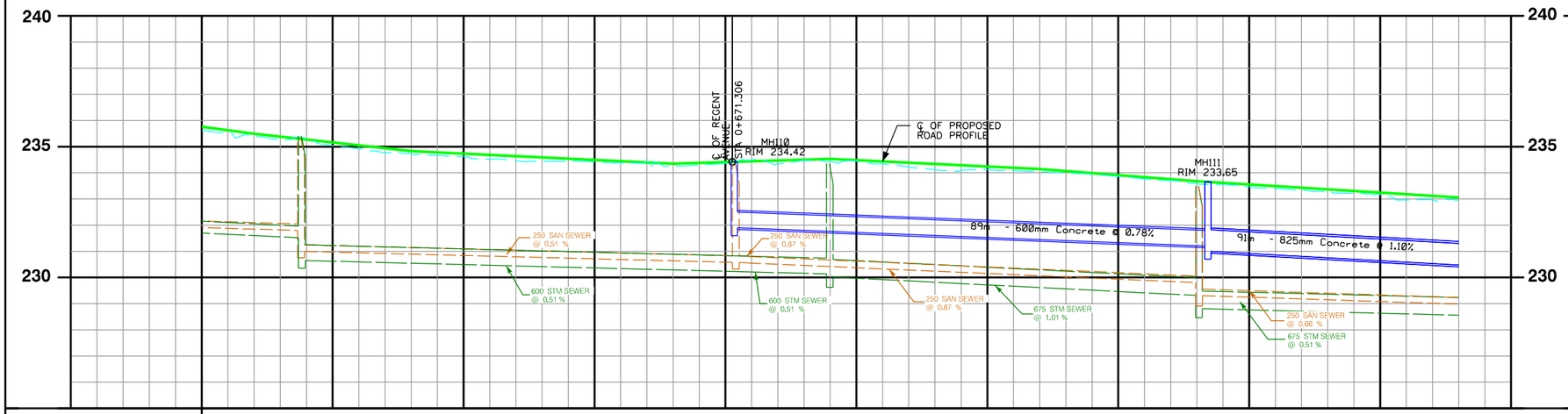


SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																	*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																	*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	235.76	235.39	235.05	234.78	234.64	234.49	234.35	234.44	234.53	234.39	234.24	234.07	233.83	233.62	233.43	233.24	233.06	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	235.63	235.26	234.92	234.67	234.46	234.42	234.25	234.50	234.43	234.22	234.12	234.01	233.77	233.56	233.34	233.17	232.96	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+570	0+585	0+600	0+615	0+630	0+645	0+660	0+675	0+690	0+705	0+720	0+735	0+750	0+765	0+780	0+795	0+810	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

SNC•LAVALIN

CITY OF HAMILTON
Public Works Department

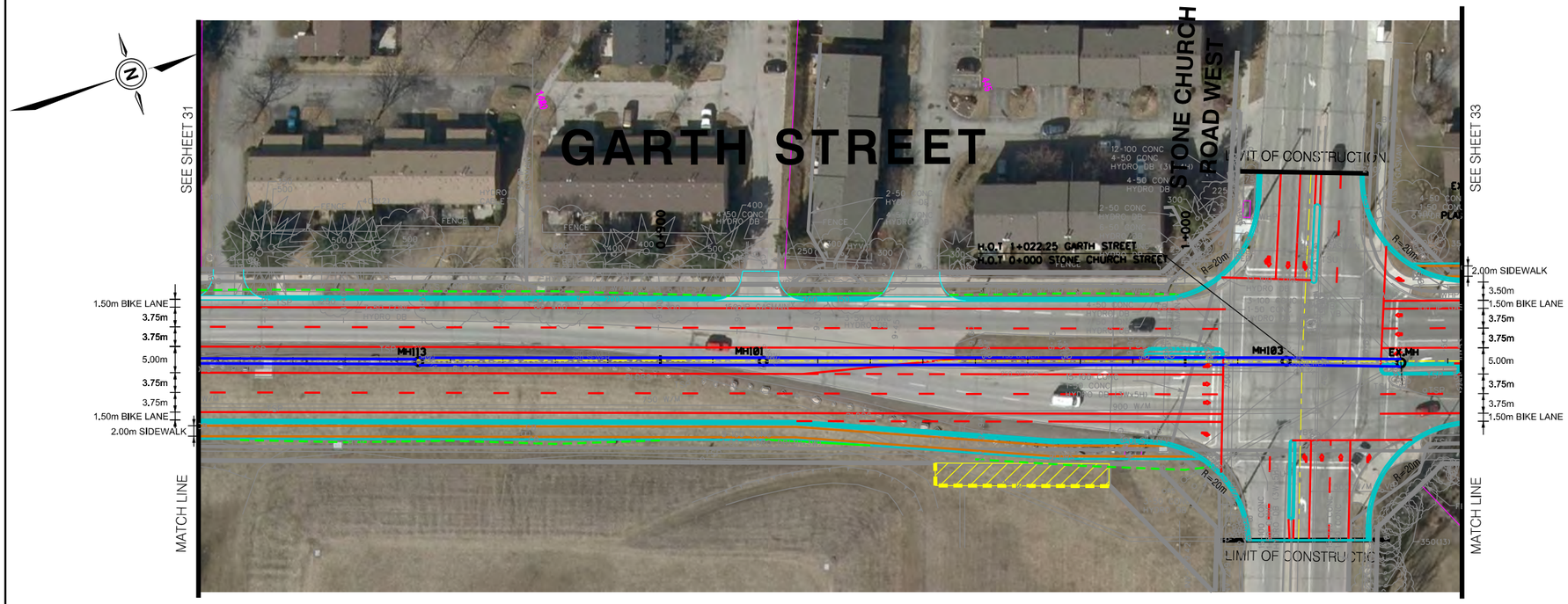
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

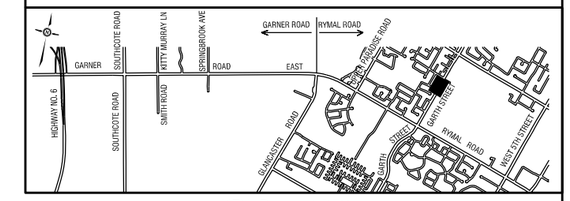
From : Highway No 6
To : West 5th Street

GARTH STREET

FILE No.	CONTRACT No.	SHEET No.
	DRAWING No.	32 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED





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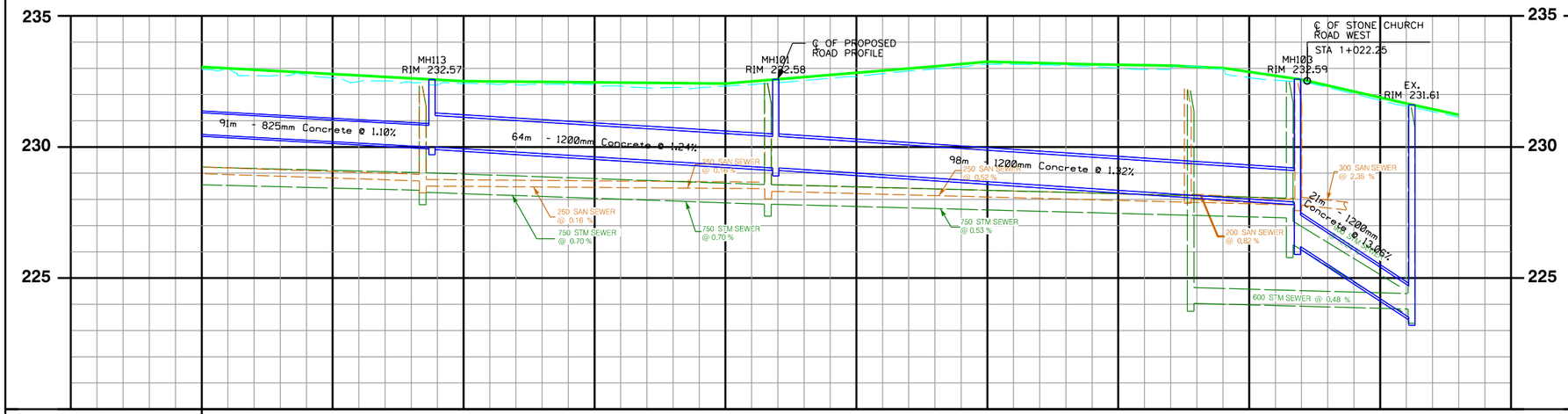

SEWER REPAIRS and OVERFLOWS
C.B. REMOVALS/REPLACEMENTS

EXISTING SEWER MANHOLES

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	233.06	232.89	232.73	232.57	232.49	232.47	232.44	232.50	232.75	232.99	233.25	233.18	233.12	233.01	232.57	231.89	231.22	*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	232.96	232.72	232.49	232.36	232.38	232.37	232.27	232.38	232.63	232.90	233.15	233.11	232.96	232.98	232.47	231.78	231.14	EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	0+810	0+825	0+840	0+855	0+870	0+885	0+900	0+915	0+930	0+945	0+960	0+975	0+990	1+005	1+020	1+035	1+050	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES

HORIZONTAL 1:1000 (0, 5m, 10m, 20m)

VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)

Peter Wowk, P. Eng.

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CITY OF HAMILTON
Public Works Department

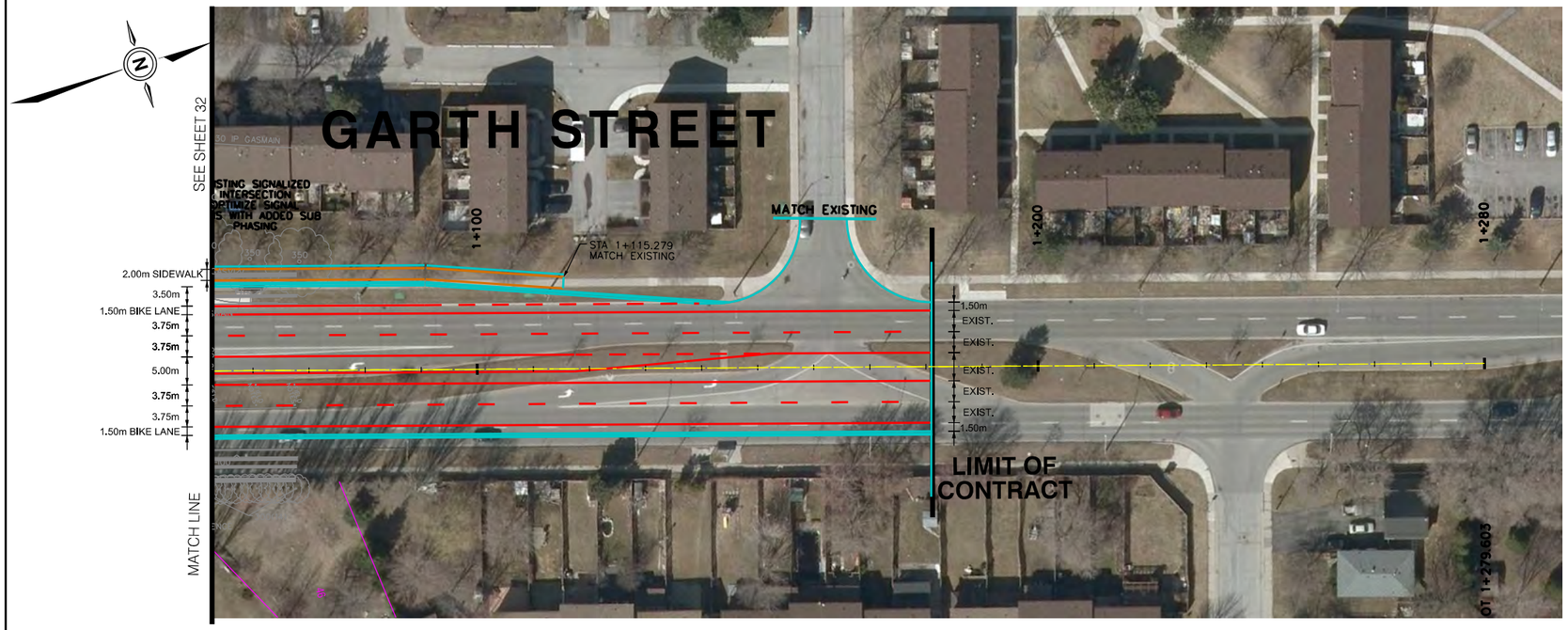
GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

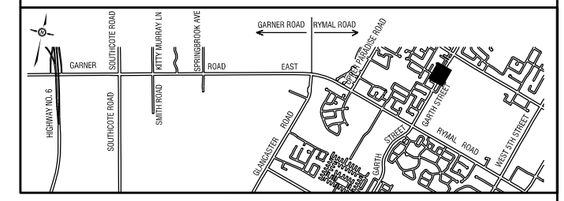
From : Highway No 6
To : West 5th Street

GARTH STREET

FILE No.	CONTRACT No. DRAWING No.	SHEET No. 33 OF 35

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED





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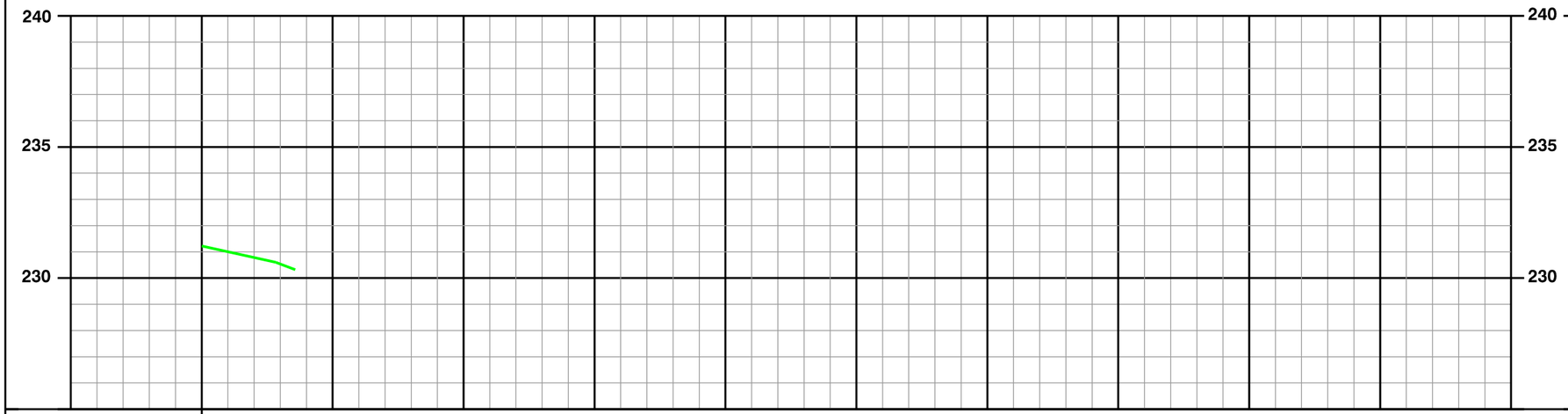

SEWER REPAIRS and OVERFLOWS	EXISTING SEWER MANHOLES
C.B. REMOVALS/REPLACEMENTS	

PROPOSED SANITARY SEWER																		*PROPOSED SANITARY SEWER*
PROPOSED STORM SEWER																		*PROPOSED STORM SEWER*
PROPOSED ℄ OF ROAD PROFILE ELEVATIONS	231.22	230.53																*PROPOSED ℄ OF ROAD PROFILE ELEVATIONS*
EXISTING ℄ OF ROAD PROFILE ELEVATIONS	231.14	230.48																EXISTING ℄ OF ROAD PROFILE ELEVATIONS
STATION	1+050	1+065	1+080	1+095	1+110	1+125	1+140	1+155	1+170	1+185	1+200	1+215	1+230	1+245	1+260	1+275	1+290	1+300	EXISTING ℄ OF ROAD ALLOWANCE CHAINAGE

No.	REVISIONS	INITIAL	DATE

DRAWN BY: D.S

DATE: NOV 18, 2013

SCALES
HORIZONTAL 1:1000 (0, 5m, 10m, 20m)
VERTICAL 1:50 (0, 1m, 2m, 4m)

Project Manager (Design)
Peter Wowk, P. Eng.

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CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

From : Highway No 6
To : West 5th Street

GARNER ROAD EAST
RYMAL ROAD WEST

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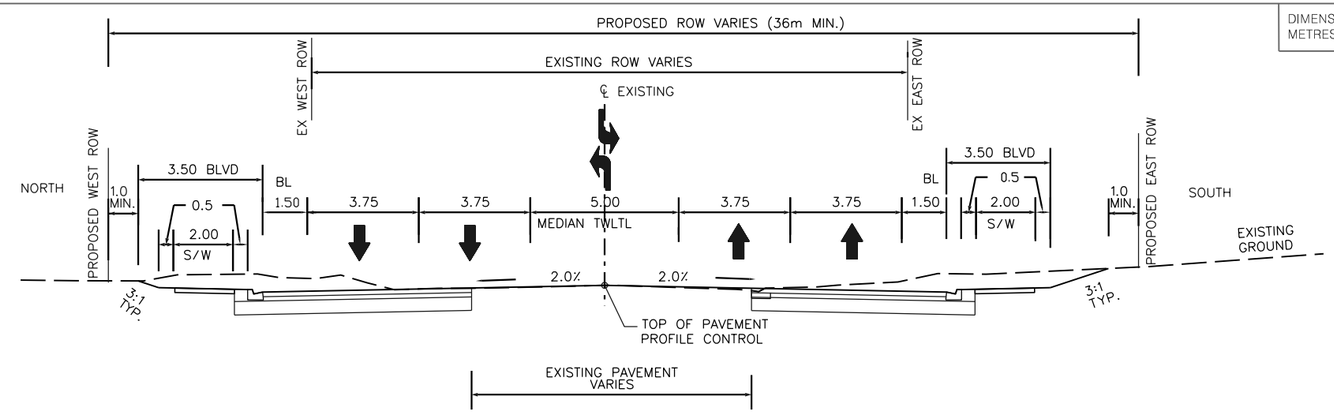
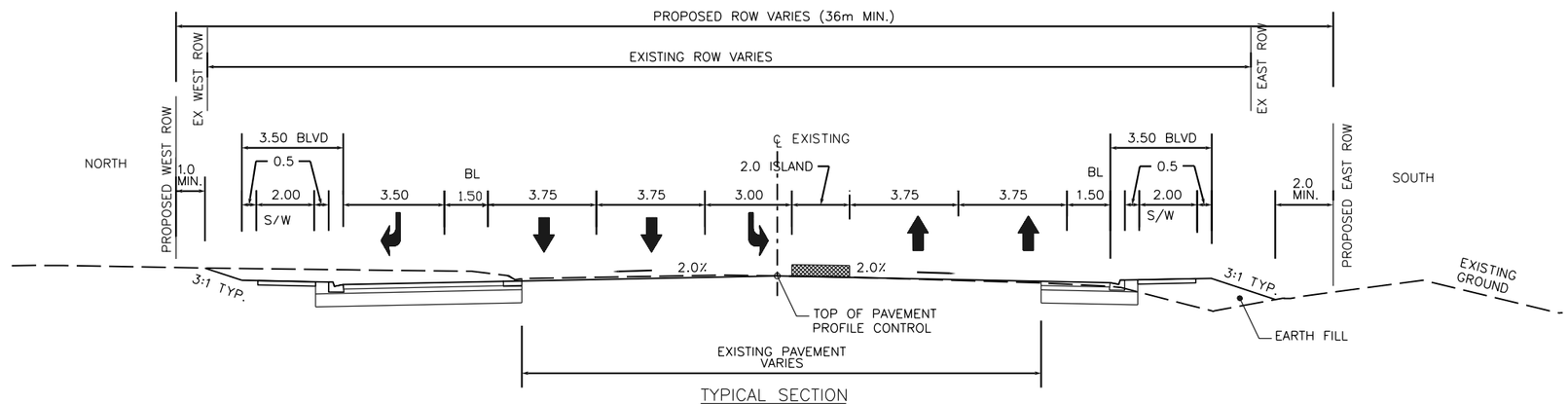
CONTRACT No.
DRAWING No.
FILE No.



TYPICAL SECTION



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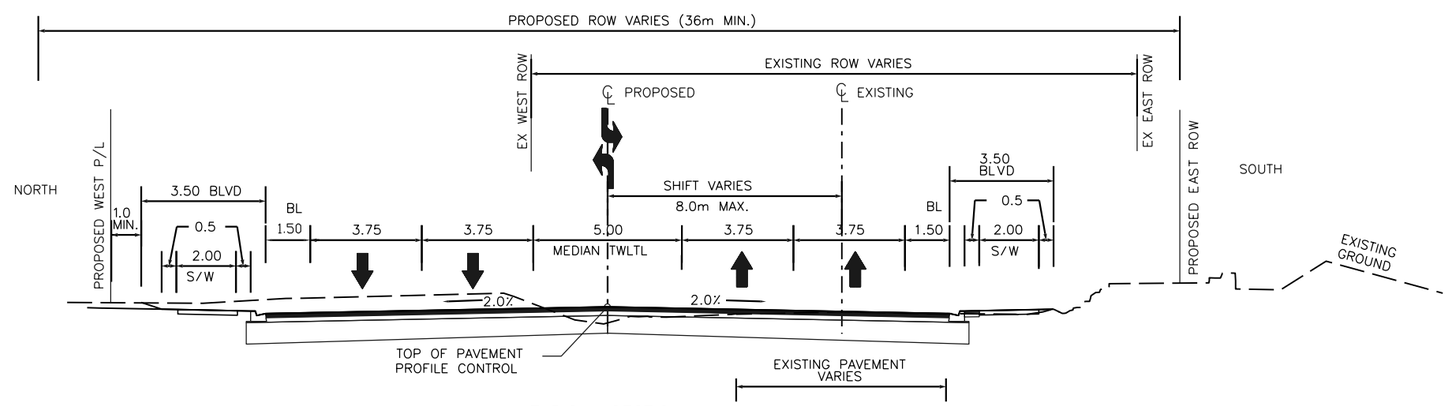
SIGNALIZED INTERSECTIONS



TYPICAL SECTION
ALIGNMENT SHIFT STA 2+076 TO 2+784

No.	REVISIONS	INITIAL	DATE	DRAWN BY: DS	DATE: NOV 18, 2013

SCALES
NTS

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CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET
SCHEDULE C CLASS EA
From : Highway No 6
To : West 5th Street

GARNER ROAD EAST
RYMAL ROAD WEST

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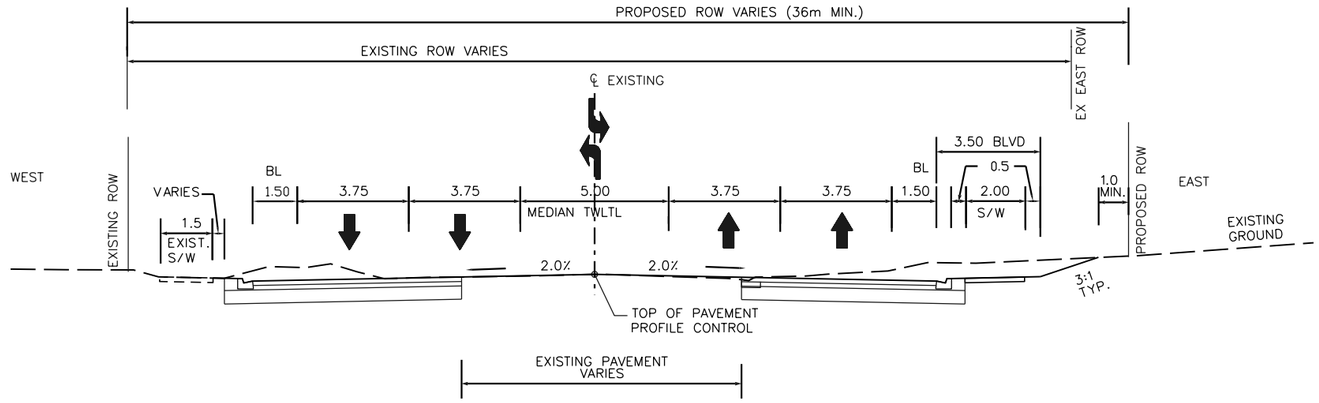

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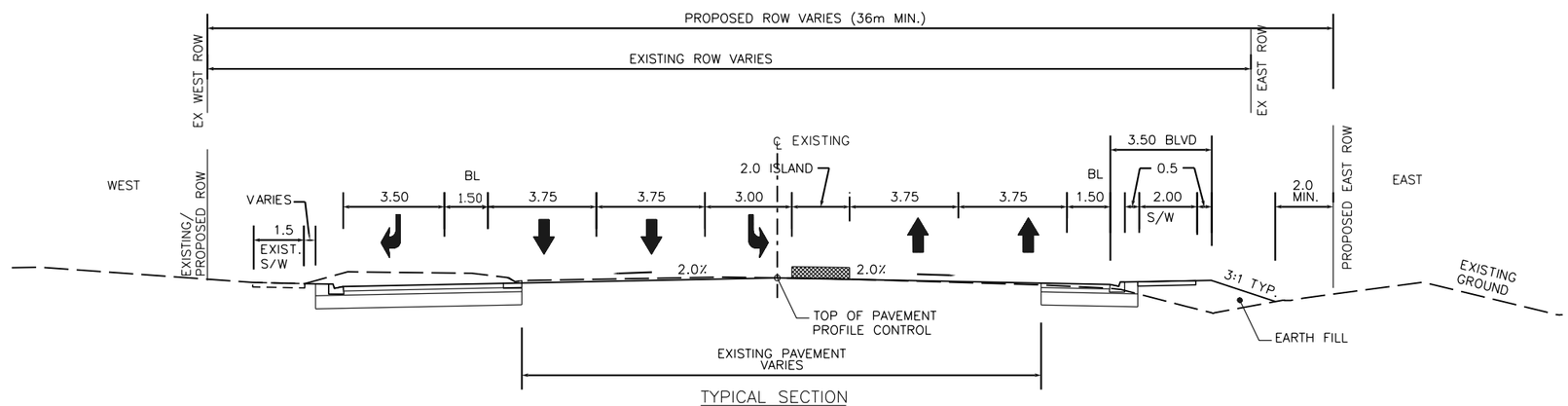

TYPICAL SECTION
SIGNALIZED INTERSECTIONS

No.	REVISIONS	INITIAL	DATE	DRAWN BY: DS	DATE: NOV 18, 2013

SCALES

NTS

Project Manager (Design)

Peter Wowk, P.Eng.

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CITY OF HAMILTON
Public Works Department

GARNER ROAD/RYMAL ROAD AND GARTH STREET SCHEDULE C CLASS EA

From : Highway No 6
To : West 5th Street

APPENDIX D
TECHNICAL SUPPORT MATERIAL

- **D.1 – Traffic Study Report (Abridged)**
- **D.2 – Stormwater Management Report (Abridged)**
- **D.3 – Natural Environment Report**
- **D.4 – Hydrogeology Report**
- **D.5 – Noise Assessment**
- **D.6 – Cultural Heritage Assessment Report**
- **D.7 – Stage 1 Archaeological Assessment**

APPENDIX D.1

TRAFFIC STUDY REPORT (Abridged)

Hamilton

GARNER ROAD EAST / RYMAL ROAD WEST AND GARTH STREET

ENVIRONMENTAL ASSESSMENT STUDY

TRAFFIC STUDY REPORT

REVISION – 00

MAY 16, 2011

SNC·LAVALIN

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APPENDIX 'B' – SYNCHRO SUMMARY SHEETS – INTERSECTION CAPACITY ANALYSIS RESULTS

APPENDIX 'C' – SIGNAL WARRANT ANALYSIS – PEAK HOUR WARRANT (MTO)

APPENDIX 'D' – SYNCHRO AND SIMTRAFFIC SUMMARY SHEETS – ARTERIAL CAPACITY ANALYSIS RESULTS

1.0 BACKGROUND

SNC Lavalin Inc. was retained by the City of Hamilton to undertake an Environmental Assessment Study (EA) Phase 3 and 4 for the Garner Road East/ Rymal Road corridor between the Highway 6 and the West 5th Street; and Garth Street between Rymal Road West to and beyond Stone Church Road. Background Study for the Meadowlands Neighbourhoods 3, 4 and 5, Class Environmental Assessment Master Plan recommended improving Garner Road East, stretching from Southcote Road to Glancaster Road. The background study was prepared for the former Town of Ancaster, now absorbed as part of the City of Hamilton, to satisfy two objectives:

1. It addresses the Environmental Assessment Act requirements; and
2. It provides the preliminary planning and engineering direction to enable urban development of the neighbourhood into the existing urban structure.

The need to widen Garner Road East to four lanes was recommended as a Schedule C project in the background study. This project is therefore necessary in order to accommodate growth in regional traffic demands. The strip of Garner Road that becomes Rymal Road, extending from Glancaster to West 5th St. and Garth Street, from Rymal Road West to Stone Church Road West, are addressed in the South Mountain Area Transportation Master Plan, which was completed in 2000 and reviewed in 2006 to reconfirm that any outstanding EA projects were still valid. This study for the City of Hamilton was undertaken to identify existing short-term and long term transportation capacity deficiencies, as well as recommendations to address these deficiencies. Furthermore, this study will review opportunities for access to a variety of transit options and transit improvements, including pedestrian friendly-streets within the study area. Specifically, the recommended project is to widen Garth Street (Rymal Rd. W. to Stone Church Rd. W.) from 2 to 4 lanes. There may also be the need for a left turn access for local access.

Collectively, the background study for the Meadowlands Neighbourhoods 3, 4 and 5, Class Environmental Assessment Master Plan and the South Mountain Area Transportation Master Plan suggest comprehensive transportation improvement projects for Garner Road and Garth Street.

Specific projects that have been identified, as per the above mentioned studies, include:

- Garner Rd. E. - widen to 4 lanes in order to accommodate for traffic demands. Further, the eastbound left turn lane on Garner Rd. at Southcote Rd. will require an increase in left turn storage from 70m to 90m; and
- Rymal Road (Glancaster Rd. to West 5th St.) – widen from 2 to 4/5 lanes in order to alleviate possible congestion across to Ancaster.
- Garth Street (Rymal Rd. W. to Stone Church Rd. W.) – widen from 2 to 4 lanes. There may also be a need for left turn access (local).

A recently completed 'Airport Employment Growth District' (AEGD) Study (May 2010)[1] recommended that Garner Road/ Rymal Road, between Fiddler's Green Road and Glancaster Road, to be widened to 4-lanes simultaneous to the full build-out (Phase – II) of the AEGD areas. A similar recommendation to widen Garth Street between Rymal Road and Stone Church Road to a 4-lane section is also reflected in the AEGD Study to accommodate the AEGD developments.

A recently completed 'Truck Route Master Plan' study indicated the Garner Road study corridor as a designated truck route, including the Garth Street corridor operating as a part time truck route simultaneous to the progression of the urbanization on Garth Street study corridor. The Cycling Master Plan indicated bike lanes and sidewalk along both the sides of the Garner Road/ Rymal Road corridor. The City of Hamilton is also anticipating to move forward with implementation of the 'S' line Light Rail Transit along the study corridor in some distant future. To minimize potential costs associated with

[1] Airport Employment Growth District (AEGD) study – Dillon Consulting (May 2010)

relocating utilities and widening structures at watercourse crossings the City is now considering securing property for the 36m wide right-of-way of and relocating or constructing these elements to accommodate the preferred cross-section as part of the EA Study findings.

AEGD Study report indicated a scenario beyond 2031 under ultimate build-out conditions anticipating approximately doubling of the primary estimated cargo freight and passengers with respect to that under full build-out conditions to the Hamilton Airport. This scenario indicated an abnormal increase of traffic volumes under the ultimate build-out AEGD area beyond 2031. The Garner Road study corridor will require a close and continuous monitoring on and from the 2031 horizon year as the AEGD area grows further, inclusive of increasing passenger and freight carrying capabilities at the Hamilton Airport. In light of the above, this EA Study evaluates the traffic conditions under the full build-out AEGD (Phase – II) scenario and does not consider the ultimate build-out of AEGD scenario.

2.0 EXISTING TRAFFIC CONDITION

2.1 EXISTING ROAD NETWORK:

Garner Road, between Highway 6 and West 5th Street, is a basic 2-lane rural arterial with a 60 km/h posted speed. All major north-south roads intersecting Garner Road (i.e. Fiddler's Green Road, Southcote Road, Glancaster Road, Upper Paradise Road, Garth Street and West 5th Street) operate under traffic signal control. Garth Street is a north-south basic two lane road with a posted speed of 50 km/h within the study limit. The only major intersection is the Stone Church Road/ Garth Street, which operates under signal control. The list of the signalized and the major unsignalized intersections are listed below:

Signalized Intersections:

- Garner Road West and Fiddler's Green Road;
- Garner Road East and Southcote Road;
- Garner Road East and Glancaster Road;
- Garner Road East and Upper Paradise Road;
- Garner Road East and Garth Street;
- Garner Road East and West 5th Street; and
- Garth Street and Stone Church Road.

Unsignalized Intersections:

- Garner Road East and Highway 403 Off-Ramp;
- Garner Road East and Highway 403 On-Ramp;
- Garner Road East and Kitty Murray Lane;
- Garner Road East and Redeemer University College;
- Garner Road East and Springbrook Avenue;
- Garner Road East and Spadara Drive;
- Garner Road and Bishop Ryan Way;
- Garner Road and Westlawn Drive;
- Garner Road and Krieghoff Drive; and
- Garth Street and Claudette Gate.

The details of the intersection configurations are illustrated in **Figure 1** in **'*Appendix A*'**.

2.2 EXISTING TRAFFIC VOLUMES:

The existing traffic volumes along Garner Road East/ Rymal Road West were provided by the City of Hamilton. The existing traffic volumes reflect the turning movement counts conducted in 2008. Based on the existing land-use around Garner Road E/ Rymal Road W, no significant change in the traffic turning volumes is anticipated since 2008. **Figures 2** in **'*Appendix A*'** illustrates the existing traffic volumes (2008) during the weekday morning and afternoon peak hours at all the study intersections within the vicinity of the Garner Road E/ Rymal Road W study area.

3.0 FUTURE BACKGROUND TRAFFIC CONDITION

3.1 CORRIDOR GROWTH:

Traffic forecast from the other traffic studies, on-going or recently completed, a corridor growth rate of 2% per year has been reflected in and around the study area. This report, primarily focuses on the 'AEGD Study Report', and considers a simple growth rate of 2% per annum to estimate the background traffic volumes. 2008 turning movement volumes at the major westerly intersections, as reported in the AEGD study report, were also extracted for comparison with the turning volumes obtained from the City for this study. The existing traffic volumes were adjusted to capture the higher turning volumes. Based on the anticipated growth rate a total corridor growth of 46% (2% per year for 23 years) will occur from 2008 to 2031. Some adjustments were applied to the turning volumes to balance the link volumes along study area corridor. **Figures 3** in **'*Appendix A*'** illustrate the future background volumes during the weekday AM and PM under 2031 background traffic conditions based on corridor growth only.

The future link volumes during the weekday AM peak hour under 2031 traffic conditions, which were extracted from the forecast traffic volumes for the AEGD, secondary plan area were compared with the estimated future background volumes (2031) as provided in Figure 3. It was noted that some of the turning volumes from the cross roads and also some link volumes along Garner Road E between Glancaster Road and Fiddler's Green Road are higher than the estimated future 2031 background volumes consisting of the simple 46% growth as reflected in Figure 3. The background volumes based on the corridor growth was further adjusted to develop a balanced traffic along Garner Road through the study corridor to match the forecast link volumes estimated in the AEGD Study.

It is worth noting that the forecast volumes provided in the AEGD studies were utilized to forecast the future background traffic volumes under 2031 horizon, which included some of the development traffic volumes primarily related to the AEGD areas. The AEGD Study report reflects only the weekday AM peak hour. The weekday PM peak hour volumes are generally reverse of that during the weekday AM peak hour and 10% higher than those during the AM peak hour. The corresponding weekday PM peak hour volumes were, therefore, developed reversing the directions of weekday AM peak hour and also adding a further 10% on the AM peak volumes.

Figure 4 in **'*Appendix A*'** illustrates the 2031 future background balanced traffic volumes under the 2031 horizon year inclusive of all the background development volumes, south of Garner Road/ Rymal Road within the vicinity of the study area, however, exclusive of any proposed developments to the north of Garner Road/ Rymal Road.

4.0 FUTURE TOTAL TRAFFIC CONDITION

Based on the comparison of the future background volumes based on corridor growth (Figure 3) and forecast traffic volumes estimated in AEGD Study (Figure 4), it became apparent that potential traffic volumes from the planned developments in the AEGD area were included, however peripheral developments to the immediate north of the AEGD area were not included in the future forecast. Based

on the information received from the City so far, the primary land developments were considered as follows:

- 435 Garner Rd E & Southcote/ Garner Road developments;
- 1061 and 1169 Garner Road E developments;
- 751 Rymal Rd W, 460 Rymal Rd W, and 310 Rymal Rd W developments; and
- 625 Garner Rd E, 713 & 777 Garner Rd E developments.

These development traffic volumes were added onto the forecast future background balanced traffic volumes to estimate the future total traffic volumes in the horizon year of 2031. Site traffic generation was estimated based on the trip generation factors extracted from the ITE Trip Generation Handbook 8th Edition. Site traffic forecast was developed based on the development information provided by the City of Hamilton. The paragraphs below discuss the site trip generation in detail.

4.1 SITE TRIP GENERATION

The site trip estimation in this study only considers the all the developments that were proposed to the north of Garner Road/ Rymal Road and does not include any site trips related to further increase in passenger trips or cargo trips as cited in the AEGD Study Report for the beyond 2031 scenario. The Hamilton Transportation Master Plan (HTMP) targets a goal of reducing auto vehicle kilometres by 20% compared to 2001. The HTMP targeted a modal split of 52% for autos with single occupant drivers, 12% for municipal transit, and 15% for walking/ bicycling. The rest of 21% are expected to be autos with higher occupancy, as a part of the 'Travel Demand Management'.

The assumptions in the HTMP included implementation of 'Travel Demand Management' measures, higher transit use, and promoting walking/ bicycling. The target of reducing auto vehicle kilometres could be achievable, subject to the City's initiative to building the proposed rapid transit network. However, possibility of implementation of rapid transit along Garner Road/ Rymal Road appears to be a distant factor, and therefore auto travel might still be predominant within the study area. Furthermore, the targeted walking or bicycling modal split will be difficult to achieve within this study area, since forecast trip distribution extracted from AEGD Study Report identifies primarily eastbound and westbound trips will be longer distance trips.

With all this, the site trip generation from all the proposed developments were adjusted presuming an achievable transit and other mode-use based on the City's current endeavour to reduce the auto travel under the 2031 traffic conditions. The modal split that was used to estimate future trip generation was primarily consisted of:

- Auto use: 80%; and
- Transit and other modes: 20%

The transit mode and other modes (i.e. bicycle and pedestrian uses) were predicted to contribute reducing 20% of auto travel on the study area road network, which could be relatively conservative, however the same modal split was considered to estimate the forecast site traffic volumes from the proposed land-use development to the north of Garner Road/ Rymal Road. The individual site trip generations are discussed in the following paragraphs:

<u>435 Garner Road East</u>: This development will consist of 114 Single Detached homes, 168 Town-homes, and 334 apartment suits. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
114 Single Detached (LU Code 210)	Directional Distribution	25%	75%	100%	63%	37%	100%
	Average Rate	0.19	0.56	0.75	0.64	0.37	1.01
	Site Traffic based on Average	20	65	85	70	45	115

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
	Equation Rate	0.20	0.59	0.79	0.66	0.38	1.04
	Site Traffic based on Equation	25	65	90	75	45	120
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit	-5	-15	-20	-15	-10	-25
	Total Trips	20	50	70	60	35	95
168 Townhouse (LU Code 230)	Directional Distribution	17%	83%	100%	67%	37%	104%
	Average Rate	0.07	0.37	0.44	0.35	0.17	0.52
	Site Traffic based on Average	15	60	75	55	30	85
	Equation Rate	0.08	0.39	0.47	0.37	0.18	0.55
	Site Traffic based on Equation	15	65	80	60	30	90
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	-5	-15	-20	-10	-5	-15
	Total Trips	10	50	60	50	25	75
334 Apartment Units (LU Code 220)	Directional Distribution	20%	80%	100%	65%	37%	102%
	Average Rate	0.10	0.41	0.51	0.40	0.22	0.62
	Site Traffic based on Average	35	135	170	135	70	205
	Equation Rate	0.10	0.40	0.5	0.39	0.21	0.6
	Site Traffic based on Equation	35	130	165	130	70	200
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	-5	-25	-30	-25	-15	-40
	Total Trips	30	105	135	105	55	160
Total **616** Units	**Net New Trips**	**60**	**205**	**265**	**215**	**115**	**330**

Southcote Road and Garner Road East: This development will consist of 65 Single Detached homes. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
65 Single Detached (LU Code 210)	Directional Distribution	25%	75%	100%	63%	37%	100%
	Average Rate	0.19	0.56	0.75	0.64	0.37	1.01
	Site Traffic based on Average	15	35	50	40	25	65
	Equation Rate	0.21	0.64	0.85	0.69	0.41	1.1
	Site Traffic based on Equation	15	40	55	45	25	70
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	-5	-10	-15	-10	-5	-15
	Total Trips	10	30	40	35	20	55

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
Total **65** Units	**Net New Trips**	**10**	**30**	**40**	**35**	**20**	**55**

1061 Garner Road East: This development will consist of 620 Single Detached homes, and 306 Town-homes. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
620 Single Detached (LU Code 210)	Directional Distribution	25%	75%	100%	63%	37%	100%
	Average Rate	0.19	0.56	0.75	0.64	0.37	1.01
	Site Traffic based on Average	115	350	465	395	230	625
	Equation Rate	0.18	0.54	0.72	0.55	0.33	0.88
	Site Traffic based on Equation	110	335	445	345	200	545
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit	-20	-65	-85	-70	-40	-110
	Total Trips	90	270	360	275	160	435
306 Townhouse (LU Code 230)	Directional Distribution	17%	83%	100%	67%	33%	100%
	Average Rate	0.07	0.37	0.44	0.35	0.17	0.52
	Site Traffic based on Average	25	110	135	105	55	160
	Equation Rate	0.07	0.34	0.41	0.33	0.16	0.49
	Site Traffic based on Equation	20	105	125	100	50	150
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	-5	-20	-25	-20	-10	-30
	Total Trips	15	85	100	80	40	120
Total **926** Units	**Net New Trips**	**105**	**355**	**460**	**355**	**200**	**555**

1169 Garner Road East: This development will consist of 68 Single Detached homes, and 81 apartment suits. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
68 Single Detached (LU Code 210)	Directional Distribution	25%	75%	100%	63%	37%	100%
	Average Rate	0.19	0.56	0.75	0.64	0.37	1.01
	Site Traffic based on Average	15	35	50	45	25	70
	Equation Rate	0.21	0.63	0.84	0.69	0.40	1.09
	Site Traffic based on Equation	15	40	55	45	30	75
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit	-5	-10	-15	-10	-5	-15

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
	Total Trips	10	30	40	35	25	60
81 Apartment Units (LU Code 220)	Directional Distribution	20%	80%	100%	65%	35%	100%
	Average Rate	0.10	0.41	0.51	0.40	0.22	0.62
	Site Traffic based on Average	10	30	40	35	15	50
	Equation Rate	0.11	0.43	0.54	0.50	0.27	0.77
	Site Traffic based on Equation	10	35	45	40	20	60
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	0	-5	-5	-10	-5	-15
	Total Trips	10	30	40	30	15	45
Total **149** Units	**Net New Trips**	**20**	**60**	**80**	**65**	**40**	**105**

751 Rymal Road West: This development will consist of 25 Town-homes. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
25 Townhouse Units (LU Code 230)	Directional Distribution	17%	83%	100%	67%	33%	100%
	Average Rate	0.07	0.37	0.44	0.35	0.17	0.52
	Site Traffic based on Average	0	10	10	10	5	15
	Equation Rate	0.12	0.56	0.68	0.52	0.25	0.77
	Site Traffic based on Equation	5	10	15	15	5	20
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	0	0	0	-5	0	-5
	Total Trips	5	10	15	10	5	15
Total **25** Units	**Net New Trips**	**5**	**10**	**15**	**10**	**5**	**15**

460 Rymal Road West: This development will consist of 114 Retirement Homes. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
114 Retirement Home Unit (LU Code 252)	Directional Distribution	36%	64%	100%	60%	40%	100%
	Average Rate	0.05	0.08	0.13	0.10	0.06	0.16
	Site Traffic based on Average	5	10	15	10	10	20
	Equation Rate	0.03	0.04	0.07	0.06	0.04	0.1
	Site Traffic based on Equation	5	5	10	5	5	10
	Transit and Other mode	20%	20%	20%	20%	20%	20%

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
	%age						
	Less Trips for Transit and Other	0	0	0	0	0	0
	Total Trips	5	5	10	5	5	10
Total **114** Units	**Net New Trips**	**5**	**5**	**10**	**5**	**5**	**10**

310 Rymal Road West: This development will consist of 413 Single Detached homes, and 174 Town-homes. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
413 Single Detached (LU Code 210)	Directional Distribution	25%	75%	100%	63%	37%	100%
	Average Rate	0.19	0.56	0.75	0.64	0.37	1.01
	Site Traffic based on Average	80	230	310	260	155	415
	Equation Rate	0.18	0.54	0.72	0.57	0.34	0.91
	Site Traffic based on Equation	75	220	295	235	140	375
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	-15	-45	-60	-45	-30	-75
	Total Trips	60	175	235	190	110	300
174 Townhouse Units(LU Code 230)	Directional Distribution	17%	83%	100%	67%	33%	100%
	Average Rate	0.07	0.37	0.44	0.35	0.17	0.52
	Site Traffic based on Average	15	60	75	60	30	90
	Equation Rate	0.08	0.38	0.46	0.36	0.18	0.54
	Site Traffic based on Equation	15	65	80	65	30	95
	Transit %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit	-5	-15	-20	-15	-5	-20
	Total Trips	10	50	60	50	25	75
Total **587** Units	**Net New Trips**	**70**	**225**	**295**	**240**	**135**	**375**

625 Garner Road East: This development will consist of 220 Single Detached homes, and 106 Town-homes. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
220 Single Detached (LU Code	Directional Distribution	25%	75%	100%	63%	37%	100%
	Average Rate	0.19	0.56	0.75	0.64	0.37	1.01
	Site Traffic based on Average	40	125	165	140	80	220

210)	Equation Rate	0.19	0.56	0.74	0.61	0.36	0.97
	Site Traffic based on Equation	40	125	165	135	80	215
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	-10	-25	-35	-25	-15	-40
	Total Trips	30	100	130	110	65	175
106 Townhouse Units(LU Code 230)	Directional Distribution	17%	83%	100%	67%	33%	100%
	Average Rate	0.07	0.37	0.44	0.35	0.17	0.52
	Site Traffic based on Average	10	35	45	35	20	55
	Equation Rate	0.09	0.42	0.51	0.40	0.19	0.59
	Site Traffic based on Equation	10	45	55	45	20	65
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	0	-10	-10	-10	-5	-15
	Total Trips	10	35	45	35	15	50
Total **326** Units	**Net New Trips**	**40**	**135**	**175**	**145**	**80**	**225**

713 and 777 Garner Road East: This development will consist of 100 Town-homes only. The following table summarizes the trip generation information:

# of Units	Horizon Year – 2031	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	2-way	In	Out	2-way
100 Townhouse Units (LU Code 230)	Directional Distribution	17%	83%	100%	67%	33%	100%
	Average Rate	0.07	0.37	0.44	0.35	0.17	0.52
	Site Traffic based on Average	10	35	45	35	15	50
	Equation Rate	0.09	0.43	0.52	0.40	0.20	0.6
	Site Traffic based on Equation	10	40	50	40	20	60
	Transit and Other mode %age	20%	20%	20%	20%	20%	20%
	Less Trips for Transit and Other	0	-10	-10	-10	-5	-15
	Total Trips	10	30	40	30	15	45
Total **100** Units	**Net New Trips**	**10**	**30**	**40**	**30**	**15**	**45**

4.2 SITE TRIP DISTRIBUTION

The site trip distribution was developed based on available information extracted from the AEGD Study Report under reference. The site traffic distribution is summarized in the following table:

Directions	Weekday AM Peak Hour		Weekday PM Peak Hour	
	IN	OUT	IN	OUT

West	50%	50%	50%	50%
East	25%	25%	25%	25%
Northeast/ Northwest	25%	25%	25%	25%
Total	100%	100%	100%	100%

4.3 SITE TRIP ASSIGNMENTS

Based on the assumptions as stated above and the site trip distribution the development trips were assigned onto Garner Road/ Rymal Road study area intersections. **Figure 5** in **'*Appendix A*'** illustrates the site traffic volumes from all the proposed developments to the north of Garner Road East/ Rymal Road West and also other cross streets including Garth Street.

4.4 FUTURE TOTAL TRAFFIC VOLUMES (2031)

The new site trips were added onto future background (2031) traffic volumes to estimate the future total traffic volumes along Garner Road/ Rymal Road. **Figure 6** in **'*Appendix A*'** illustrates the future total traffic volumes (i.e. Figure 4 + Figure 5) during the weekday AM and PM peak hours under the 2031 future total traffic conditions.

It would be worth noting that the AEGD Study included an ultimate build out scenario anticipating a significant increased freight and passenger of the AEGD lands (Stage 2). Since these developments are anticipated beyond the horizon year of 2031, this study does not include any additional Airport District bound traffic volumes from any beyond 2031 developments. It appears that with the ultimate build-out scenario of the AEGD District the traffic volumes will almost be doubled in the peak direction of flow.

5.0 TRAFFIC IMPACT ASSESSMENT

As discussed in the previous sections, the traffic assessment is based upon the 2008 traffic counts, corridor growth factors, future forecast traffic volumes from AEGD Study Report and anticipated additional site traffic volumes from the proposed developments to the north of Garner Road East/ Rymal Road West and also in the northeast quadrant of the Rymal Road West/ Garth Street intersection. As discussed earlier, the study area intersection consists of ten unsignalized public road intersections including major driveways, and seven signalized intersections. Evaluation of the performance measures of the signalized and unsignalized intersections are completed under the existing (2008) and future traffic conditions (2031). The following paragraphs discuss the traffic analysis results and identify traffic operation issues if any. Analysis of the study area intersections was undertaken using the procedure set out in the Highway Capacity Manual (HCM 2000) with the assistance of Synchro, Version 7 - Trafficware Traffic Signal Timing software package. The intersection operation is typically described based on the Level of Service (LOS) ratings that are expressed on a scale of "A" to "F", where "A" is considered excellent (i.e. very little delay) and "F" is considered unacceptable (i.e. very congested, very long delays), as outlined below.

LEVEL OF SERVICE	Signalized Intersection	Unsignalized Intersection
A	≤ 10 sec	≤ 10 sec
B	10-20 sec	10-15 sec
C	20-35 sec	15-25 sec
D	35-55 sec	25-35 sec
E	55-80 sec	35-50 sec
F	≥ 80 sec	≥ 50 sec

5.1 EXISTING TRAFFIC CONDITIONS (2008)

Existing signal timing plans were utilized to assess the performance measures of the existing signalized intersections within the study area. The review of existing traffic conditions reveals that all the study area intersections operate within their respective capacities during the weekday morning and afternoon peak hours, and the respective average delays are moderate to low and well within the acceptable limit. During the afternoon peak period, the signalized intersections within study area operate within their respective capacities although the average delay increases in comparison to that during the weekday morning peak hour. The following paragraphs discuss the performance level of individual movements at all the study area intersections. The summary results are enclosed in ***Appendix 'B'***.

Signalized Intersections:

Table 1 – Signalized Intersections – Existing Traffic Conditions[1, 2] (2008)

Intersection	Weekday AM Peak			Weekday PM Peak		
	v/c	Delay	LOS	v/c	Delay	LOS
Garner Road / Fiddler's Green Road	0.38	16.1	B	0.31	15.7	B

Intersection	Weekday AM Peak			Weekday PM Peak		
	v/c	Delay	LOS	v/c	Delay	LOS
Garner Road / Southcote Road	0.28	14.0	B	0.33	14.9	B
Garner Road / Glancaster Road	0.31	12.5	B	0.36	11.8	B
Garner Road/ Upper Paradise Road	0.46	18.0	B	0.64	21.8	C
Garner Road/ Garth Street	0.54	13.8	B	0.59	14.3	B
Garner Road/ West 5th Street	0.57	15.1	B	0.94	36.7	D
Garth Street/ Stone Church Road West	0.35	18.8	B	0.52	18.6	B

Note:
1. Existing turning movement volumes developed based on traffic data, signal timing, and phasing plan obtained from the City of Hamilton;
2. A peak hour factor of 0.92 was used for all movements at all intersection.

The critical movements (v/c>0.85) at the study area intersections are identified below:

Garner Road/ West 5th Street:

- The eastbound shared through-right and the southbound shared left-through-right operate with v/c ratios of approximately 0.91 and 0.97 during the weekday afternoon peak hour.

Excluding the above no other critical movements are noted during both the weekday AM and PM peak hours under the existing traffic conditions.

Unsignalized Intersections:

Table 2 – Unsignalized Intersections-Existing Traffic Conditions (2008)

Intersection/ Movement		Weekday AM Peak			Weekday PM Peak		
		V/C	Delay	LOS	V/C	Delay	LOS
Garner Road/ Highway 403 Off-Ramp	SBLR	0.26	21.9	C	0.32	18.6	C
Overall		-	1.5	A	-	2.0	A
Garner Road/ Highway 403 On-Ramp	EBL	0.06	8.7	A	0.05	8.7	A
Overall		-	0.5	A	-	0.4	A
Garner Road/ Kitty Murray Lane	NBLTR	0.06	19.7	C	0.06	20.1	C
	SBLTR	0.30	19.0	C	0.22	18.3	C
	EBLT	0.06	1.7	A	0.06	1.6	A
Overall		-	3.1	A	-	2.5	A
Garner Road/ Redeemer College Access	EBL	0.03	8.4	A	0.04	8.4	A
	SBL	0.03	17.0	B	0.08	18.9	B
	SBR	0.02	10.8	B	0.04	11.0	B

Intersection/ Movement		Weekday AM Peak			Weekday PM Peak		
		V/C	Delay	LOS	V/C	Delay	LOS
Overall		-	0.7	A	-	1.1	A
Garner Road/ Springbrook Road	EBLT	0.01	0.3	A	0.01	0.3	A
	SBLR	0.06	13.2	B	0.06	16.0	C
Overall			0.6	A	-	0.5	A
Garner Road/ Spadara Drive	NBLTR	0.07	20.4	C	0.06	19.6	C
	SBLTR	0.20	23.1	C	0.09	21.5	C
Overall		-	1.4	A	-	1.1	A
Garner Road/ Bishop Ryan Road	NBLT	0.05	17.8	C	0.11	26.9	D
	SBLTR	0.06	19.6	C	0.08	24.7	C
Overall		-	0.8	A	-	1.0	A
Garner Road/ Westlawn Drive	WBL	0.02	8.8	A	0.03	8.8	A
	NBLR	0.18	19.9	C	0.09	18.2	C
Overall		-	1.2	A	-	0.6	A
Garner Road/ Krieghoff Dr.	WBL	0.01	8.4	A	0.01	8.9	A
	NBL	0.06	12.7	B	0.04	18.6	C
Overall		-	0.5	A	-	0.3	A
Garth Street/ Claudette Gate	EBLTR	0.31	22.5	C	0.19	22.4	C
	WBLTR	0.05	16.2	C	0.05	17.4	C
Overall		-	2.6	A	-	1.5	A

Note:
1. Existing turning movement volumes developed based on traffic data obtained from the City of Hamilton;
2. A peak hour factor of 0.92 was used for all movements at all intersection.

The capacity analysis results of the unsignalized intersections do not indicate any traffic operation issues under the existing traffic conditions.

5.2 FUTURE TOTAL TRAFFIC CONDITIONS (2031)

The performance measure evaluation of the study area intersections were carried out based on the future traffic forecast for the 2031 horizon year. To identify any traffic operation issues under the future total traffic conditions 2031 the capacity analysis of the study area intersections was developed presuming varying alternatives, including "Do Nothing' and other relevant and applicable improvement.

5.2.1. Do Nothing

The initial assessment assumes "Do Nothing" alternative, which presumes the existing road network and existing signal plans will remain as they are under existing condition. The capacity analysis results of the signalized intersections and unsignalized intersections are summarized below. The summary output results are provided in ***Appendix 'B'***.

Signalized Intersections:

Table 3 – Signalized Intersections – Future Total Traffic Conditions[1, 2] (2031) – Do Nothing

Intersection	Weekday AM Peak			Weekday PM Peak		
	v/c	Delay	LOS	v/c	Delay	LOS

Intersection	Weekday AM Peak			Weekday PM Peak		
	v/c	Delay	LOS	v/c	Delay	LOS
Garner Road / Fiddler's Green Road	1.03	31.5	C	0.74	42.4	D
Garner Road / Southcote Road	2.00	168.3	F	3.79	237.7	F
Garner Road / Glancaster Road	0.96	24.2	C	1.60	71.2	E
Garner Road/ Upper Paradise Road	1.71	220.6	F	2.09	208.2	F
Garner Road/ Garth Street	2.10	193.5	F	1.85	264.5	F
Garner Road/ West 5th Street	1.04	58.2	E	1.50	210.6	F
Garth Street/ Stone Church Road West	0.83	31.8	C	1.47	93.8	F

Note:
1. Signal timing, and phasing plan obtained from the City of Hamilton;
2. A peak hour factor of 0.92 was used for all movements at all intersection.

The critical movements (v/c>0.85) at the study area signalized intersections are identified below:

Garner Road and Fiddler's Green Road:

- The eastbound left operates at 24% over capacity during the weekday AM peak hour and at 90% of the available capacity during the weekday PM peak hour;
- The westbound through operates at 90% of the available capacity during the weekday AM and 4% over the capacity during the weekday PM peak hour; and
- The eastbound through operates at 91% of the available capacity and westbound left operates at 93% of the available capacity during the weekday PM peak hour;

Garner Road and Southcote Road:

- The eastbound left operates much over capacity during both the weekday AM and PM peak hours;
- The westbound through becomes critical during the weekday PM peak hour;
- The northbound through and southbound left operate exceeding the available respective capacities during the weekday PM peak hour; and
- The southbound shared through-right movement operates well over the available capacity during both the weekday AM and weekday PM peak hours.

Garner Road and Glancaster Road:

- The westbound left operates over capacity during both the weekday AM and PM peak hours; and
- The westbound through operates at 93% of the available capacity during the weekday PM hour.

Rymal Road and Upper Paradise Road:

- The eastbound left exceeds the available capacity by approximately 200% during both the weekday AM and PM peak hours;
- The eastbound shared through-right operates approximately 35% over the available capacity during both the weekday AM and PM peak hours;
- The westbound shared through-right exceeds available capacity during both the weekday AM and PM peak hours; and
- The northbound left exceeds the available capacity during the weekday PM peak hour.

Rymal Road and Garth Street:

- All the movements become critical and excluding the westbound and northbound shared through-right movements all other movements exceed available respective capacities during the weekday AM peak our; and
- The eastbound left, westbound shared through-right, northbound left, northbound shared through-right and southbound left exceed respective capacities during the weekday PM peak hour.

Rymal Road and West 5th Street:

- The eastbound left movement operates, at 99% and 86% of the available capacity during the weekday AM and PM peak hour, respectively;
- The eastbound shared through-right, the westbound through and southbound shared left-through-right operate over their respective capacities, and the westbound left movement operates at 95% of the available capacity during the weekday morning peak hour; and
- The eastbound shared through-right exceeds available capacity and the westbound through operates at 90% of the available capacity during the weekday PM peak hour.

Stone Church Road and Garth Street:

- The northbound left, northbound shared through-right and the southbound left movement exceed their respective capacities, and the eastbound left and the southbound shared through-right movements become critical during the weekday AM hour; and
- The northbound left remains capacity constrained and the southbound shared through-right operates at 97% of the available capacity during the weekday PM peak hour.

Unsignalized Intersections:

Signalized intersection capacity analysis results under future total traffic condition (2031) clearly demonstrate that all the study area signalized intersections will operate over their respective capacities with 'Do Nothing' alternative; and therefore, only two major unsignalized intersections were analyzed to demonstrate the traffic operation constraint with 'Do Nothing' alternative. The summary results of the two major unsignalized intersections indicate that mitigation measures will be required to address the traffic operation conditions under 2031 future total traffic conditions.

Table 4 – Unsignalized Intersections-Future Traffic Conditions (2031) – Do Nothing

Intersection/ Movement		Weekday AM Peak			Weekday PM Peak		
		V/C	Delay	LOS	V/C	Delay	LOS
Garner Road/ Highway 403 Off-Ramp	SBLR	6.13	Err	F	17.05	Err	F
Overall		-	887.0	F	-	1401.9	F
Garner Road/ Kitty Murray Lane	NBLTR	236.96	Err	F	Err	Err	F
	SBLTR	9.26	Err	F	Err	Err	F

Intersection/ Movement	Weekday AM Peak			Weekday PM Peak		
	V/C	Delay	LOS	V/C	Delay	LOS
Overall	-	1289.9	F	-	Err	F

5.2.2. 4 Lanning Garner Road/ Rymal Road

The "4 Lanning" alternative presumes widening of the Garner Road/ Rymal Road corridor to a 4-lane cross section, with some optimization of cycle timing and other attributes of the existing road network will remain as they are under existing condition. The capacity analysis results of the signalized intersections and unsignalized intersections are summarized below. The summary output results are provided in ***Appendix 'B'***.

Signalized Intersections:

Table 5 – Signalized Intersections – Future Total Traffic Conditions[1, 2] (2031) – 4-Lane Section

Intersection	Weekday AM Peak			Weekday PM Peak		
	v/c	Delay	LOS	v/c	Delay	LOS
Garner Road / Fiddler's Green Road	0.95	23.2	C	0.75	17.8	B
Garner Road / Southcote Road	2.05	160.4	F	2.11	155.4	F
Garner Road / Glancaster Road	0.58	16.1	B	0.98	20.6	C
Garner Road/ Upper Paradise Road	0.86	21.9	C	1.74	73.1	E
Garner Road/ Garth Street	1.37	87.0	F	2.17	125.0	F
Garner Road/ West 5th Street	0.71	15.3	B	1.11	65.0	E
Garth Street/ Stone Church Road West	0.84	17.8	B	1.39	48.3	D

Note:
1. 4-Lane of Garner Road/ Rymal Road and optimized signal timing;
2. A peak hour factor of 0.92 was used for all movements at all intersection.

The capacity analysis results as summarized above indicate that some of the study area signalized intersections will still remain over the respective capacities with the presumed 4-lanning of the study area corridor. The average delays will be reduced in comparison to that with the "Do Nothing" alternative, although most of the intersections will still operate beyond the acceptable levels. The critical movements (v/c>0.85) at the study area intersections are identified below:

Garner Road and Fiddler's Green Road:

- The westbound shared through-right and the southbound left will remain critical during the weekday AM peak hour; otherwise all the movements will operate well within their respective capacities under both the weekday AM and PM peak hours.

Garner Road and Southcote Road:

- The eastbound left still operates much over capacity during both the weekday AM and PM peak hours;
- The westbound through exceeds respective capacity during the weekday PM peak hour;
- The northbound through and southbound left still operate exceeding the available respective capacities during the weekday PM peak hour; and
- The southbound shared through-right movement still remains well over the available capacity during both the weekday AM and weekday PM peak hours.

Garner Road and Glancaster Road:

- The westbound left operates at capacity and the northbound left becomes critical during the weekday PM peak hour, and all other movements well within their respective capacities during both the weekday peak hours.

Rymal Road and Upper Paradise Road:

- The eastbound remains over the available capacity by approximately 200% during the weekday PM peak hour;
- The southbound left becomes critical during the weekday AM and PM peak hours; and
- The northbound left exceeds the available capacity during the weekday PM peak hour.

Rymal Road and Garth Street:

- The, westbound left, northbound left and the southbound though exceed respective capacities and the eastbound left becomes critical during the weekday AM peak our; and
- The eastbound left, westbound shared through-right, northbound shared through-right and southbound left exceed respective capacities during the weekday PM peak hour.

Rymal Road and West 5th Street:

- The eastbound shared through-right, and southbound shared left-through-right operate over their respective capacities, and the eastbound left, westbound left and the westbound through movements operates at critical levels during the weekday PM peak hour; and

Stone Church Road and Garth Street:

- The eastbound left becomes critical during the weekday AM hour; and
- The eastbound left, northbound left, northbound shared through right and southbound left remain capacity constrained during the weekday PM peak hour.

Unsignalized Intersections:

The traffic operation at the two major unsignalized intersections improves with 4-lanning of Garner Road/ Rymal Road with respect to that with "Do Nothing" alternative, although the controlled movements still remain capacity constrained. The performance measures of the controlled movements clearly indicate requirements of further improvements. The intersection capacity analysis results are summarized below:

Table 6 – Unsignalized Intersections-Future Traffic Conditions (2031) – 4-Lane Section

Intersection/ Movement		Weekday AM Peak			Weekday PM Peak		
		V/C	Delay	LOS	V/C	Delay	LOS
Garner Road/ Highway 403 Off-Ramp	SBLR	1.03	112.8	F	2.23	606.7	F
Overall		-	10.0	B	-	85.1	F

Garner Road/ Kitty Murray Lane	NBLTR	1.62	874.4	F	12.57	Err	F
	SBLTR	1.16	141.3	F	1.65	362.4	F
Overall		-	25.8	C	-	170.6	F

5.2.3. 4/5-Lanning of Garner Road/ Rymal Road

The "4/5 Lanning" alternative presumes a cross-section consisting of a 4-lane Garner Road/ Rymal Road corridor including a central 'two-way-left-turn-lane' (TWLTL) at the study corridor. This alternative also considers optimization of signal plans, sub-phasing, cycle timings, and implementation of any intersection improvements including installation of new signals at warranted intersections. The capacity analysis results of the signalized intersections and unsignalized intersections are summarized below. The summary output results are provided in ***Appendix 'B'***.

Signalized Intersections:

Table 7 – Signalized Intersections – Future Total Traffic Conditions[1, 2] (2031) – 5-Lane Section

Intersection	Weekday AM Peak			Weekday PM Peak		
	v/c	Delay	LOS	v/c	Delay	LOS
Garner Road / Fiddler's Green Road[4]	0.76	27.7	C	0.66	17.4	B
Garner Road / Southcote Road[5]	0.77	24.7	C	0.95	50.8	D
Garner Road / Glancaster Road	0.61	13.1	B	0.73	22.9	C
Garner Road/ Upper Paradise Road[7]	0.64	15.1	B	0.89	45.7	D
Garner Road/ Garth Street[7]	0.78	20.8	C	0.77	32.8	C
Garner Road/ West 5th Street[8]	0.56	12.8	B	0.78	24.9	C
Garth Street/ Stone Church Road W[9]	0.65	18.2	B	0.88	35.3	D
Garner Road / Hwy 403 Off-ramp[3]	0.58	11.1	B	0.70	15.9	B
Garner Road / Kitty Murray Lane[6]	0.74	12.7	B	0.62	22.0	C

Note:

1. 5-Lane of Garner Road/ Rymal Road and optimized signal timing, phasing and sub-phasing;
2. A peak hour factor of 0.92 was used for all movements at all intersection;
3. Add one southbound right turn lane and signalize the intersection;
4. Add an exclusive westbound right turn lane;
5. Add an exclusive westbound right turn lane, one through lane and exclusive right turn lane both for the northbound and southbound directions;
6. Add exclusive left turn lanes for the eastbound, westbound, northbound and southbound directions; add an exclusive southbound right turn lane and install new signals at the intersection;
7. Add exclusive right turn lanes to all the 4 approaches and widen Garth Street as a 5-lane section;
8. Add exclusive right turn lane for the eastbound, northbound and southbound approaches and exclusive left turn lane for the northbound and southbound approaches; and

9. Add exclusive right turn lane for the eastbound, northbound and southbound approaches, and widen Garth Street as a 5-lane section.

Two of the existing unsignalized intersections i.e. Garner Road/ Hwy 403 Off-ramp and Garner Road/ Kitty Murray Lane became warranted for installation of signals to accommodate the future total traffic under 2031 traffic conditions. Signal warrant analyses based on MTO future intersection warrant guidelines for the two intersections are enclosed in '***Appendix C***'.

The capacity analyses as summarized above indicates with the presumed 5-lanning of the study area corridor all the study area signalized intersections will operate within their respective capacities. The average delays will further be reduced in comparison to that with the "4-lanning" alternative. The critical movements (v/c>0.85) at all the study area intersections are identified below:

Garner Road and Fiddler's Green Road:

- The southbound left will remain critical during the weekday AM peak hour. No other critical movements noted during either of the peak hours;

Garner Road and Southcote Road:

- The eastbound left still operates at capacity, the northbound through, the southbound left nominally exceed their respective capacities, and the westbound through operates at 98% of the available capacity during the weekday PM peak hours. No other critical movements are noted during either of the peak hours[2];

Rymal Road and Upper Paradise Road:

- The eastbound left, the westbound through, the northbound through and the southbound left remain critical during the weekday PM peak hour. No other movements are identified as critical during either of the peak hours;

Rymal Road and Garth Street:

- The, northbound though becomes critical during the weekday PM peak our, and no other movements are identified as critical during either of the peak hours;

Rymal Road and West 5th Street:

- The southbound left operates at critical levels during the weekday PM peak hour; and

Stone Church Road and Garth Street:

- The eastbound left and the northbound through become critical during the weekday PM hour.

It is worth noting that with the recommended improvements, all movements at all the study area intersections, excluding the southbound left movement at the Fiddler's Green/ Garner Road East intersection, will operate even below critical level during the weekday AM peak hour. The weekday PM peak hour will be busier; however, all the study area intersections operate at acceptable levels.

Unsignalized Intersections:

The unsignalized intersection capacity analysis results are summarized below:

Table 8 – Unsignalized Intersections-Future Traffic Conditions (2031) – 5-Lane Section

Intersection/ Movement		Weekday AM Peak			Weekday PM Peak		
		V/C	Delay	LOS	V/C	Delay	LOS
Garner Road/	EBL	0.23	16.1	C	0.09	14.7	B

[2] With a signal cycle of 145 seconds the capacity constrained movements will operate within their respective capacities, remaining critical during the afternoon peak hour under the 2031 future total traffic conditions.

Intersection/ Movement		Weekday AM Peak			Weekday PM Peak		
		V/C	Delay	LOS	V/C	Delay	LOS
Highway 403 On-Ramp							
Overall		-	0.5	A	-	0.2	A
Garner Road/ Redeemer College Access	EBL	0.12	12.0	B	0.17	13.9	B
	SBL	0.07	21.2	C	0.17	27.8	D
	SBR	0.04	13.1	B	0.20	16.3	C
Overall		-	0.6	A	-	1.2	A
Garner Road/ Springbrook Road	EBLT	0.02	11.8	B	0.04	13.6	B
	SBL	0.08	17.1	C	0.33	27.7	D
Overall			0.4	A	-	1.1	A
Garner Road/ Irwin Road[1]	EBL	0.06	10.6	B	0.26	14.4	B
	SBL	0.32	16.0	C	0.24	18.7	C
Overall	-		1.6	A	-	1.5	A
Garner Road/ Raymond Road[1]	EBL	0.08	10.0	A	0.39	16.3	C
	SBL	0.27	20.9	C	0.28	36.8	E
	SBR	0.29	13.6	B	0.23	15.7	C
Overall	-	-	2.1	A	-	2.5	A
Garner Road/ Spadara Drive	EBL	0.02	12.9	B	0.01	14.7	B
	WBL	0.01	11.2	B	0.01	9.8	A
	NBLTR	0.07	22.0	C	0.08	16.1	C
	SBLTR	0.19	20.7	C	0.25	27.6	D
Overall		-	0.7	A	-	1.0	A
Garner Road/ Bishop Ryan Road	EBL	0.05	10.2	B	0.18	12.5	B
	WBL	0.01	10.6	B	0.05	11.2	B
	NBLT	0.09	17.9	C	0.20	29.5	D
	SBLTR	0.38	20.1	C	0.45	32.6	D
Overall		-	1.8	A	-	2.4	A
Garner Road/ Westlawn Drive	WBL	0.05	11.4	B	0.09	11.9	B
	NBLR	0.37	25.0	D	0.15	16.6	C
Overall		-	1.4	A	-	0.6	A
Garner Road/ Krieghoff Dr.	WBL	0.01	10.9	B	0.04	11.5	B
	NBL	0.13	14.3	B	0.09	14.7	B
Overall		-	0.5	A	-	0.3	A
Garth Street/ Claudette Gate	EBL	0.67	62.6	F	0.43	54.2	F
	EBTR	0.06	15.8	C	0.07	30.6	D
	WBLTR	0.25	13.4	B	0.27	19.2	C
	NBL	0.01	12.0	B	0.01	9.9	A
	SBL	0.05	9.4	A	0.26	14.5	B
Overall		-	4.4	A	-	3.0	A

Note:
1. Future public road intersections as planned by the City of Hamilton.

It becomes evident that with the proposed 5-lane cross section all the controlled movements at all the unsignalized study area intersections operate well within their respective capacities. The average controlled delay will be nominal to moderate levels excluding the eastbound left movement at the Claudette Gate and Garth Street intersection; although an average delay in a range of 1 minute to 1.5 minute for a controlled movement at an unsignalized intersection will still be within acceptable level.

Garner Road/ Rymal Road and Garth Street Corridor:

Evaluation of the Garner Road/ Rymal Road corridor between Fiddler's Green Road and West 5th Street/ Christie Street, and the Garth Street Corridor between Rymal Road West and Stone Church Road was carried out utilizing the 'Arterial Level of Service' function of Synchro 7. The analyses results are summarized in the table below and the results of the arterial levels of service summary sheets are enclosed in the ***Appendix 'D'***.

Table 9 – Arterial Level of Service-Future Traffic Conditions (2031) 5-Lane Section

Cross Roads	4/5 – Lane Garner Road/ Rymal Road							
	2031 (Eastbound)				2031 (Westbound)			
	[AM]		[PM]		[AM]		[PM]	
	Arterial Speed (km/hr)	LOS	Arterial Speed (km/hr)	LOS	Arterial Speed (km/hr)	LOS	Arterial Speed (km/hr)	LOS
Fiddler's Green – Highway 403 Off-ramp	52.9	B	50.0	B	46.5	B	51.2	B
Highway 403 Off-ramp – Southcote Road	48.0	B	38.5	C	50.6	B	47.1	B
Southcote Road – Kitty Murray Lane	40.4	C	38.3	C	27.1	E	16.5	F
Kitty Murray Lane – Glancaster Road	55.7	B	48.3	B	55.8	B	47.7	B
Glancaster Road – Upper Paradise Road	43.2	C	35.2	C	47.1	B	43.3	C
Upper Paradise Road – Garth Street	45.5	B	40.0	C	50.1	B	29.2	D
Garth Street – West 5th Street	52.4	B	46.8	B	49.9	B	40.0	C
Cross Roads	**4/5 – Lane Garth Street**							
	2031 (Northbound)				**2031 (Southbound)**			
Rymal Road – Stone Church Road	40.8	B	31.7	C	36.8	C	36.9	C

Note:
1. Free Flow Speed along the Garner Road and the Garth Street study corridor is considered as 60 km/h.

A SimTraffic simulation was carried out for both the weekday AM and PM peak hours under the 2031 future total traffic conditions. The SimTraffic results were generated based on a 5-run – a seeding time of 15 minutes followed by a simulation period of 1 hour for both the weekday peak hour scenarios. The output results of the Synchro 7.0 and SimTraffic evaluation of the Garner Road/ Rymal Road corridor between Fiddler's Green Road and West 5th Street/ Christie were tallied at random, and the results found comparable. The output results of the SimTraffic analysis were enclosed in '***Appendix 'D''***.

6.0 CONCLUSIONS AND RECOMMENDATIONS

A detailed traffic assessment of the corridor volumes was carried out for the Garner Road/ Rymal Road corridor within Fiddler's Green Road and West 5th/ Christie Street, and the Garth Street corridor within Rymal Road West and Stone Church Road. The study findings are summarized below:

- The study evaluates the performance measures of the study area intersections and corridor during the weekday peak hours under existing (2008) and future (2031) traffic conditions;
- The existing study area corridor is a basic 2-lane road with some special intersection treatments at the major study area intersections;
- The study area corridor and the study area intersections operate well during the weekday peak hours under the existing traffic conditions;
- The Garner Road/ Rymal Road corridor has been proposed to be a potential truck route, which will facilitate movement of heavier/ wider loads. Garth Street has also been considered as a truck
- route subject to the urbanization of the Garth Street corridor. In addition to a truck route the study area corridor has been proposed as a designated bike route. The study area corridor is also proposed to accommodate future 'S' line, a LRT corridor along Garner Road/ Rymal Road;
- Based on the Airport Employment Growth District (AEGD) Study findings, a substantial corridor growth is expected simultaneous to the expansion of AEGD area. With the anticipated corridor growth and the AEGD land-use developments, the future background traffic volumes under 2031 traffic conditions along the Garner Road/ Rymal Road corridor and Garth Street corridor will be approximately doubled with respect to the existing traffic volumes under 2008 traffic conditions;
- The City has been proceeding with approvals of the several land-use developments to the north of the Garner Road/ Rymal Road study area corridor, and also in the northeast quadrant of the Garth Street/ Rymal Road intersection. With all these development site traffic volumes the 2031 corridor volumes along the study area corridors will further be increased by approximately 20% over the future background traffic volumes;
- An assessment of the study area intersections clearly indicates that the existing cross-section/ existing study area intersections will not be able to accommodate the traffic volumes under 2031 traffic conditions, and warrant several improvements including widening of the study area corridor;
- Major study area intersections will require improved intersection configurations, including addition of signal plan adjustments through introduction of new sub-phases etc. and also optimizing of signal timings. Installation of roundabout at any of the study area intersections were never considered due to the proposed heavy truck route along the Garner Road/ Rymal Road corridor;
- With all the recommended improvements the study area corridor operates at acceptable level of service (LOS) varying from LOS 'B' to LOS 'D', excluding the westbound flow on Garner Road between Kitty Murray Lane and Southcote Road. The subject section is expected to have higher density due to higher control delay at the Southcote Road/ Garner Road East intersection;
- All the major study area intersections will operate at acceptable levels of service varying from LOS 'B' to LOS 'D'; and
- The study area corridors including the study area intersections will operate well with the recommended road area improvements.

The study recommends a number of improvements to the study area corridor and the study area intersections to accommodate the forecast 2031 traffic volumes. The study recommendations are summarized below:

- Provide generally a 4/5-lane cross section of the Garner Road/ Rymal Road corridor within the study area limits i.e. from Fiddler's Green Road to beyond West 5th Street/ Christie Street including providing additional auxiliary lanes at identified intersections and two-way-left-turn-lane (TWLTL) at the major unsignalized intersection areas. Restrict future full moves accesses to avoid generation of additional conflict points to enhance road safety situation;
- Install traffic signals at the Highway 403 ramp terminal intersection on Garner Road and the Kitty Murray Lane and Garner Road intersection;
- Provide an exclusive westbound right turn lane with a minimum 30m storage length at the Fiddler's Green Road/ Garner Road intersection. Optimize signal timing;
- Provide an exclusive southbound right turn lane with a minimum storage length of 30m, and convert the existing shared left-right lane to an exclusive southbound left turn lane at the Highway 403 Off-ramp terminal;
- Provide an exclusive right turn lane at all the approaches at the Southcote/ Garner Road East intersection. Provide 20m and 150m storage lengths for the eastbound and westbound right turn lanes, respectively. Provide 40m and 100m storage lengths for the northbound and southbound right turn lanes, respectively. Extend the northbound and southbound left turn lanes and provide a minimum of 40m and 175m storage lengths, respectively. Widen the northbound and southbound approaches to a 4-lane section along Southcote Road. Optimize signal plans with added sub-phasing;
- Provide exclusive left turn lanes at all the approaches at the Kitty Murray Lane/ Garner Road intersection. In addition to that provide a westbound right and a southbound right turn lane at the subject intersection. The storage length of the eastbound left will be minimum 90m, and that should be 50m for the westbound left. The storage lengths for the northbound and southbound left turn lanes will be 20m and 25m, respectively. The storage length for each of the eastbound and the southbound right turn lanes should be minimum 50m;
- Provide an exclusive right turn lane at all the approaches with a minimum 50m storage length at the Upper Paradise/ Rymal Road West intersection. Optimize signal plans with added sub-phasing;
- Provide an exclusive right turn lane at all the approaches with a minimum 50m storage length for the eastbound, westbound and northbound approaches and 30m storage length for the southbound approach at the Garth Street/ Rymal Road West intersection. Optimize signal plans with added sub-phasing;
- Provide an exclusive right turn lane at the eastbound and westbound approaches with a minimum 30m and 40m storage lengths, respectively at the West 5th Street/ Rymal Road West intersection. Optimize signal plans with added sub-phasing;
- Provide an exclusive right turn lane at the northbound with a 30m storage length, southbound and westbound approaches with a minimum 50m storage length at the Stone Church Road/ Garth Street intersection. Optimize signal plans with added sub-phasing.

The study area unsignalized intersections were also recommended to be provided with necessary auxiliary lanes on the main approaches, as well as on the cross streets/ major accesses. **Figure 7** enclosed in '***Appendix 'A'***" illustrates the recommended improvements at all the study area intersections including the existing, future signalized intersections and major unsignalized intersections.

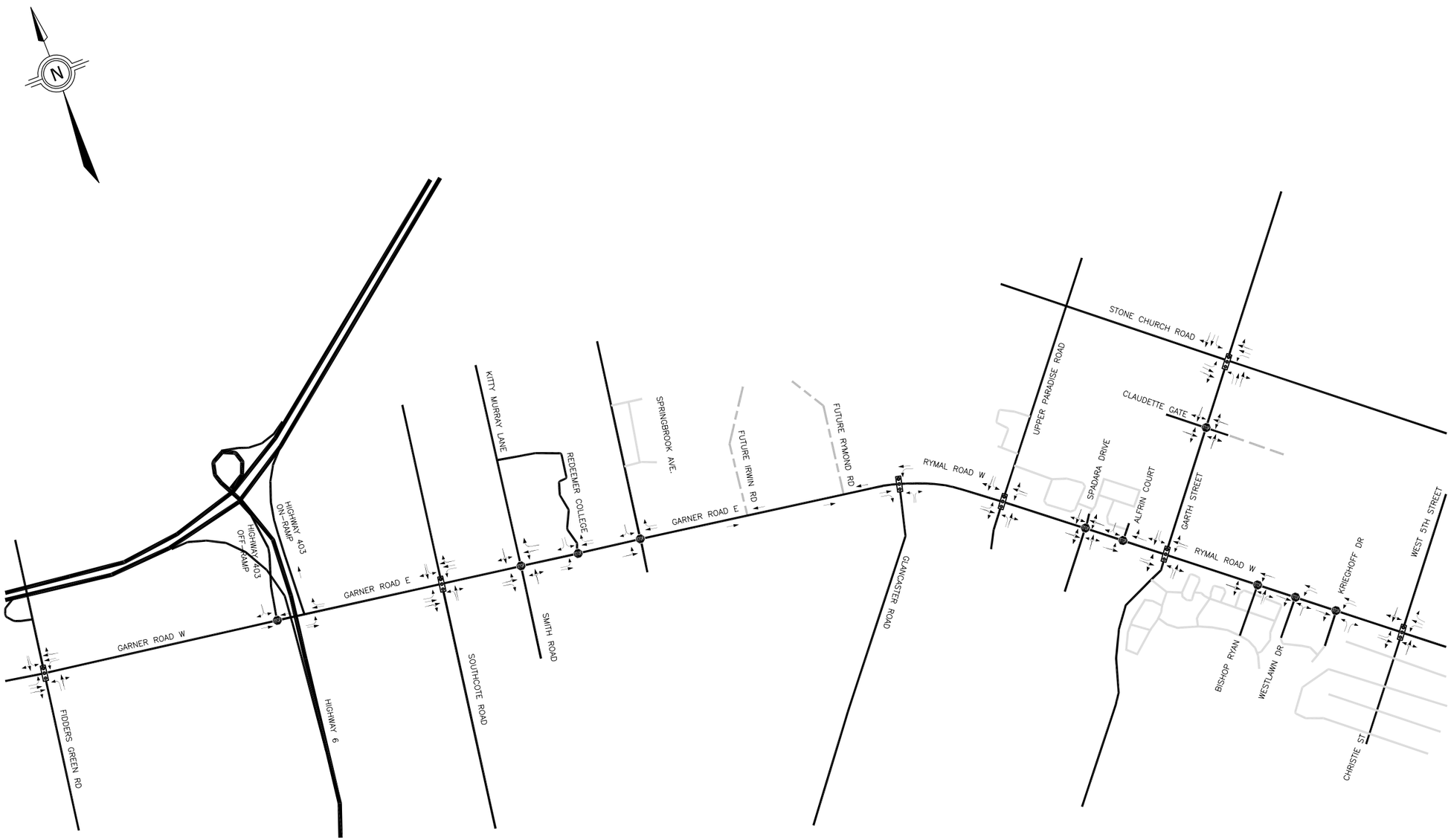
Based on the above, it is concluded that widening Garner Road East/ Rymal Road West throughout the study area from a 2-lane section to a 4/5-lane section including installation of required intersection improvements. An approximate right-of-way width of 36m is estimated to be necessary to accommodate the recommended improvements; however some adjustments could be made at constrained locations, to avoid major impacts on the corridor. Similar widening will also be warranted along Garth Street between

Rymal Road West and Stone Church Road, provided Garth Street is extended south beyond its current south terminus on Twenty Road West. The widened cross section of Garner Road/ Rymal Road and Garth Street will be necessary to accommodate the AEGD development and all the proposed area developments within the horizon year of 2031.

The timing or phasing plan of installation of the recommended road and intersection improvements will directly be dependent on the proposed land area developments around the study area. The traffic volume forecast for this traffic study was developed based on the approved AEGD Study Report and also the proposed land-use developments to the north of Garner Road East/ Rymal Road West. The recommended improvements were identified to accommodate all this increased traffic volumes of the proposed land-use developments around Garner Road East and Garth Street corridor within the study limits. The study area corridor should be monitored closely simultaneous to the full build out of the proposed land area developments to the north and south of the study area. The corridor will require widening as the through volumes (i.e. eastbound/ westbound on Garner Road and northbound/ southbound on Garth Street) exceed approximately 800 vehicles per hour per lane during the weekday peak hours. The recommended improvements to the study area intersection will simultaneously be necessary including the signalization of the Hwy 403 Off Ramp/ Garner Road and Kitty Murray Lane/ Garner Road intersections based on the unfolding of the development scenario.

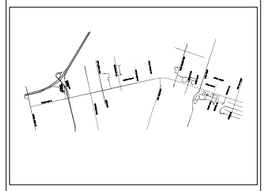
APPENDIX 'A'

FIGURES



General Notes

KEY PLAN:



LEGEND:

EXISTING TRAFFIC SIGNAL

TRAFFIC FLOW DIRECTION

000 AM PEAK HOUR

(000) PM PEAK HOUR

STOP SIGN

No.	Revision/Issue	Date

SNC·LAVALIN

FIGURE - 1

Project Name & Title

EXISTING INTERSECTION
CONFIGURATION
GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
Scale	N.T.S
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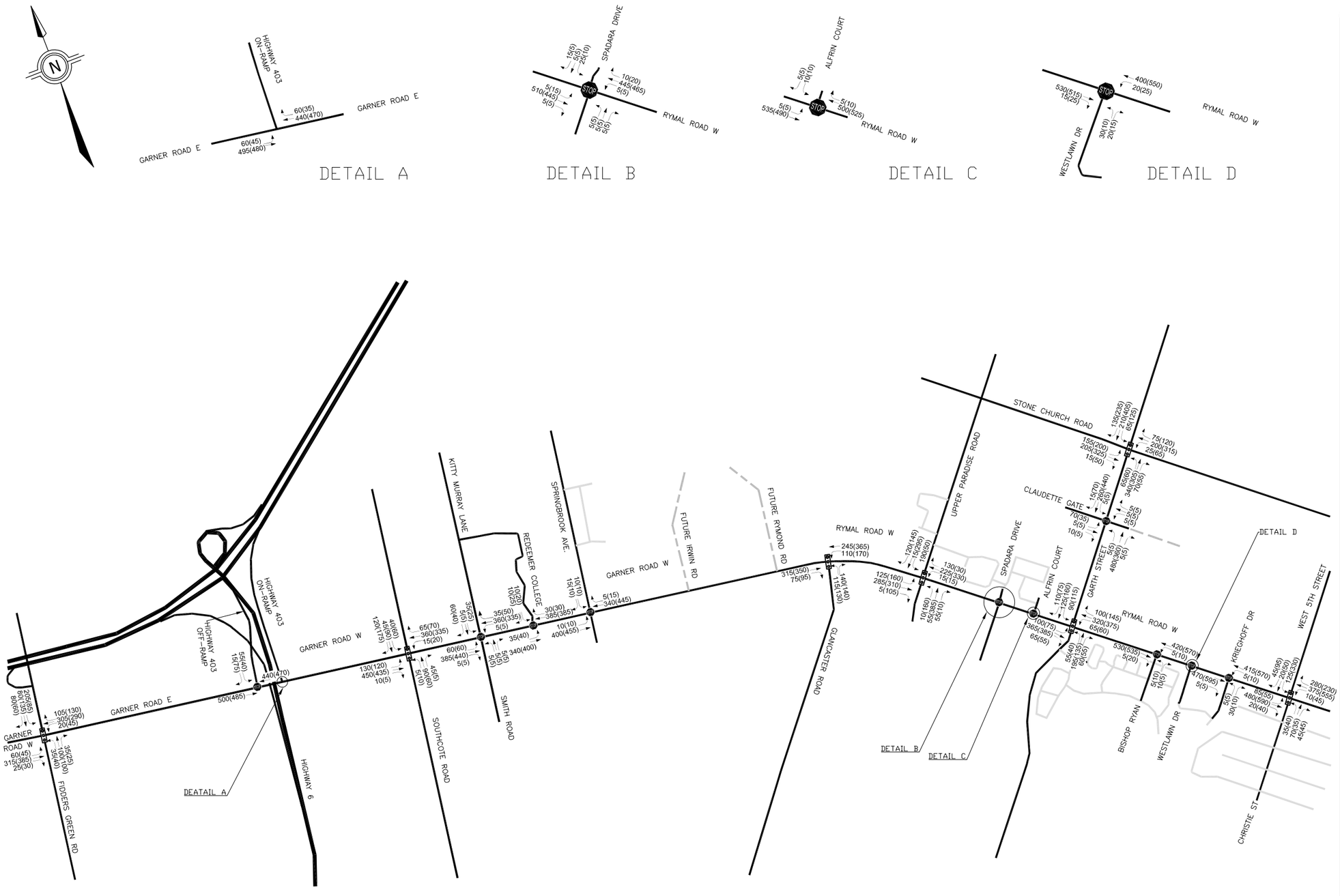

General Notes

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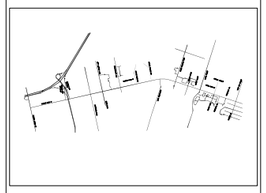

LEGEND:

EXISTING TRAFFIC SIGNAL

TRAFFIC FLOW DIRECTION

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STOP STOP SIGN

No.	Revision/Issue	Date

SNC·LAVALIN

FIGURE - 2

Project Name & Title

EXISTING TRAFFIC VOLUMES (2008)
GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
Scale	N.T.S
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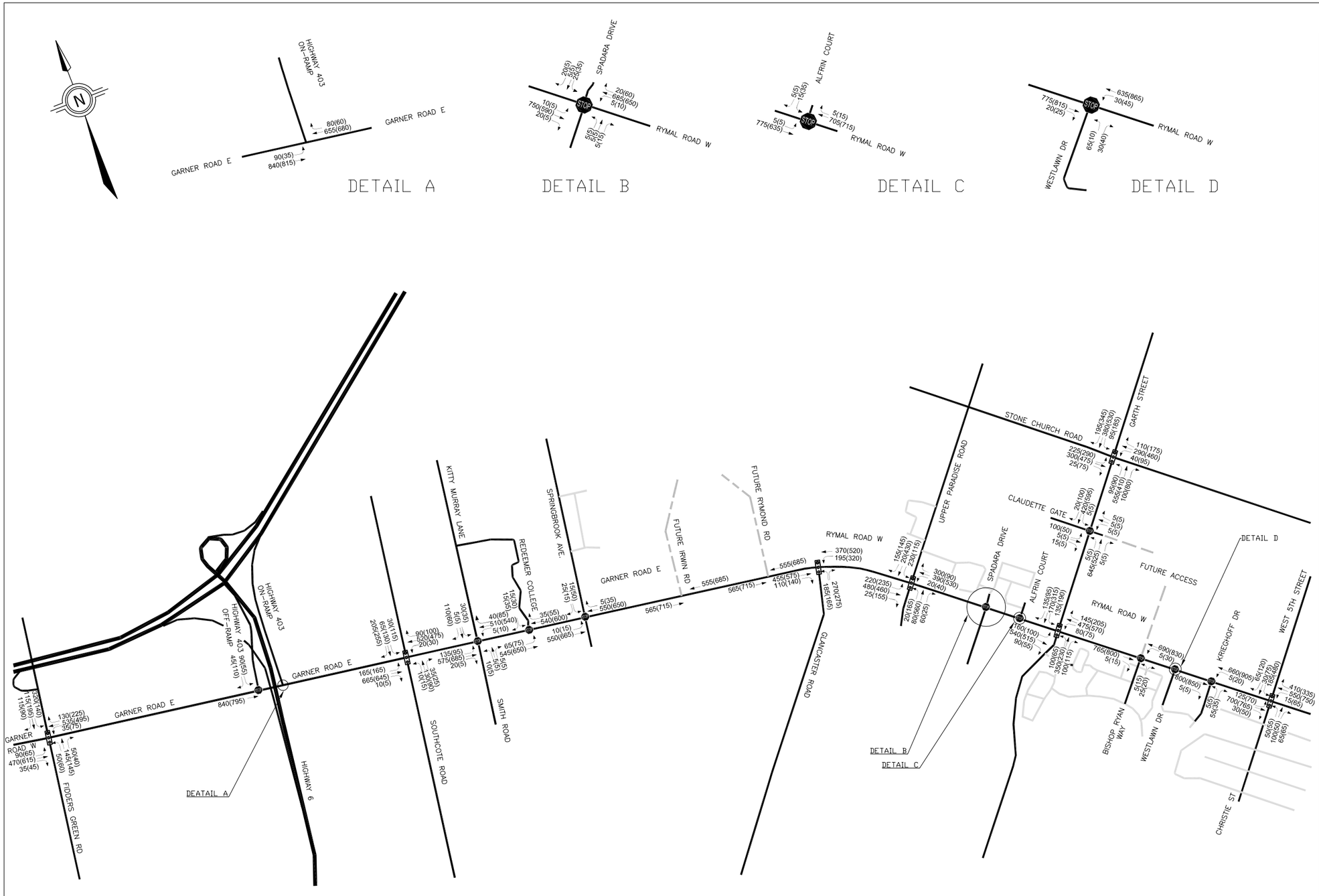

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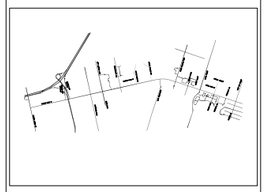

LEGEND:

EXISTING TRAFFIC SIGNAL

TRAFFIC FLOW DIRECTION

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STOP STOP SIGN

No.	Revision/Issue	Date

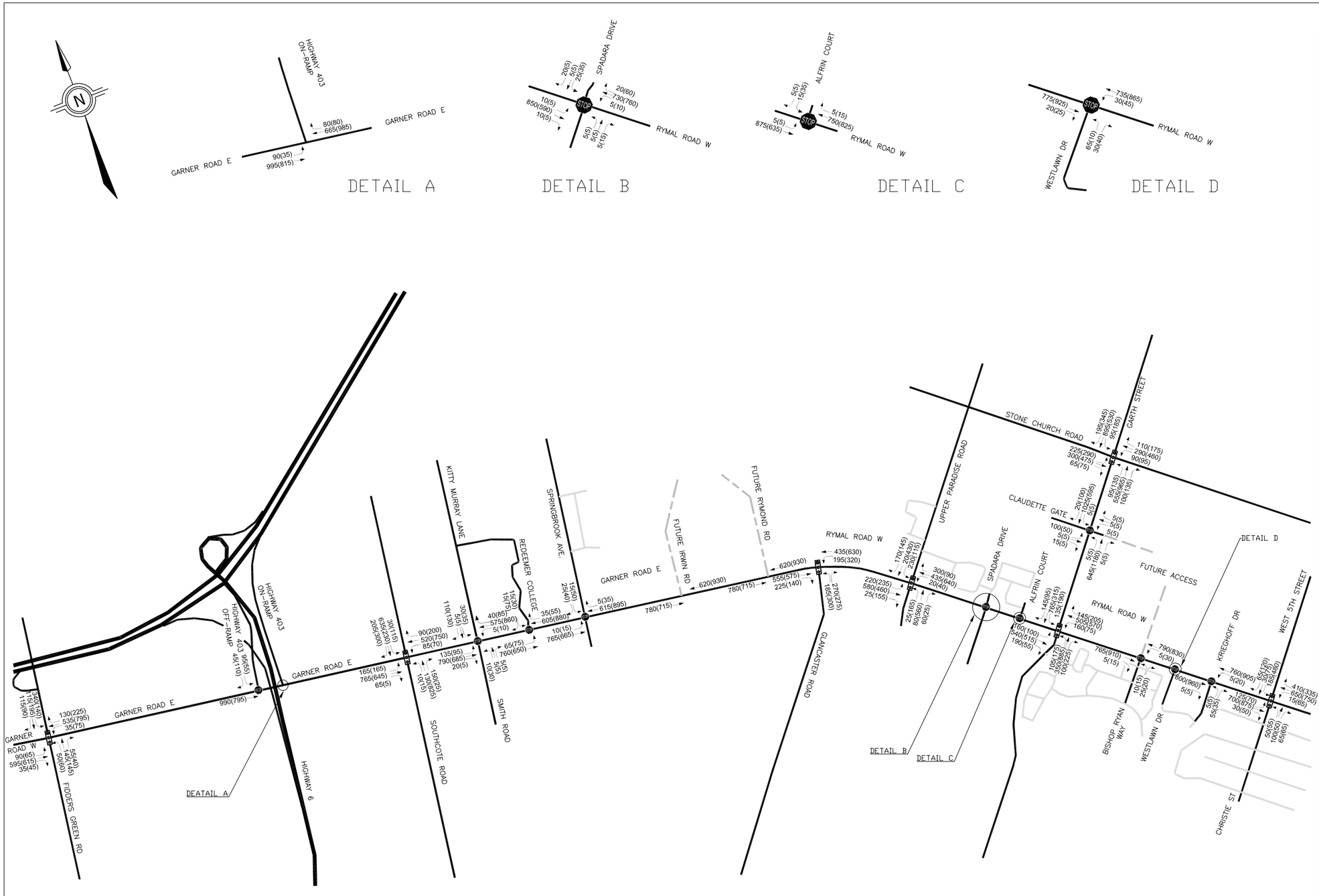
SNC·LAVALIN

FIGURE - 3

Project Name & Title

FUTURE BACKGROUND VOLUMES 2031 (CORRIDOR GROWTH ONLY)
GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
Scale	N.T.S
Dwg. File	v:\jusr\garner\garner3_fb.dwg



General Notes

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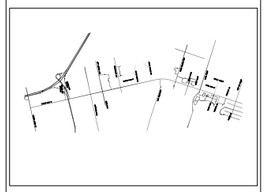

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EXISTING TRAFFIC SIGNAL

TRAFFIC FLOW DIRECTION

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STOP STOP SIGN

No.	Revision/Issue	Date

SNC·LAVALIN

FIGURE - 4

Project Name & Title

FUTURE BACKGROUND VOLUMES 2031 (INCLUDING BACKGROUND DEVELOPMENTS)
GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
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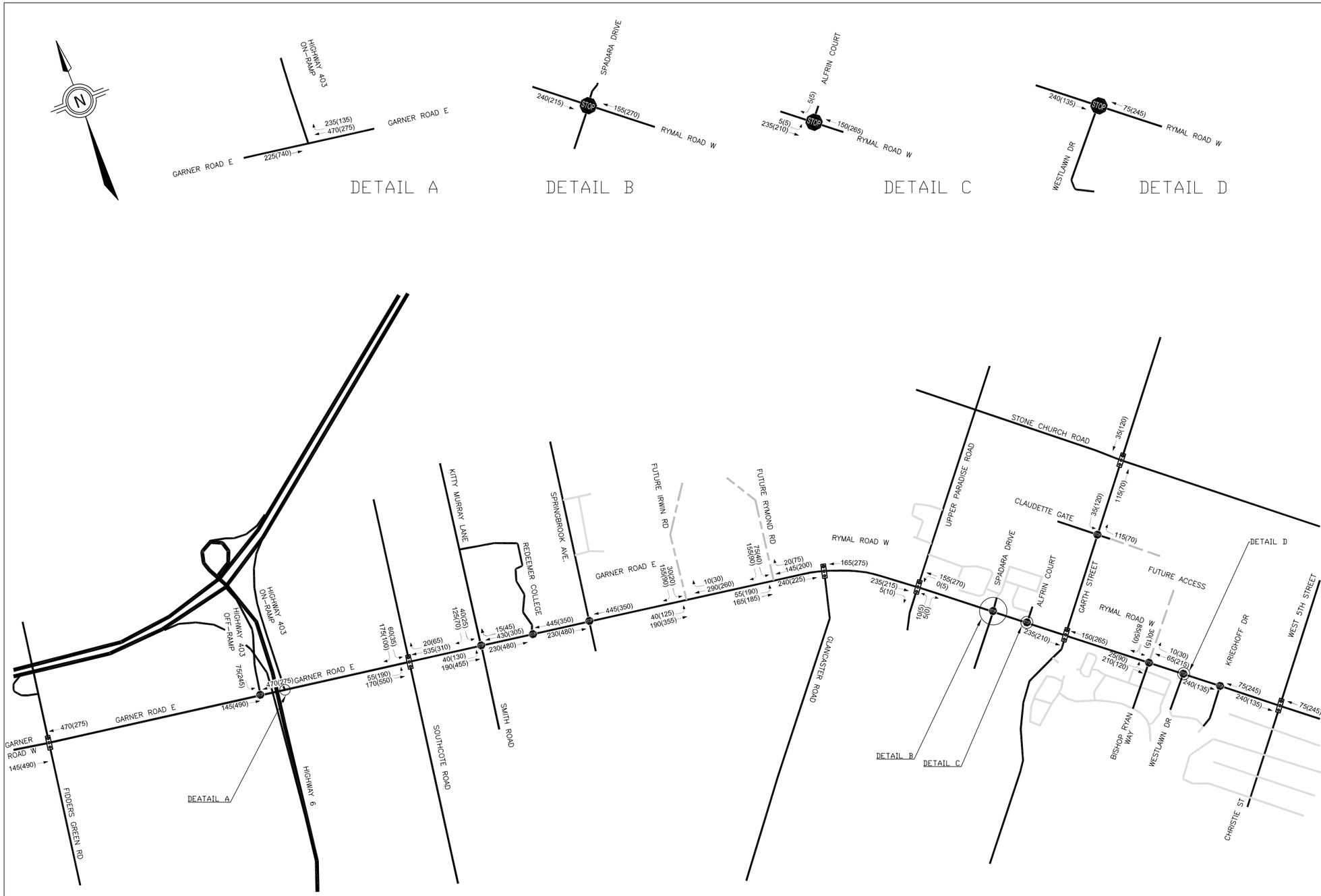

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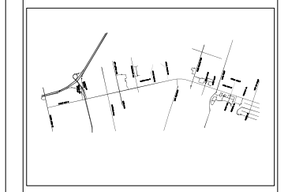

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- TRAFFIC FLOW DIRECTION
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- (000) PM PEAK HOUR
- STOP STOP SIGN

No.	Revision/Issue	Date

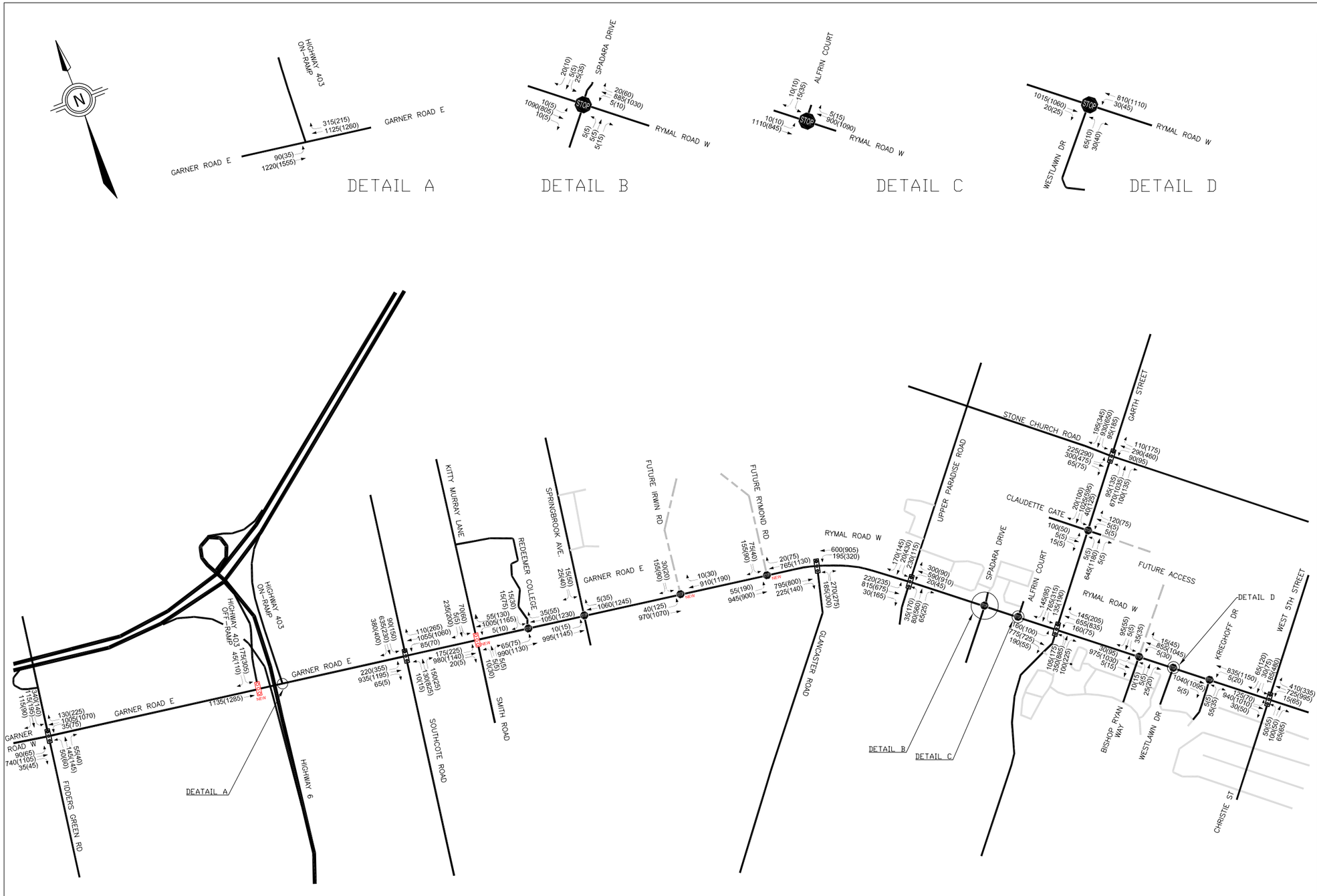
SNC·LAVALIN

FIGURE - 5

Project Name & Title

SITE TRAFFIC VOLUMES (DEVELOPMENTS TO THE NORTH OF GARNER/RYMAL ROAD)
GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
Scale	N.T.S
Dwg. File	v:\ban\garner\garnerfi_fig.dwg



General Notes

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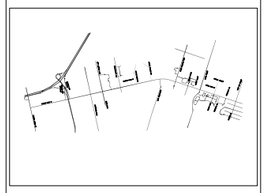


LEGEND:

- EXISTING TRAFFIC SIGNAL
- TRAFFIC FLOW DIRECTION
- 000 AM PEAK HOUR
- (000) PM PEAK HOUR
- STOP SIGN
- NEW TRAFFIC SIGNAL

No.	Revision/Issue	Date

SNC·LAVALIN

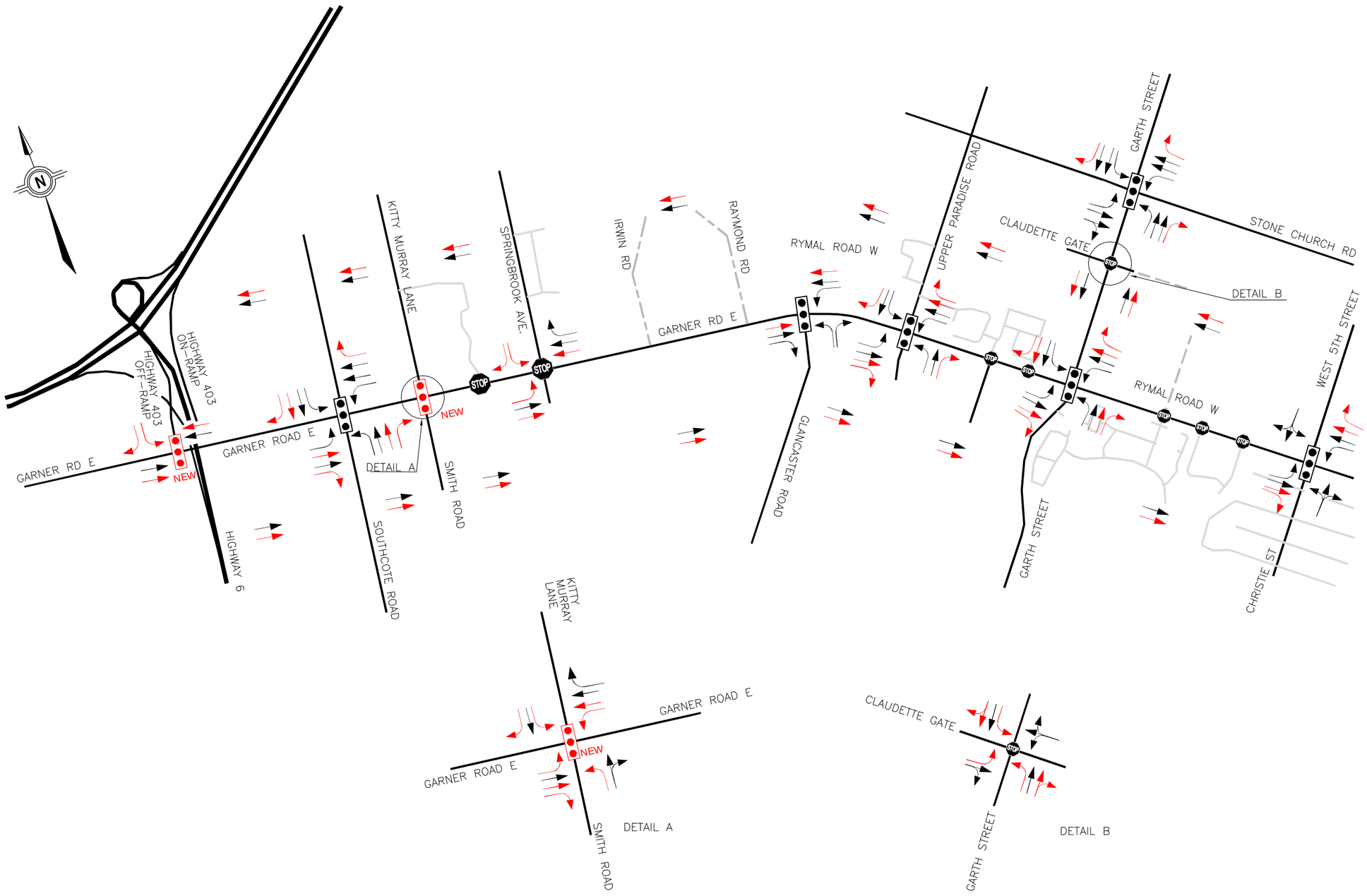
FIGURE - 6

Project Name & Title

FUTURE TOTAL TRAFFIC VOLUMES 2031

GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
Scale	N.T.S
Dwg. File	v:\buen\garner\garnett_fn.dwg



General Notes

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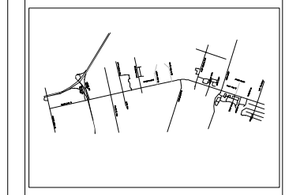

LEGEND:

- EXISTING TRAFFIC SIGNAL
- EXISTING LANES
- NEW TRAFFIC SIGNAL (NEW)
- PROPOSED IMPROVEMENTS
- STOP SIGN

No.	Revision/Issue	Date

SNC·LAVALIN

FIGURE - 7

Project Name & Title
RECOMMENDED ROAD & INTERSECTION IMPROVEMENTS
GARNER ROAD EA STUDY

Project	331605
Date	DECEMBER 2010
Scale	N.T.S
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APPENDIX D.2

STORMWATER MANAGEMENT REPORT (Abridged)

City of Hamilton
Garner-Garth-Rymal Road Improvements Class EA

Drainage and Stormwater Management

Draft Report

Prepared by:

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Water Resources and Environmental Engineering
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Toronto, Ontario
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November 28, 2013

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1. INTRODUCTION

1.1 Study Purpose

The City of Hamilton is carrying out a Class EA study for the proposed improvements to Garner Road, Rymal Road and Garth Street. The study location is shown in Figure 1 and an air photo of the study area is shown in Figure 2. The Class EA study is being conducted by SNC-Lavalin Inc. This Drainage and Stormwater Management Report has been prepared in support of the Class EA study.

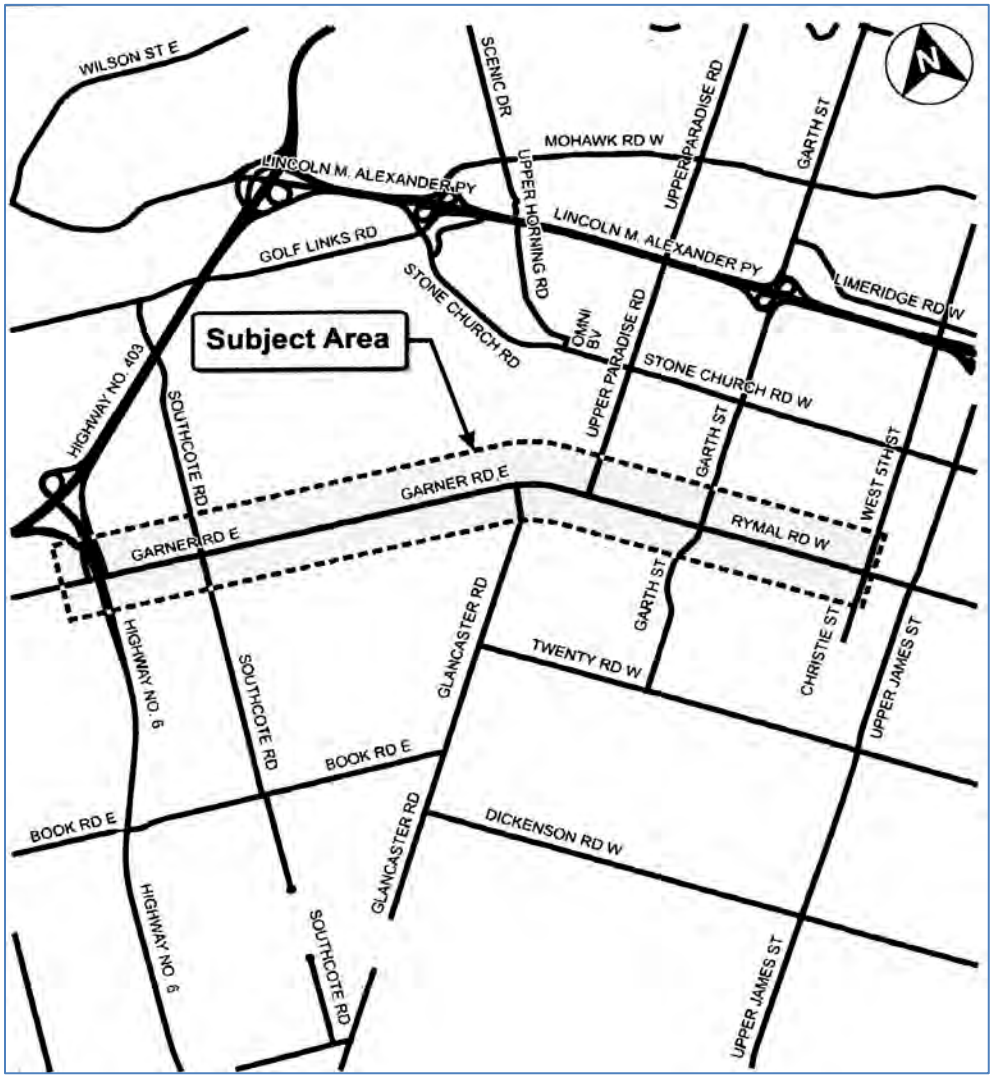


Figure 1 - Location Plan

Figure 2 - Aerial Photo of Study Area

1.2 Background Studies

1.2.1 Previous Drainage Planning Studies

There are a number of existing planning studies for the Garner Road section of the project. These studies have addressed land use planning issues including general storm drainage requirements.

Garner Neighborhood Master Drainage Plan (Oct. 2006): This study prepared a master drainage and Stormwater management plan for the development lands located within the Ancaster Creek watershed west of Southcote Road. The proposed development considered is all located north of Garner Rd. However there is no specific consideration of future improvements to Garner road as part of this development study. Several stormwater management facilities are proposed on the tablelands adjacent to the creeks within the development, but there is no indication that future Garner Road drainage has been considered in the planning or design of these facilities.

Meadowlands Neighborhoods 3, 4 and 5, Class EA Master Plan (Feb. 2000): This master plan considered development within the Tiffany Creek watershed north of Garner Road between Southcote Road in the west and Rymal road in the east. The drainage and Stormwater management learned proposed numerous SWM ponds on the headwater tributaries of Tiffany Creek. An existing pond at Redeemer College has been expended as part of this plan. However the planning does not appear to include the existing drainage from Garner Road or the future expansion of Garner Road.

Airport Employment Growth District (AEGD) - Phase 2 - Draft Subwatershed Study and Stormwater Master Plan (Dec. 2009): This study addressed development and planning issues in the 20 mile Creek and Sulfur Creek (including Ancaster Creek and Tiffany Creek subwatersheds) south of Garner Rd. and south of Twenty Road. This high-level study did not specifically address future drainage of Garner Road. However it did include a comprehensive review Stormwater Management technologies and low impact development measures (LID's) in particular. The recommendations for implementation of LID conveyance controls along roadways may be applicable to future Garner road improvements.

Falkirk East Neighborhood Class EA (Dec. 2003): This study evaluated the impact of diverting the Falkirk West neighborhood minor drainage system from Tiffany Creek to the Upper Paradise road trunk sewer in the Twenty Mile Creek watershed. The Upper Paradise Road trunk sewer is connected to the box sewer on Rymal road which discharges to the St. Elizabeth Village ponds. The analysis included hydrologic and hydraulic analysis of the ponds and the Rymal Road storm sewer. The study was based upon previous hydraulic analysis carried out for the Southwest mountain drainage study in 1991 The Falkirk study demonstrated that the Rymal road and upper Paradise storm sewer systems are under surcharge for existing development levels and that Street flooding occurs at the sag point on Upper Paradise Road. A number of alternatives were investigated to mitigate these flooding impacts including on-site controls, conveyance controls, relief sewers and modification to the ponds. The study recommended that a stormwater detention

pond be constructed in William Schwenger Park and that a relief sewer be considered for Rymal Road in conjunction with future road improvements

The study also recommended that a maintenance easement for the St. Elizabeth ponds should be acquired by the City to permit access for maintenance and design improvements. It is understood that an agreement with St. Elizabeth Village to acquire this maintenance easement has been completed in 2013.

1.2.2 Existing Storm Drainage Studies

Eden Park Phase 1 Stormwater Management Report: (Sept. 2010) This report was undertaken to evaluate the impact of the proposed Eden Park development north of Rymal Road and east of Garth Street on the existing surcharge and flooding problems in Rymal Road storm sewer system. It included an updated analysis of the Rymal Road storm sewer and the water levels in the St. Elizabeth ponds. The drainage plan for the development included partial diversion of major system flows out of the system to compensate for increased minor system flows to Rymal Road. The study concluded that the Rymal Road drainage system could accommodate the additional development and there would be minimal impact on the existing flooding problems.

St. Elizabeth Village Stormwater Management Facilities Functional Servicing Report (AECOM 2013 –ongoing) The City is currently conducting a study of the St. Elizabeth pond system to identify modifications needed to improve their performance and address the existing erosion problems. The report is expected at the end of 2013.

1.2.3 Existing Storm Drainage Design Plans

Design information for existing and proposed drainage systems is also available from a number of studies, design calculations and drawings:

- Ancaster Glen Subdivision Functional Servicing Study, MTE Ltd. – Phase 2 Update- Dec. 12, 2012
- Bungalows of Ancaster South, A.J. Clarke Ltd., (March 2011) -Redeemer College lands and SWM pond
- Ancaster Meadows Phase 1, Metropolitan Consulting Ltd. - Raymond Road storm sewer design
- Redeemer University College, Van der Woerd & Assoc. Ltd. (March 2005) – Kitty Murray Lane storm sewer design
- Rymal Road West storm sewer design – City of Hamilton (Feb. 1991)
- Garth Street storm sewer design – City of Hamilton (Oct. 1991)

2. EXISTING CONDITIONS

2.1 Study Area Watersheds

The Stormwater drainage systems within the study limit are located in headwater reaches of four separate watersheds. Garner Road from Highway 6 in the West to just east of Southcote Road Is located in the Ancaster Creek Subwatershed. The section of Garner Road from east of Southcote Road to West of Upper Paradise Road is located in the Tiffany Creek Subwatershed. From Upper Paradise Road to east of Garth St., the Rymal Road drainage area is located in the Twenty Mile Creek watershed. The remainder of Rymal Road to the west limits at West. 5th Street And the north section of Garth Street are located in the Upper Ottawa Creek Subwatershed which is a tributary of Redhill Creek. The Twenty Mile Creek watershed is under the jurisdiction of the Niagara Region Conservation Authority (NRCA) while the remaining areas are under the jurisdiction of Hamilton Conservation Authority (HCA). None of the existing watercourses are sufficiently large to be regulated. However the regulation limit on Tiffany Creek terminates just north of the existing culvert on Garner Road.

2.2 Flood Plain Mapping

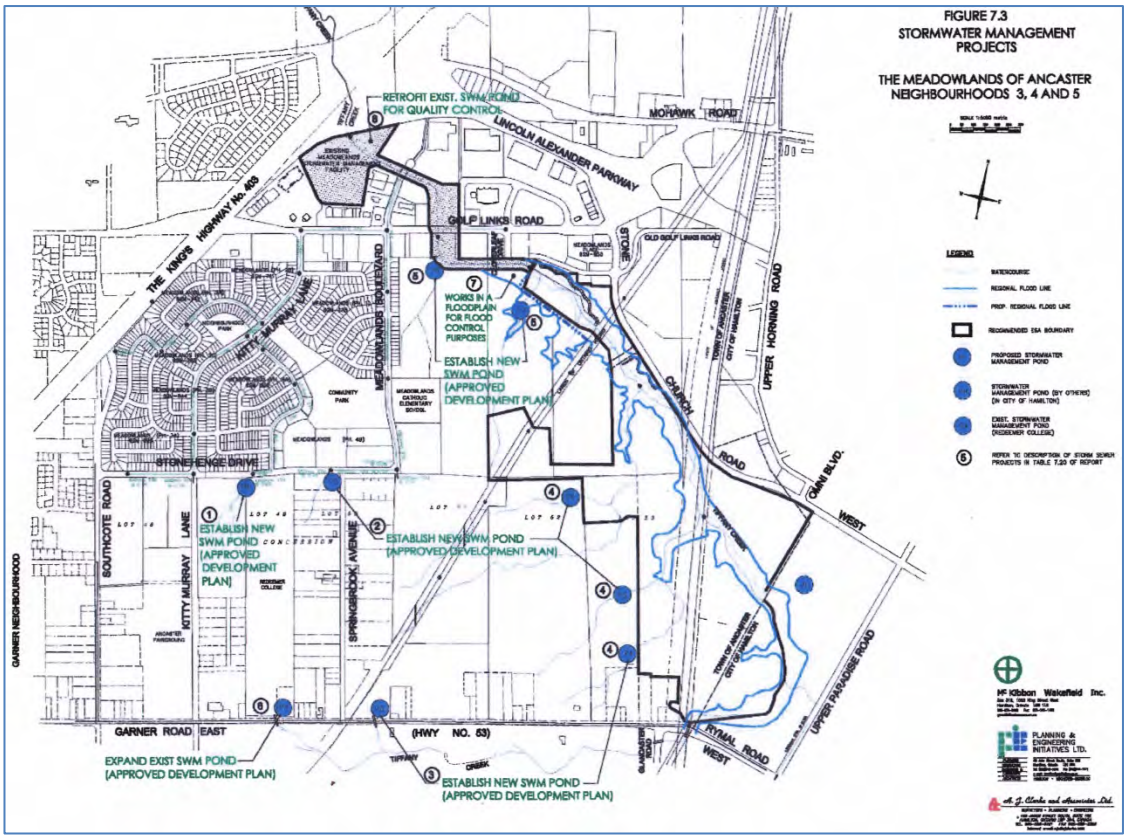
Floodplain mapping has been prepared for the Tiffany Creek by the Hamilton Conservation Authority (HCA). The extent of the existing regulation mapping terminates at Garner Road as shown in Figure 3.

2.3 Existing Drainage Systems

2.3.1 Road Drainage

The Garner Road section west of Upper Paradise Road is in a rural cross-section with drainage provided by roadside ditches and crossing culverts connected to the local watercourses. The general drainage direction is from south to north although there are locations at headwaters of Tiffany and Ancaster creeks where the flow direction is from north to south. A new storm sewer has been constructed on Raymond road northward from Garner road. This storm sewer has been designed to capture a portion of Garner Road west of Raymond Road. There is also a storm sewer on Kitty Murray Lane hat capture a small portion of Garner Road drainage in the vicinity of the intersection.

On Rymal Road from Upper Paradise Road to the Twenty Mile Creek outlet at St. Elizabeth Village, there is a large (3000mm x 1800mm) trunk storm sewer installed under Rymal Road with connections to the crossing culverts and the adjacent ditches. The catchment area for this storm sewer includes subdivisions on Upper Paradise road and external areas south of Rymal Road draining to the existing crossing culverts. This storm sewer discharges to an existing series of on line ponds located on Twenty Mile Creek within St. Elizabeth Village south of Rymal Road. The east end of Rymal Road between Westlawn Road and West 5th Street is serviced by a 900mm storm sewer discharging to the storm sewer system on Upper James Street in the Ottawa Creek watershed.



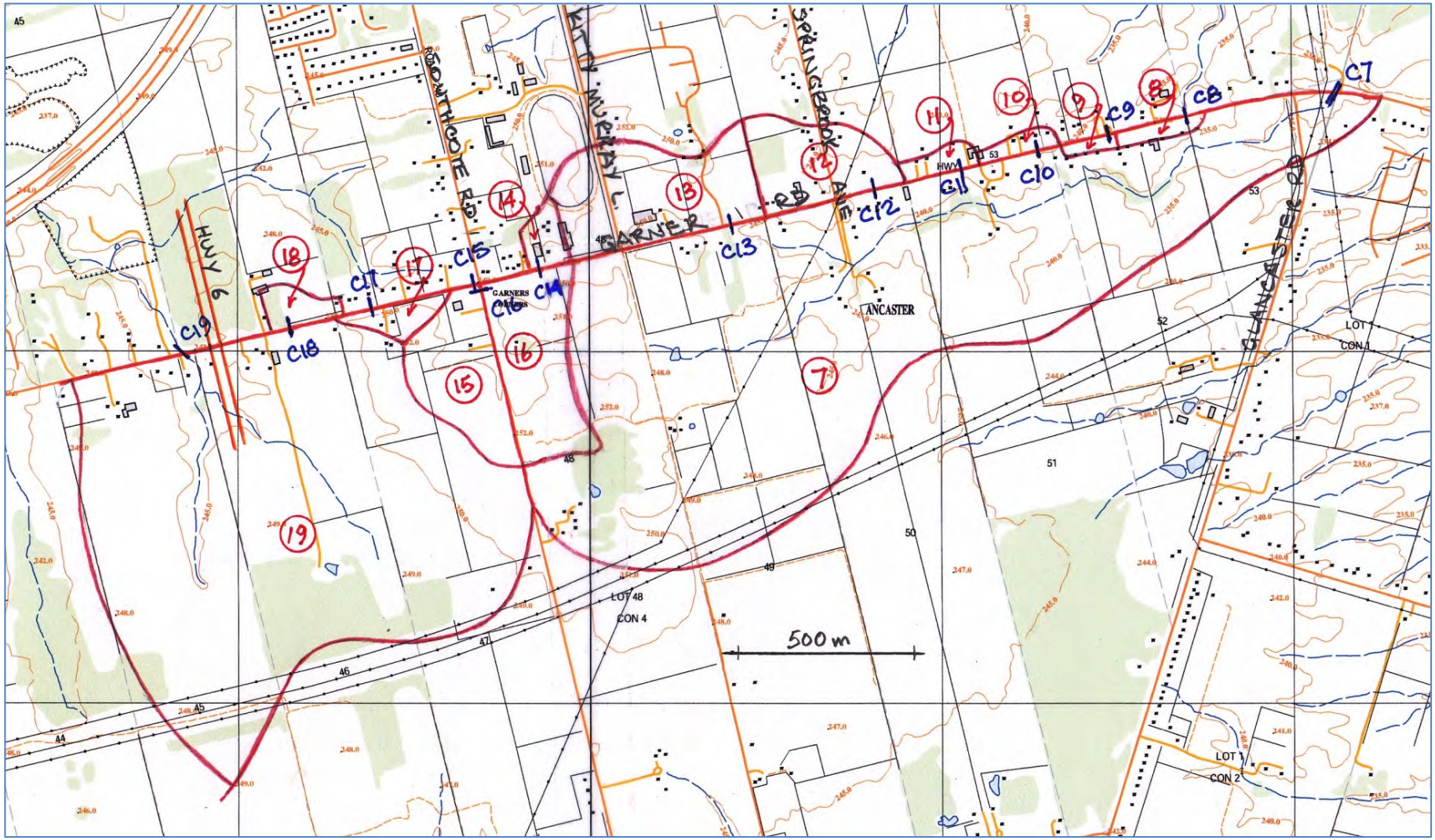
<u>Figure 3</u> – Extent of Flood Plain Mapping

The south end of Garth Street is serviced by storm sewers connected to the Rymal Road trunk sewer. The north end of Garth Street has storm sewers connected to the storm drainage system on Stone Church Road to the north.

2.3.2 Existing Culverts

The Garner Road section of the project is predominantly in a rural section with roadside ditches connected to 12 crossing culverts. The existing catchment boundaries and culvert locations are shown in Figures 4a and 4b. The majority of the culverts are corrugated steel pipe (CSP) ranging in size from 600 mm to 1000 mm. Two of the crossings are permanent watercourses with catchment areas greater than 25 ha. At Tiffany Creek there is an 1800 mm x 900 mm open

footing concrete box culvert with the catchment area of about 150 ha. At the West end of the project, the Ancaster Creek culvert is a 2440 mm x 1750 mm CSP with a catchment area of about 120 ha.


GARNER
HWY 6
ROSETHCOTE RD
KITTY MURRAY L
SPRINGBROOK AVE
ANCASTER
LANCASTER RD
GARNERS CORNERS
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LOT 48
CON 4
LOT 1
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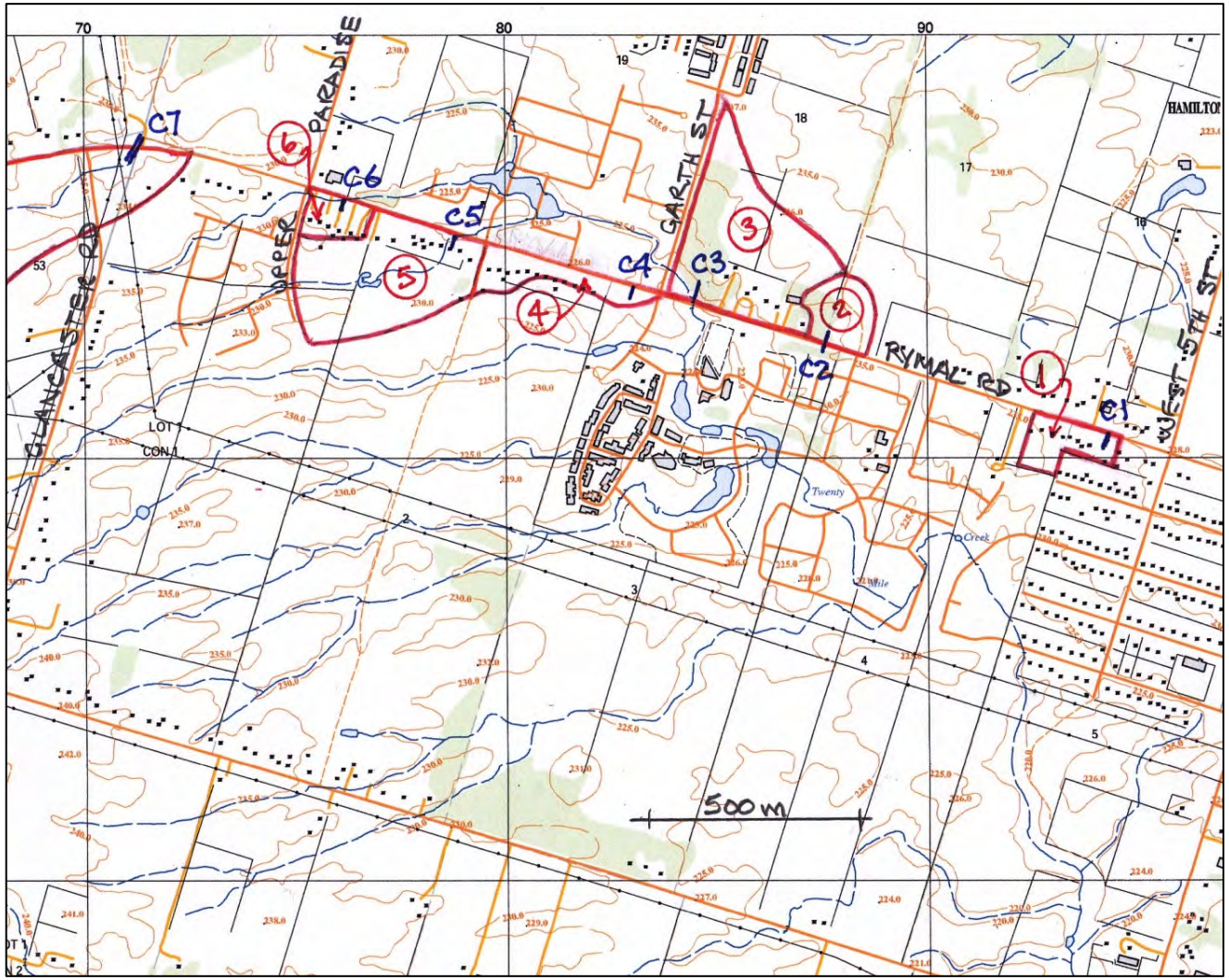
Figure 4a - Existing Garner Road Culverts and Catchment Boundaries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80
90
PARADISE
GARTH ST
RYMAL RD
WEST 5TH ST
LANCASTER DR
DEPEW
C1
C2
C3
C4
C5
C6
C7
1
2
3
4
5
6
500 m

Figure 4b - Existing Rymal Road Culverts and Catchment Boundaries

Rymal Road from station 3+880 West of Upper Paradise Street to station 5+355 East of Bishop Ryan way discharges to Pond C in St. Elizabeth Village just East of Garth St. at station 5+078. This section includes the southerly portion of Garth Street up to station 0+480. The roadways are not urbanized at present. West of the outlet, drainage from Rymal Road and external areas from the south is conveyed in roadside ditches to several crossing culverts. These culverts are connected to the existing 3000 mm x 1800 mm box storm sewer. The Garth Street drainage is captured in a number of ditch inlets connected to the existing storm sewer that discharges to the Rymal Road storm sewer. The Rymal Road drainage from the east is conveyed in roadside ditches to the outlet.

2.3.3 Existing Culvert Condition Assessment

Eighteen (18) centreline crossing culverts and one Sideroad Culvert (Southcote Road) within the project area were identified and inspected during the field investigation. The results of the inspection are summarized in Table 1, while the detailed field inspection photos are presented in Appendix A.

Twelve of the culverts were found to be in good to fair condition. The other six culverts (C1, C8, C11, C16, C17 and C18) were found in poor condition as indicated in Table 1.

Table 1
Summary of Culvert Field Assessment

Culvert ID	Culvert Station	Location	Culvert Size/ Type/ Length	Condition Rating	Drains Direction	Field Observations	Condition Assessment
Ottawa Creek Watershed							
C1		Rymal Road West	500mm/CSP/14.5m	Poor	South to North	●100mm silted at culvert inlet end ●250mm of silted at culvert outlet end ●Observed deformed at inlet end ●Heavy rusted at bottom half of culver	Replace
Twenty Mile Creek Watershed							
C2		Rymal Road West	500mm/CSP/26.7m	Good	North to South	●120mm silted at culvert inlet end ●Culvert outlet end are not located	Remove Sediment
C3		Rymal Road West	920mmx920mm Conc. Box/19.6m	Good	North to South	●Outlet end connected to storm structure	OK
C4		Rymal Road West	600mm CSP/16.9m	Poor	South to North	●Heavy rusted over entire culvert ●Outlet end connected to storm manhole	Replace

Table 1
Summary of Culvert Field Assessment

Culvert ID	Culvert Station	Location	Culvert Size/ Type/ Length	Condition Rating	Drains Direction	Field Observations	Condition Assessment
C5		Rymal Road West	900mm/CSP/37.4m 1200mm/CSP/21.63m	Good	South to North	●Heavy rusted and broken bottom at culvert inlet end (length approx. 2.5-3m) ●Outlet end connected to storm manhole	OK
C6		Rymal Road West	1500mm/CSP/21.9m	Good	South to North	●150mm silted at culvert inlet end ●Outlet end connected to storm manhole	Remove Sediment
Tiffany Creek Watershed							
C7	3+694	Rymal Road West	1800mmx 900mm Conc. Box/20.9m	Good	South to North	●200mm silted at culvert inlet end ●250mm silted at culvert outlet end	Remove Sediment
C8	3+270	Garner Road East	800mm/ CSP/18.9m	Poor	South to North	●50mm silted at culvert inlet end ●150mm silted at culvert outlet end ●Observed pipe joint separated (approx. 5m from the culvert inlet end) ●Top rusted and broken at culvert outlet end	Replace
C9	3+040	Garner Road East	750mm CSP/19.6m	Good	South to North	●250mm silted at culvert inlet end ●150mm silted at culvert outlet end	Remove Sediment
C10	2+845	Garner Road East	800mm CSP/22.1m	Fair	North to South	●330mm silted at culvert outlet end ●Observed pipe joint separated approx. 3m at culvert inlet end	-Remove Sediment -Replace the pipe joint section
C11	2+620	Garner Road East	800mm CSP/22.0m	Fair	North to South	●Broken bottom at culvert inlet end (length approx. 3m) ●Observed pipe joint separated approx. 5m at culvert outlet end ● Observed deformed at top of culvert	OK

Table 1
Summary of Culvert Field Assessment

Culvert ID	Culvert Station	Location	Culvert Size/ Type/ Length	Condition Rating	Drains Direction	Field Observations	Condition Assessment
C12	2+346	Garner Road East	800mm CSP/15.4m	Fair	North to South	●200mm silted at culvert inlet end ●350mm silted at culvert outlet end ●Moderate rusted at bottom half of culvert	Replace
C13	1+190	Garner Road East	1000 mm CSP/28.3m 610mm conc. Pipe/28.3m	Good	North to South	●Concrete headwall at inlet and outlet ends ●Existing SWM pond located at upstream of the culvert	OK
Ancaster Creek Watershed							
C14	1+364	Garner Road East	700mm/CSP/21.1m	Good	North to South	●180mm silted at culvert inlet end ●200mm silted at culvert outlet	Remove Sediment
C15	1+176	Garner Road East	800mm/CSP/31.3m	Fair	South to North	●100mm silted at culvert inlet end ●400mm silted at culvert outlet end ●Concrete headwall at culvert inlet end	Remove Sediment
C16	-	Southcote Road south of Garner Road	600mm CSP/19.3m	Poor	East to West	●Top broken at culvert inlet end ●Heavy rusted at bottom half of culvert ●Observed pipe joint separated approx. 4m at culvert inlet end	Replace
C17	0+851	Garner Road East	800mm CSP/18.6m	Poor	South to North	●Deformed and broken at culvert inlet end ●Deformed at top of culvert approx. 5m from the culvert outlet end	Replace
C18	0+665	Garner Road East	700mm CSP/24.3m	Fair	South to North	●Minor deformation inside the culvert	OK
C19	0+338	Garner Road East	2650mm x 1900mm CSPA/ 34.4m	Good	South to North	●Minor sediment accumulated inside the culvert	OK

2.3.4 Existing Drainage Deficiencies

The Rymal Road trunk storm sewer, which was designed in 1991, collects runoff from a large area extending from west of Upper Paradise Road to Westlawn Road in the east, including lands north and south of Rymal Road. Periodic flooding is experienced on Upper Paradise north of Rymal due in part to a depressed area where the only outlet is the underground storm sewer system. This flooding problem has been studied in the past in the Falkirk Neighborhood Class EA (Phillips Engineering, May 2004). The study determined that two other factors contributing to the flooding are surcharge of the Rymal Road storm sewer due to excessive inflows and high tail water elevations in the St. Elizabeth Village ponds at the outlet. The storm sewer surcharge is due in part to the contributions of the external drainage areas from south of Rymal Road via the existing culverts and other major system contributions at the road sag locations.

The City is also currently conducting a study of the St. Elizabeth Village pond system to identify modifications needed to improve their performance and address the existing erosion problems.

3. HYDROLOGIC ANALYSIS OF EXISTING CONDITIONS

3.1 Method

The analysis was conducted in four sections based on the characteristics of the existing watersheds and development areas. The three sections have been defined as:

1. Garner Road and west Rymal Road to the east limits of the Tiffany Creek watershed. This area is generally characterized by rural lands with new development occurring to the north of Garner Road. Drainage is to Ancaster Creek and Tiffany Creek.
2. Rymal Road within the Twenty Mile Creek watershed. This area is mostly developed with storm runoff directed to a single outlet at the St. Elizabeth ponds.
3. Rymal Road east of Westlawn Road and North Garth Street. This section is fully developed with storm sewers discharging to storm sewers in the City of Hamilton to the north and east in the Ottawa Creek watershed.

3.2 Garner Road and West Rymal Road

The existing catchment boundaries for each culvert are shown in Figures 3a and 3b. The boundaries have been determined using the detailed survey data from the City supplemented by 1:10 000 OBM mapping, field inspections and planning study and design reports where available.

Design flows have been determined using the OTTHYMO model. In order to examine the potential impact of the future road widening, the catchments were defined in two sections: the road right-of-way and the rural undeveloped areas upstream of the road right-of-way. The road catchments were modeled as urban areas with impervious ratios estimated from the existing site survey and aerial photography. The right-of-way area was further divided along the centre-line to separate the upstream culvert inflows from the downstream flows to permit the evaluation of

downstream flow impacts after the road widening. Input parameters for the rural areas (runoff curve Numbers - CN and Time to Peak - Tp) were developed from the available land use information, satellite imagery, agricultural soils maps and topographic mapping. The data used in the hydrologic calculations and the model input parameters for the existing condition are given in Appendix B.

Design storms were developed from the Mount Hope gauge IDF curves from the City of Hamilton Drainage design criteria. Previous planning studies (i.e. the AEGD study and others) have determined the SCS 24 hour design storm should be used for determining design flows in this area and this storm was used in this study. However, the Chicago distribution was also used to verify the model data from the existing SWM pond design. A time step of 2minutes was selected based on the storage coefficient values for the small road catchments.

At Culvert C13, the upstream development area (Bungalows of Ancaster) is largely developed and contains an existing SWM pond. For the existing condition analysis, the model data for the SWM pond design was imported to the model. Test runs were made to verify that the imported data gives comparable results to the model results published in the design report. For comparison, an estimate was also made of the pre-development condition at this location.

3.2.1 Computed Design Flows

The culvert design flows computed with the OTTHYMO model are summarized in Table 2. OTTHYMO outputs are given in Appendix C. These flows were used to analyze the capacity of the existing culverts under existing conditions.

3.2.2 Hydraulic Analysis of Existing Culverts

The hydraulic analysis of the culverts was undertaken with the CulvertMaster Model. Downstream Tailwater levels were estimated in the model for an assumed trapezoidal channel. The results are summarized in Table 3 while the CulvertMaster outputs are given in Appendix D.

The hydraulic analysis of the culverts for existing conditions indicated that the majority of the pipes are of adequate size. However, a field inspection of the culverts determined that many of the small CSP pipes were in poor condition. The results of the analysis of the existing culverts on Garner Road are summarized in Table 3. At three locations it was determined that the existing culverts have inadequate capacity. These locations are:

- C7 - Tiffany Creek - Station 3+695
- C15 – East Tributary of East Ancaster Creek - Station 1+176
- C19 - Ancaster Creek - Station 0+338

Table 2

Garner Road Culvert Design Flows [1] [2]

No.	Station	Case	Catch-ment Area	Design Event			
				25-yr	50-yr	100-yr	Regional Storm
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
Outlets to Tiffany Creek							
C7	3+694	Exist.	147.90	**3.281**	**3.858**	**4.454**	**10.506**
		Future	149.96	**3.257**	**3.832**	**4.424**	**10.435**
C8	3+270	Exist.	0.93	**0.065**	**0.079**	**0.093**	**-**
		Future	0.77	**0.054**	**0.065**	**0.077**	**-**
C9	3+040	Exist.	0.48	**0.034**	**0.041**	**0.048**	**-**
		Future	0.35	**0.024**	**0.030**	**0.035**	**-**
C10	2+845	Exist.	1.04	**0.073**	**0.088**	**0.104**	**-**
		Future	0.88	**0.062**	**0.074**	**0.088**	**-**
C11	2+620	Exist.	1.32	**0.092**	**0.111**	**0.132**	**-**
		Future	1.19	**0.083**	**0.100**	**0.119**	**-**
C12	2+346	Exist.	8.03	**0.775**	**0.913**	**1.056**	**1.10**
		Future	7.73	**0.746**	**0.879**	**1.016**	**1.06**
C13	1+190	Exist.	14.60	**0.753**	**0.949**	**1.137**	**1.46**
		Future	14.68	**0.745**	**0.940**	**1.127**	**1.44**
Outlets to Ancaster Creek East Tributary							
C14 (To C15)	1+364	Exist.	1.57	**0.173**	**0.156**	**0.183**	**-**
		Future	1.52	**0.101**	**0.122**	**0.144**	**-**
C15	1+176	Exist.	22.91	**1.210**	**1.432**	**1.673**	**2.67**
		Future	22.58	**1.177**	**1.405**	**1.644**	**2.58**
C16 (To C15)	Southcote Rd. S. of Garner	Exist.	13.51	**0.674**	**0.804**	**0.939**	**1.54**
		Future	12.85	**0.588**	**0.714**	**0.834**	**1.47**
C17	0+851	Exist.	1.69	**0.251**	**0.292**	**0.338**	**-**
		Future	1.65	**0.140**	**0.168**	**0.197**	**-**
Outlets to Ancaster Creek Main Branch							
C18 (To C19)	0+665	Exist.	1.57	**0.173**	**0.203**	**0.236**	**-**
		Future	1.54	**0.105**	**0.127**	**0.150**	**-**
C19	0+338	Exist.	119.89	**5.583**	**6.794**	**7.936**	**11.58**
		Future	119.82	**5.536**	**6.690**	**7.906**	**11.45**

Notes: [1] Existing culvert flows include ½ of existing Garner Rd. drainage (i.e. u/s ditches).
[2] Future culvert flows exclude Garner Rd. drainage. Garner storm sewers are assumed to discharge d/s of culverts.

Table 3
Hydraulic Analysis of Garner Road Culverts -Existing Conditions

Culvert ID	Station (sta.-m)	Type	Ex. Size W (mm)	Ex. Size H (Dia.) (mm)	Length (m)	Invert Elevations U/S (m)	Invert Elevations D/S (m)	U/S Culvert Obvert Elevation (m)	Centerline Road Elevation [4] (m)	Min. Road Elevation [1] (m)	Computed U/S Water Elevation 50 yr (m)	Computed U/S Water Elevation 100 yr (m)	Computed U/S Water Elevation Reg. St. (m)	Culvert Clearance [2] 50 yr (m)	Culvert Clearance [2] 100 yr (m)	Freeboard [3] 50 yr (m)	Freeboard [3] 100 yr (m)	Freeboard [3] Reg. St. (m)	Comments
C7	3+695	Conc. Box	1800	900	31.0	228.98	228.90	229.88	230.76	230.63	230.28	230.46	230.93	-0.40	-0.58	0.35	0.17	-0.30	Assume invert is 0.5m below surveyed level of sediment at d/s end and 0.6m below survey level at u/s end, based on field observations. >Q25 capacity but freeboard too low.
C8	3+269	CSP		800	18.86	235.96	235.85	236.76	237.86	237.78	236.22	236.25	n/a	0.54	0.51	1.56	1.53	n/a	Culvert damaged
C9	3+040	CSP		750	35.0	238.30	238.19	239.05	239.76	239.63	238.49	238.51	n/a	0.56	0.54	1.14	1.12	n/a	
C10	2+842	CSP		800	22.05	238.85	238.34	239.65	241.32	241.23	239.17	239.17	n/a	0.48	0.48	2.06	2.06	n/a	Culvert damaged
C11	2+619	CSP		800	22.04	241.42	241.06	242.22	243.30	243.15	239.14	242.59	n/a	3.08	-0.37	4.01	0.56	n/a	Culvert damaged; too shallow for road reconstruction
C12	2+345	CSP		800	15.38	242.80	242.34	243.60	245.00	244.91	243.89	244.01	n/a	-0.29	-0.41	1.02	0.90	n/a	
C13	1+960	Conc.		1,000	28.33	244.30	243.98	245.30	246.70	246.51	245.56	245.64	n/a	-0.26	-0.34	0.95	0.87	n/a	Cuvert C13 comprised of two barrels located downstream of Bungalows of Ancaster pond outlet .
	1+960	Conc.		600	28.33	244.30	243.98	244.90	246.70	246.51	245.56	245.64	n/a	-0.66	-0.74	0.95	0.87	n/a	
C14	1+364	CSP		700	21.08	247.92	247.77	248.62	249.25	249.10	248.33	248.37	n/a	0.29	0.25	0.77	0.73	n/a	Too shallow for road reconstruction
C15	1+176	CSP		800	31.27	245.65	245.38	246.45	248.53	248.38	248.27	248.52	248.57	-1.82	-2.07	0.11	-0.14	-0.19	Road overtops for Q100
C16	1+203 rt	CSP		600	19.25	246.62	246.54	247.22	248.59	248.30	248.09	248.11	n/a	-0.87	-0.89	0.21	0.19	n/a	Culvert located on Southcote Rd. - Culvert damaged
C17	0+850	CSP		800	18.61	246.01	245.79	246.81	247.80	247.65	246.55	246.59	n/a	0.26	0.22	1.10	1.06	n/a	Culvert damaged
C18	0+665	CSP		700	24.33	245.41	245.21	246.11	247.10	246.96	245.87	245.91	n/a	0.24	0.20	1.09	1.05	n/a	Culvert damaged
C19	0+338	CSPA	2,440	1,750	34.4	239.83	239.23	241.58	242.20	241.92	241.65	241.85	242.11	-0.07	-0.27	0.27	0.07	-0.19	Freeboard too low; Road overtops for Reg. Storm

Notes:
[1] Minimum road EOP for freeboard calculation.
[2] Distance from water elevation to culvert obvert.
[3] Distance from water elevation to minimum road EOP elevation.
[4] Centerline Road elevation adjacent to culvert

At C7 and C19 the culverts do not meet the freeboard requirement for the 100-year storm. At C15 the road overtops for the 100 year storm. At all three locations the road overtops for the Regional Storm.

3.3 Rymal Road to Twenty Mile Creek

The Rymal Road storm sewer system has been studied extensively. Previous studies have determined that this system is undersized for the existing development conditions and there are known flooding problems at the sag points on Upper Paradise Road. Flooding and erosion problems have also been documented within the pond system downstream of the Rymal Road storm sewer outlet. Due to these previous results, further analysis of the Rymal Road storm sewer for existing conditions was not needed in this study. However an assessment of the existing Garth Street storm sewer draining to Rymal Road was undertaken and it was determined that this storm sewer has sufficient capacity for the existing conditions.

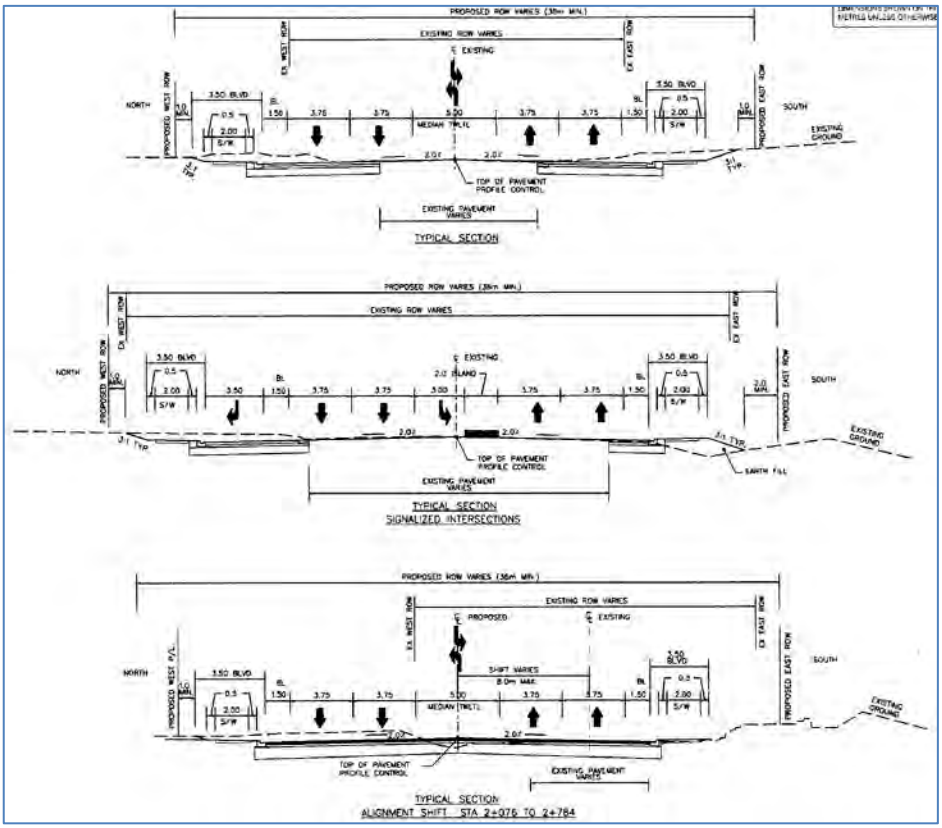
3.4 East Rymal Road and Garth Street North

These sections of the project area have existing storm sewers that pick up runoff from the roadside ditches connected to cross culverts and ditch inlets. An assessment of these storm sewers was undertaken that it was determined that they provide adequate capacity for the existing minor system drainage requirements. However, on the Garth Street North section there is a significant sag in the road profile at Station 0+900. Under major system flow conditions (i.e. 100 year) ponding depths at this location could exceed 0.8 m. The additional inflows to the storm sewer under these conditions could also lead to surcharging and flooding in the downstream storm sewers.

4. PROPOSED FUTURE CONDITIONS

The proposed road design cross sections are shown in Figure 5. The new road will consist of four lanes and two bike lanes with a standard urban curb and gutter section and standard sidewalks on each boulevard. The new right of way will be expanded to about 36m throughout. Left turn lanes and right turn lanes will be added at major intersections. The road profile will approximate the existing profile although there will be a general increase in the elevations of about 0.01m to 0.02m throughout. As a result, the future road drainage system will maintain the existing catchment boundaries and outlets. Diversion of flows between catchment areas will be minimized.

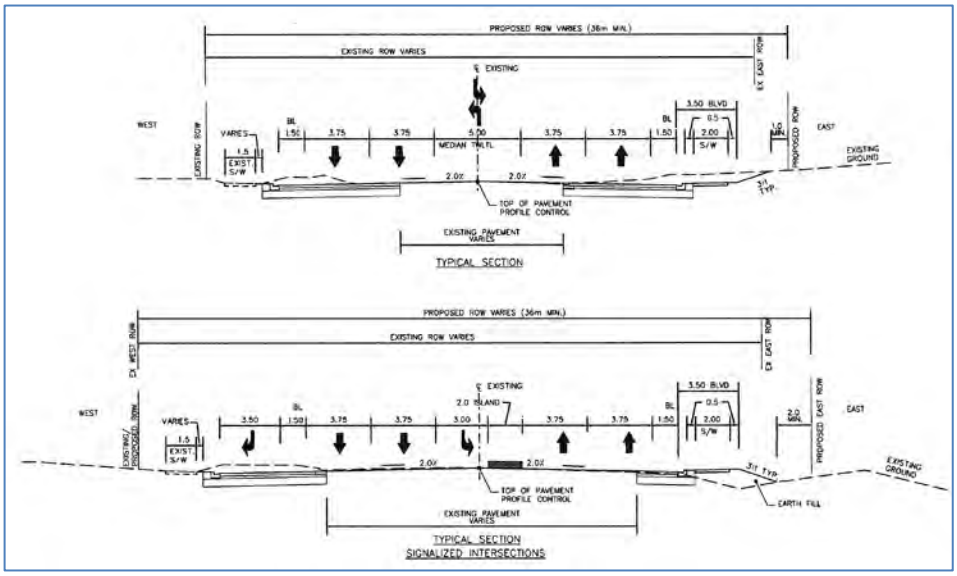
The future road will feature a standard curb and gutter cross section with catch basins connected to storm sewers with five year capacity. Existing storm sewers will be utilized and supplemented where needed with additional storm sewer lines. Storm sewer connections to adjacent development areas will be utilized where available. In general, major system outlets will be maintained at existing sag point in the road profile. However, major system flows will be directed to adjacent roadways at intersections where appropriate.


PROPOSED ROW VARIES (36m MIN.)
EXISTING ROW VARIES
EXISTING
NORTH
SOUTH
3.50 BLVD
MEDIAN (TRLT)
TOP OF PAVEMENT PROFILE CONTROL
EXISTING PAVEMENT VARIES
TYPICAL SECTION
PROPOSED ROW VARIES (36m MIN.)
EXISTING ROW VARIES
EXISTING
ISLAND
TOP OF PAVEMENT PROFILE CONTROL
EXISTING PAVEMENT VARIES
TYPICAL SECTION
SIGNALIZED INTERSECTIONS
PROPOSED ROW VARIES (36M MIN.)
EXISTING ROW VARIES
PROPOSED
EXISTING
SHIFT VARIES
8.0m MAX.
MEDIAN (TRLT)
TOP OF PAVEMENT PROFILE CONTROL
EXISTING PAVEMENT VARIES
TYPICAL SECTION
ALIGNMENT SHIFT STA 2+076 TO 2+784

a) Garner Road East/Rymal Road West

b) Garth Street

<u>Figure 5</u> - Typical Future Road Cross Sections



All of the major crossing culvert outlets will be maintained for the Garner Road section. The existing culvert will be replaced at some locations due to poor condition, insufficient capacity or insufficient depth to accommodate future road construction. The roadside ditches will generally be reinstated to convey the external drainage areas to the culverts. In some locations, a ditch inlet will be placed at the upstream end of the culvert due to property limitations and revised grading for the road widening.

For the Rymal Road section, most of the culverts capturing external drainage areas are connected to the existing storm sewer system. These connections will be replaced with new ditch inlets connected to a new storm sewer system to provide relief to the existing storm sewer. The future road drainage will be connected directly to the new storm sewers and the contributing area to the culvert inlet will be reduced for the future condition.

5. DRAINAGE AND SWM DESIGN CRITERIA

The SWM targets, criteria and design standards of the City of Hamilton and the Conservation Authorities have been applied. The specific drainage and SWM criteria applicable to this project are:

- Road drainage will be provided by storm sewers designed for a 5-year return period.
- Stormwater runoff will be discharged to the existing outlets.
- Major system capacity is required for the 100-year design storm.
- Crossing culverts should have a minimum 25 year capacity with adequate freeboard to prevent flooding of the roadway pavement for the 100 year event. Crossing culverts with larger catchment areas (i.e. >50 ha or so) have also been evaluated for the Regional Storm. There will not be any increase in upstream flood elevations due to changes to the culverts or road profiles.
- The target for stormwater quality control is enhanced Level 1 treatment (i.e., 80% suspended solids removal).
- Stormwater quantity control is generally required to match pre-development levels.

In general, post-development flows are not to exceed predevelopment flows at all locations. However, at the East Tributary of the East Ancaster Creek (culvert C15), previous study has indicated that peak flow control is not required on this tributary. Similarly for the catchment areas connected to the Twenty Mile Creek outlet at St. Elizabeth Village East of Garth St., it has been determined in previous studies and confirmed by the Hamilton Conservation Authority that the downstream pond system has been designed to accommodate future development in the upstream catchment area. As a result, peak flow control is not required for the sections of Rymal Road and Garth Street contributing to these ponds. It has also been assumed that the runoff from any future development areas tributary to the culverts will be controlled to existing levels, as a minimum.

The water quality target for Stormwater management for the receiving watersheds is defined as an enhanced (Level 1) treatment at all locations. However, where this is not possible due to the

limited opportunities available for Stormwater management within the right-of-way, a "best effort" approach has been applied to maximize the available opportunities.

6. HYDROLOGIC ANALYSIS OF FUTURE CONDITIONS

6.1 Garner Road and West Rymal Road

6.1.1 Method

The future road widening will increase the impervious area connected to the local water courses. At locations where the contributing catchment area is small, the increase in the pavement area may be a significant percentage of the total area, which could lead to increases in peak flows. The impact of the road improvements on peak flows to the downstream watercourses was assessed for the Garner Road culverts.

All of the adjacent development has been assumed to remain the same or, if developed, to employ runoff controls to match existing conditions to determine the impact of the road improvements alone. Future road drainage will be by storm sewers. It has been assumed that the storm sewers will discharge downstream of the existing culverts. As a result, the contributing area to the upstream end of the culvert is generally smaller for the future condition. In order to provide data for determining the impact of the road improvements on the downstream flows, the road areas have been defined as separate urban catchments each outlet.

The future roadway drainage area was based on the proposed design data. External drainage areas were taken from the hydrologic analysis for the existing condition. Existing outlets have been maintained wherever possible. However, some of the existing culverts are very shallow and the downstream watercourse is often too shallow to accommodate storm sewer outlets from the roadway. At these locations, the storm sewer has been directed to the next available outlet. However, in no case is the storm sewer diverted out of the principal watershed.

On Garner Road, the development planning studies for the lands to the north of the road generally do not include drainage from Garner Road. However, some of the existing storm sewers in the adjacent developments have been designed to accept existing flows from the adjacent local sections of Garner Road. At these locations, the available design capacity in the existing storm sewers has been utilized for some of the future Garner Road drainage. These connections occur at Raymond Road and Kitty Murray Lane on Garner Road. The available design capacity for Garner Road drainage at these locations was determined from the original design calculations for the downstream sewers.

At Culvert C13, model data was again imported from the design studies for the existing SWM pond in the Bungalows of Ancaster South development.

The OTTHYMO model has been used with the the SCS 24-hour storm distribution to develop existing and future design flows in the watercourses downstream of Garner Road. The future flows were compared to existing flows to determine the impact on peak flows after the

completion of the proposed road improvements. The hydrologic model parameters are given in Appendix B while the OTTHYMO model outputs are given in Appendix C

6.1.2 Computed Design Flows

The results for the Tiffany Creek watershed outlets are summarized in Table 4a. At the Tiffany Creek culvert itself (culvert C7) the future peak flows with the Garner Road storm sewers connected to the culvert are predicted to be slightly lower than the existing peak flow values. At culverts C8 and C9, future Garner Road drainage will be taken to the existing Raymond Road storm sewer, resulting in significantly reduced flows downstream at these locations.

At culvert C12, the future upstream development area will be reduced from about 9.3 ha to about 7.1 ha as a result of a portion of the area being connected to the drainage system to the West based on the design report for the Bungalows of Ancaster development. This reduction in area will result in an overall reduction in flow to the downstream watercourse at culvert C12 after the Rymal Road improvements.

At outlet C13, the upstream Bungalows of Ancaster development includes an existing Stormwater management pond. The hydrologic model for this pond design was used in assessing the future flow conditions at this outlet including the full development of the Bungalows of Ancaster and the future Garner Road widening. However, because this is a fairly recent development, the natural pre-development flows to the watercourse South of Garner Road were also estimated for comparison. The future flows to this outlet after the Garner Road improvements were found to be generally lower than the flow rates for all return periods events except the two year storm. For the two year storm an increase of about 5.6% is predicted. However the future two-year flow is estimated to be about two thirds of the predevelopment flow at this location. Therefore, when considering the overall effect of the future development and the stormwater management pond, the flows downstream of culvert C13 will be significantly lower than the predevelopment flows.

Future peak flows are predicted to increase significantly at culverts C10 and C11 after the roadway is reconstructed and storm sewers installed. Both of these locations have catchment areas less than 2.0 ha and the future road area is a significant part of the total area in both cases. Although the magnitudes of the flows are small, the downstream watercourses are poorly defined and they are connected to designated wetland areas on Tiffany Creek to the South.

The results of the analysis for the Ancaster Creek watershed are summarized in Table 4b. The future downstream flows will be significantly reduced at culverts C14, C16, C17 and C18 in the Ancaster Creek watershed because the future Garner Road storm sewers will bypass these culverts to discharge to the principal drainage outlets. This does not constitute a diversion of flows from the existing outlets because these smaller culverts are now connected through roadside ditches to the same outlets. These culverts will be retained in the future design to accommodate external area flows.

Table 4a
Garner Road Tiffany Creek Culverts - Downstream Flows

No.	Sta.	Case	Catch-ment Area	Design Event							Comments
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Reg. Storm	
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	
C7	3+694	Exist.	147.90	1.058	1.875	2.467	3.281	3.858	4.454	10.506	Future condition includes Garner Rd. storm sewers from Sta. 3+270 to Sta. 3+880
		Future	149.96	1.057	1.870	2.460	3.270	3.845	4.438	10.436	
C8	3+270	Exist.	1.46	0.061	0.110	0.140	0.180	0.210	0.242	-	Future storm sewers to Raymond Road (Ancaster Meadow Ph.1)
		Future	1.29	0.028	0.051	0.069	0.094	0.112	0.131	-	
C9	3+040	Exist.	0.81	0.045	0.074	0.094	0.122	0.142	0.164	-	Future storm sewers to Raymond Road (Ancaster Meadow Ph.1)
		Future	0.35	0.013	0.023	0.031	0.043	0.051	0.060		
C10	2+845	Exist.	1.53	0.075	0.128	0.164	0.214	0.249	0.289	-	
		Future	1.69	0.132	0.199	0.246	0.310	0.350	0.403	-	
		Future Mitiga-tion	0.81	0.079	0.125	0.157	0.202	0.235	0.268		Road drainage only after full development of u/s area; Divert 115m of road drainage to Raymond Rd.
C11	2+620	Exist.	1.73	0.117	0.195	0.247	0.318	0.367	0.419	-	
		Future	1.86	0.159	0.247	0.308	0.388	0.445	0.502	-	
		Future Mitiga-tion	0.67	0.080	0.121	0.145	0.177	0.199	0.222		Road drainage only after full development of u/s area
C12	2+346	Exist.	9.32	0.287	0.502	0.652	0.866	1.018	1.163	1.265	Future u/s area reduced; diversion to Bungalows of Ancaster South SWM pond
		Future	7.08	0.263	0.446	0.607	0.816	0.964	1.125	0.950	
C13	1+190	Pre-dev.	15.42	0.318	0.580	0.781	1.066	1.274	1.487	1.714	Prior to development and SWM pond
		Exist.	14.94	0.193	0.363	0.534	0.787	0.991	1.195	1.534	OK. Q2<pre-development Q2.
		Future	15.03	0.204	0.358	0.530	0.779	0.981	1.173	1.529	

Table 4b
Garner Road Ancaster Creek Culverts - Downstream Flows

No.	Sta.	Case	Catch-ment Area	Design Event							Comments
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Reg. Storm	
			(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	
Outlets to East Ancaster Creek East Tributary											
C14	1+364	Exist.	**2.42**	**0.090**	**0.160**	**0.203**	**0.261**	**0.301**	**0.347**		Future storm sewers to C15
		Future	**1.52**	**0.028**	**0.053**	**0.073**	**0.130**	**0.122**	**0.144**		
C15	1+176	Exist.	**23.58**	**0.375**	**0.679**	**0.912**	**1.240**	**1.477**	**1.724**	**2.737**	Future includes diversion to Kitty Murray Lane of local major system and 0.055m^3/s to existing storm sewers. Peak flow control not required based on study of East Tributary of Ancaster Creek.
		Future	**24.28**	**0.475**	**0.773**	**0.965**	**1.258**	**1.495**	**1.744**	**2.805**	
C16		Exist.	**14.06**	**0.213**	**0.383**	**0.514**	**0.699**	**0.832**	**0.977**	**1.598**	Southcote Rd. South of Garner. Future storm sewers to C15
		Future	**12.85**	**0.191**	**0.353**	**0.476**	**0.649**	**0.702**	**0.907**	**1.473**	
C17	0+851	Exist.	**2.69**	**0.083**	**0.149**	**0.192**	**0.251**	**0.292**	**0.338**		Future storm sewers to C19
		Future	**2.73**	**0.040**	**0.075**	**0.101**	**0.140**	**0.168**	**0.197**		
Outlets to East Ancaster Creek											
C18	0+665	Exist.	**2.23**	**0.089**	**0.160**	**0.203**	**0.262**	**0.303**	**0.350**	-	Future Storm Sewers to C19
		Future	**2.28**	**0.029**	**0.055**	**0.075**	**0.015**	**0.127**	**0.150**	-	
C19	0+338	Exist.	**121.91**	**1.441**	**2.895**	**4.023**	**5.627**	**6.798**	**8.028**	**14.046**	Future condition includes Garner Rd. storm sewer drainage from Sta 0+000 to Sta 1+170 (west of Southcote Rd.)
		Future	**125.35**	**1.456**	**2.921**	**4.054**	**5.668**	**6.843**	**8.081**	**14.167**	
		Future Mitiga-tion	**122.25**	**1.424**	**2.870**	**3.984**	**5.569**	**6.724**	**7.942**	**13.861**	Diversion of Q5 and ½ major system flows to John Frederick Dr. (Ancaster Glen Ph.2)

At the remaining two outlets in the Ancaster Creek system at culverts C15 and C19, future peak flows will increase as a result of the discharge of the Garner Road storm sewers at these locations. The C15 outlet is on the East tributary of the East Ancaster Creek and it has been determined that peak flow controls are not required at this location. However, at the C19 outlet on East Ancaster Creek the peak flow increases may have a detrimental impact on the downstream watercourse.

6.1.3 Culvert Improvements

The future design flows were used to analyze potential impacts on the cross culverts that will be retained for the Garner Road section of the project. Design flows were based upon the future road widening and road storm sewer drainage connected to the culverts. In addition to hydraulic capacity, the condition of the existing culvert and physical constraints such as the depth of cover were also considered in the evaluation. Culverts that are in poor condition or are too shallow for the construction of the new roadway were recommended for replacement.

The results for the hydraulic analysis of the culverts are shown in Table 5. Only culverts C9 and C13 may be retained. All of the smaller culverts (700 mm to 800 mm diameter CSP's) are recommended for replacement with concrete pipes of equivalent diameter. At the existing 800 mm CSP culvert C 15 on the East tributary of East Ancaster Creek, future road overtopping is predicted for the 50 year event. It is recommended that this culvert be replaced with a 1000 mm concrete pipe to provide the 50 year capacity and protection against road overtopping for the Regional Storm.

At the Tiffany Creek crossing C7, the existing culvert has less than a 50 year capacity and the road will overtop by a depth of 0.3 m for the Regional Storm. This culvert is also very shallow, which may interfere with the construction of the new roadway widening. At this location is recommended that the existing culvert be replaced by a 2400 mm x 1220 mm concrete open footing box culvert with the invert filled to a depth of about 300 mm with round stone to provide an effective hydraulic opening 900 mm high. To provide additional cover, the invert should be lowered by about 150 mm.

At the East Ancaster Creek crossing, culvert C19, the freeboard for the hundred year storm is inadequate and the road overtops for the Regional Storm. This culvert is also too shallow for future road construction. As a result, it is recommended that this culvert be replaced with a 3660 mm x 1220 mm concrete open footing box culvert.

Table 5
Hydraulic Analysis of Centerline Culverts - Future Condition

Culvert ID	Station (sta.-m)	Type	Size Width (mm)	Size Height (mm)	Fut. Length (m)	Invert Elevations U/S (m)	Invert Elevations D/S (m)	U/S Culvert Obvert Elevation (m)	Centerline Road Elevation [1] (m)	Min. Road Elevation [2] (m)	Computed U/S Water Elevation 50 yr (m)	Computed U/S Water Elevation 100 yr (m)	Computed U/S Water Elevation Reg. St. (m)	Culvert Clearance [3] 50 yr (m)	Culvert Clearance [3] 100 yr (m)	Freeboard [4] 50 yr (m)	Freeboard [4] 100 yr (m)	Freeboard [4] Reg. St. (m)	Comments
C7 Existing	3+695	Conc. Box	1800	900	20.87	228.98	228.90	229.88	230.76	230.63	230.20	230.38	230.93	-0.32	-0.50	0.43	0.25	-0.30	>Q50 capacity; too shallow for road construction - Replace
C7 Proposed	3+695	Conc. Box	2400	1220	40.0	228.83	228.75	230.05	230.76	230.63	229.84	229.97	230.88	0.21	0.08	0.79	0.66	-0.25	Lower invert by 0.15m; fill base with round stone to depth of 0.3m. May connect storm sewers.
C8	3+269	CSP		800	39.0	235.96	235.85	236.76	237.86	237.78	236.21	236.23	n/a	0.55	0.53	1.57	1.55	n/a	Culvert damaged - replace; Storm sewers to Raymond Rd.
C9	3+040	CSP		750	35.0	238.30	238.19	239.05	239.76	239.63	238.47	238.49	n/a	0.58	0.56	1.16	1.14	n/a	Extend Culvert; Storm sewers to Raymond Rd.
C10	2+842	CSP		800	38.0	238.85	238.34	239.65	241.32	241.23	239.11	239.14	n/a	0.54	0.51	2.12	2.09	n/a	Culvert damaged - replace; May connect storm sewers
C11	2+619	CSP		800	38.0	241.42	241.06	242.22	243.30	243.15	242.56	242.58	n/a	-0.34	-0.36	0.59	0.57	n/a	Culvert damaged; replace
C11	2+619	Conc.		800	38.0	241.42	241.06	242.22	243.30	243.15	242.55	242.57	n/a	-0.33	-0.35	0.60	0.58	n/a	May connect connect storm sewers.
C12 Existing	2+345	CSP		800	15.4	242.80	242.31	243.60	245.00	244.91	243.70	243.95	n/a	-0.10	-0.35	1.21	0.96	n/a	d/s ditch eliminated by widening; small driveway culvert d/s.
C12 Proposed	2+345	Conc.		800	35.0	242.80	242.31	243.60	245.00	244.91	243.67	243.76	n/a	-0.07	-0.16	1.24	1.15	n/a	~Q50 Capacity. Relocate 20m east; May connect connect storm sewers.
C13	1+960	CSP		1,000	38.0	244.00	243.98	245.00	246.70	246.51	245.57	245.65	n/a	-0.57	-0.65	0.94	0.86	n/a	Pipes are new; Capacity <Q25 but freeboard is adequate. Extend culverts.
	1+960	CSP		600	38.0	244.00	243.98	244.60	246.70	246.51	245.57	245.65	n/a	-0.97	-1.05	0.94	0.86	n/a	
C14	1+364	CSP		700	36.8	247.92	247.77	248.62	249.25	249.25	248.29	248.33	n/a	0.33	0.29	0.96	0.92	n/a	Capacity OK. Cover < 0.5m. Replace at lower elevation with DI u/s. Storm sewers to C15.
C15 Existing	1+176	CSP		800	44.8	245.65	245.38	246.45	248.52	248.52	248.51	248.53	n/a	-2.06	-2.08	0.01	-0.01	n/a	Road may overtop for Q50. Inadequate capacity. Replace
C15 Proposed	1+176	Conc.		1,000	44.8	245.65	245.38	246.65	248.65	248.65	246.75	246.89	247.60	-0.10	-0.24	1.90	1.76	1.05	Q50 Capacity + Storm sewer connections; No overtopping for Reg. Storm.
C16	1+203 rt	CSP		600	19.25	246.62	246.54	247.22	248.59	248.59	248.08	248.09	n/a	-0.86	-0.87	0.51	0.50	n/a	Culvert located on Southcote Rd, Culvert damaged. Replace.
C16 Proposed	1+203 rt	Conc.		800	19.25	246.62	246.54	247.42	248.59	248.59	247.31	247.48	n/a	0.11	-0.06	1.28	1.11	n/a	Q50 capacity
C17	0+850	CSP		800	33.6	246.01	245.79	246.81	247.86	247.86	246.40	246.44	n/a	0.41	0.37	1.46	1.42	n/a	Culvert damaged; too shallow for future road construction. Replace at lower elevation with DI upstream.
C18	0+665	CSP		700	24.33	245.41	245.21	246.11	247.10	247.10	245.77	245.80	n/a	0.34	0.31	1.33	1.30	n/a	Culvert damaged; too shallow for future road construction. Replace at lower elevation with DI upstream.
C19	0+338	CSPA	2,440	1,750	42.0	239.83	239.23	241.58	242.02	241.98	241.65	241.86	242.11	-0.07	-0.28	0.33	0.12	-0.13	Too shallow for future road construction; Freeboard inadequate. Replace.
C19 Proposed	0+338	Conc. Box	3,660	1,220	42.0	239.83	239.23	241.05	242.02	241.98	241.00	241.13	241.62	0.05	-0.08	0.98	0.85	0.36	Q50 capacity (including storm sewers); No overtopping for Reg. Storm.

Notes:
[1] Distance from water elevation to culvert obvert.
[2] Distance from water elevation to minimum road EOP elevation.
[3] Centerline Road elevation adjacent to culvert
[4] Minimum road elevation for freeboard calculation.

6.2 Rymal Road Drainage to Twenty Mile Creek

6.2.1 Method

The Rymal Road culverts were not assessed for the future conditions because they will not receive road drainage in the future and the upstream design flows will be reduced. They have been evaluated as inlets to the proposed storm sewers on Rymal Road as discussed in Section However, for the Rymal Road and Garth Street sections discharging to the St. Elizabeth ponds, the change in peak inflow rates and volumes to the ponds were evaluated for the future condition with the proposed road improvements.

The Rymal Road outlet to the Twenty Mile Creek system consists of a 3000 mm x 1800 mm box storm sewer which discharges to Pond C in the St. Elizabeth Village. This pond system is presently under study by AECOM Ltd. to identify existing erosion and flooding problems and to recommend operational improvements and maintenance requirements. A hydrologic model (QUALHYMO) has been prepared for the St. Elizabeth Village study and the model and catchment definition was obtained for use in the present EA study. The QUALHYMO parameter data are comparable to OTTHYMO parameters allowing the AECOM model to be converted directly to the OTTHYMO format to create an existing condition model for Pond C. The pond rating curve data were taken directly from the AECOM model. The catchment areas containing Rymal Road and Garth Street were identified and the degree of imperviousness in each was increased to represent the proposed road improvements to create the future condition model. The existing and future conditions were analyzed with these models to determine the impact of the proposed road improvements on the St. Elizabeth Village Pond system.

6.2.2 Impact on St. Elizabeth Village Pond C

The results of the analysis are summarized in Table 6. Peak inflows to the pond are predicted to increase in the future from 7.8% to 3.4% for the 2-year to 100-year design events although the corresponding inflow volumes increased by 2.1% or less. The peak flow discharges from the pond will increase from 4.6% for the 2-year event to low of 2% for the 5-year event. The estimated total future pond volume ranges from 0.295 ha-m to 0.86 ha-m representing percentage increases of 5.0% for the 2-year event to 0.6% for the 100-year event. The largest percentage increase in volume used occurs for the 2-year and 5-year events even though the relative increase in inflow volumes is about the same for all events. This reflects the design of the outlet control structure to have a greater flow control function for the smaller

Table 6
Impact on St. Elizabeth Pond C

Design Storm	Condition	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Inflow Volume (mm)	Pond Volume Used (ha-m)
2-yr	Existing	**5.164**	**4.235**	**24.92**	**0.281**
	Future	**5.567**	**4.430**	**25.58**	**0.295**
	% Change	**7.8**	**4.6**	**1.0**	**5.0**
5-yr	Existing	**8.596**	**6.304**	**39.09**	**0.608**
	Future	**9.124**	**6.429**	**39.90**	**0.629**
	% Change	**6.1**	**2.0**	**2.1**	**3.5**
10-yr	Existing	**11.362**	**9.354**	**48.98**	**0.744**
	Future	**11.931**	**9.645**	**49.86**	**0.748**
	% Change	**5.0**	**3.1**	**1.8**	**0.5**
25-yr	Existing	**14.702**	**13.303**	**62.28**	**0.805**
	Future	**15.283**	**13.797**	**63.26**	**0.809**
	% Change	**4.0**	**3.7**	**1.6**	**0.5**
50-yr	Existing	**17.137**	**16.367**	**71.60**	**0.831**
	Future	**17.753**	**16.981**	**72.63**	**0.837**
	% Change	**3.6**	**3.8**	**1.0**	**0.7**
100-yr	Existing	**19.552**	**19.070**	**81.16**	**0.855**
	Future	**20.222**	**19.713**	**82.25**	**0.860**
	% Change	**3.4**	**3.4**	**1.3**	**0.6**

Based on these results, it would appear that the impact of the future Rymal Road and Garth Street improvements on Pond C in St. Elizabeth Village will not be significant, particularly for the larger storm events. The small increase in the total pond volume for the 100-year event will result in a negligible increase in the maximum water level. Furthermore, the relative impact will be further diminished in the pond system downstream of Pond C. However, water levels corresponding to smaller design events in the 2-year to 5-year range may show a greater increase and may affect considerations for the redesign of the pond outlet control structure and measures for flooding and erosion control currently being considered for the pond system. Peak flow conveyance downstream of Pond C may also be affected by flow increases in the order of 3% to 4%, assuming there is no modification to the pond volume or outlet control structure.

6.3 East Rymal Road and Garth Street North

6.3.1 Method

For the remaining areas of Rymal Road and Garth Street discharging to the Upper Ottawa Watershed storm sewer systems, future flows to the existing storm sewer systems were assessed using the Rational Method as part of the preliminary design process for the storm sewers. The future drainage conditions were used with the existing storm sewers on Garth Street and the east end of Rymal Road to determine if they are adequate for the proposed future condition and to identify potential impacts on the downstream systems.

6.3.2 Potential Future Impacts

The storm sewer design spreadsheets and supporting information are given in Appendix G. The existing and future design flows at the outlets are summarized in Table 7. It was found that the existing storm sewers are generally adequate for the future 5-year design flow conditions in all locations although, there will be minor surcharge in the storm sewers on Rymal Road between West 5th Street and Upper James Street. These results for Rymal Road are consistent with the results of the West Central Mountain Drainage Assessment Study by AMEC in 2011.

At the Rymal Road outlet to Upper James Street, the future 5-year design flow is estimated to be significantly lower than the original design allowance, based on the original design calculations obtained from the City (see Appendix G). However, this is based on the current drainage area boundaries defined in the AMEC study. These boundaries should be verified in preliminary design.

At the north end of Garth Street, the future design flows are predicted to increase due to the proposed road widening, which may impact the downstream storm sewer systems. At this location, the 5-year design flow will increase from 0.835m^3/s 1.0m^3/s (+19%), which could have a detrimental impact on the hydraulic capacity of the downstream storm sewers. The drainage area boundaries at this location should also be verified in the field in preliminary design, particularly the storm connections from the town house development to the west.

Notwithstanding the potential impact of these flow increases at Garth Street, there are no alternative outlets for the storm drainage from these sections of Garth Street or Rymal Road. The West Central Mountain Drainage Assessment Study did not include the storm drainage system downstream of the Garth Street location and an assessment of the hydraulic capacity of these systems was not available to this study. A quantitative assessment of the potential impact of the flow increases on the downstream storm sewers was also beyond the scope of the EA studies. However, before the proposed improvements are undertaken, the capacity of the downstream storm sewers at both the Rymal Road and Garth Street outlets should be reviewed with the City during preliminary design to verify that the works can be undertaken without causing unacceptable problems in the downstream systems.

6.3.3 Major System Flooding

There are also sag points in the Garth Street profile north of Regent Avenue at Sta. 0+660 and Sta. 0+900 that may cause flooding during major system flows events (i.e. greater than the 5-year storm). A relief storm sewer may be required for the 100-year flow from these sag pints to the outlet art Stone Church Road. Since this could provide an additional load on the downstream storm sewers, the need for the relief sewer and the potential downstream impact should be assessed further at preliminary design.

Table 7
Peak Flow Impacts at Garth St. North and Rymal Road East

Location	Outlet Pipe	Capacity	Existing (Design) Q5	Future Q5	% Change
		(m^3/s)	(m^3/s)	(m^3/s)	
Garth Street at Stone Church Road	750mm CP @0.53%	0.81	0.84	1.0	+19.0
Rymal Road at Upper James Street	900mm CP @0.55%	1.34	(1.839)	1.447	-21.4

6.4 Proposed Future Drainage Improvements

6.4.1 Tiffany Creek Culverts C10 and C11

Future peak flows are predicted to increase significantly at culverts C10 and C11 after the roadway is reconstructed and storm sewers installed. Lands on the North side of Garner Road at these locations are part of the Meadowlands Neighborhood 4 planning area. According to the Master Plan for these lands, the drainage North of Garner Road will be taken to the North, as shown in Figure 3. When this development occurs, the remaining drainage area to these outlets will consist entirely of Garner Road storm sewer discharge. Therefore future flows to these outlets will be reduced after the upstream lands develop. At culvert C10 it is also possible to divert about 100 m of road drainage by connecting the storm sewers from this area to the Raymond Road storm sewer.

As a result of these considerations, the ultimate flows to these outlets will be less than the current conditions after full development of the lands North of Garner Road and construction of the Garner Road storm sewers. However if the Garner Road widening takes place before the upstream development or only part of the Garner Road frontage is diverted to the North, additional erosion control measures may be required in the stream channels immediately downstream of these outlets.

6.4.2 East Ancaster Creek Culvert C19

At the West end of the project at the East Ancaster Creek outlet (culvert C19), peak flow increases can be mitigated by diverting the storm sewers from Garner Road to the North at the future John Frederick Drive in the Ancaster Glen Phase 2 development. This would have the additional benefit of providing water quality treatment for some of the Garner Road drainage in the proposed stormwater management pond in this development. The design data for the Ancaster Glen Phase 2 stormwater pond were obtained from the Ancaster Glen Phase 2 Functional Servicing Study Addendum Phase 2 Update (MTE Ltd. 2012). To analyze the impact of the additional flows on the Ancaster Glen pond, a hydrologic model was prepared from this data and verified against the results in the report. Additional drainage area representing storm sewers diversion from Garner Road was then added to the model with the purpose of determining the impact of the additional drainage area on the Ancaster Glen pond.

The standard for the Garner Road storm sewers is for a 5-year design capacity. However, The Ancaster Glen pond has been designed to control the 2-year flows from the subdivision area. Therefore, four design scenarios were evaluated: diversion of Garner Road flows up to the 2-year level and analyzed for the 2-year and 5-year design storms and diversion of Garner Road flows up to the 5-year level, also analyzed for the 2-year and 5-year design storms. For consistency with the functional design report, the 4-hour Chicago storm was used.

The modelling data and OTTHYMO outputs are given in Appendix F while the results are summarized in Table 8. If the only the 2-year flows are diverted from Garner Road, the pond volume used for the 2-year event would increase by about 400m^3 (12.9%). For the 5-year event, the total pond volume used would increase by only 191m^3 (4.1%). If the 5-yesar flow is diverted from Garner Road, the pond volumes increase very little over the 2-year diversion scenario. It would appear that it is feasible to consider the diversion of the Garner Road storm sewers to the Ancaster Glen South pond facility with relatively minor changes to the pond area and outlet control structure. It is recommended that the pond design be reviewed to confirm the feasibility of this revised design.

Table 8
Ancaster Glen South Pond Analysis

Case	Description		Q2-yr			Q5-yr		
	Design Storm	Diversion Flow to John Frederick Rd.	Pond Inflow	Pond Outflow	Total Storage Volume	Pond Inflow	Pond Outflow	Total Storage Volume
		(m^3/s)	(m^3/s)	(m^3/s)	(ha-m)	(m^3/s)	(m^3/s)	(ha-m)
MTE Study (2012)	Chicago 4hr	-	1.37	0.038	0.3014	-	-	-
EA Study Model Verification	Chicago 4hr	-	1.38	0.038	0.3004	2.08	1.20	0.4621
Flow Diversion Option 1	Chicago 4hr	Q2 = 0.294	1.61	0.040	0.3404 (+13.4%)	2.35	0.177	0.4812 (+4.1%)
Flow Diversion Option 2	Chicago 4hr	Q5 = 0.434	1.61	0.040	0.3404 (+13.4%)	2.48	0.181	0.4825 (+4.4%)

The diversion of storm sewer flows to John Frederick Drive will reduce flows to the East Ancaster Creek outlet C19. For the future condition, it was also assumed that the major system flows from the North side of Garner Road would be diverted to John Frederick Drive, although this will not affect the pond operation. The result of these measures is that the future flows downstream of culvert C19 will be slightly lower than the existing flows.

7. WATER QUALITY TREATMENT

The water quality treatment target for the watersheds study area is enhanced level I treatment based on the city of Hamilton and conservation authority design criteria. Opportunities for stormwater treatment for road projects are limited by the spatial constraints of the right-of-way. Ideally, stormwater management for roadways would be incorporated into conventional stormwater treatment for the adjacent development areas. For the Garner Road section of the project, this is proposed for the areas draining to the future Raymond Road storm sewer (Ancaster Meadow Phase 1), and a small section at Kitty Murray Lane connected to the bungalows of Ancaster stormwater management facility. It is also proposed to direct Garner Road drainage to the Ancaster: South stormwater management pond that John Frederick Drive stormwater management facility was currently proposed on the North side of Garner Road near Springbrook Drive. It may be possible to direct some of the Garner Road drainage to this facility but this has not yet been confirmed.

For the remaining sections of Garner Road, feasible measures are generally restricted to linear storage and infiltration type devices such as bio retention swales and exfiltration pipes or oil grit separators at the storm sewer outlets. Bio retention swales would increase the width of the required road platform by about 4 m which would extend beyond the available space within the proposed 36 m right-of-way. Exfiltration pipes and other infiltration type systems require pretreatment to remove sediments and are not generally recommended for roadway drainage systems due to maintenance concerns. For these reasons, recommended stormwater treatment method for the Garner Road drainage areas are not connected to other stormwater management facilities is oil grit separators at the storm sewer outlets.

For the Rymal Road and Garth Street sections in the Twenty Mile Creek watershed, stormwater treatment will be provided by the existing ponds and St. Elizabeth village. For Garth Street North and the East end of Rymal road, the storm sewers will be connected into the existing storm sewer systems of the Upper Ottawa Creek watershed and no additional stormwater management is proposed at these locations.

8. DRAINAGE AND STORMWATER MANAGEMENT PLAN

8.1 Design Details

Details of the proposed drainage and stormwater management plan are given in the Preliminary Design drawings in Appendix H and summarized in Table 9. Storm sewer design calculation sheets are given in Appendix G. Additional information is provided in the following sections.

8.2 Recommended Drainage Plan

The recommended future drainage improvements for Garner Road, Rymal Road and Garth Street include new crossing culverts and storm sewers on Garner Road, new storm sewers and storm relief sewers on Rymal Road, and ditch inlets at a number of locations to accommodate flows from external areas.

Most of the crossing culverts are recommended for replacement due to poor condition, lack of hydraulic capacity or insufficient depth for the new road construction. Larger replacement culverts are recommended at the East Ancaster Creek outlet C19, the East Ancaster Creek East Tributary outlet C 15 and the Tiffany Creek outlet C7.

The existing storm sewers have been utilized throughout. However, additional storm sewer capacity will be added to the section of Rymal Road discharging to the Twenty Mile Creek outlet at the St. Elizabeth Pond C. This will provide hydraulic relief to the existing Rymal Road storm sewer and reduce the flooding on Upper Paradise Road. At the sag locations on Garth Street north, the need for major system storm relief will further investigated at preliminary design.

8.3 Recommended Stormwater Management Plan

Water quality treatment will be provided in the adjacent subdivisions where possible. This is proposed at Raymond Road, Kitty Murray Lane, and John Frederick Drive. At the remaining sections Garner Road, oil grit separators will be utilized at the storm sewer outlets.

For the Rymal Road and Garth Street sections in the Twenty Mile Creek watershed, stormwater treatment will be provided by the existing ponds and St. Elizabeth Village. For Garth Street North and the East end of Rymal Road, the storm sewers will be connected into the existing storm sewer systems of the Upper Ottawa Creek watershed and no additional stormwater management is proposed at these locations.

9. EROSION AND SEDIMENT CONTROL

Erosion and sediment control measures are required during the road construction and after construction at the storm sewer outlets. A sediment and erosion control plan will be prepared in accordance with the policies and criteria of the Hamilton and Niagara Peninsula Conservation Authorities.

Table 9
Drainage and Stormwater Management Plan Summary

Outlet	Road Segment	Culvert	Minor System	Major System	SWM Treatment	Comments
Ancaster Creek Watershed						
C19 (Sta. 0+388) Ancaster Creek East Branch	0+734 to 0+388	Replace existing 2440mm x 1750mm CSPA with twin 1800m x 900m Open Footing Box Structure	Connected storm sewer to new culvert	To existing outlet to East Ancaster Creek at C19 (0+388)	OGS	• Culvert replacement due to lack of cover for new road. • Provide freeboard for 100-yr design.
C18 (Sta. 0+665)	n/a	Replace existing 700mm CSP with 800mm CP with u/s DI	No minor system connection	To existing outlet at C19 (0+388)	n/a	• Existing culvert is damaged. • Drains upstream external area only. • Deepen culvert to provide adequate clearance for new road structure.
Future John Frederick Drive (0+734)	1+170 to 0+734	n/a	Connected storm sewers to future storm sewer on John Frederick Dr.	North side major system to John Frederick Dr.; south side to C19 (0+388)	Connection to Ancaster Glen SWM Pond 2	• Review design of Ancaster Glen Pond 2 with the proposed Garner Rd. drainage connection. • Estimated maximum additional volume is 210m^3 for the 5-year design
C17 (Sta. 0+850)	n/a	Replace existing 800mm CSP with 800mm CP with u/s DI	No minor system connection	To existing outlet at C19 (0+388)	n/a	• Existing culvert is damaged. • Drains upstream external area only. • Deepen culvert to provide adequate clearance for new road structure.
C15 (Sta. 1+176) Ancaster Creek East Branch - East Tributary	1+760 to 1+176	Replace existing 800mm CSP with 1000mm CP	Connect storm sewer to new culvert. Connect north side road drainage from 1+760 to 1+614 to existing Kitty Murray Lane storm sewer.	Outlet to Kitty Murray Lane/Smith Road (1+614) and C15 (1+176)	OGS	• Culvert replacement due to insufficient capacity; Provide freeboard for 100-yr design. • Diversion of Storm sewer flow to Kitty Murray Lane up to design allowance of 55L/s. • Local peak flow increases but quantity control is not required on this watercourse per Garner Neighborhood Master Drainage Plan. • Provide erosion control in d/s watercourse.

Table 9
Drainage and Stormwater Management Plan Summary

Outlet	Road Segment	Culvert	Minor System	Major System	SWM Treatment	Comments
C14 (Sta 1+364)	n/a	Replace existing 700mm CSP with 800mm CP with u/s DI	No minor system connection	To existing outlet at C15 (1+176)	n/a	• Drains upstream external area only. • Deepen culvert to provide adequate clearance for new road structure.
Tiffany Creek Watershed						
C13 (Sta 1+960)	1+760 to 1+960	Existing 1000mm + 600mm culverts are adequate	Connect storm sewer to new culvert.	To existing outlet at C13 (1+960)	OGS	• d/s of existing Bungalows of Ancaster SWM pond
C12 (Sta 2+346)	1+960 to 2+425	Replace existing 800mm CSP with 800mm CP located 24m east at 2+370	Connect storm sewers to new culvert.	To existing outlet at 2+360	2 OGS (east and west)	• Future upstream area reduced due to partial diversion to Bungalows of Ancaster SWM pond • Remaining area assumed to be equivalent to pre-development conditions.
C11 (Sta 2+620)	2+425 to 2+620	Replace existing 800mm CSP with 800mm CP	Connect storm sewer to new culvert.	To existing outlet at 2+620	OGS	• Culvert damaged • Provide erosion control in d/s watercourse
C10 (Sta 2+842)	2+620 to 2+870	Replace existing 800mm CSP with 800mm CP	• Road drainage from 2+750 to 2+870 conveyed to Raymond Road outlet. • Connect storm sewer to new culvert.	To existing outlet at 2+870	OGS	• Culvert damaged • Provide erosion control in d/s watercourse
C9 (Sta 3+040)	n/a	Extend existing 750mm CSP Culvert	No minor system connection	To Raymond Road.	To Ancaster Meadow Phase 1 SWM	• The existing Raymond Road storm sewer design includes drainage from Garner Rd.
Raymond Road (Sta 3+125)	2+750 to 3+265	Existing 600mm storm sewer	Connect Garner Road storm sewers from west of C10 to C8	To Raymond Road.	To Ancaster Meadow Phase 1 SWM	• Garner Rd. drainage to the existing Raymond Road storm sewer up to the design allowance of 0.37m3/.
C8 (Sta 3+270)	n/a	Replace existing 800mm CSP with 800mm CP	No minor system connection	To Tiffany Creek C7 (3+694)	OGS at C7 outlet	• The existing Raymond Road storm sewer design includes drainage from Garner Rd.

Table 9
Drainage and Stormwater Management Plan Summary

Outlet	Road Segment	Culvert	Minor System	Major System	SWM Treatment	Comments
C7 (Sta 3+270)	3+265 to 3+880	Replace existing 1800mm x 900mm structure with 2400mm x 1200mm Conc. Open Footing Box Structure	Connect storm sewer to new culvert.	To existing Tiffany Creek C7 outlet (3+694)	2 OGS (east and west)	• Existing culvert may be too shallow for road widening and reconstruction. • Lower invert by 0.15m. • Fill bottom with roundstone to provide a minimum conveyance depth of 900mm.
Twenty Mile Creek Watershed						
Garth Street Storm sewers (Sta 4+990)	0+480 to 0+000	Use existing storm sewers	Connect all of the new road drainage to the existing storm sewers	To existing outlet at St. Elizabeth Village Pond C (Garner 5+078)	Treatment in existing St. Elizabeth Village Pond system.	• Existing storm sewers are adequate for the future road widening.
Rymal Road West storm sewers (Sta 5+348)	3+880 to 5+535	New storm sewers for Rymal Road drainage	Connect all of Rymal Road drainage and external areas to the new storm sewers. Cross over existing Rymal Road Box storm sewer	To existing outlet at St. Elizabeth Village Pond C (5+078)	Treatment in existing St. Elizabeth Village Pond system.	• Pick up Q100 from external area connections. • New storm sewer provides relief to the existing Rymal Road Box storm sewer. • Possible over-sizing to provide additional relief – to be addressed in preliminary design.
C6 (Sta 4+230)	3+880 to 4+253	Replace existing 1500mm CSP with a Ditch Inlet and 600mm CP	Connect to new Rymal Road storm sewer	To existing outlet at St. Elizabeth Village Pond C (5+078)	Treatment in existing St. Elizabeth Village Pond system.	• External drainage area only. • Pre-development area reduced by construction of Upper Paradise Storm sewer south of Rymal Road. • Design for Q100 external area flow.
C5 (Sta 4+500)	4+253 to 4+565	Replace existing 1200mm CSP with a Ditch Inlet and 600mm CP	Connect to new Rymal Road storm sewer	To existing outlet at St. Elizabeth Village Pond C (5+078)	Treatment in existing St. Elizabeth Village Pond system.	• External drainage area only. • Design for Q100 external area flow.
C4 (Sta 4+903)	4+565 to 4+990	Replace existing 1200mm CSP with a Ditch Inlet and 600mm CP	Connect to new Rymal Road storm sewer	To existing outlet at St. Elizabeth Village Pond C (5+078)	Treatment in existing St. Elizabeth Village Pond system.	• External drainage area only. • Design for Q100 external area flow.

Table 9
Drainage and Stormwater Management Plan Summary

Outlet	Road Segment	Culvert	Minor System	Major System	SWM Treatment	Comments
C3 Sta 5+078)	n/a	Extend existing 920mm x 920mm conc. Box Culvert	No minor system connection	To existing outlet at St. Elizabeth Village Pond C (5+078)	Treatment in existing St. Elizabeth Village Pond system.	• External drainage area only. • Design for Q100 external area flow.
C2 (Sta 5+348)	n/a	Replace existing 450mm CSP with a Ditch Inlet and 450mm Conc. pipe	Connect to new Rymal Road storm sewer	To existing outlet at St. Elizabeth Village Pond C (5+078)	Treatment in existing St. Elizabeth Village Pond system.	• External drainage area only. • Design for Q100 external area flow.
Upper Ottawa Creek Watershed						
Garth Street Storm sewers (Sta 1+020)	0+480 to 1+020	Use existing storm sewers	Connect all of the new road drainage to the existing storm sewers	To existing Garth Street outlet at Stone Church Road	Treatment in existing d/s storm sewer system.	• Existing storm sewers are adequate for the 5-year design flow and future road widening. • Relief storm sewer may be required for Q100 from sag at 0+900 to outlet – to be addressed at preliminary design.
Rymal Road East (Sta 6+225)	5+535 to 6+225	Use existing storm sewers	Connect to existing storm sewers.	To existing outlet west on Rymal Road	Treatment in existing d/s storm sewer system.	
C1 (Sta 6+093)	n/a	Replace existing 450mm CSP with a Ditch Inlet and 450mm Conc. pipe	Connect to new Rymal Road storm sewer	To existing outlet west on Rymal Road		• External drainage area only. • Design for Q100 external area flow.

Appendix A

Culvert Inspection Photographs

Culvert 1: Inlet End

Culvert 1: Looking Inside at Culvert Inlet End

Culvert 1: Outlet End

Culvert 1: Looking Inside at Culvert Outlet End

Culvert 2: Inlet End

Culvert 2: Looking Inside at Culvert Inlet End

Culvert 2: Outlet End (Not located)

Culvert 3: Inlet End

Culvert 3: Looking Inside at Culvert Inlet End

Culvert 3: Outlet to the Pond

Culvert 3: Looking Inside at Culvert Outlet End

Culvert 4: Inlet End

Culvert 4: Looking Inside at Culvert Inlet End

Culvert 4: Outlet Connected to the Storm MH

Culvert 5: Inlet End

Culvert 5: Looking Inside at Culvert Inlet End

Culvert 5: Outlet Connected to the Storm MH

Culvert 6: Inlet End

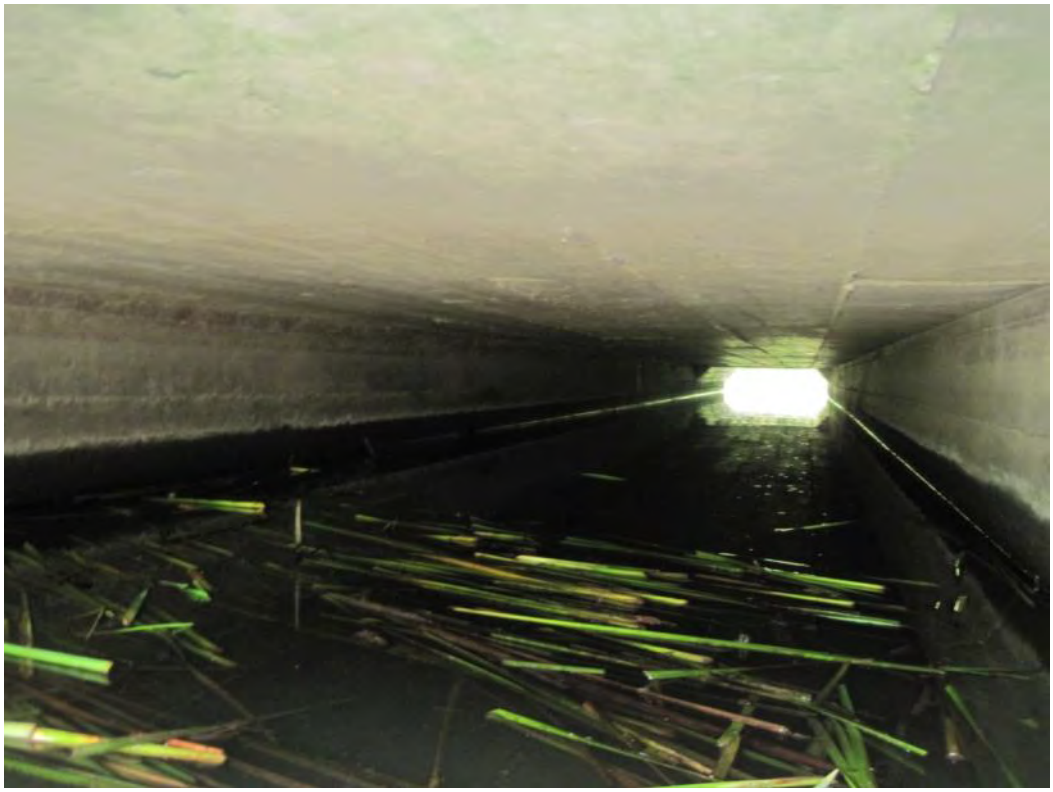
Culvert 6: Looking Inside at Culvert Inlet End

Culvert 6: Outlet Connected to the Storm MH

Culvert 7: Inlet End

Culvert 7: Looking Inside at Culvert Inlet End

Culvert 7: Outlet End



Culvert 7: Looking Inside at Culvert Outlet End

Culvert 8: Inlet End

Culvert 8: Looking Inside at Culvert Inlet End

Culvert 8: Outlet End

Culvert 8: Looking Inside at Culvert Outlet End

Culvert 9: Inlet End

Culvert 9: Looking Inside at Culvert Inlet End

Culvert 9: Outlet End

Culvert 9: Looking Inside at Culvert Outlet End

Culvert 10: Inlet End

Culvert 10: Looking Inside at Culvert Inlet End

Culvert 10: Outlet End

Culvert 10: Looking Inside at Culvert Outlet End

Culvert 11: Inlet End

Culvert 11: Looking Inside at Culvert Inlet End

Culvert 11: Outlet End

Culvert 11: Looking Inside at Culvert Outlet End

Culvert 12: Inlet End

Culvert 12: Looking Inside at Culvert Inlet End

Culvert 12: Outlet End

Culvert 12: Looking Inside at Culvert Outlet End

Culvert 13: Inlet End

Culvert 13: Outlet End

Culvert 14: Inlet End

Culvert 14: Looking Inside at Culvert Inlet End

Culvert 14: Outlet End

Culvert 14: Looking Inside at Culvert Outlet End

Culvert 15: Inlet End

Culvert 15: Outlet End

Culvert 16: Inlet End

Culvert 16: Looking Inside at Culvert Inlet End

Culvert 16: Outlet End

Culvert 16: Looking Inside at Culvert Outlet End

Culvert 17: Inlet End

Culvert 17: Looking Inside at Culvert Inlet End

Culvert 17: Outlet End

Culvert 17: Looking Inside at Culvert Outlet End

Culvert 18: Inlet End

Culvert 18: Looking Inside at Culvert Inlet End

Culvert 18: Outlet End

Culvert 18: Looking Inside at Culvert Outlet End

Culvert 19: Inlet End

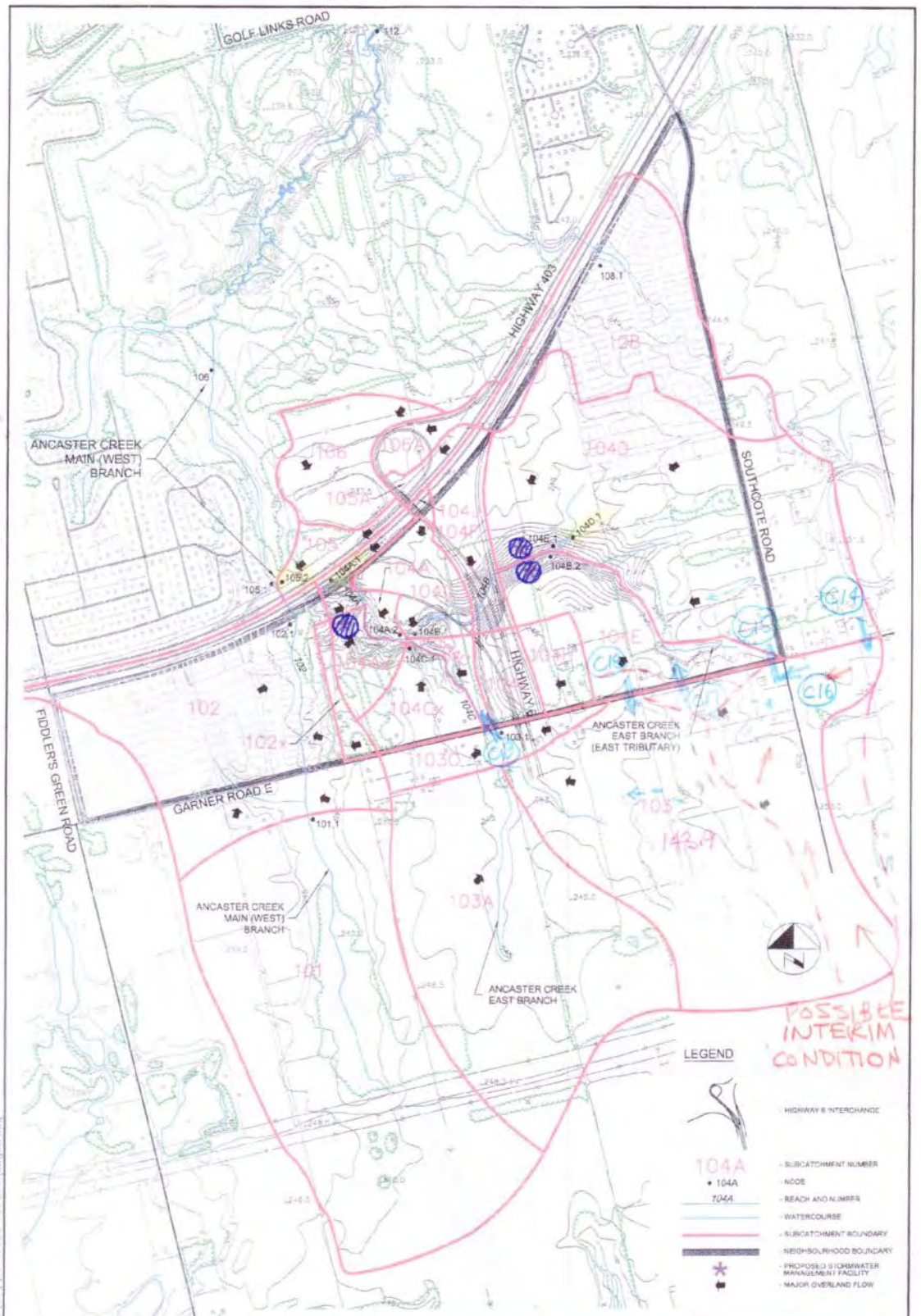
Culvert 19: Looking Inside at Culvert Inlet End

Culvert 19: Outlet End

Culvert 19: Looking Inside at Culvert Outlet End

Appendix B

Hydrologic Data



GARNER NEIGHBOURHOOD
MASTER DRAINAGE PLAN

CITY OF HAMILTON

FUTURE SUBCATCHMENT BOUNDARIES
FOR DETAILED EROSION ASSESSMENT

PHILIPS ENGINEERING

Project No.	92018
Date	OCTOBER 2006
Scale	1:10,000
Drawing No.	3B

TABLE 3.1
HYDROLOGIC PARAMETERIZATION

Sub-Area No.	Area (ha)	CN AMC-II	Soil Class	Ia (mm)	Tp (hrs)	TIMP (%)	XIMP (%)	Algorithm Type
Existing Land Use								
101	76.6	65.8	A/B	10.1	0.632	N/A	N/A	RURAL
102	44.4	51.0	A/B	18.3	N/A	0.22	0.22	URBAN
103	137.4	66.9	A/C	9.9	0.600	N/A	N/A	RURAL
104A	12.6	68.0	B	9.7	0.238	N/A	N/A	RURAL
104B	15.6	62.0	A/B	11.7	0.254	N/A	N/A	RURAL
104C	16.2	69.0	B	9.5	0.241	N/A	N/A	RURAL
104D	24.8	58.0	A/B	13.8	N/A	N/A	N/A	URBAN
104E	43.0	58.0	A/B	13.8	0.354	N/A	N/A	RURAL
108	23.3	52.0	A/B	17.6	N/A	0.25	0.25	URBAN
Future Land Use								
101	76.6	65.8	A/B	10.1	0.632	N/A	N/A	RURAL
102	44.4	51.0	A/B	19.0	N/A	0.24	0.24	URBAN
103A	52.1	66.9	A/C	9.9	0.62	N/A	N/A	RURAL
103B	80.5	66.9	A/C	9.9	0.57	N/A	N/A	RURAL
103C	4.8	66.9	A/C	9.9	0.17	N/A	N/A	RURAL
104A	8.2	68.0	B	9.7	0.24	N/A	N/A	URBAN
104B	6.3	62.0	A/B	11.7	0.19	N/A	N/A	URBAN
104C	9.5	69.0	B	9.5	0.19	N/A	N/A	URBAN
104D	13.6	58.0	A/B	13.8	0.17	N/A	N/A	URBAN
104E	43.0	58.0	A/B	13.8	0.35	N/A	N/A	URBAN
104F	8.9	62.0	B	11.7	N/A	18	N/A	URBAN
104G	4.2	62.0	A/B	11.7	0.17	N/A	N/A	URBAN
104H	3.1	69.0	B	9.5	0.17	N/A	N/A	URBAN
104I	3.6	69.0	A/B	9.5	N/A	36	N/A	URBAN
104J	1.1	68.0	A/B	9.7	N/A	9	N/A	URBAN
105	3.2	60.0	B	12.8	0.24	N/A	N/A	URBAN
105A	2.0	60.0	A/B	12.8	N/A	15	N/A	URBAN
106	8.9	60.0	B	12.8	0.24	N/A	N/A	URBAN

TO → C19

GARNER NEIGHBORHOOD MDP - PHILIPS ENG
OCT. 2006

APPENDIX I

SUPPLEMENTARY FLOODING ANALYSIS

The hydrologic analysis in Section 3 has demonstrated that future land use peak flows at Highway 403 exhibit little or no change for events less frequent than the 5 year return period. However, the frequent event (2 year return period) would increase by over 30 % based on future, uncontrolled conditions; and would increase by 15 % under future, controlled conditions (ref. Table I1, Node 105.2).

On the eastern branch of the Ancaster Creek, on Reach 104B (ref. Drawing 3A), the hydrologic analyses has demonstrated that the future land use peak flows would increase for all of the return period events (i.e. 2 to 100 year). These increases would result in higher water levels, however the Ancaster Creek in this location flows through a deep, densely vegetated, well-defined valley, and the limits of flooding would only increase marginally. There are no existing structures within the Regional flood plain, however the proposed Highway 6 (New) interchange would potentially be negatively impacted by unmitigated increases in peak flow.

Typically, stormwater management controls have been implemented to reduce post development peak flows to pre-development levels, effectively eliminating any potential flooding impact. However, additional constraints/impacts may arise as the result of the implementation of stormwater management. In this particular case, implementing flood control in the form of storage on the developing reaches of the creek within the Garner Neighbourhood would increase the less frequent event peak flows and hence increase the flooding potential on the downstream reaches of the creek.

Table I1 demonstrates the downstream effect at Node 105.2 of controlling the major event peak flow increases on-site at Nodes 104D.1 and 104.1 using the post- to pre- criterion.

Implementing flood control in the form of storage within the Garner Neighbourhood would delay discharge of the more urbanized peak flows, and thereby tend to synchronize the peak flows with those generated by the large, rural subcatchment south of Garner Road (ref. Drawing 3A). This "management" of peak flows on one tributary of the Ancaster Creek would contribute to the increase of peak flows less frequent than the 10 year event and increase flooding potential on the remaining downstream reaches of the creek.

This increase in the less frequent peak flows has also been determined to occur on-site, at the confluence of the eastern tributary to the east branch and the east branch (Node 104A.2, ref. Table I2).

Garner Nbhd
MDP - Philips oc

TABLE I1

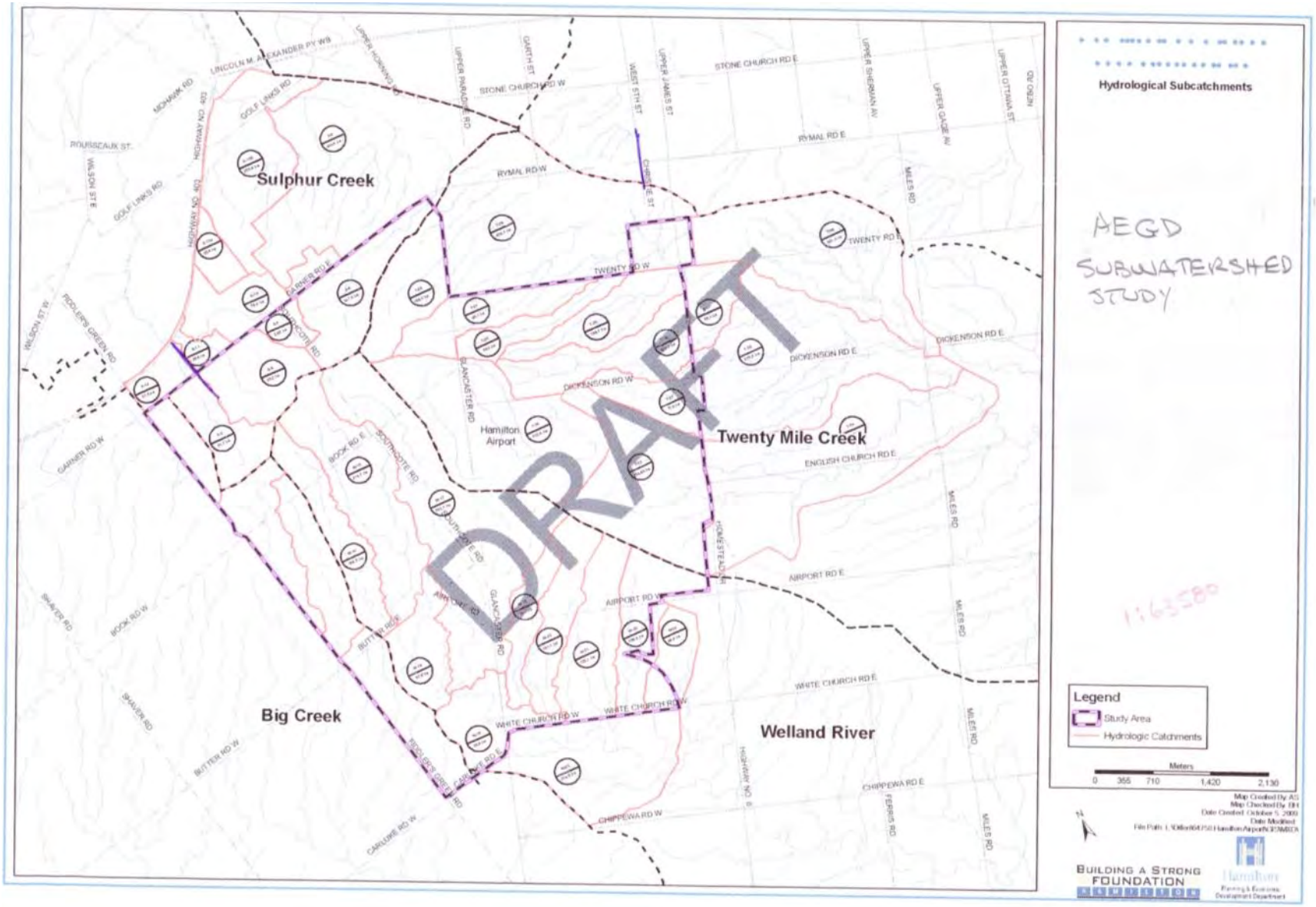
PEAK FLOW SUMMARY DOWNSTREAM OF HIGHWAY 403
AT OTTHYMO89 NODE 105.2

Event Frequency (Yrs)	Existing	Future (No Controls)	Future Controlled at Nodes 104D.1, 104E.1
2	2.30	3.04	2.66
5	4.63	4.88	4.85
10	6.19	6.38	6.38
25	8.58	8.63	8.68
50	10.49	10.42	10.48
100	12.54	12.37	12.46
Regional	33.81	33.42	34.17

TABLE I2

PEAK FLOW SUMMARY
AT OTTHYMO89 NODE 104A.2

Event Frequency (Yrs)	Existing	Future (No Controls)	Future Controlled at Nodes 104D.1, 104E.1
2	1.80	2.76	2.12
5	3.45	4.16	3.61
10	4.75	5.14	4.79
25	6.16	6.49	6.48
50	8.18	7.42	7.88
100	9.83	9.10	9.41
Regional	25.89	24.95	24.93


Hydrological Subcatchments
AEGD
SUBWATERSHED
STUDY
1:63580
Sulphur Creek
Twenty Mile Creek
Big Creek
Welland River
Hamilton Airport
DRAFT
Legend
Study Area
Hydrologic Catchments
Meters
0 355 710 1,420 2,130
Map Created By: AS
Map Checked By: BH
Date Created: October 5, 2009
Date Modified:
BUILDING A STRONG FOUNDATION
REMEMBER
Hamilton
Planning & Economic Development Department

	B	C	D	E	F	G	H	I	J	K	L	M
3	Subcatchment	Instantaneous	Drainage	Runoff	Curve	Initial Abstraction (mm)		Imperviousness (%)				
4	I.D.	Unit Hydrograph	Area	Coefficient	Number	Pervious	Impervious	Direct	+	Indirect	=	Total
5		Classification	(ha)	(<10 Year)								
6	***Existing Conditions***											
7	1-5	Nash	81.7	0.26	68	11.95	n/a	2	+	3	=	4
8	1-6	Nash	99.2	0.32	73	9.39	n/a	4	+	2	=	5
9	1-7	Standard	26.2	0.56	70	10.89	2.00	47	+	0	=	47
10	1-8	Nash	147.9	0.39	77	7.59	n/a	18	+	3	=	21
11	1-9	Standard	424.8	0.39	69	11.41	2.00	20	+	3	=	24
12	1-10	Nash	78.1	0.35	72	9.88	n/a	18	+	2	=	20
13	1-11	Standard	20.6	0.37	61	16.24	2.00	25	+	3	=	28
14	1-12	Standard	37.5	0.61	61	16.24	2.00	58	+	5	=	63
15	1-13A	Standard	35.6	0.59	61	16.24	2.00	55	+	6	=	61
16	1-13B	Standard	200.9	0.60	66	13.08	2.00	55	+	4	=	60
17												
18												
19												
20	TIFFANY CREEK AT GARNER RD											
21												
22												
23												
24												
25												

Garner/Rymal Road Culverts
CN Calculations

Sub-catch-ment No.	Catch. Area	Soil Type	Hydro-logic Group	Soil Area	CN Values for Land Cover Categories: Forest/Wetland Area	Forest/Wetland CN	Crops Area	Crops CN	Fallow/Meadow Area	Fallow/Meadow CN	Roads (Excl. Garner/Rymal ROW) Area	Roads CN	Urban/ Farmsteads Area	Urban/ Farmsteads CN	Total Area	Weighted CN
2	2.65	BRANTFORD/GRIMSBY Sandy/Silt loam	AB	2.65	0.25	40			2.18	44	0.12	78	0.10	67	2.65	**46.0**
3	11.00	BRANTFORD/GRIMSBY Sandy/Silt loam	AB	11.00	3.00	40			7.4	44	0.2	78	0.40	67	11.00	**44.4**
4	2.97	BRANT silt loam	B	2.97					1.5	58			1.47	74	2.97	**65.9**
5	7.81	BRANT silt loam	B	7.81	5.98	55							1.83	74	7.81	**59.5**
6	1.92	BRANT silt loam	B	1.92									1.92	74	1.92	**74.0**
8	1.2	GRIMSBY/BRANT Sandy/Silt loam	AB	1.20									1.20	67	1.20	**67.0**
9	0.64	GRIMSBY/BRANT Sandy/Silt loam	AB	0.64									0.64	67	0.64	**67.0**
10	1.29	GRIMSBY/BRANT Sandy/Silt loam	AB	1.29									1.29	67	1.29	**67.0**
11	1.52	BEVERLY silt loam	C	1.52		70	1.37	83				90	0.15	82	1.52	**82.9**
12	8.56	GRIMSBY/BRANT Sandy/Silt loam	A	2.57			2.12	63			0.20	74	0.25	59	2.57	19.1
		BEVERLY silt loam	C	5.99	1.00	70	4.49	83			0.25	90	0.25	82	5.99	56.7
		Catchment Totals:		8.56											8.56	**75.8**
13	15.42	SPRINGVALE sandy loam	A	11.58		25	10.40	63			0.18	74	1.00	59	11.58	47.2
		GRIMSBY/BRANT Sandy/Silt loam	AB	3.84		40	3.79	69				87	0.05	67	3.84	17.2
		Catchment Totals:		15.42											15.4	**64.4**
14	1.57	SPRINGVALE sandy loam	A	1.57	0.20	25	1.12	63				74	0.25	59	1.57	**57.5**
15	8.9	SPRINGVALE sandy loam	A	5.30			4.48	63			0.57	74	0.25	59	5.30	38.1
		BEVERLY silt loam	C	3.60	2.50	70	1.10	83				90		82	3.60	29.9
		Catchment Totals:		8.90											8.90	**68.0**
16	11.1	SPRINGVALE sandy loam	A	6.90			6.20	63			0.57	74	0.13	59	6.90	39.7
		BEVERLY silt loam	C	4.20	2.50	70	1.70	83				90		82	4.20	28.5
		Catchment Totals:		11.10											11.1	**68.2**
17	1.61	SPRINGVALE sandy loam	A	1.61		25	1.36	63				74	0.25	59	1.61	**62.4**
18	1.55	SPRINGVALE sandy loam	A	1.35	0.20	25	1.02	63				74	0.13	59	1.35	49.6
		GRIMSBY/BRANT Sandy/Silt loam	AB	0.20	0.15	40	0.05	69				87		67	0.20	6.1
		Catchment Totals:		1.55											1.6	**55.7**

Total: 23.12

Garner/Rymal Road Culverts
Time to Peak Calculations

Catch-ment No.	Length	Delta H	Slope		Area	CN	C	Watt & Chow	Bransby-Williams		Airport Method		SCS CN Method	Kirpich Formula		Avg.	Comments
								Tp	Tc	Tp	Tc	Tp	Tp	Tc	Tp	Tp	
	(m)	(m)	(%)	(m/m)	(ha)			(hrs)	(mins)	(hrs)	(mins)	(hrs)	(hrs)	(hrs)	(hrs)	(hrs)	
2	150	4.5	3.00	0.0300	2.65	46.0	0.2	0.07	6.23	0.06	25.01	0.25	0.26	0.12	0.07	**0.25**	
3	450	13.5	3.00	0.0300	11.00	44.4	0.2	0.16	16.20	0.16	43.31	0.43	0.64	0.27	0.16	**0.54**	
4	400	6.0	1.50	0.0150	2.97	65.9	0.2	0.19	18.9	0.2	51.33	0.51	0.48	0.33	0.20	**0.50**	
5	400	3.0	0.75	0.0075	7.81	59.5	0.2	0.26	19.7	0.2	64.52	0.65	0.79	0.42	0.25	**0.72**	
6	150	3.5	2.33	0.0233	1.92	74.0	0.2	0.08	6.76	0.07	27.17	0.27	0.14	0.13	0.08	**0.21**	
8	200	1.0	0.50	0.0050	1.20	67.0	0.2	0.17	12.86	0.13	52.16	0.52	0.46	0.29	0.17	**0.23**	
9	120	1.0	0.83	0.0083	0.64	67.0	0.2	0.09	7.42	0.07	34.13	0.34	0.24	0.16	0.10	**0.15**	Tp=0.15 minimiu
10	150	1.0	0.67	0.0067	1.29	67.0	0.2	0.12	9.04	0.09	41.08	0.41	0.32	0.21	0.13	**0.16**	
11	150	1.0	0.67	0.0067	1.52	82.9	0.2	0.12	8.89	0.09	41.08	0.41	0.20	0.21	0.13	**0.15**	Tp=0.15 minimiu
12	375	2.0	0.53	0.0053	8.56	75.8	0.2	0.28	19.56	0.20	69.91	0.70	0.58	0.46	0.28	**0.33**	
13	500	5.0	1.00	0.0100	15.42	64.4	0.2	0.27	21.68	0.22	65.61	0.66	0.73	0.45	0.27	**0.37**	Pre-development
14	200	1.0	0.50	0.0050	1.57	57.5	0.2	0.17	12.52	0.13	52.16	0.52	0.59	0.29	0.17	**0.27**	
15	500	3.0	0.60	0.0060	8.90	68.0	0.2	0.33	25.37	0.25	77.65	0.78	0.85	0.55	0.33	**0.51**	
16	600	3.5	0.58	0.0058	11.10	68.2	0.2	0.39	29.94	0.30	85.86	0.86	1.00	0.64	0.38	**0.59**	

Google earth

miles 3
km 5

KITTYMINERY
SPRING BROOK
UPPER PARADISE
STONE CHURCH
GARNER
GARTH
RYNAL
WEST STH
UPPER JAMES
Ti:B0
6:e0
Bl:c0
Sp:d1
Bl:C0
800
Bl:e0
Bl:
C0
To:B0
Br:c0
Ti:A0
4:d0
Gl:e0
4:f0
Br:
d0
Sp:cl
Co:A0
Br:d0
Ar:B0
To:b0

TYPE

MAP SYMBOL	SOIL TYPE	ACREAGE	GREAT GROUP	PARENT MATERIALS	SOIL MOISTURE CL
Al	ALBERTON silt loam	8,870	Mull Regosol	Silt loam over clay	Variable
Ab	ALBERTON silty clay loam	2,510	Mull Regosol	Silty clay loam over clay	Variable
An	ANCASTER silt loam	5,850	Gray-Brown Podzolic	Silty clay loam till	Well drained
Bv	BEVERLY silty clay loam	1,380	Gray-Brown Podzolic	Lacustrine silty clay loam and silty clay	Imperfectly drained
Bl	BEVERLY silt loam	11,490	Gray-Brown Podzolic	Lacustrine silty clay loam and silty clay	Imperfectly drained
Bm	BEVERLY silt loam — shallow phase	6,550	Gray-Brown Podzolic	Lacustrine silty clay loam and silty clay	Imperfectly drained
Br	BINBROOK silt loam	16,870	Gray-Brown Podzolic	Silt loam over clay till	Imperfectly drained
Bt	BRANT silt loam	7,530	Gray-Brown Podzolic	Water deposited silt loam and fine sandy loam	Well drained
Bs	BRANT silt loam — shallow phase	870	Gray-Brown Podzolic	Water deposited silt loam and fine sandy loam	Well drained
Bh	BRANTFORD silt loam	15,730	Gray-Brown Podzolic	Lacustrine silty clay loam and silty clay	Well drained
Bu	BURFORD loam	2,960	Gray-Brown Podzolic	Loam over outwash gravel	Well drained
Ch	CHINGUACOUSY loam	1,900	Gray-Brown Podzolic	Clay loam till	Imperfectly drained
Cl	CHINGUACOUSY silt loam	870	Gray-Brown Podzolic	Clay loam till	Imperfectly drained
Cm	CHINGUACOUSY silt loam — shallow phase	830	Gray-Brown Podzolic	Clay loam till	Imperfectly drained
Co	COLWOOD silt loam	1,120	Humic Gleysol	Water deposited silt loam and fine sandy loam	Poorly drained
Cd	COLWOOD silt loam — shallow phase	1,490	Humic Gleysol	Water deposited silt loam and fine sandy loam	Poorly drained
Dn	DONNYBROOK gravelly loam	450	Gray-Brown Podzolic	Glacial gravel and coarse sandy gravel	Well drained
Du	DUMFRIES loam	9,930	Gray-Brown Podzolic	Generally stony clay till	Well drained
Dc	DUMFRIES loam — stony phase	1,840	Gray-Brown Podzolic	Generally stony clay till	Well drained
Dh	DUMFRIES loam — shallow phase	1,220	Gray-Brown Podzolic	Generally stony clay till	Well drained
Fl	FARMINGTON loam	1,880	Brown Forest	Lime rich till over lime rich bedrock	Well drained
Fb	FLAMBORO sandy loam	3,130	Humic Gleysol	Water deposited medium and fine sand	Poorly drained
Fl	FLAMBORO sandy loam — shallow phase	1,870	Humic Gleysol	Water deposited medium and fine sand	Poorly drained
Gu	GUELPH loam	13,130	Gray-Brown Podzolic	Loam till	Well drained
Gh	GUELPH loam — shallow phase	1,790	Gray-Brown Podzolic	Loam till	Well drained
Gr	GRANBY sandy loam	300	Humic Gleysol	Water deposited medium sand	Poorly drained
Gs	GRIMSBY sandy loam	19,600	Gray-Brown Podzolic	Water deposited medium and fine sand	Well drained
Gm	GRIMSBY sandy loam — shallow phase	2,320	Gray-Brown Podzolic	Water deposited medium and fine sand	Well drained
Hd	HALDIMAND silty clay loam	4,700	Gray-Brown Podzolic	Clay till	Imperfectly drained
Hl	HALDIMAND silt loam	2,950	Gray-Brown Podzolic	Clay till	Imperfectly drained
Jl	JEDDO loam	1,230	Humic Gleysol	Clay loam till	Poorly drained
Jd	JEDDO sandy loam	1,880	Humic Gleysol	Clay loam till	Poorly drained
Kl	KILLEAN loam	2,690	Gray-Brown Podzolic	Generally sandy loam till	Imperfectly drained
Ly	LILY loam	1,350	Humic Gleysol	Generally sandy loam till	Poorly drained
Ln	LINCOLN silty clay loam	1,690	Humic Gleysol	Clay till	Poorly drained
Ll	LONDON loam	2,440	Gray-Brown Podzolic	Loam till	Imperfectly drained
Lh	LONDON loam — shallow phase	2,370	Gray-Brown Podzolic	Loam till	Imperfectly drained
Ma	MARSH	1,000			Very poorly drained
Mo	MORLEY silty clay loam	910	Humic Gleysol	Silty clay loam till	Poorly drained
Mk	MUCK	11,030	Organic		Very poorly drained
Oi	ONEIDA loam	4,210	Gray-Brown Podzolic	Clay loam till	Well drained
Ol	ONEIDA silt loam	2,930	Gray-Brown Podzolic	Clay loam till	Well drained
Pk	PARKHILL loam	1,840	Humic Gleysol	Loam till	Poorly drained
Pl	PARKHILL loam — shallow phase	930	Humic Gleysol	Loam till	Poorly drained
Sm	SMITHVILLE silt loam	1,870	Gray-Brown Podzolic	Silt loam over clay till	Moderately well drained
Sp	SPRINGVALE sandy loam	4,830	Gray-Brown Podzolic	Sand over outwash gravel	Well drained
To	TOLEDO silty clay loam	3,420	Humic Gleysol	Lacustrine silty clay loam	Poorly drained

C →

B →

A →

A →

COMPLEXES: 6 - GRIMSBY sl + BRANT sil (A, B)
4 - BRANTFORD sil + GRIMSBY sl (BC, A)

SOIL COMPLEXES

MAP SYMBOL		ACREAGE
1	ANCASTER silt loam — ONEIDA clay loam	980
2	BEVERLY silt loam — VINELAND sandy loam	5,300
3	BRANTFORD silt loam — BRANT silt loam	4,850
4	BRANTFORD silt loam — GRIMSBY sandy loam	6,280
5	GRIMSBY sandy loam — ANCASTER silt loam	1,150
6	GRIMSBY sandy loam — BRANT silt loam	6,150
7	TRAFALGAR silty clay loam — MORLEY silty clay loam	310
8	WINONA sandy loam — JEDDO sandy loam	1,280

Design Storm Information

Design storm information used in the hydrologic modeling was based on Chicago Storm distribution Intensity-Duration-Frequency (IDF) equations for Mount Hope [A] in the form:

$$i = \frac{A}{(t + B)^C}$$

Where: i = Rainfall intensity (mm/hr)
t = Time of duration (min)
A, B and C = Constant (see below)

The value of the parameters for the various storm events is provided below:

Constant	2-Yr. [B]	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.	25 mm [C]
A	646.0	1049.5	1343.7	1719.5	1954.8	2317.4	555.0
B	6.0	8.0	9.0	10.0	10.0	11.0	5.9
C	0.781	0.803	0.814	0.823	0.826	0.836	0.813

[A] IDF parameters from Appendix A, "*City of Hamilton Criteria and Guidelines for Stormwater Infrastructure Design*" (Philips Engineering Ltd., March 24, 2004).

[B] IDF equations used to generate rainfall files with Duration (TD) = 4 hours and Time-to-Peak Ratio (TPR) = 0.33

[C] IDF parameters to generate a ± 25 mm storm over a 4 hour duration

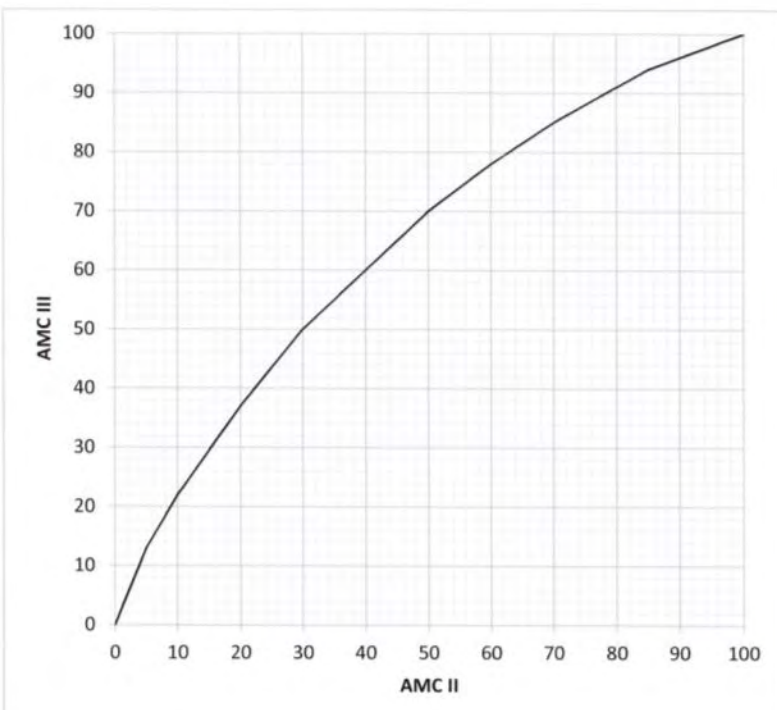
Table 1.1 Variation of S with CN under SCS Antecedent Moisture Conditions (AMC I, II & III)

CN VALUE AMC I	CN VALUE AMC II	CN VALUE AMC III	CORRESPONDING S VALUES (mm) AMC I	AMC II	AMC III
100	100	100	.0	.0	.0
87	95	98	37.9	13.4	5.2
78	90	96	71.7	28.2	10.6
70	85	94	108	44.8	16.2
63	80	91	149	63.5	25.1
51	70	85	244	109	44.8
40	60	78	381	169	71.7
31	50	70	565	254	109
22	40	60	901	381	169
15	30	50	1439	592	254
9	20	37	2570	1016	433
4	10	22	6096	2286	901
2	5	13	12446	4826	1700

Note: AMC I = Lowest runoff potential. Soils are dry enough for satisfactory cultivation. Empirically $S_{(AMC I)}$ is defined as approximately 0.85(SMAX), where SMAX is empirically derived from a plot of API against S as the value of S at API=0 (Figure 1.5 (insert)).

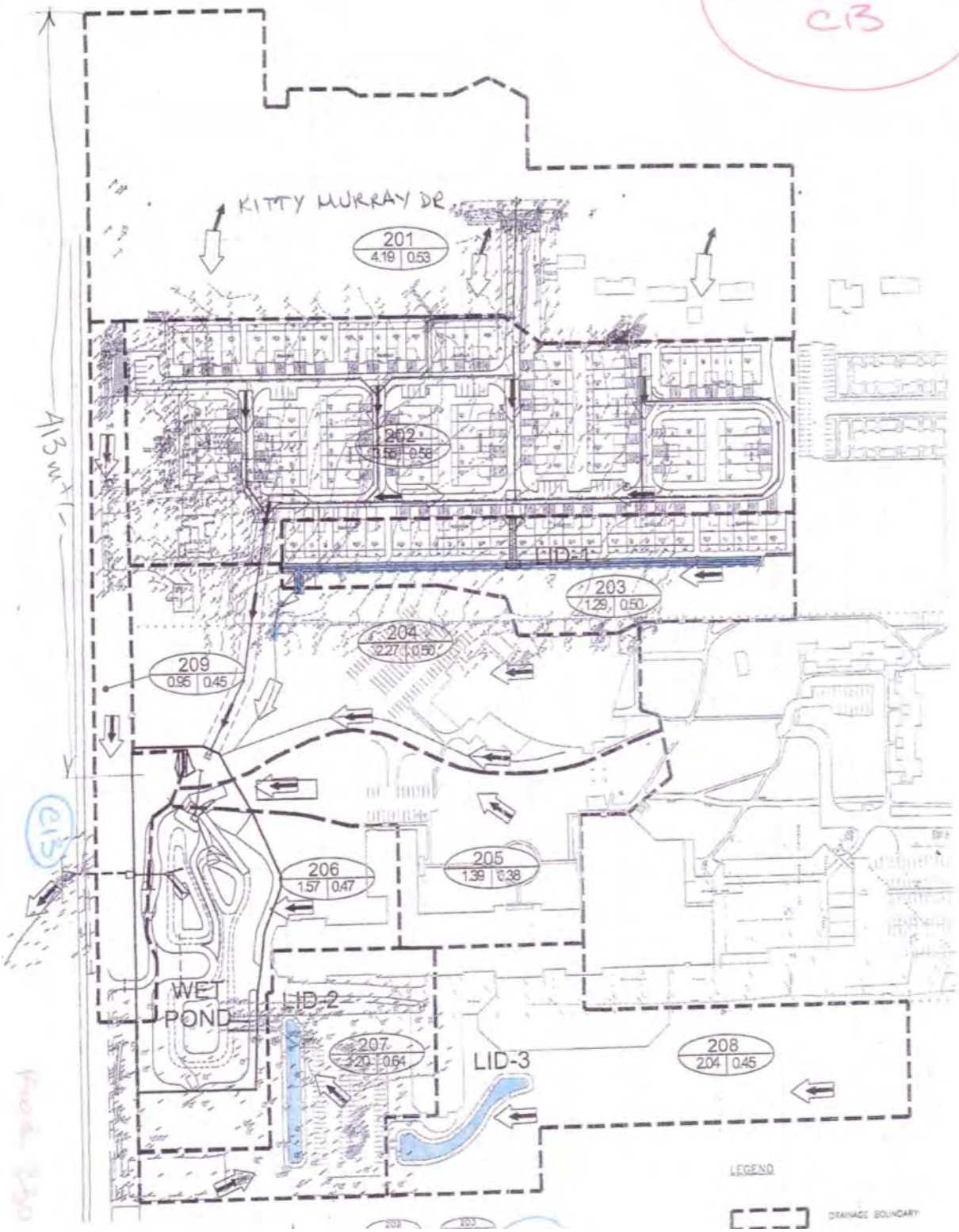
AMC II = The average condition.

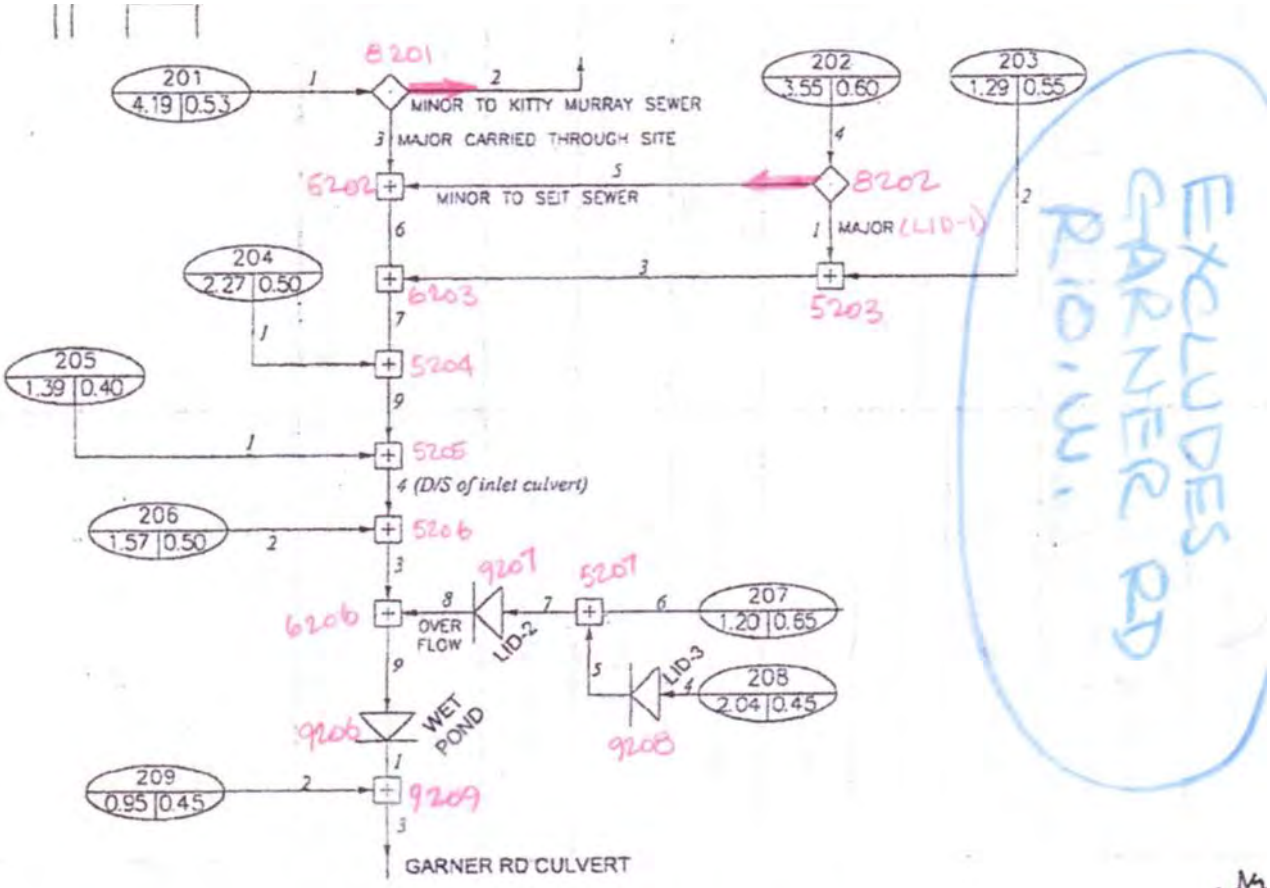
AMC III = Highest runoff potential. Soils in the watershed are near saturation from antecedent precipitation. Empirically $S_{(AMC III)}$ is defined as approximately 0.15(SMAX), (Figure 1.5(insert)).



REDEEMER POND

C13





POST-DEVELOPMENT HYDROLOGIC SIMULATION SCHEMATIC

Redeemer Pond
⇒ C13

SWM	1719	m^2
Total imp	7688	m^2
% imp	64	
Used % imp	64	

Subcatchment 208

Total area	2.04	ha
Building	5130	m^2
Road and parking	2323	m^2
SWM	1489	m^2
Total imp	8942	m^2
% imp	44	
Used % imp	45	

Subcatchment 209

Total area	0.95	ha
Building	0	
Road and parking	3528	
SWM	0	
Total imp	3528	
% imp	37	
Used % imp	45	

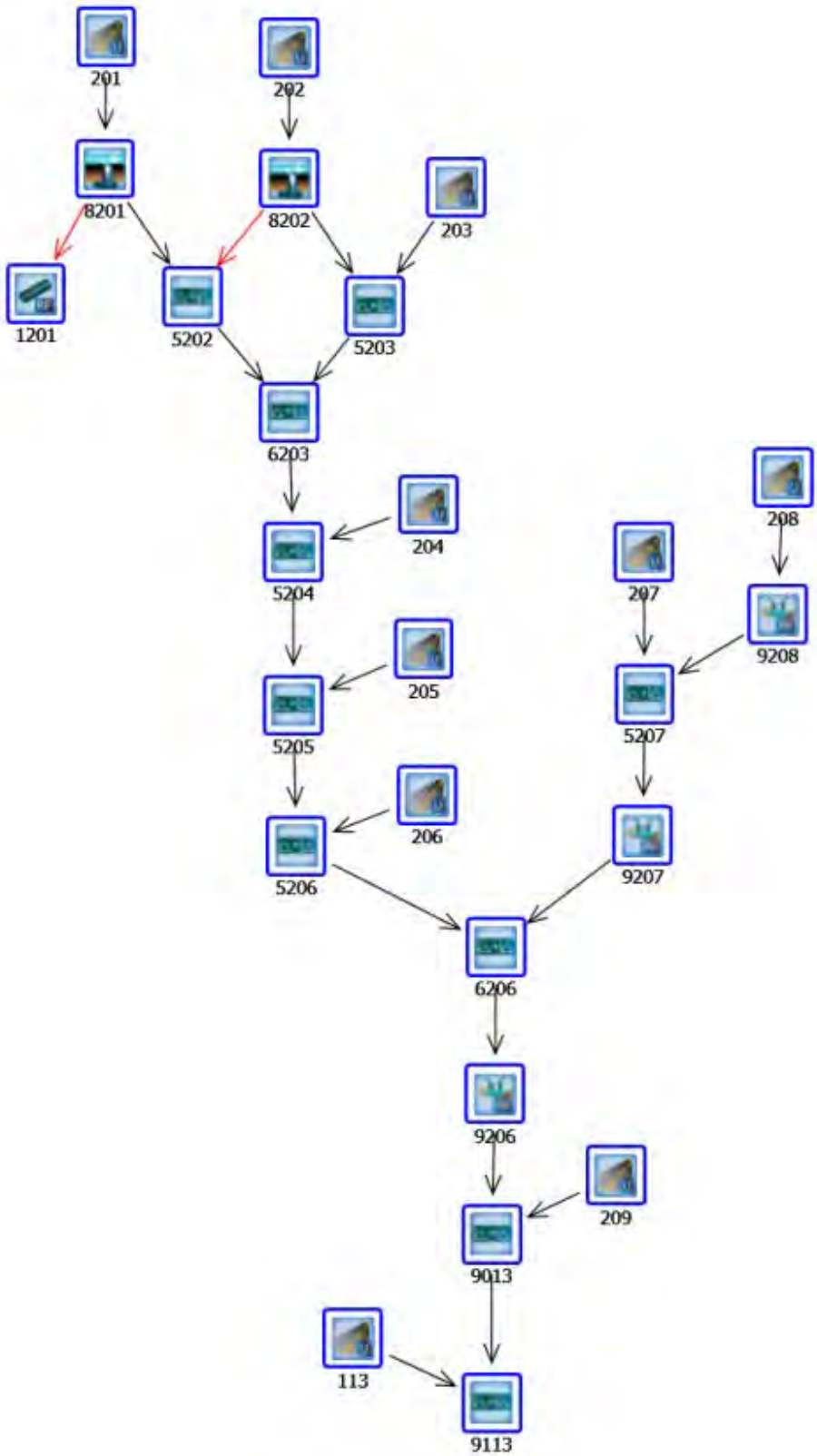
C2 — Input List

```
2     Metric units
*#*************************************************************************
*#  Project Name: [Redeemer-713 Garner]     Project Number: [        ]
*#  Date         : March-30-2011
*#  Modeller     : [JLU]
*#  Company      : Not registered to anycne
*#  License #    : 9999999
*#*************************************************************************
START                 TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
                     ["CH4H25mm.stm"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------|
READ STORM            STORM_FILENAME=["STORM.001"]
*%-----------------|-------------------------------------------------------|
*#
*# Area 201
*#
CALIB STANDHYD        ID=1, NHYD=["201"], DT=[5](min), AREA=[4.19](ha),
                      XIMP=[0.41], TIMP=[0.53], DWF=[0](cms), LOSS=[2],
                      SCS curve number CN=[74],
                      Pervious   surfaces: IAper=[2.5](mm), SLPP=[2](%),
                                           LGP=[30](m), MNP=[0.20], SCP=[0](min),
                      Impervious surfaces: IAimp=[1.5](mm), SLPI=[.5](%),
                                           LGI=[200](m), MNI=[0.015], SCI=[0](min),
                      RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*#
*# SPLIT HYDROGRAPH      B201
*# Minor flow lost to Kitty Murray Lane storm sewer (5 Yr)
*# Major flow carried by sewer of the Site
*#
COMPUTE DUALHYD       IDin=[1], CINLET=[0.560](cms), NINLET=[1],
                      MAJID=[3], MajNHYD=["201Maj"],
                      MINID=[2], MinNHYD=["201Min"],
                      TMJSTO=[0](cu-m)
```

```
*%-----------------|-------------------------------------------------------------|
*#
*# Area 202
*#
CALIB STANDHYD      ID=4, NHYD=["202"], DT=[5](min), AREA=[3.55](ha),
                    XIMP=[0.40], TIMP=[0.58], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[70],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                         LGP=[30](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                         LGI=[200](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
*#
*# SPLIT HYDROGRAPH  8202
*# Minor flow carried by storm sewer (5 Yr)
*# Major system spilled to LID-1
*#
COMPUTE DUALHYD     IDin=[4], CINLET=[0.426](cms), NINLET=[1],
                    MAJID=[1], MajNHYD=["202Maj"],
                    MINID=[5], MinNHYD=["202Min"],
                    TMJSTO=[0](cu-m)
*%-----------------|-------------------------------------------------------------|
ADD HYD  5202       IDsum=[6], NHYD=["2020"], IDs to add=[3+5]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 203
*#
CALIB STANDHYD      ID=2, NHYD=["203"], DT=[5](min), AREA=[1.29](ha),
                    XIMP=[0.25], TIMP=[0.50], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[70],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                         LGP=[30](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD  5203       IDsum=[3], NHYD=["2030"], IDs to add=[1+2]  5
*%-----------------|-------------------------------------------------------------|
ADD HYD  6203       IDsum=[7], NHYD=["2031"], IDs to add=[3+6]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 204
*#
CALIB STANDHYD      ID=1, NHYD=["204"], DT=[5](min), AREA=[2.27](ha),
                    XIMP=[0.42], TIMP=[0.50], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[70],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                         LGP=[30](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                         LGI=[200](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD  5204       IDsum=[9], NHYD=["W-Culv"], IDs to add=[1+7]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 205
*#
CALIB STANDHYD      ID=1, NHYD=["205"], DT=[5](min), AREA=[1.39](ha),
                    XIMP=[0.25], TIMP=[0.38], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[70],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                         LGP=[30](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                         LGI=[200](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD  5205       IDsum=[4], NHYD=["2040"], IDs to add=[9+1]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 206
```

```
*#
CALIB STANDHYD        ID=2, NHYD=["206"], DT=[5](min), AREA=[1.57](ha),
                      XIMP=[0.38], TIMP=[0.47], DWF=[0](cms), LOSS=[2],
                      SCS curve number CN=[70],
                      Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                           LGP=[30](m), MNP=[0.25], SCP=[0](min),
                      Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                           LGI=[80](m), MNI=[0.015], SCI=[0](min),
                      RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD 5206          IDsum=[3], NHYD=["2060"], IDs to add=[2+4]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 208
*#
CALIB STANDHYD        ID=4, NHYD=["208"], DT=[5](min), AREA=[2.04](ha),
                      XIMP=[0.40], TIMP=[0.45], DWF=[0](cms), LOSS=[2],
                      SCS curve number CN=[75],
                      Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                           LGP=[30](m), MNP=[0.25], SCP=[0](min),
                      Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                           LGI=[200](m), MNI=[0.015], SCI=[0](min),
                      RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
*#
*# Bioretention LID-3   9208
*#
ROUTE RESERVOIR       IDout=[5],   NHYD=["Pond"],  IDin=[4],
                      RDT=[1](min),
                            TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
                                 [   0.0000  0.0000 ]
                                 [   0.0074  0.0134 ]
                                 [   0.0074  0.0192 ]
                                 [   0.0074  0.0259 ]
                                 [   0.0074  0.0296 ]
                                 [   0.2098  0.0377 ]
                                 [   0.5799  0.0468 ]
                                 [   0.8074  0.0518 ]
                                      [   -1  ,  -1  ]  (max twenty pts)
                            IDovf=[], NHYDovf=[]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 207
*#
CALIB STANDHYD        ID=6, NHYD=["207"], DT=[5](min), AREA=[1.20](ha),
                      XIMP=[0.58], TIMP=[0.64], DWF=[0](cms), LOSS=[2],
                      SCS curve number CN=[75],
                      Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                           LGP=[30](m), MNP=[0.25], SCP=[0](min),
                      Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                           LGI=[200](m), MNI=[0.015], SCI=[0](min),
                      RAINFALL=[ , , , , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD 5207          IDsum=[7], NHYD=["2070"], IDs to add=[5+6]
*%-----------------|-------------------------------------------------------------|
*#
*# Bioretention LID-2   9207
*#
ROUTE RESERVOIR       IDout=[8],   NHYD=["Pond"],  IDin=[7],
                      RDT=[1](min),
                            TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
                                 [   0.0000  0.0000 ]
                                 [   0.0069  0.0125 ]
                                 [   0.0069  0.0178 ]
                                 [   0.0069  0.0240 ]
                                 [   0.0069  0.0274 ]
                                 [   0.2093  0.0349 ]
                                 [   0.5794  0.0432 ]
                                 [   0.8069  0.0477 ]
```

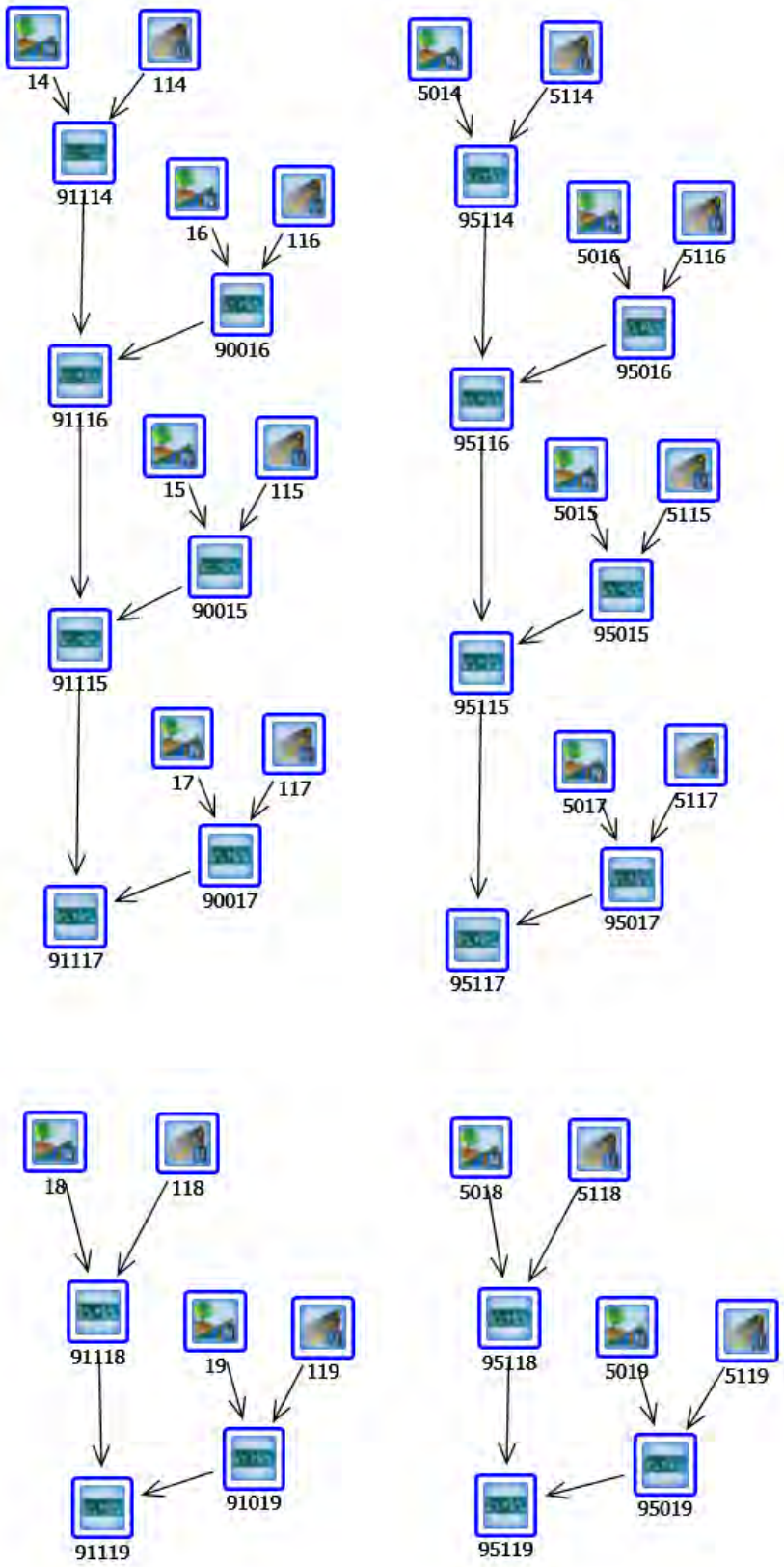
```
                                [   -1   ,   -1   ]  (max twenty pts)
                        IDovf=[], NHYDovf=[]
*%-----------------|-------------------------------------------------------------|
ADD HYD 6206    IDsum=[9], NHYD=["Inlet"], IDs to add=[3+8]
*%-----------------|-------------------------------------------------------------|
*#
*# Wet Pond  9206
*#
ROUTE RESERVOIR     IDout=[1],   NHYD=["Pond"],  IDin=[9],
                    RDT=[1](min),
                        TABLE of ( OUTFLOW-STORAGE ) values
                                 (cms) - (ha-m)
                              [   0.0000  0.0000 ]
                              [   0.0133  0.0684 ]
                              [   0.0173  0.1024 ]
                              [   0.0567  0.1387 ]
                              [   0.1258  0.1772 ]
                              [   0.2142  0.2177 ]
                              [   0.3181  0.2601 ]
                              [   0.4356  0.3045 ]
                              [   0.5651  0.3509 ]
                              [   0.7056  0.3992 ]
                              [   0.8563  0.4495 ]
                              [   1.0165  0.5018 ]
                              [   1.0497  0.5287 ]
                              [   1.2259  0.5561 ]
                              [   1.4142  0.5840 ]
                              [   1.6430  0.6124 ]
                              [   2.8864  0.6707 ]
                              [   4.9224  0.7312 ]
                              [   7.6130  0.7938 ]
                                [   -1   ,   -1   ]  (max twenty pts)
                        IDovf=[    ], NHYDovf=[    ]
*%-----------------|-------------------------------------------------------------|
*#
*# Area 209
*#
CALIB STANDHYD      ID=2, NHYD=["209"], DT=[5](min), AREA=[0.95](ha),
                    XIMP=[0.45], TIMP=[0.45], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[70],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[2](%),
                                         LGP=[5](m), MNP=[0.25], SCP=[0](min),
                    Impervious surfaces: IAimp=[2](mm), SLPI=[.5](%),
                                         LGI=[140](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD 5209    IDsum=[3], NHYD=["Inlet"], IDs to add=[1+2]
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[2]
                   ["MHSCS24H.002"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[3]
                   ["MHSCS24H.005"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[4]
                   ["MHSCS24H.010"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[5]
                   ["MHSCS24H.025"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[6]
                   ["MHSCS24H.050"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[7]
                   ["MHSCS24H.100"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
START               TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[8]
                   ["RegFull.stm"] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------------|
FINISH
```



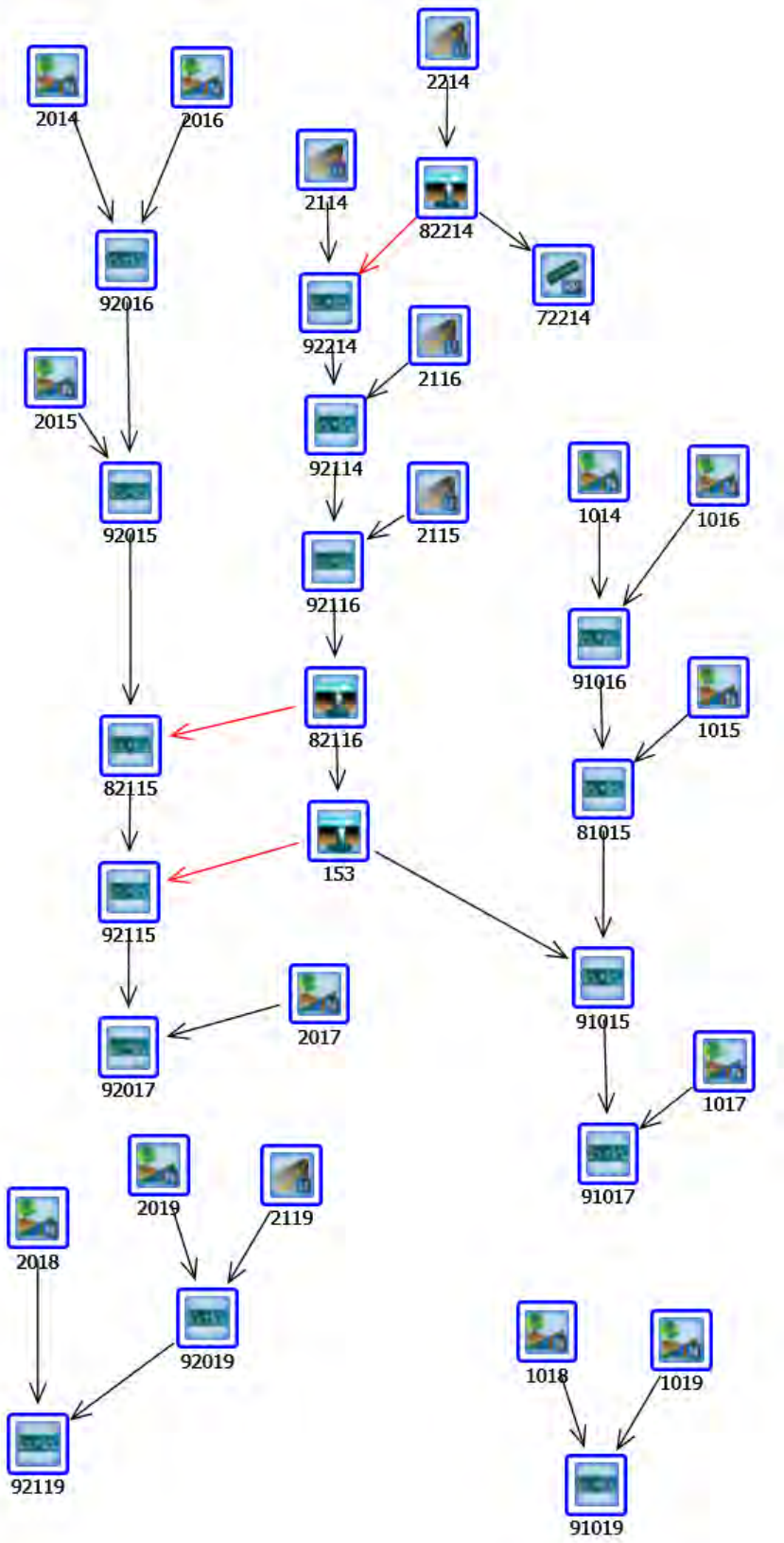
OTTHYMO Model Schematic for Bungalows of Ancaster Development at Culver C13

Appendix C

OTTHYMO Model Data and Outputs



OTTHYMO Schematic: Ancaster Creek Existing Culverts



OTTHYMO Schematic: Ancaster Creek Future Culverts

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

       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    Company
        OOO     T      T    H   H    Y    M   M   OOO                 Serial

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                    *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual Otthymo 2.4\VO2\voin.dat
  Output  filename: C:\Users\Bill\AppData\Local\Temp\9576485d-7f24-43dc-b821-
de71fb614f89\Scenario.out
  Summary filename: C:\Users\Bill\AppData\Local\Temp\9576485d-7f24-43dc-b821-
de71fb614f89\Scenario.sum


DATE: 11/01/2013                          TIME: 10:24:35
```

Ancaster Creek
Existing 100-yr

```
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************
--------------------
| MASS STORM       |    Filename: C:\Users\Bill\AppD
|                  |              ata\Local\Temp\
|                  |              9576485d-7f24-43dc-b821-de71fb614f89\b4dbaf59
| Ptotal=126.49 mm |    Comments: 24hr SCS Mass Storm
--------------------
                       Duration of storm    = 24.00 hrs
                       Mass curve time step = 15.00 min
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	1.39	6.25	2.53	12.25	18.21	18.25	2.28
0.50	1.39	6.50	2.53	12.50	18.21	18.50	2.28
0.75	1.39	6.75	2.53	12.75	9.36	18.75	2.28
1.00	1.39	7.00	2.53	13.00	9.36	19.00	2.28
1.25	1.39	7.25	2.53	13.25	6.07	19.25	2.28
1.50	1.39	7.50	2.53	13.50	6.07	19.50	2.28
1.75	1.39	7.75	2.53	13.75	6.07	19.75	2.28
2.00	1.39	8.00	2.53	14.00	6.07	20.00	2.28
2.25	1.64	8.25	3.42	14.25	3.79	20.25	1.52
2.50	1.64	8.50	3.42	14.50	3.79	20.50	1.52
2.75	1.64	8.75	3.42	14.75	3.79	20.75	1.52
3.00	1.64	9.00	3.42	15.00	3.79	21.00	1.52
3.25	1.64	9.25	4.05	15.25	3.79	21.25	1.52
3.50	1.64	9.50	4.05	15.50	3.79	21.50	1.52
3.75	1.64	9.75	4.55	15.75	3.79	21.75	1.52
4.00	1.64	10.00	4.55	16.00	3.79	22.00	1.52
4.25	2.02	10.25	5.82	16.25	2.28	22.25	1.52
4.50	2.02	10.50	5.82	16.50	2.28	22.50	1.52
4.75	2.02	10.75	7.84	16.75	2.28	22.75	1.52
5.00	2.02	11.00	7.84	17.00	2.28	23.00	1.52
5.25	2.02	11.25	12.14	17.25	2.28	23.25	1.52
5.50	2.02	11.50	12.14	17.50	2.28	23.50	1.52
5.75	2.02	11.75	52.62	17.75	2.28	23.75	1.52
6.00	2.02	12.00	139.64	18.00	2.28	24.00	1.52

```
--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0015) |   Area    (ha)=   9.27   Curve Number   (CN)= 68.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.51

         NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.033	1.39	6.033	2.53	12.033	18.21	18.03	2.28
0.067	1.39	6.067	2.53	12.067	18.21	18.07	2.28
0.100	1.39	6.100	2.53	12.100	18.21	18.10	2.28
0.133	1.39	6.133	2.53	12.133	18.21	18.13	2.28
0.167	1.39	6.167	2.53	12.167	18.21	18.17	2.28
0.200	1.39	6.200	2.53	12.200	18.21	18.20	2.28
0.233	1.39	6.233	2.53	12.233	18.21	18.23	2.28
0.267	1.39	6.267	2.53	12.267	18.21	18.27	2.28
0.300	1.39	6.300	2.53	12.300	18.21	18.30	2.28
0.333	1.39	6.333	2.53	12.333	18.21	18.33	2.28
0.367	1.39	6.367	2.53	12.367	18.21	18.37	2.28
0.400	1.39	6.400	2.53	12.400	18.21	18.40	2.28
0.433	1.39	6.433	2.53	12.433	18.21	18.43	2.28
0.467	1.39	6.467	2.53	12.467	18.21	18.47	2.28
0.500	1.39	6.500	2.53	12.500	18.20	18.50	2.28
0.533	1.39	6.533	2.53	12.533	9.36	18.53	2.28
0.567	1.39	6.567	2.53	12.567	9.36	18.57	2.28
0.600	1.39	6.600	2.53	12.600	9.36	18.60	2.28
0.633	1.39	6.633	2.53	12.633	9.36	18.63	2.28
0.667	1.39	6.667	2.53	12.667	9.36	18.67	2.28
0.700	1.39	6.700	2.53	12.700	9.36	18.70	2.28
0.733	1.39	6.733	2.53	12.733	9.36	18.73	2.28
0.767	1.39	6.767	2.53	12.767	9.36	18.77	2.28
0.800	1.39	6.800	2.53	12.800	9.36	18.80	2.28
0.833	1.39	6.833	2.53	12.833	9.36	18.83	2.28
0.867	1.39	6.867	2.53	12.867	9.36	18.87	2.28
0.900	1.39	6.900	2.53	12.900	9.36	18.90	2.28
0.933	1.39	6.933	2.53	12.933	9.36	18.93	2.28
0.967	1.39	6.967	2.53	12.967	9.36	18.97	2.28
1.000	1.39	7.000	2.53	13.000	9.35	19.00	2.28
1.033	1.39	7.033	2.53	13.033	6.07	19.03	2.28
1.067	1.39	7.067	2.53	13.067	6.07	19.07	2.28
1.100	1.39	7.100	2.53	13.100	6.07	19.10	2.28
1.133	1.39	7.133	2.53	13.133	6.07	19.13	2.28
1.167	1.39	7.167	2.53	13.167	6.07	19.17	2.28
1.200	1.39	7.200	2.53	13.200	6.07	19.20	2.28
1.233	1.39	7.233	2.53	13.233	6.07	19.23	2.28
1.267	1.39	7.267	2.53	13.267	6.07	19.27	2.28
1.300	1.39	7.300	2.53	13.300	6.07	19.30	2.28
1.333	1.39	7.333	2.53	13.333	6.07	19.33	2.28
1.367	1.39	7.367	2.53	13.367	6.07	19.37	2.28
1.400	1.39	7.400	2.53	13.400	6.07	19.40	2.28
1.433	1.39	7.433	2.53	13.433	6.07	19.43	2.28
1.467	1.39	7.467	2.53	13.467	6.07	19.47	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.533	1.39	7.533	2.53	13.533	6.07	19.53	2.28
1.567	1.39	7.567	2.53	13.567	6.07	19.57	2.28
1.600	1.39	7.600	2.53	13.600	6.07	19.60	2.28
1.633	1.39	7.633	2.53	13.633	6.07	19.63	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.700	1.39	7.700	2.53	13.700	6.07	19.70	2.28
1.733	1.39	7.733	2.53	13.733	6.07	19.73	2.28
1.767	1.39	7.767	2.53	13.767	6.07	19.77	2.28
1.800	1.39	7.800	2.53	13.800	6.07	19.80	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.867	1.39	7.867	2.53	13.867	6.07	19.87	2.28
1.900	1.39	7.900	2.53	13.900	6.07	19.90	2.28
1.933	1.39	7.933	2.53	13.933	6.07	19.93	2.28
1.967	1.39	7.967	2.53	13.967	6.07	19.97	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.033	1.64	8.033	3.42	14.033	3.79	20.03	1.52
2.067	1.64	8.067	3.42	14.067	3.79	20.07	1.52
2.100	1.64	8.100	3.42	14.100	3.79	20.10	1.52
2.133	1.64	8.133	3.42	14.133	3.79	20.13	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.200	1.64	8.200	3.42	14.200	3.79	20.20	1.52
2.233	1.64	8.233	3.42	14.233	3.79	20.23	1.52
2.267	1.64	8.267	3.42	14.267	3.79	20.27	1.52
2.300	1.64	8.300	3.42	14.300	3.79	20.30	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.367	1.64	8.367	3.42	14.367	3.79	20.37	1.52
2.400	1.64	8.400	3.42	14.400	3.79	20.40	1.52
2.433	1.64	8.433	3.42	14.433	3.79	20.43	1.52
2.467	1.64	8.467	3.42	14.467	3.79	20.47	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.533	1.64	8.533	3.42	14.533	3.79	20.53	1.52
2.567	1.64	8.567	3.42	14.567	3.79	20.57	1.52
2.600	1.64	8.600	3.42	14.600	3.79	20.60	1.52
2.633	1.64	8.633	3.42	14.633	3.79	20.63	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.700	1.64	8.700	3.42	14.700	3.79	20.70	1.52
2.733	1.64	8.733	3.42	14.733	3.79	20.73	1.52
2.767	1.64	8.767	3.42	14.767	3.79	20.77	1.52
2.800	1.64	8.800	3.42	14.800	3.79	20.80	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.867	1.64	8.867	3.42	14.867	3.79	20.87	1.52
2.900	1.64	8.900	3.42	14.900	3.79	20.90	1.52
2.933	1.64	8.933	3.42	14.933	3.79	20.93	1.52
2.967	1.64	8.967	3.42	14.967	3.79	20.97	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.033	1.64	9.033	4.05	15.033	3.79	21.03	1.52
3.067	1.64	9.067	4.05	15.067	3.79	21.07	1.52
3.100	1.64	9.100	4.05	15.100	3.79	21.10	1.52
3.133	1.64	9.133	4.05	15.133	3.79	21.13	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.200	1.64	9.200	4.05	15.200	3.79	21.20	1.52
3.233	1.64	9.233	4.05	15.233	3.79	21.23	1.52
3.267	1.64	9.267	4.05	15.267	3.79	21.27	1.52
3.300	1.64	9.300	4.05	15.300	3.79	21.30	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.367	1.64	9.367	4.05	15.367	3.79	21.37	1.52
3.400	1.64	9.400	4.05	15.400	3.79	21.40	1.52
3.433	1.64	9.433	4.05	15.433	3.79	21.43	1.52
3.467	1.64	9.467	4.05	15.467	3.79	21.47	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.533	1.64	9.533	4.55	15.533	3.79	21.53	1.52
3.567	1.64	9.567	4.55	15.567	3.79	21.57	1.52
3.600	1.64	9.600	4.55	15.600	3.79	21.60	1.52
3.633	1.64	9.633	4.55	15.633	3.79	21.63	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.700	1.64	9.700	4.55	15.700	3.79	21.70	1.52
3.733	1.64	9.733	4.55	15.733	3.79	21.73	1.52
3.767	1.64	9.767	4.55	15.767	3.79	21.77	1.52
3.800	1.64	9.800	4.55	15.800	3.79	21.80	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.867	1.64	9.867	4.55	15.867	3.79	21.87	1.52
3.900	1.64	9.900	4.55	15.900	3.79	21.90	1.52
3.933	1.64	9.933	4.55	15.933	3.79	21.93	1.52

3.967	1.64	9.967	4.55	15.967	3.79	21.97	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.033	2.02	10.033	5.82	16.033	2.28	22.03	1.52
4.067	2.02	10.067	5.82	16.067	2.28	22.07	1.52
4.100	2.02	10.100	5.82	16.100	2.28	22.10	1.52
4.133	2.02	10.133	5.82	16.133	2.28	22.13	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.200	2.02	10.200	5.82	16.200	2.28	22.20	1.52
4.233	2.02	10.233	5.82	16.233	2.28	22.23	1.52
4.267	2.02	10.267	5.82	16.267	2.28	22.27	1.52
4.300	2.02	10.300	5.82	16.300	2.28	22.30	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.367	2.02	10.367	5.82	16.367	2.28	22.37	1.52
4.400	2.02	10.400	5.82	16.400	2.28	22.40	1.52
4.433	2.02	10.433	5.82	16.433	2.28	22.43	1.52
4.467	2.02	10.467	5.82	16.467	2.28	22.47	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.533	2.02	10.533	7.84	16.533	2.28	22.53	1.52
4.567	2.02	10.567	7.84	16.567	2.28	22.57	1.52
4.600	2.02	10.600	7.84	16.600	2.28	22.60	1.52
4.633	2.02	10.633	7.84	16.633	2.28	22.63	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.700	2.02	10.700	7.84	16.700	2.28	22.70	1.52
4.733	2.02	10.733	7.84	16.733	2.28	22.73	1.52
4.767	2.02	10.767	7.84	16.767	2.28	22.77	1.52
4.800	2.02	10.800	7.84	16.800	2.28	22.80	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.867	2.02	10.867	7.84	16.867	2.28	22.87	1.52
4.900	2.02	10.900	7.84	16.900	2.28	22.90	1.52
4.933	2.02	10.933	7.84	16.933	2.28	22.93	1.52
4.967	2.02	10.967	7.84	16.967	2.28	22.97	1.52
5.000	2.02	11.000	7.85	17.000	2.28	23.00	1.52
5.033	2.02	11.033	12.14	17.033	2.28	23.03	1.52
5.067	2.02	11.067	12.14	17.067	2.28	23.07	1.52
5.100	2.02	11.100	12.14	17.100	2.28	23.10	1.52
5.133	2.02	11.133	12.14	17.133	2.28	23.13	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.200	2.02	11.200	12.14	17.200	2.28	23.20	1.52
5.233	2.02	11.233	12.14	17.233	2.28	23.23	1.52
5.267	2.02	11.267	12.14	17.267	2.28	23.27	1.52
5.300	2.02	11.300	12.14	17.300	2.28	23.30	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.367	2.02	11.367	12.14	17.367	2.28	23.37	1.52
5.400	2.02	11.400	12.14	17.400	2.28	23.40	1.52
5.433	2.02	11.433	12.14	17.433	2.28	23.43	1.52
5.467	2.02	11.467	12.14	17.467	2.28	23.47	1.52
5.500	2.02	11.500	12.19	17.500	2.28	23.50	1.52
5.533	2.02	11.533	52.62	17.533	2.28	23.53	1.52
5.567	2.02	11.567	52.62	17.567	2.28	23.57	1.52
5.600	2.02	11.600	52.62	17.600	2.28	23.60	1.52
5.633	2.02	11.633	52.62	17.633	2.28	23.63	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.700	2.02	11.700	52.62	17.700	2.28	23.70	1.52
5.733	2.02	11.733	52.62	17.733	2.28	23.73	1.52
5.767	2.02	11.767	96.25	17.767	2.28	23.77	1.52
5.800	2.02	11.800	139.64	17.800	2.28	23.80	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.867	2.02	11.867	139.64	17.867	2.28	23.87	1.52
5.900	2.02	11.900	139.64	17.900	2.28	23.90	1.52
5.933	2.02	11.933	139.64	17.933	2.28	23.93	1.52
5.967	2.02	11.967	139.64	17.967	2.28	23.97	1.52
6.000	2.02	12.000	139.47	18.000	2.28	24.00	1.52

```
     Unit Hyd Qpeak  (cms)=   0.694

     PEAK FLOW       (cms)=   0.740 (i)
     TIME TO PEAK    (hrs)=  12.400
     RUNOFF VOLUME    (mm)=  61.238
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.484

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0115) |   Area    (ha)=   0.13
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         0.06
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      75.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64     ********
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.05 (ii)    8.22 (ii)
     Unit Hyd. Tpeak (min)=       4.00        10.00
     Unit Hyd. peak  (cms)=       0.40         0.13
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.02          0.042 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.03          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.71
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69


       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0015):     9.27   0.740    12.40    61.24
        + ID2= 2 (0115):     0.13   0.042    12.00    87.71
          ===============================================
          ID = 3 (****):     9.40   0.747    12.40    61.59

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0014) |   Area    (ha)=   1.57   Curve Number   (CN)= 57.5
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.26

     Unit Hyd Qpeak  (cms)=   0.231

     PEAK FLOW       (cms)=   0.153 (i)
     TIME TO PEAK    (hrs)=  12.133
     RUNOFF VOLUME    (mm)=  47.729
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.377

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0114) |   Area    (ha)=   0.34
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.07         0.05          0.118 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0014):     1.57   0.153    12.13    47.73
        + ID2= 2 (0114):     0.34   0.118    12.00    87.72
          ===============================================
          ID = 3 (****):     1.91   0.234    12.00    54.85

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0016) |   Area    (ha)=  11.38   Curve Number   (CN)= 68.2
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.59

     Unit Hyd Qpeak  (cms)=   0.737

     PEAK FLOW       (cms)=   0.824 (i)
     TIME TO PEAK    (hrs)=  12.500
     RUNOFF VOLUME    (mm)=  61.517
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.486

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0116) |   Area    (ha)=   0.22
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.11         0.11
     Dep. Storage     (mm)=       1.00         1.50
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     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.03          0.076 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0016):    11.38   0.824    12.50    61.52
        + ID2= 2 (0116):     0.22   0.076    12.00    87.72
          ================================================
          ID = 3 (****):    11.60   0.834    12.50    62.01

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):    11.60   0.834    12.50    62.01
        + ID2= 2 (****):     1.91   0.234    12.00    54.85
          ================================================
          ID = 3 (****):    13.51   0.939    12.43    61.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):     9.40   0.747    12.40    61.59
        + ID2= 2 (****):    13.51   0.939    12.43    61.00
          ================================================
          ID = 3 (****):    22.91   1.686    12.40    61.24

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0017) |   Area    (ha)=   1.69   Curve Number   (CN)= 62.4
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.23

     Unit Hyd Qpeak  (cms)=   0.281

     PEAK FLOW       (cms)=   0.202 (i)
     TIME TO PEAK    (hrs)=  12.100
     RUNOFF VOLUME    (mm)=  53.759
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.425

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0117) |   Area    (ha)=   0.50
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.25         0.25
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.10         0.08          0.173 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0017):     1.69   0.202    12.10    53.76
        + ID2= 2 (0117):     0.50   0.173    12.00    87.72
          ================================================
          ID = 3 (****):     2.19   0.338    12.00    61.51

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):     2.19   0.338    12.00    61.51
        + ID2= 2 (****):    22.91   1.686    12.40    61.24
          ================================================
          ID = 3 (****):    25.10   1.832    12.37    61.27

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0019) |   Area    (ha)= 119.89   Curve Number   (CN)= 66.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   9.90   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.60

     Unit Hyd Qpeak  (cms)=   7.632

     PEAK FLOW       (cms)=   7.844 (i)
     TIME TO PEAK    (hrs)=  12.533
     RUNOFF VOLUME    (mm)=  56.109
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.444

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0119) |   Area    (ha)=   1.01
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.50
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.20         0.15          0.349 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0019):   119.89   7.844    12.53    56.11
        + ID2= 2 (0119):     1.01   0.349    12.00    87.72
          ================================================
          ID = 3 (****):   120.90   7.884    12.53    56.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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| CALIB            |
| NASHYD    (0018) |   Area    (ha)=   1.57   Curve Number   (CN)= 55.7
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.24

     Unit Hyd Qpeak  (cms)=   0.250

     PEAK FLOW       (cms)=   0.153 (i)
     TIME TO PEAK    (hrs)=  12.133
     RUNOFF VOLUME    (mm)=  45.622
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.361

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0118) |   Area    (ha)=   0.33
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.05          0.114 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0018):     1.57   0.153    12.13    45.62
        + ID2= 2 (0118):     0.33   0.114    12.00    87.72
          ================================================
          ID = 3 (****):     1.90   0.236    12.03    52.93

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):   120.90   7.884    12.53    56.37
        + ID2= 2 (****):     1.90   0.236    12.03    52.93
          ================================================
          ID = 3 (****):   122.80   7.968    12.50    56.32

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| CALIB            |
| NASHYD    (5017) |   Area    (ha)=   1.69   Curve Number   (CN)= 62.4
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.23

     Unit Hyd Qpeak  (cms)=   0.281

     PEAK FLOW       (cms)=   0.202 (i)
     TIME TO PEAK    (hrs)=  12.100
     RUNOFF VOLUME    (mm)=  53.759
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.425

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (5117) |   Area    (ha)=   0.99
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.50
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.19         0.15          0.342 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5017):     1.69   0.202    12.10    53.76
        + ID2= 2 (5117):     0.99   0.342    12.00    87.72
          ================================================
          ID = 3 (****):     2.68   0.507    12.00    66.31

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (5016) |   Area    (ha)=  11.38   Curve Number   (CN)= 68.2
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.59

     Unit Hyd Qpeak  (cms)=   0.737

     PEAK FLOW       (cms)=   0.824 (i)
     TIME TO PEAK    (hrs)=  12.500
     RUNOFF VOLUME    (mm)=  61.517
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.486

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (5116) |   Area    (ha)=   0.43
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.22         0.22
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      75.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.05 (ii)    8.22 (ii)
     Unit Hyd. Tpeak (min)=       4.00        10.00
     Unit Hyd. peak  (cms)=       0.40         0.13
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.08         0.06          0.145 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.03          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69


       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5016):    11.38   0.824    12.50    61.52
        + ID2= 2 (5116):     0.43   0.145    12.00    87.72
          ================================================
          ID = 3 (****):    11.81   0.844    12.50    62.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

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--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (5014) |   Area    (ha)=   1.57   Curve Number   (CN)= 57.5
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.27

     Unit Hyd Qpeak  (cms)=   0.222

     PEAK FLOW       (cms)=   0.149 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  47.729
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.377

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (5114) |   Area    (ha)=   0.68
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.34         0.34
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.10          0.235 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5014):     1.57   0.149    12.17    47.73
        + ID2= 2 (5114):     0.68   0.235    12.00    87.72
          ===============================================
          ID = 3 (****):     2.25   0.347    12.00    59.82

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):    11.81   0.844    12.50    62.47
        + ID2= 2 (****):     2.25   0.347    12.00    59.82
          ===============================================
          ID = 3 (****):    14.06   0.970    12.40    62.05

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (5015) |   Area    (ha)=   9.27   Curve Number   (CN)= 68.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.51

     Unit Hyd Qpeak  (cms)=   0.694

     PEAK FLOW       (cms)=   0.740 (i)
     TIME TO PEAK    (hrs)=  12.400
     RUNOFF VOLUME    (mm)=  61.238
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.484

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (5115) |   Area    (ha)=   0.25
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.12         0.12
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64     ********
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.05         0.04          0.086 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5015):     9.27   0.740    12.40    61.24
        + ID2= 2 (5115):     0.25   0.086    12.00    87.72
          ===============================================
          ID = 3 (****):     9.52   0.753    12.40    61.93

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):     9.52   0.753    12.40    61.93
        + ID2= 2 (****):    14.06   0.970    12.40    62.05
          ===============================================
          ID = 3 (****):    23.58   1.723    12.40    62.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):     2.68   0.507    12.00    66.31
        + ID2= 2 (****):    23.58   1.723    12.40    62.00
          ===============================================
          ID = 3 (****):    26.26   1.903    12.33    62.44

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (5018) |   Area    (ha)=   1.57   Curve Number   (CN)= 55.7
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.24

     Unit Hyd Qpeak  (cms)=   0.250

     PEAK FLOW       (cms)=   0.153 (i)
     TIME TO PEAK    (hrs)=  12.133
     RUNOFF VOLUME    (mm)=  45.622
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.361

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (5118) |   Area    (ha)=   0.66
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.33         0.33
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                            *TOTALS*
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     PEAK FLOW       (cms)=       0.13         0.10          0.228 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5018):     1.57   0.153    12.13    45.62
        + ID2= 2 (5118):     0.66   0.228    12.00    87.72
          ===============================================
          ID = 3 (****):     2.23   0.350    12.00    58.08

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (5019) |   Area    (ha)= 119.89   Curve Number   (CN)= 66.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   9.90   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.60

     Unit Hyd Qpeak  (cms)=   7.632

     PEAK FLOW       (cms)=   7.844 (i)
     TIME TO PEAK    (hrs)=  12.533
     RUNOFF VOLUME    (mm)=  56.109
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.444

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (5119) |   Area    (ha)=   2.02
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.01         1.01
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.39         0.31          0.699 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          87.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5019):   119.89   7.844    12.53    56.11
        + ID2= 2 (5119):     2.02   0.699    12.00    87.72
          ===============================================
          ID = 3 (****):   121.91   7.925    12.53    56.63

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):   121.91   7.925    12.53    56.63
        + ID2= 2 (****):     2.23   0.350    12.00    58.08
          ===============================================
          ID = 3 (****):   124.14   8.028    12.50    56.66

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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 FINISH
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       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    Company
        OOO     T      T    H   H    Y    M   M   OOO                 Serial

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                    *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual Otthymo 2.4\VO2\voin.dat
  Output  filename: C:\Users\Bill\AppData\Local\Temp\5e2110a1-6774-4b0a-b15c-
5c4525426196\Scenario.out
  Summary filename: C:\Users\Bill\AppData\Local\Temp\5e2110a1-6774-4b0a-b15c-
5c4525426196\Scenario.sum


DATE: 11/01/2013                          TIME: 10:25:38
```

Ancaster Creek
Future 100-yr

```
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************

--------------------
| MASS STORM       |    Filename: C:\Users\Bill\AppD
|                  |              ata\Local\Temp\
|                  |              5e2110a1-6774-4b0a-b15c-5c4525426196\b4dbaf59
| Ptotal=126.49 mm |    Comments: 24hr SCS Mass Storm
--------------------
                        Duration of storm    = 24.00 hrs
                        Mass curve time step = 15.00 min
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	1.39	6.25	2.53	12.25	18.21	18.25	2.28
0.50	1.39	6.50	2.53	12.50	18.21	18.50	2.28
0.75	1.39	6.75	2.53	12.75	9.36	18.75	2.28
1.00	1.39	7.00	2.53	13.00	9.36	19.00	2.28
1.25	1.39	7.25	2.53	13.25	6.07	19.25	2.28
1.50	1.39	7.50	2.53	13.50	6.07	19.50	2.28
1.75	1.39	7.75	2.53	13.75	6.07	19.75	2.28
2.00	1.39	8.00	2.53	14.00	6.07	20.00	2.28
2.25	1.64	8.25	3.42	14.25	3.79	20.25	1.52
2.50	1.64	8.50	3.42	14.50	3.79	20.50	1.52
2.75	1.64	8.75	3.42	14.75	3.79	20.75	1.52
3.00	1.64	9.00	3.42	15.00	3.79	21.00	1.52
3.25	1.64	9.25	4.05	15.25	3.79	21.25	1.52
3.50	1.64	9.50	4.05	15.50	3.79	21.50	1.52
3.75	1.64	9.75	4.55	15.75	3.79	21.75	1.52
4.00	1.64	10.00	4.55	16.00	3.79	22.00	1.52
4.25	2.02	10.25	5.82	16.25	2.28	22.25	1.52
4.50	2.02	10.50	5.82	16.50	2.28	22.50	1.52
4.75	2.02	10.75	7.84	16.75	2.28	22.75	1.52
5.00	2.02	11.00	7.84	17.00	2.28	23.00	1.52
5.25	2.02	11.25	12.14	17.25	2.28	23.25	1.52
5.50	2.02	11.50	12.14	17.50	2.28	23.50	1.52
5.75	2.02	11.75	52.62	17.75	2.28	23.75	1.52
6.00	2.02	12.00	139.64	18.00	2.28	24.00	1.52

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--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (1014) |   Area    (ha)=   1.52   Curve Number   (CN)= 57.5
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.27

         NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.033	1.39	6.033	2.53	12.033	18.21	18.03	2.28
0.067	1.39	6.067	2.53	12.067	18.21	18.07	2.28
0.100	1.39	6.100	2.53	12.100	18.21	18.10	2.28
0.133	1.39	6.133	2.53	12.133	18.21	18.13	2.28
0.167	1.39	6.167	2.53	12.167	18.21	18.17	2.28
0.200	1.39	6.200	2.53	12.200	18.21	18.20	2.28
0.233	1.39	6.233	2.53	12.233	18.21	18.23	2.28
0.267	1.39	6.267	2.53	12.267	18.21	18.27	2.28
0.300	1.39	6.300	2.53	12.300	18.21	18.30	2.28
0.333	1.39	6.333	2.53	12.333	18.21	18.33	2.28
0.367	1.39	6.367	2.53	12.367	18.21	18.37	2.28
0.400	1.39	6.400	2.53	12.400	18.21	18.40	2.28
0.433	1.39	6.433	2.53	12.433	18.21	18.43	2.28
0.467	1.39	6.467	2.53	12.467	18.21	18.47	2.28
0.500	1.39	6.500	2.53	12.500	18.20	18.50	2.28
0.533	1.39	6.533	2.53	12.533	9.36	18.53	2.28
0.567	1.39	6.567	2.53	12.567	9.36	18.57	2.28
0.600	1.39	6.600	2.53	12.600	9.36	18.60	2.28
0.633	1.39	6.633	2.53	12.633	9.36	18.63	2.28
0.667	1.39	6.667	2.53	12.667	9.36	18.67	2.28
0.700	1.39	6.700	2.53	12.700	9.36	18.70	2.28
0.733	1.39	6.733	2.53	12.733	9.36	18.73	2.28
0.767	1.39	6.767	2.53	12.767	9.36	18.77	2.28
0.800	1.39	6.800	2.53	12.800	9.36	18.80	2.28
0.833	1.39	6.833	2.53	12.833	9.36	18.83	2.28
0.867	1.39	6.867	2.53	12.867	9.36	18.87	2.28
0.900	1.39	6.900	2.53	12.900	9.36	18.90	2.28
0.933	1.39	6.933	2.53	12.933	9.36	18.93	2.28
0.967	1.39	6.967	2.53	12.967	9.36	18.97	2.28
1.000	1.39	7.000	2.53	13.000	9.35	19.00	2.28
1.033	1.39	7.033	2.53	13.033	6.07	19.03	2.28
1.067	1.39	7.067	2.53	13.067	6.07	19.07	2.28
1.100	1.39	7.100	2.53	13.100	6.07	19.10	2.28
1.133	1.39	7.133	2.53	13.133	6.07	19.13	2.28
1.167	1.39	7.167	2.53	13.167	6.07	19.17	2.28
1.200	1.39	7.200	2.53	13.200	6.07	19.20	2.28
1.233	1.39	7.233	2.53	13.233	6.07	19.23	2.28
1.267	1.39	7.267	2.53	13.267	6.07	19.27	2.28
1.300	1.39	7.300	2.53	13.300	6.07	19.30	2.28
1.333	1.39	7.333	2.53	13.333	6.07	19.33	2.28
1.367	1.39	7.367	2.53	13.367	6.07	19.37	2.28
1.400	1.39	7.400	2.53	13.400	6.07	19.40	2.28
1.433	1.39	7.433	2.53	13.433	6.07	19.43	2.28
1.467	1.39	7.467	2.53	13.467	6.07	19.47	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.533	1.39	7.533	2.53	13.533	6.07	19.53	2.28
1.567	1.39	7.567	2.53	13.567	6.07	19.57	2.28
1.600	1.39	7.600	2.53	13.600	6.07	19.60	2.28
1.633	1.39	7.633	2.53	13.633	6.07	19.63	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.700	1.39	7.700	2.53	13.700	6.07	19.70	2.28
1.733	1.39	7.733	2.53	13.733	6.07	19.73	2.28
1.767	1.39	7.767	2.53	13.767	6.07	19.77	2.28
1.800	1.39	7.800	2.53	13.800	6.07	19.80	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.867	1.39	7.867	2.53	13.867	6.07	19.87	2.28
1.900	1.39	7.900	2.53	13.900	6.07	19.90	2.28
1.933	1.39	7.933	2.53	13.933	6.07	19.93	2.28
1.967	1.39	7.967	2.53	13.967	6.07	19.97	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.033	1.64	8.033	3.42	14.033	3.79	20.03	1.52
2.067	1.64	8.067	3.42	14.067	3.79	20.07	1.52
2.100	1.64	8.100	3.42	14.100	3.79	20.10	1.52
2.133	1.64	8.133	3.42	14.133	3.79	20.13	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.200	1.64	8.200	3.42	14.200	3.79	20.20	1.52
2.233	1.64	8.233	3.42	14.233	3.79	20.23	1.52
2.267	1.64	8.267	3.42	14.267	3.79	20.27	1.52
2.300	1.64	8.300	3.42	14.300	3.79	20.30	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.367	1.64	8.367	3.42	14.367	3.79	20.37	1.52
2.400	1.64	8.400	3.42	14.400	3.79	20.40	1.52
2.433	1.64	8.433	3.42	14.433	3.79	20.43	1.52
2.467	1.64	8.467	3.42	14.467	3.79	20.47	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.533	1.64	8.533	3.42	14.533	3.79	20.53	1.52
2.567	1.64	8.567	3.42	14.567	3.79	20.57	1.52
2.600	1.64	8.600	3.42	14.600	3.79	20.60	1.52
2.633	1.64	8.633	3.42	14.633	3.79	20.63	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.700	1.64	8.700	3.42	14.700	3.79	20.70	1.52
2.733	1.64	8.733	3.42	14.733	3.79	20.73	1.52
2.767	1.64	8.767	3.42	14.767	3.79	20.77	1.52
2.800	1.64	8.800	3.42	14.800	3.79	20.80	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.867	1.64	8.867	3.42	14.867	3.79	20.87	1.52
2.900	1.64	8.900	3.42	14.900	3.79	20.90	1.52
2.933	1.64	8.933	3.42	14.933	3.79	20.93	1.52
2.967	1.64	8.967	3.42	14.967	3.79	20.97	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.033	1.64	9.033	4.05	15.033	3.79	21.03	1.52
3.067	1.64	9.067	4.05	15.067	3.79	21.07	1.52
3.100	1.64	9.100	4.05	15.100	3.79	21.10	1.52
3.133	1.64	9.133	4.05	15.133	3.79	21.13	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.200	1.64	9.200	4.05	15.200	3.79	21.20	1.52
3.233	1.64	9.233	4.05	15.233	3.79	21.23	1.52
3.267	1.64	9.267	4.05	15.267	3.79	21.27	1.52
3.300	1.64	9.300	4.05	15.300	3.79	21.30	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.367	1.64	9.367	4.05	15.367	3.79	21.37	1.52
3.400	1.64	9.400	4.05	15.400	3.79	21.40	1.52
3.433	1.64	9.433	4.05	15.433	3.79	21.43	1.52
3.467	1.64	9.467	4.05	15.467	3.79	21.47	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.533	1.64	9.533	4.55	15.533	3.79	21.53	1.52
3.567	1.64	9.567	4.55	15.567	3.79	21.57	1.52
3.600	1.64	9.600	4.55	15.600	3.79	21.60	1.52
3.633	1.64	9.633	4.55	15.633	3.79	21.63	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.700	1.64	9.700	4.55	15.700	3.79	21.70	1.52
3.733	1.64	9.733	4.55	15.733	3.79	21.73	1.52
3.767	1.64	9.767	4.55	15.767	3.79	21.77	1.52
3.800	1.64	9.800	4.55	15.800	3.79	21.80	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.867	1.64	9.867	4.55	15.867	3.79	21.87	1.52
3.900	1.64	9.900	4.55	15.900	3.79	21.90	1.52
3.933	1.64	9.933	4.55	15.933	3.79	21.93	1.52
3.967	1.64	9.967	4.55	15.967	3.79	21.97	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.033	2.02	10.033	5.82	16.033	2.28	22.03	1.52
4.067	2.02	10.067	5.82	16.067	2.28	22.07	1.52
4.100	2.02	10.100	5.82	16.100	2.28	22.10	1.52
4.133	2.02	10.133	5.82	16.133	2.28	22.13	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.200	2.02	10.200	5.82	16.200	2.28	22.20	1.52
4.233	2.02	10.233	5.82	16.233	2.28	22.23	1.52
4.267	2.02	10.267	5.82	16.267	2.28	22.27	1.52

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              4.300    2.02 |10.300    5.82 |16.300    2.28 | 22.30    1.52
              4.333    2.02 |10.333    5.82 |16.333    2.28 | 22.33    1.52
              4.367    2.02 |10.367    5.82 |16.367    2.28 | 22.37    1.52
              4.400    2.02 |10.400    5.82 |16.400    2.28 | 22.40    1.52
              4.433    2.02 |10.433    5.82 |16.433    2.28 | 22.43    1.52
              4.467    2.02 |10.467    5.82 |16.467    2.28 | 22.47    1.52
              4.500    2.02 |10.500    5.82 |16.500    2.28 | 22.50    1.52
              4.533    2.02 |10.533    7.84 |16.533    2.28 | 22.53    1.52
              4.567    2.02 |10.567    7.84 |16.567    2.28 | 22.57    1.52
              4.600    2.02 |10.600    7.84 |16.600    2.28 | 22.60    1.52
              4.633    2.02 |10.633    7.84 |16.633    2.28 | 22.63    1.52
              4.667    2.02 |10.667    7.84 |16.667    2.28 | 22.67    1.52
              4.700    2.02 |10.700    7.84 |16.700    2.28 | 22.70    1.52
              4.733    2.02 |10.733    7.84 |16.733    2.28 | 22.73    1.52
              4.767    2.02 |10.767    7.84 |16.767    2.28 | 22.77    1.52
              4.800    2.02 |10.800    7.84 |16.800    2.28 | 22.80    1.52
              4.833    2.02 |10.833    7.84 |16.833    2.28 | 22.83    1.52
              4.867    2.02 |10.867    7.84 |16.867    2.28 | 22.87    1.52
              4.900    2.02 |10.900    7.84 |16.900    2.28 | 22.90    1.52
              4.933    2.02 |10.933    7.84 |16.933    2.28 | 22.93    1.52
              4.967    2.02 |10.967    7.84 |16.967    2.28 | 22.97    1.52
              5.000    2.02 |11.000    7.85 |17.000    2.28 | 23.00    1.52
              5.033    2.02 |11.033   12.14 |17.033    2.28 | 23.03    1.52
              5.067    2.02 |11.067   12.14 |17.067    2.28 | 23.07    1.52
              5.100    2.02 |11.100   12.14 |17.100    2.28 | 23.10    1.52
              5.133    2.02 |11.133   12.14 |17.133    2.28 | 23.13    1.52
              5.167    2.02 |11.167   12.14 |17.167    2.28 | 23.17    1.52
              5.200    2.02 |11.200   12.14 |17.200    2.28 | 23.20    1.52
              5.233    2.02 |11.233   12.14 |17.233    2.28 | 23.23    1.52
              5.267    2.02 |11.267   12.14 |17.267    2.28 | 23.27    1.52
              5.300    2.02 |11.300   12.14 |17.300    2.28 | 23.30    1.52
              5.333    2.02 |11.333   12.14 |17.333    2.28 | 23.33    1.52
              5.367    2.02 |11.367   12.14 |17.367    2.28 | 23.37    1.52
              5.400    2.02 |11.400   12.14 |17.400    2.28 | 23.40    1.52
              5.433    2.02 |11.433   12.14 |17.433    2.28 | 23.43    1.52
              5.467    2.02 |11.467   12.14 |17.467    2.28 | 23.47    1.52
              5.500    2.02 |11.500   12.19 |17.500    2.28 | 23.50    1.52
              5.533    2.02 |11.533   52.62 |17.533    2.28 | 23.53    1.52
              5.567    2.02 |11.567   52.62 |17.567    2.28 | 23.57    1.52
              5.600    2.02 |11.600   52.62 |17.600    2.28 | 23.60    1.52
              5.633    2.02 |11.633   52.62 |17.633    2.28 | 23.63    1.52
              5.667    2.02 |11.667   52.62 |17.667    2.28 | 23.67    1.52
              5.700    2.02 |11.700   52.62 |17.700    2.28 | 23.70    1.52
              5.733    2.02 |11.733   52.62 |17.733    2.28 | 23.73    1.52
              5.767    2.02 |11.767   96.25 |17.767    2.28 | 23.77    1.52
              5.800    2.02 |11.800  139.64 |17.800    2.28 | 23.80    1.52
              5.833    2.02 |11.833  139.64 |17.833    2.28 | 23.83    1.52
              5.867    2.02 |11.867  139.64 |17.867    2.28 | 23.87    1.52
              5.900    2.02 |11.900  139.64 |17.900    2.28 | 23.90    1.52
              5.933    2.02 |11.933  139.64 |17.933    2.28 | 23.93    1.52
              5.967    2.02 |11.967  139.64 |17.967    2.28 | 23.97    1.52
              6.000    2.02 |12.000  139.47 |18.000    2.28 | 24.00    1.52

     Unit Hyd Qpeak  (cms)=   0.215

     PEAK FLOW       (cms)=   0.144 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  47.729
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.377

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| NASHYD    (1016) |   Area    (ha)=  11.33   Curve Number   (CN)= 68.2
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.59

     Unit Hyd Qpeak  (cms)=   0.733

     PEAK FLOW       (cms)=   0.820 (i)
     TIME TO PEAK    (hrs)=  12.500
     RUNOFF VOLUME    (mm)=  61.517
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.486

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1014):     1.52   0.144    12.17    47.73
        + ID2= 2 (1016):    11.33   0.820    12.50    61.52
          ================================================
          ID = 3 (****):    12.85   0.907    12.43    59.89

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (1015) |   Area    (ha)=   9.23   Curve Number   (CN)= 68.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.51

     Unit Hyd Qpeak  (cms)=   0.691

     PEAK FLOW       (cms)=   0.737 (i)
     TIME TO PEAK    (hrs)=  12.400
     RUNOFF VOLUME    (mm)=  61.238
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.484

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1015):     9.23   0.737    12.40    61.24
        + ID2= 2 (****):    12.85   0.907    12.43    59.89
          ================================================
          ID = 3 (****):    22.08   1.644    12.43    60.45

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (2115) |   Area    (ha)=   0.33
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.25         0.08
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.20
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.10         0.03         0.124 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96        106.60
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.99         0.39          0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB            |
| STANDHYD  (2114) |   Area    (ha)=   0.88
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.66         0.22
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64     ********
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.20
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.26         0.07         0.330 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96        106.61
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.99         0.39          0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB            |
| STANDHYD  (2214) |   Area    (ha)=   0.45
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.34         0.11
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
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     Unit Hyd. peak  (cms)=       0.45         0.20
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.04          0.169 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96         106.60
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| DUHYD     (****) |
| Inlet Cap.=0.093 |
| #of Inlets=    1 |
| Total(cms)=  0.1 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   0.45      0.17     12.00  106.60
     ==================================================
     MAJOR SYS.(ID= 2):   0.05      0.08     12.00  106.60
     MINOR SYS.(ID= 3):   0.40      0.09     11.80  106.60

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2114):     0.88   0.330    12.00   106.61
        + ID2= 2 (****):     0.40   0.093    11.80   106.60
          ================================================
          ID = 3 (****):     1.28   0.423    12.00   106.61

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (2116) |   Area    (ha)=   0.54
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.41         0.14
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.20
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.16         0.05          0.203 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96         106.61
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2116):     0.54   0.203    12.00   106.61
        + ID2= 2 (****):     1.28   0.423    12.00   106.61
          ================================================
          ID = 3 (****):     1.82   0.626    12.00   106.60

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2115):     0.33   0.124    12.00   106.60
        + ID2= 2 (****):     1.82   0.626    12.00   106.60
          ================================================
          ID = 3 (****):     2.15   0.750    12.00   106.61

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| DUHYD     (****) |
| Inlet Cap.=0.455 |
| #of Inlets=    1 |
| Total(cms)=  0.5 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   2.15      0.75     12.00  106.61
     ==================================================
     MAJOR SYS.(ID= 2):   0.20      0.29     12.00  106.61
     MINOR SYS.(ID= 3):   1.94      0.46     11.80  106.61

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| DUHYD     (0153) |
| Inlet Cap.=0.206 |
| #of Inlets=    1 |
| Total(cms)=  0.2 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   0.20      0.29     12.00  106.61
     ==================================================
     MAJOR SYS.(ID= 2):   0.04      0.09     12.00  106.61
     MINOR SYS.(ID= 3):   0.16      0.21     11.87  106.61

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0153):     0.04   0.089    12.00   106.61
        + ID2= 2 (****):    22.08   1.644    12.43    60.45
          ================================================
          ID = 3 (****):    22.12   1.644    12.43    60.53

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (1017) |   Area    (ha)=   1.65   Curve Number   (CN)= 62.4
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.23

     Unit Hyd Qpeak  (cms)=   0.274

     PEAK FLOW       (cms)=   0.197 (i)
     TIME TO PEAK    (hrs)=  12.100
     RUNOFF VOLUME    (mm)=  53.759
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.425

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1017):     1.65   0.197    12.10    53.76
        + ID2= 2 (****):    22.12   1.644    12.43    60.53
          ================================================
          ID = 3 (****):    23.77   1.756    12.37    60.06

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (2015) |   Area    (ha)=   9.23   Curve Number   (CN)= 68.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.51

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    1.39 | 6.083    2.53 |12.083   18.23 | 18.08    2.28
                 0.167    1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
                 0.250    1.39 | 6.250    2.53 |12.250   18.21 | 18.25    2.28
                 0.333    1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
                 0.417    1.39 | 6.417    2.53 |12.417   18.21 | 18.42    2.28
                 0.500    1.39 | 6.500    2.53 |12.500   18.21 | 18.50    2.28
                 0.583    1.39 | 6.583    2.53 |12.583    9.36 | 18.58    2.28
                 0.667    1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
                 0.750    1.39 | 6.750    2.53 |12.750    9.36 | 18.75    2.28
                 0.833    1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
                 0.917    1.39 | 6.917    2.53 |12.917    9.36 | 18.92    2.28
                 1.000    1.39 | 7.000    2.53 |13.000    9.36 | 19.00    2.28
                 1.083    1.39 | 7.083    2.53 |13.083    6.07 | 19.08    2.28
                 1.167    1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
                 1.250    1.39 | 7.250    2.53 |13.250    6.07 | 19.25    2.28
                 1.333    1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
                 1.417    1.39 | 7.417    2.53 |13.417    6.07 | 19.42    2.28
                 1.500    1.39 | 7.500    2.53 |13.500    6.07 | 19.50    2.28
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1.583	1.39	7.583	2.53	13.583	6.07	19.58	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.750	1.39	7.750	2.53	13.750	6.07	19.75	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.917	1.39	7.917	2.53	13.917	6.07	19.92	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.083	1.64	8.083	3.42	14.083	3.80	20.08	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.250	1.64	8.250	3.42	14.250	3.79	20.25	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.417	1.64	8.417	3.42	14.417	3.79	20.42	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.583	1.64	8.583	3.42	14.583	3.79	20.58	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.750	1.64	8.750	3.42	14.750	3.79	20.75	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.917	1.64	8.917	3.42	14.917	3.79	20.92	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.083	1.64	9.083	4.05	15.083	3.79	21.08	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.250	1.64	9.250	4.05	15.250	3.79	21.25	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.417	1.64	9.417	4.05	15.417	3.79	21.42	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.583	1.64	9.583	4.55	15.583	3.79	21.58	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.750	1.64	9.750	4.55	15.750	3.79	21.75	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.917	1.64	9.917	4.55	15.917	3.79	21.92	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.083	2.02	10.083	5.82	16.083	2.28	22.08	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.250	2.02	10.250	5.82	16.250	2.28	22.25	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.417	2.02	10.417	5.82	16.417	2.28	22.42	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.583	2.02	10.583	7.84	16.583	2.28	22.58	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.750	2.02	10.750	7.84	16.750	2.28	22.75	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.917	2.02	10.917	7.84	16.917	2.28	22.92	1.52
5.000	2.02	11.000	7.84	17.000	2.28	23.00	1.52
5.083	2.02	11.083	12.14	17.083	2.28	23.08	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.250	2.02	11.250	12.14	17.250	2.28	23.25	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.417	2.02	11.417	12.14	17.417	2.28	23.42	1.52
5.500	2.02	11.500	12.14	17.500	2.28	23.50	1.52
5.583	2.02	11.583	52.62	17.583	2.28	23.58	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.750	2.02	11.750	52.62	17.750	2.28	23.75	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.917	2.02	11.917	139.64	17.917	2.28	23.92	1.52
6.000	2.02	12.000	139.64	18.000	2.28	24.00	1.52

Unit Hyd Qpeak (cms)= 0.691

PEAK FLOW (cms)= 0.736 (i)
TIME TO PEAK (hrs)= 12.417
RUNOFF VOLUME (mm)= 61.236
TOTAL RAINFALL (mm)= 126.490
RUNOFF COEFFICIENT = 0.484

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB			
NASHYD (2014)	Area (ha)= 1.52	Curve Number (CN)= 57.5	
ID= 1 DT= 2.0 min	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00	
	U.H. Tp(hrs)= 0.27		

NOTE: RAINFALL WAS TRANSFORMED TO 2.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.033	1.39	6.033	2.53	12.033	18.21	18.03	2.28
0.067	1.39	6.067	2.53	12.067	18.21	18.07	2.28
0.100	1.39	6.100	2.53	12.100	18.21	18.10	2.28
0.133	1.39	6.133	2.53	12.133	18.21	18.13	2.28
0.167	1.39	6.167	2.53	12.167	18.21	18.17	2.28
0.200	1.39	6.200	2.53	12.200	18.21	18.20	2.28
0.233	1.39	6.233	2.53	12.233	18.21	18.23	2.28
0.267	1.39	6.267	2.53	12.267	18.21	18.27	2.28
0.300	1.39	6.300	2.53	12.300	18.21	18.30	2.28
0.333	1.39	6.333	2.53	12.333	18.21	18.33	2.28
0.367	1.39	6.367	2.53	12.367	18.21	18.37	2.28
0.400	1.39	6.400	2.53	12.400	18.21	18.40	2.28
0.433	1.39	6.433	2.53	12.433	18.21	18.43	2.28
0.467	1.39	6.467	2.53	12.467	18.21	18.47	2.28
0.500	1.39	6.500	2.53	12.500	18.20	18.50	2.28
0.533	1.39	6.533	2.53	12.533	9.36	18.53	2.28
0.567	1.39	6.567	2.53	12.567	9.36	18.57	2.28
0.600	1.39	6.600	2.53	12.600	9.36	18.60	2.28
0.633	1.39	6.633	2.53	12.633	9.36	18.63	2.28
0.667	1.39	6.667	2.53	12.667	9.36	18.67	2.28
0.700	1.39	6.700	2.53	12.700	9.36	18.70	2.28
0.733	1.39	6.733	2.53	12.733	9.36	18.73	2.28
0.767	1.39	6.767	2.53	12.767	9.36	18.77	2.28
0.800	1.39	6.800	2.53	12.800	9.36	18.80	2.28
0.833	1.39	6.833	2.53	12.833	9.36	18.83	2.28
0.867	1.39	6.867	2.53	12.867	9.36	18.87	2.28
0.900	1.39	6.900	2.53	12.900	9.36	18.90	2.28
0.933	1.39	6.933	2.53	12.933	9.36	18.93	2.28
0.967	1.39	6.967	2.53	12.967	9.36	18.97	2.28
1.000	1.39	7.000	2.53	13.000	9.35	19.00	2.28
1.033	1.39	7.033	2.53	13.033	6.07	19.03	2.28
1.067	1.39	7.067	2.53	13.067	6.07	19.07	2.28
1.100	1.39	7.100	2.53	13.100	6.07	19.10	2.28
1.133	1.39	7.133	2.53	13.133	6.07	19.13	2.28
1.167	1.39	7.167	2.53	13.167	6.07	19.17	2.28
1.200	1.39	7.200	2.53	13.200	6.07	19.20	2.28
1.233	1.39	7.233	2.53	13.233	6.07	19.23	2.28
1.267	1.39	7.267	2.53	13.267	6.07	19.27	2.28
1.300	1.39	7.300	2.53	13.300	6.07	19.30	2.28
1.333	1.39	7.333	2.53	13.333	6.07	19.33	2.28
1.367	1.39	7.367	2.53	13.367	6.07	19.37	2.28
1.400	1.39	7.400	2.53	13.400	6.07	19.40	2.28
1.433	1.39	7.433	2.53	13.433	6.07	19.43	2.28
1.467	1.39	7.467	2.53	13.467	6.07	19.47	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.533	1.39	7.533	2.53	13.533	6.07	19.53	2.28
1.567	1.39	7.567	2.53	13.567	6.07	19.57	2.28
1.600	1.39	7.600	2.53	13.600	6.07	19.60	2.28
1.633	1.39	7.633	2.53	13.633	6.07	19.63	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.700	1.39	7.700	2.53	13.700	6.07	19.70	2.28
1.733	1.39	7.733	2.53	13.733	6.07	19.73	2.28
1.767	1.39	7.767	2.53	13.767	6.07	19.77	2.28
1.800	1.39	7.800	2.53	13.800	6.07	19.80	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.867	1.39	7.867	2.53	13.867	6.07	19.87	2.28
1.900	1.39	7.900	2.53	13.900	6.07	19.90	2.28
1.933	1.39	7.933	2.53	13.933	6.07	19.93	2.28
1.967	1.39	7.967	2.53	13.967	6.07	19.97	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.033	1.64	8.033	3.42	14.033	3.79	20.03	1.52
2.067	1.64	8.067	3.42	14.067	3.79	20.07	1.52
2.100	1.64	8.100	3.42	14.100	3.79	20.10	1.52
2.133	1.64	8.133	3.42	14.133	3.79	20.13	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.200	1.64	8.200	3.42	14.200	3.79	20.20	1.52
2.233	1.64	8.233	3.42	14.233	3.79	20.23	1.52
2.267	1.64	8.267	3.42	14.267	3.79	20.27	1.52
2.300	1.64	8.300	3.42	14.300	3.79	20.30	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.367	1.64	8.367	3.42	14.367	3.79	20.37	1.52
2.400	1.64	8.400	3.42	14.400	3.79	20.40	1.52
2.433	1.64	8.433	3.42	14.433	3.79	20.43	1.52
2.467	1.64	8.467	3.42	14.467	3.79	20.47	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.533	1.64	8.533	3.42	14.533	3.79	20.53	1.52
2.567	1.64	8.567	3.42	14.567	3.79	20.57	1.52
2.600	1.64	8.600	3.42	14.600	3.79	20.60	1.52
2.633	1.64	8.633	3.42	14.633	3.79	20.63	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.700	1.64	8.700	3.42	14.700	3.79	20.70	1.52
2.733	1.64	8.733	3.42	14.733	3.79	20.73	1.52
2.767	1.64	8.767	3.42	14.767	3.79	20.77	1.52
2.800	1.64	8.800	3.42	14.800	3.79	20.80	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.867	1.64	8.867	3.42	14.867	3.79	20.87	1.52
2.900	1.64	8.900	3.42	14.900	3.79	20.90	1.52
2.933	1.64	8.933	3.42	14.933	3.79	20.93	1.52
2.967	1.64	8.967	3.42	14.967	3.79	20.97	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.033	1.64	9.033	4.05	15.033	3.79	21.03	1.52
3.067	1.64	9.067	4.05	15.067	3.79	21.07	1.52
3.100	1.64	9.100	4.05	15.100	3.79	21.10	1.52
3.133	1.64	9.133	4.05	15.133	3.79	21.13	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.200	1.64	9.200	4.05	15.200	3.79	21.20	1.52
3.233	1.64	9.233	4.05	15.233	3.79	21.23	1.52
3.267	1.64	9.267	4.05	15.267	3.79	21.27	1.52
3.300	1.64	9.300	4.05	15.300	3.79	21.30	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.367	1.64	9.367	4.05	15.367	3.79	21.37	1.52
3.400	1.64	9.400	4.05	15.400	3.79	21.40	1.52
3.433	1.64	9.433	4.05	15.433	3.79	21.43	1.52
3.467	1.64	9.467	4.05	15.467	3.79	21.47	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.533	1.64	9.533	4.55	15.533	3.79	21.53	1.52
3.567	1.64	9.567	4.55	15.567	3.79	21.57	1.52
3.600	1.64	9.600	4.55	15.600	3.79	21.60	1.52
3.633	1.64	9.633	4.55	15.633	3.79	21.63	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.700	1.64	9.700	4.55	15.700	3.79	21.70	1.52
3.733	1.64	9.733	4.55	15.733	3.79	21.73	1.52
3.767	1.64	9.767	4.55	15.767	3.79	21.77	1.52
3.800	1.64	9.800	4.55	15.800	3.79	21.80	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.867	1.64	9.867	4.55	15.867	3.79	21.87	1.52
3.900	1.64	9.900	4.55	15.900	3.79	21.90	1.52
3.933	1.64	9.933	4.55	15.933	3.79	21.93	1.52
3.967	1.64	9.967	4.55	15.967	3.79	21.97	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.033	2.02	10.033	5.82	16.033	2.28	22.03	1.52
4.067	2.02	10.067	5.82	16.067	2.28	22.07	1.52
4.100	2.02	10.100	5.82	16.100	2.28	22.10	1.52
4.133	2.02	10.133	5.82	16.133	2.28	22.13	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.200	2.02	10.200	5.82	16.200	2.28	22.20	1.52
4.233	2.02	10.233	5.82	16.233	2.28	22.23	1.52
4.267	2.02	10.267	5.82	16.267	2.28	22.27	1.52
4.300	2.02	10.300	5.82	16.300	2.28	22.30	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.367	2.02	10.367	5.82	16.367	2.28	22.37	1.52
4.400	2.02	10.400	5.82	16.400	2.28	22.40	1.52
4.433	2.02	10.433	5.82	16.433	2.28	22.43	1.52
4.467	2.02	10.467	5.82	16.467	2.28	22.47	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.533	2.02	10.533	7.84	16.533	2.28	22.53	1.52
4.567	2.02	10.567	7.84	16.567	2.28	22.57	1.52
4.600	2.02	10.600	7.84	16.600	2.28	22.60	1.52
4.633	2.02	10.633	7.84	16.633	2.28	22.63	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.700	2.02	10.700	7.84	16.700	2.28	22.70	1.52
4.733	2.02	10.733	7.84	16.733	2.28	22.73	1.52

4.767	2.02	10.767	7.84	16.767	2.28	22.77	1.52
4.800	2.02	10.800	7.84	16.800	2.28	22.80	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.867	2.02	10.867	7.84	16.867	2.28	22.87	1.52
4.900	2.02	10.900	7.84	16.900	2.28	22.90	1.52
4.933	2.02	10.933	7.84	16.933	2.28	22.93	1.52
4.967	2.02	10.967	7.84	16.967	2.28	22.97	1.52
5.000	2.02	11.000	7.85	17.000	2.28	23.00	1.52
5.033	2.02	11.033	12.14	17.033	2.28	23.03	1.52
5.067	2.02	11.067	12.14	17.067	2.28	23.07	1.52
5.100	2.02	11.100	12.14	17.100	2.28	23.10	1.52
5.133	2.02	11.133	12.14	17.133	2.28	23.13	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.200	2.02	11.200	12.14	17.200	2.28	23.20	1.52
5.233	2.02	11.233	12.14	17.233	2.28	23.23	1.52
5.267	2.02	11.267	12.14	17.267	2.28	23.27	1.52
5.300	2.02	11.300	12.14	17.300	2.28	23.30	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.367	2.02	11.367	12.14	17.367	2.28	23.37	1.52
5.400	2.02	11.400	12.14	17.400	2.28	23.40	1.52
5.433	2.02	11.433	12.14	17.433	2.28	23.43	1.52
5.467	2.02	11.467	12.14	17.467	2.28	23.47	1.52
5.500	2.02	11.500	12.19	17.500	2.28	23.50	1.52
5.533	2.02	11.533	52.62	17.533	2.28	23.53	1.52
5.567	2.02	11.567	52.62	17.567	2.28	23.57	1.52
5.600	2.02	11.600	52.62	17.600	2.28	23.60	1.52
5.633	2.02	11.633	52.62	17.633	2.28	23.63	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.700	2.02	11.700	52.62	17.700	2.28	23.70	1.52
5.733	2.02	11.733	52.62	17.733	2.28	23.73	1.52
5.767	2.02	11.767	96.25	17.767	2.28	23.77	1.52
5.800	2.02	11.800	139.64	17.800	2.28	23.80	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.867	2.02	11.867	139.64	17.867	2.28	23.87	1.52
5.900	2.02	11.900	139.64	17.900	2.28	23.90	1.52
5.933	2.02	11.933	139.64	17.933	2.28	23.93	1.52
5.967	2.02	11.967	139.64	17.967	2.28	23.97	1.52
6.000	2.02	12.000	139.47	18.000	2.28	24.00	1.52

```
     Unit Hyd Qpeak  (cms)=   0.215

     PEAK FLOW       (cms)=   0.144 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  47.729
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.377

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (2016) |   Area    (ha)=  11.33   Curve Number   (CN)= 68.2
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.59

     Unit Hyd Qpeak  (cms)=   0.733

     PEAK FLOW       (cms)=   0.820 (i)
     TIME TO PEAK    (hrs)=  12.500
     RUNOFF VOLUME    (mm)=  61.517
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.486

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2014):     1.52   0.144    12.17    47.73
        + ID2= 2 (2016):    11.33   0.820    12.50    61.52
          ================================================
          ID = 3 (****):    12.85   0.907    12.43    59.89

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2015):     9.23   0.736    12.42    61.24
        + ID2= 2 (****):    12.85   0.907    12.43    59.89
          ================================================
          ID = 3 (****):    22.08   1.641    12.40    60.45

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (****):     1.94   0.455    11.80   106.61
        + ID2= 2 (****):    22.08   1.641    12.40    60.45
          ================================================
          ID = 3 (****):    24.02   1.744    12.40    64.19

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0153):     0.16   0.206    11.87   106.61
        + ID2= 2 (****):    24.02   1.744    12.40    64.19
          ================================================
          ID = 3 (****):    24.19   1.744    12.40    64.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (2017) |   Area    (ha)=   1.65   Curve Number   (CN)= 62.4
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.23

     Unit Hyd Qpeak  (cms)=   0.274

     PEAK FLOW       (cms)=   0.197 (i)
     TIME TO PEAK    (hrs)=  12.100
     RUNOFF VOLUME    (mm)=  53.759
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.425

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2017):     1.65   0.197    12.10    53.76
        + ID2= 2 (****):    24.19   1.744    12.40    64.47
          ================================================
          ID = 3 (****):    25.84   1.864    12.33    63.79

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (1019) |   Area    (ha)= 119.82   Curve Number   (CN)= 66.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   9.90   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.60

     Unit Hyd Qpeak  (cms)=   7.628

     PEAK FLOW       (cms)=   7.839 (i)
     TIME TO PEAK    (hrs)=  12.533
     RUNOFF VOLUME    (mm)=  56.109
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.444

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (1018) |   Area    (ha)=   1.54   Curve Number   (CN)= 55.7
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.24

     Unit Hyd Qpeak  (cms)=   0.245

     PEAK FLOW       (cms)=   0.150 (i)
     TIME TO PEAK    (hrs)=  12.133
     RUNOFF VOLUME    (mm)=  45.622
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.361

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1018):     1.54   0.150    12.13    45.62
        + ID2= 2 (1019):   119.82   7.839    12.53    56.11
          ================================================
          ID = 3 (****):   121.36   7.906    12.53    55.98

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (2019) |   Area    (ha)= 119.82   Curve Number   (CN)= 66.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   9.90   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.60

     Unit Hyd Qpeak  (cms)=   7.628

     PEAK FLOW       (cms)=   7.839 (i)
     TIME TO PEAK    (hrs)=  12.533
     RUNOFF VOLUME    (mm)=  56.109
```

```
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.444

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (2119) |   Area    (ha)=   3.99
|ID= 1 DT= 2.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  65.00
--------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.59         1.40
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       131.63
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    6.43 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.16
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.01         0.45          1.453 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        49.96          99.05
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.39           0.78

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2019):   119.82   7.839    12.53    56.11
        + ID2= 2 (2119):     3.99   1.453    12.00    99.05
          ================================================
          ID = 3 (****):   123.81   8.009    12.50    57.49

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (2018) |   Area    (ha)=   1.54   Curve Number   (CN)= 55.7
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.24

     Unit Hyd Qpeak  (cms)=   0.245

     PEAK FLOW       (cms)=   0.150 (i)
     TIME TO PEAK    (hrs)=  12.133
     RUNOFF VOLUME    (mm)=  45.622
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.361

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2018):     1.54   0.150    12.13    45.62
        + ID2= 2 (****):   123.81   8.009    12.50    57.49
          ================================================
          ID = 3 (****):   125.35   8.081    12.50    57.35

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| ROUTE PIPE (****)|     PIPE Number     =   1.00
| IN= 2---> OUT= 1 |     Diameter    (mm)=1650.00
| DT=  1.0 min     |     Length       (m)= 500.00
--------------------     Slope      (m/m)=  0.005
                         Manning n       =  0.013

     <---------------- TRAVEL TIME TABLE -------------------->
       DEPTH      VOLUME    FLOW RATE    VELOCITY    TRAV.TIME
        (m)      (cu.m.)      (cms)        (m/s)        min
       0.09     .216E+02       0.0          0.80        10.40
       0.17     .600E+02       0.1          1.25         6.67
       0.26     .108E+03       0.3          1.61         5.18
       0.35     .164E+03       0.6          1.91         4.36
       0.43     .225E+03       1.0          2.18         3.83
       0.52     .290E+03       1.4          2.41         3.46
       0.61     .358E+03       1.9          2.61         3.19
       0.69     .428E+03       2.4          2.79         2.99
       0.78     .499E+03       2.9          2.95         2.83
       0.87     .570E+03       3.5          3.08         2.70
       0.96     .642E+03       4.1          3.20         2.61
       1.04     .712E+03       4.7          3.29         2.53
       1.13     .780E+03       5.2          3.36         2.48
       1.22     .844E+03       5.8          3.41         2.44
       1.30     .905E+03       6.2          3.44         2.43
       1.39     .961E+03       6.6          3.43         2.43
       1.48     .101E+04       6.9          3.40         2.45
       1.56     .105E+04       6.9          3.31         2.52
       1.65     .107E+04       6.5          3.02         2.76
                                     <---- hydrograph ---->   <-pipe / channel->
                                AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                                (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (****)    0.05     0.08   12.00 106.60      0.12      0.92
     OUTFLOW: ID= 1 (****)    0.05     0.05   12.02 105.57      0.10      0.84


--------------------------------------------------------------------------------

 FINISH
================================================================================
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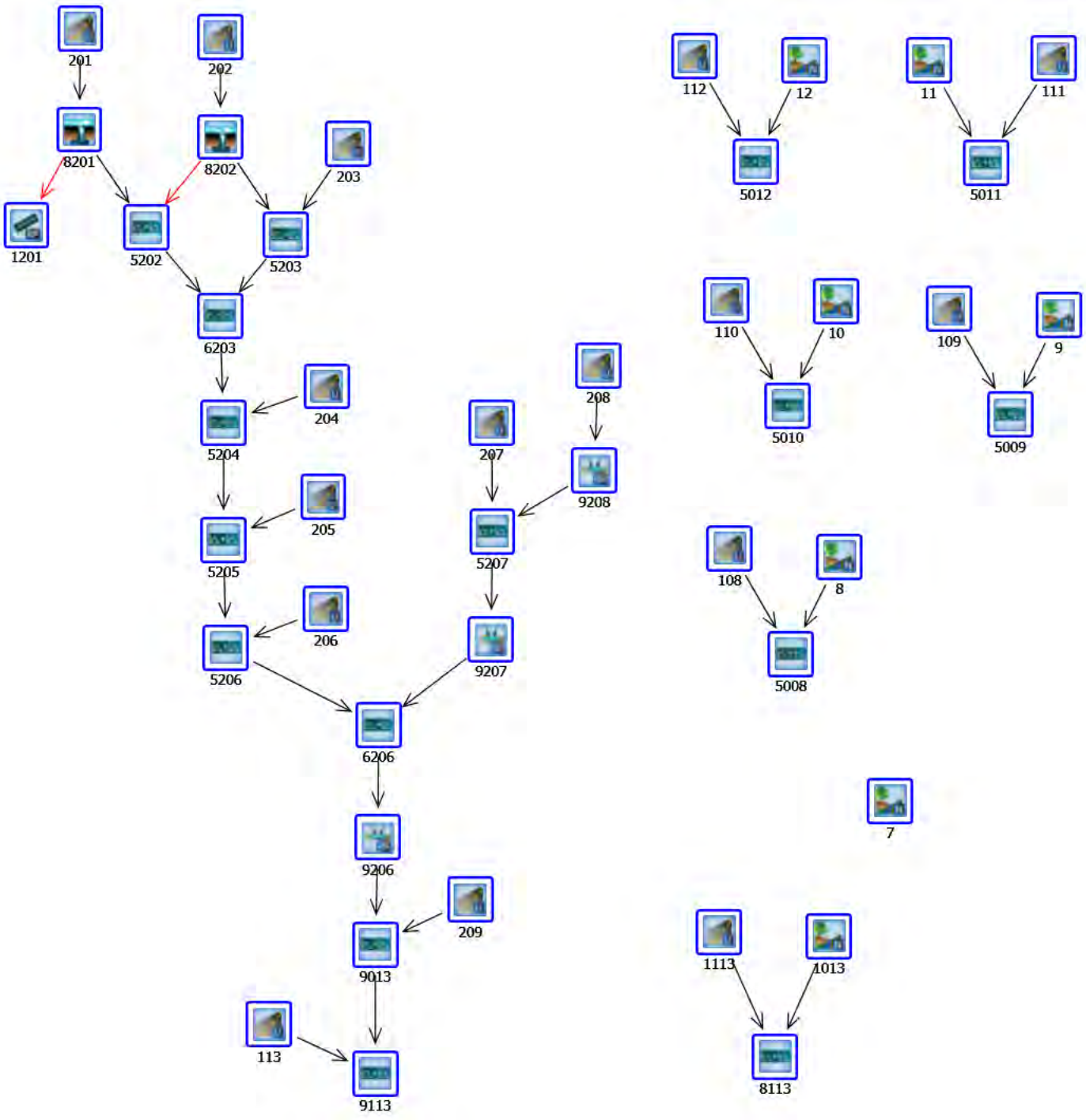
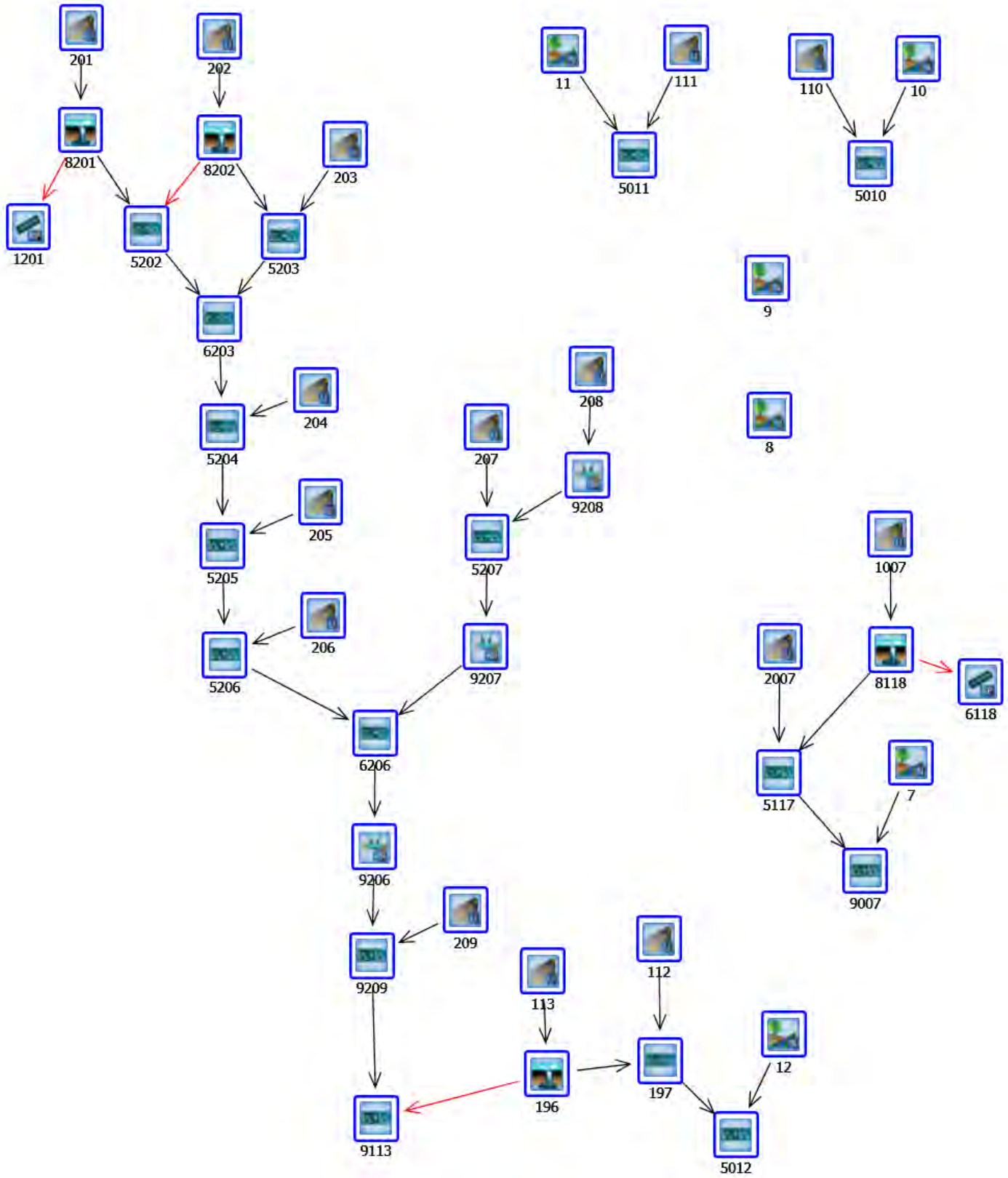


OTTHYMO Model Schematic - Tiffany Creek Existing conditions



OTTHYMO Model Schematic - Tiffany Creek Future Conditions

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==============================================================================
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       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    Company
        OOO     T      T    H   H    Y    M   M   OOO                 Serial

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                    *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual Otthymo 2.4\VO2\voin.dat
  Output  filename: C:\Users\Bill\AppData\Local\Temp\10c952af-4349-452b-b6b4-
e9364d8f635a\Scenario.out
  Summary filename: C:\Users\Bill\AppData\Local\Temp\10c952af-4349-452b-b6b4-
e9364d8f635a\Scenario.sum


DATE: 11/23/2013                          TIME: 03:52:27
```

Tiffany Creek
Existing100-yr

```
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************


--------------------
| MASS STORM       |    Filename: C:\Users\Bill\AppD
|                  |              ata\Local\Temp\
|                  |              10c952af-4349-452b-b6b4-e9364d8f635a\b4dbaf59
| Ptotal=126.49 mm |    Comments: 24hr SCS Mass Storm
--------------------
                        Duration of storm    = 24.00 hrs
                        Mass curve time step = 15.00 min
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	1.39	6.25	2.53	12.25	18.21	18.25	2.28
0.50	1.39	6.50	2.53	12.50	18.21	18.50	2.28
0.75	1.39	6.75	2.53	12.75	9.36	18.75	2.28
1.00	1.39	7.00	2.53	13.00	9.36	19.00	2.28
1.25	1.39	7.25	2.53	13.25	6.07	19.25	2.28
1.50	1.39	7.50	2.53	13.50	6.07	19.50	2.28
1.75	1.39	7.75	2.53	13.75	6.07	19.75	2.28
2.00	1.39	8.00	2.53	14.00	6.07	20.00	2.28
2.25	1.64	8.25	3.42	14.25	3.79	20.25	1.52
2.50	1.64	8.50	3.42	14.50	3.79	20.50	1.52
2.75	1.64	8.75	3.42	14.75	3.79	20.75	1.52
3.00	1.64	9.00	3.42	15.00	3.79	21.00	1.52
3.25	1.64	9.25	4.05	15.25	3.79	21.25	1.52
3.50	1.64	9.50	4.05	15.50	3.79	21.50	1.52
3.75	1.64	9.75	4.55	15.75	3.79	21.75	1.52
4.00	1.64	10.00	4.55	16.00	3.79	22.00	1.52
4.25	2.02	10.25	5.82	16.25	2.28	22.25	1.52
4.50	2.02	10.50	5.82	16.50	2.28	22.50	1.52
4.75	2.02	10.75	7.84	16.75	2.28	22.75	1.52
5.00	2.02	11.00	7.84	17.00	2.28	23.00	1.52
5.25	2.02	11.25	12.14	17.25	2.28	23.25	1.52
5.50	2.02	11.50	12.14	17.50	2.28	23.50	1.52
5.75	2.02	11.75	52.62	17.75	2.28	23.75	1.52
6.00	2.02	12.00	139.64	18.00	2.28	24.00	1.52

```
------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=   4.19
|ID= 1 DT= 5.0 min |   Total Imp(%)=  53.00   Dir. Conn.(%)=  41.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.22          1.97
     Dep. Storage     (mm)=       1.50          2.50
     Average Slope     (%)=       0.50          2.00
     Length            (m)=     200.00         30.00
     Mannings n           =      0.015         0.200

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	1.39	6.083	2.53	12.083	18.23	18.08	2.28
0.167	1.39	6.167	2.53	12.167	18.21	18.17	2.28
0.250	1.39	6.250	2.53	12.250	18.21	18.25	2.28
0.333	1.39	6.333	2.53	12.333	18.21	18.33	2.28
0.417	1.39	6.417	2.53	12.417	18.21	18.42	2.28
0.500	1.39	6.500	2.53	12.500	18.21	18.50	2.28
0.583	1.39	6.583	2.53	12.583	9.36	18.58	2.28
0.667	1.39	6.667	2.53	12.667	9.36	18.67	2.28
0.750	1.39	6.750	2.53	12.750	9.36	18.75	2.28
0.833	1.39	6.833	2.53	12.833	9.36	18.83	2.28
0.917	1.39	6.917	2.53	12.917	9.36	18.92	2.28
1.000	1.39	7.000	2.53	13.000	9.36	19.00	2.28
1.083	1.39	7.083	2.53	13.083	6.07	19.08	2.28
1.167	1.39	7.167	2.53	13.167	6.07	19.17	2.28
1.250	1.39	7.250	2.53	13.250	6.07	19.25	2.28
1.333	1.39	7.333	2.53	13.333	6.07	19.33	2.28
1.417	1.39	7.417	2.53	13.417	6.07	19.42	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.583	1.39	7.583	2.53	13.583	6.07	19.58	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.750	1.39	7.750	2.53	13.750	6.07	19.75	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.917	1.39	7.917	2.53	13.917	6.07	19.92	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.083	1.64	8.083	3.42	14.083	3.80	20.08	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.250	1.64	8.250	3.42	14.250	3.79	20.25	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.417	1.64	8.417	3.42	14.417	3.79	20.42	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.583	1.64	8.583	3.42	14.583	3.79	20.58	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.750	1.64	8.750	3.42	14.750	3.79	20.75	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.917	1.64	8.917	3.42	14.917	3.79	20.92	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.083	1.64	9.083	4.05	15.083	3.79	21.08	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.250	1.64	9.250	4.05	15.250	3.79	21.25	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.417	1.64	9.417	4.05	15.417	3.79	21.42	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.583	1.64	9.583	4.55	15.583	3.79	21.58	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.750	1.64	9.750	4.55	15.750	3.79	21.75	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.917	1.64	9.917	4.55	15.917	3.79	21.92	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.083	2.02	10.083	5.82	16.083	2.28	22.08	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.250	2.02	10.250	5.82	16.250	2.28	22.25	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.417	2.02	10.417	5.82	16.417	2.28	22.42	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.583	2.02	10.583	7.84	16.583	2.28	22.58	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.750	2.02	10.750	7.84	16.750	2.28	22.75	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.917	2.02	10.917	7.84	16.917	2.28	22.92	1.52
5.000	2.02	11.000	7.84	17.000	2.28	23.00	1.52
5.083	2.02	11.083	12.14	17.083	2.28	23.08	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.250	2.02	11.250	12.14	17.250	2.28	23.25	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.417	2.02	11.417	12.14	17.417	2.28	23.42	1.52
5.500	2.02	11.500	12.14	17.500	2.28	23.50	1.52
5.583	2.02	11.583	52.62	17.583	2.28	23.58	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.750	2.02	11.750	52.62	17.750	2.28	23.75	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.917	2.02	11.917	139.64	17.917	2.28	23.92	1.52
6.000	2.02	12.000	139.64	18.000	2.28	24.00	1.52

```
     Max.Eff.Inten.(mm/hr)=     139.64       130.64
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.55 (ii)    9.35 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.65         0.55         1.196 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     124.99        79.25         98.00
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.99         0.63          0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| DUHYD     (8201) |
| Inlet Cap.=0.560 |
| #of Inlets=    1 |
| Total(cms)=  0.6 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   4.19      1.20     12.00   98.00
     ==================================================
     MAJOR SYS.(ID= 2):   0.48      0.64     12.00   98.00
     MINOR SYS.(ID= 3):   3.71      0.56     11.83   98.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
--------------------
| ROUTE PIPE (1201)|     PIPE Number     =   1.00
| IN= 2---> OUT= 1 |     Diameter    (mm)=1650.00
| DT=  5.0 min     |     Length       (m)= 100.00
--------------------     Slope      (m/m)=  0.005
                         Manning n        =  0.013
```

```
<---------------- TRAVEL TIME TABLE -------------------->
  DEPTH      VOLUME    FLOW RATE    VELOCITY    TRAV.TIME
   (m)      (cu.m.)      (cms)        (m/s)        min
  0.09     .431E+01       0.0         0.80         2.08
  0.17     .120E+02       0.1         1.25         1.33
  0.26     .217E+02       0.3         1.61         1.04
  0.35     .328E+02       0.6         1.91         0.87
  0.43     .449E+02       1.0         2.18         0.77
  0.52     .579E+02       1.4         2.41         0.69
  0.61     .715E+02       1.9         2.61         0.64
  0.69     .855E+02       2.4         2.79         0.60
  0.78     .998E+02       2.9         2.95         0.57
  0.87     .114E+03       3.5         3.08         0.54
  0.96     .128E+03       4.1         3.20         0.52
  1.04     .142E+03       4.7         3.29         0.51
  1.13     .156E+03       5.2         3.36         0.50
  1.22     .169E+03       5.8         3.41         0.49
  1.30     .181E+03       6.2         3.44         0.49
  1.39     .192E+03       6.6         3.43         0.49
  1.48     .202E+03       6.9         3.40         0.49
  1.56     .210E+03       6.9         3.31         0.50
  1.65     .214E+03       6.5         3.02         0.55
                                <---- hydrograph ---->   <-pipe / channel->
                              AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                              (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
INFLOW : ID= 2 (8201)    3.71     0.56   11.83  98.00      0.33      1.83
OUTFLOW: ID= 1 (1201)    3.71     0.58   11.92  98.00      0.33      1.86


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   3.55
|ID= 1 DT= 5.0 min |   Total Imp(%)=  58.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.06         1.49
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       143.98
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.55 (ii)    9.68 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.11
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.54         0.45          0.985 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        75.94          95.36
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.60           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| DUHYD     (8202) |
| Inlet Cap.=0.426 |
| #of Inlets=    1 |
| Total(cms)=  0.4 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   3.55      0.99     12.00   95.36
     ==================================================
     MAJOR SYS.(ID= 2):   0.45      0.56     12.00   95.36
     MINOR SYS.(ID= 3):   3.10      0.43     11.83   95.36

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (5202) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (8201):     0.48   0.636    12.00    98.00
        + ID2= 2 (8202):     3.10   0.426    11.83    95.36
          ================================================
          ID = 3 (5202):     3.58   1.062    12.00    95.72

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0203) |   Area    (ha)=   1.29
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.64         0.64
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=      30.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       153.96
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.46 (ii)    6.45 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.24          0.360 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        77.49          89.24
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.61           0.71

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5203) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0203):     1.29   0.360    12.00    89.24
        + ID2= 2 (8202):     0.45   0.559    12.00    95.36
          ================================================
          ID = 3 (5203):     1.74   0.919    12.00    90.83

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (6203) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5202):     3.58   1.062    12.00    95.72
        + ID2= 2 (5203):     1.74   0.919    12.00    90.83
          ================================================
          ID = 3 (6203):     5.32   1.982    12.00    94.12

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0204) |   Area    (ha)=   2.27
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  42.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.13         1.13
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       107.18
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.55 (ii)   10.32 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.23         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.36         0.23          0.570 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        69.10          92.36
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.55           0.73

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5204) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0204):     2.27   0.570    12.00    92.36
        + ID2= 2 (6203):     5.32   1.982    12.00    94.12
          ================================================
          ID = 3 (5204):     7.59   2.552    12.00    93.59

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0205) |   Area    (ha)=   1.39
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.53         0.86
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
```

```
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       113.89
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.55 (ii)   10.18 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.23         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.19          0.302 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        70.50          84.00
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.56           0.66

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (5205) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0205):     1.39   0.302    12.00    84.00
        + ID2= 2 (5204):     7.59   2.552    12.00    93.59
          ===============================================
          ID = 3 (5205):     8.98   2.854    12.00    92.11

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0206) |   Area    (ha)=   1.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  38.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.74         0.83
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=      80.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       108.50
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.62 (ii)    8.37 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.29         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.23         0.20          0.427 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        69.39          90.32
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.55           0.71

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5206) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0206):     1.57   0.427    12.00    90.32
        + ID2= 2 (5205):     8.98   2.854    12.00    92.11
          ===============================================
          ID = 3 (5206):    10.55   3.281    12.00    91.84

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0208) |   Area    (ha)=   2.04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.92         1.12
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     150.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       108.57
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       3.82 (ii)    9.57 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.25         0.11
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.31         0.25          0.567 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        74.49          94.48
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.59           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  75.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR (9208) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0074      0.0296
                          0.0000     0.0000   |   0.2098      0.0377
                          0.0074     0.0134   |   0.5799      0.0468
                          0.0074     0.0192   |   0.8074      0.0518
                          0.0074     0.0259   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0208)      2.040      0.567     12.00      94.48
     OUTFLOW: ID= 1 (9208)      2.040      0.504     12.02      90.93

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 89.01
                   TIME SHIFT OF PEAK FLOW         (min)=  1.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0450

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--------------------
| CALIB            |
| STANDHYD  (0207) |   Area    (ha)=   1.20
|ID= 1 DT= 5.0 min |   Total Imp(%)=  64.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.77         0.43
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     100.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       111.38
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       3.00 (ii)    7.23 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.28         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.28         0.11          0.388 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        75.09         104.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.59           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  75.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5207) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0207):     1.20   0.388    12.00   104.72
        + ID2= 2 (9208):     2.04   0.504    12.02    90.93
          ===============================================
          ID = 3 (5207):     3.24   0.881    12.00    96.04

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| RESERVOIR (9207) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.2093      0.0349
                          0.0069     0.0125   |   0.5794      0.0432
                          0.0069     0.0178   |   0.8069      0.0477
                          0.0069     0.0274   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (5207)      3.240      0.881     12.00      96.04
     OUTFLOW: ID= 1 (9207)      3.240      0.807     12.03      88.06

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 91.57
                   TIME SHIFT OF PEAK FLOW         (min)=  2.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0477

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| ADD HYD   (6206) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5206):    10.55   3.281    12.00    91.84
        + ID2= 2 (9207):     3.24   0.807    12.03    88.06
          ==================================================
          ID = 3 (6206):    13.79   4.055    12.00    90.95

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| RESERVOIR (9206) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.8563     0.4495
                          0.0133     0.0684   |   1.0165     0.5018
                          0.0173     0.1024   |   1.0497     0.5287
                          0.0567     0.1387   |   1.2259     0.5561
                          0.1258     0.1772   |   1.4142     0.5840
                          0.2142     0.2177   |   1.6430     0.6124
                          0.3181     0.2601   |   2.8864     0.6707
                          0.4356     0.3045   |   4.9224     0.7312
                          0.5651     0.3509   |   7.6130     0.7938
                          0.7056     0.3992   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (6206)     13.794     4.055     12.00      90.95
     OUTFLOW: ID= 1 (9206)     13.794     1.103     12.28      84.77

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 27.21
                    TIME SHIFT OF PEAK FLOW         (min)= 17.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.5371

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--------------------
| CALIB            |
| STANDHYD  (0209) |   Area    (ha)=   1.29
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  45.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.58          0.71
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       0.50          2.00
     Length            (m)=     140.00          5.00
     Mannings n          =       0.015         0.250

     Max.Eff.Inten.(mm/hr)=     139.64          5.40
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       3.67 (ii)     5.59 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.25          0.16
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.22          0.01        0.232 (iii)
     TIME TO PEAK    (hrs)=      12.00         12.00        12.00
     RUNOFF VOLUME    (mm)=     124.49          4.22        58.34
     TOTAL RAINFALL   (mm)=     126.49        126.49       126.49
     RUNOFF COEFFICIENT   =       0.98          0.03         0.46

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =   7.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (9013) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0209):     1.29   0.232    12.00    58.34
        + ID2= 2 (9206):    13.79   1.103    12.28    84.77
          ==================================================
          ID = 3 (9013):    15.08   1.137    12.28    82.51

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0113) |   Area    (ha)=   0.68
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.34          0.34
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      50.00         40.00
     Mannings n          =       0.015         0.250

     Max.Eff.Inten.(mm/hr)=     139.64        118.42
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       1.61 (ii)     8.20 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.32          0.13
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.13          0.09        0.223 (iii)
     TIME TO PEAK    (hrs)=      12.00         12.00        12.00
     RUNOFF VOLUME    (mm)=     125.49         92.00       108.74
     TOTAL RAINFALL   (mm)=     126.49        126.49       126.49
     RUNOFF COEFFICIENT   =       0.99          0.73         0.86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (9113) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0113):     0.68   0.223    12.00   108.74
        + ID2= 2 (9013):    15.08   1.137    12.28    82.51
          ==================================================
          ID = 3 (9113):    15.76   1.195    12.02    83.64

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0012) |   Area    (ha)=   8.03   Curve Number   (CN)= 75.8
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.33

        NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.


                          ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.033    1.39 | 6.033    2.53 |12.033   18.21 | 18.03    2.28
                0.067    1.39 | 6.067    2.53 |12.067   18.21 | 18.07    2.28
                0.100    1.39 | 6.100    2.53 |12.100   18.21 | 18.10    2.28
                0.133    1.39 | 6.133    2.53 |12.133   18.21 | 18.13    2.28
                0.167    1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
                0.200    1.39 | 6.200    2.53 |12.200   18.21 | 18.20    2.28
                0.233    1.39 | 6.233    2.53 |12.233   18.21 | 18.23    2.28
                0.267    1.39 | 6.267    2.53 |12.267   18.21 | 18.27    2.28
                0.300    1.39 | 6.300    2.53 |12.300   18.21 | 18.30    2.28
                0.333    1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
                0.367    1.39 | 6.367    2.53 |12.367   18.21 | 18.37    2.28
                0.400    1.39 | 6.400    2.53 |12.400   18.21 | 18.40    2.28
                0.433    1.39 | 6.433    2.53 |12.433   18.21 | 18.43    2.28
                0.467    1.39 | 6.467    2.53 |12.467   18.21 | 18.47    2.28
                0.500    1.39 | 6.500    2.53 |12.500   18.20 | 18.50    2.28
                0.533    1.39 | 6.533    2.53 |12.533    9.36 | 18.53    2.28
                0.567    1.39 | 6.567    2.53 |12.567    9.36 | 18.57    2.28
                0.600    1.39 | 6.600    2.53 |12.600    9.36 | 18.60    2.28
                0.633    1.39 | 6.633    2.53 |12.633    9.36 | 18.63    2.28
                0.667    1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
                0.700    1.39 | 6.700    2.53 |12.700    9.36 | 18.70    2.28
                0.733    1.39 | 6.733    2.53 |12.733    9.36 | 18.73    2.28
                0.767    1.39 | 6.767    2.53 |12.767    9.36 | 18.77    2.28
                0.800    1.39 | 6.800    2.53 |12.800    9.36 | 18.80    2.28
                0.833    1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
                0.867    1.39 | 6.867    2.53 |12.867    9.36 | 18.87    2.28
                0.900    1.39 | 6.900    2.53 |12.900    9.36 | 18.90    2.28
                0.933    1.39 | 6.933    2.53 |12.933    9.36 | 18.93    2.28
                0.967    1.39 | 6.967    2.53 |12.967    9.36 | 18.97    2.28
                1.000    1.39 | 7.000    2.53 |13.000    9.35 | 19.00    2.28
                1.033    1.39 | 7.033    2.53 |13.033    6.07 | 19.03    2.28
                1.067    1.39 | 7.067    2.53 |13.067    6.07 | 19.07    2.28
                1.100    1.39 | 7.100    2.53 |13.100    6.07 | 19.10    2.28
                1.133    1.39 | 7.133    2.53 |13.133    6.07 | 19.13    2.28
                1.167    1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
                1.200    1.39 | 7.200    2.53 |13.200    6.07 | 19.20    2.28
                1.233    1.39 | 7.233    2.53 |13.233    6.07 | 19.23    2.28
                1.267    1.39 | 7.267    2.53 |13.267    6.07 | 19.27    2.28
                1.300    1.39 | 7.300    2.53 |13.300    6.07 | 19.30    2.28
                1.333    1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
                1.367    1.39 | 7.367    2.53 |13.367    6.07 | 19.37    2.28
                1.400    1.39 | 7.400    2.53 |13.400    6.07 | 19.40    2.28
                1.433    1.39 | 7.433    2.53 |13.433    6.07 | 19.43    2.28
                1.467    1.39 | 7.467    2.53 |13.467    6.07 | 19.47    2.28
                1.500    1.39 | 7.500    2.53 |13.500    6.07 | 19.50    2.28
                1.533    1.39 | 7.533    2.53 |13.533    6.07 | 19.53    2.28
                1.567    1.39 | 7.567    2.53 |13.567    6.07 | 19.57    2.28
                1.600    1.39 | 7.600    2.53 |13.600    6.07 | 19.60    2.28
                1.633    1.39 | 7.633    2.53 |13.633    6.07 | 19.63    2.28
                1.667    1.39 | 7.667    2.53 |13.667    6.07 | 19.67    2.28
                1.700    1.39 | 7.700    2.53 |13.700    6.07 | 19.70    2.28
                1.733    1.39 | 7.733    2.53 |13.733    6.07 | 19.73    2.28
                1.767    1.39 | 7.767    2.53 |13.767    6.07 | 19.77    2.28
                1.800    1.39 | 7.800    2.53 |13.800    6.07 | 19.80    2.28
                1.833    1.39 | 7.833    2.53 |13.833    6.07 | 19.83    2.28
                1.867    1.39 | 7.867    2.53 |13.867    6.07 | 19.87    2.28
                1.900    1.39 | 7.900    2.53 |13.900    6.07 | 19.90    2.28
                1.933    1.39 | 7.933    2.53 |13.933    6.07 | 19.93    2.28
                1.967    1.39 | 7.967    2.53 |13.967    6.07 | 19.97    2.28
                2.000    1.39 | 8.000    2.53 |14.000    6.07 | 20.00    2.28
                2.033    1.64 | 8.033    3.42 |14.033    3.79 | 20.03    1.52
                2.067    1.64 | 8.067    3.42 |14.067    3.79 | 20.07    1.52
                2.100    1.64 | 8.100    3.42 |14.100    3.79 | 20.10    1.52
                2.133    1.64 | 8.133    3.42 |14.133    3.79 | 20.13    1.52
                2.167    1.64 | 8.167    3.42 |14.167    3.79 | 20.17    1.52
                2.200    1.64 | 8.200    3.42 |14.200    3.79 | 20.20    1.52
                2.233    1.64 | 8.233    3.42 |14.233    3.79 | 20.23    1.52
                2.267    1.64 | 8.267    3.42 |14.267    3.79 | 20.27    1.52
                2.300    1.64 | 8.300    3.42 |14.300    3.79 | 20.30    1.52
                2.333    1.64 | 8.333    3.42 |14.333    3.79 | 20.33    1.52
                2.367    1.64 | 8.367    3.42 |14.367    3.79 | 20.37    1.52
                2.400    1.64 | 8.400    3.42 |14.400    3.79 | 20.40    1.52
                2.433    1.64 | 8.433    3.42 |14.433    3.79 | 20.43    1.52
                2.467    1.64 | 8.467    3.42 |14.467    3.79 | 20.47    1.52
                2.500    1.64 | 8.500    3.42 |14.500    3.79 | 20.50    1.52
                2.533    1.64 | 8.533    3.42 |14.533    3.79 | 20.53    1.52
```

2.567	1.64	8.567	3.42	14.567	3.79	20.57	1.52
2.600	1.64	8.600	3.42	14.600	3.79	20.60	1.52
2.633	1.64	8.633	3.42	14.633	3.79	20.63	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.700	1.64	8.700	3.42	14.700	3.79	20.70	1.52
2.733	1.64	8.733	3.42	14.733	3.79	20.73	1.52
2.767	1.64	8.767	3.42	14.767	3.79	20.77	1.52
2.800	1.64	8.800	3.42	14.800	3.79	20.80	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.867	1.64	8.867	3.42	14.867	3.79	20.87	1.52
2.900	1.64	8.900	3.42	14.900	3.79	20.90	1.52
2.933	1.64	8.933	3.42	14.933	3.79	20.93	1.52
2.967	1.64	8.967	3.42	14.967	3.79	20.97	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.033	1.64	9.033	4.05	15.033	3.79	21.03	1.52
3.067	1.64	9.067	4.05	15.067	3.79	21.07	1.52
3.100	1.64	9.100	4.05	15.100	3.79	21.10	1.52
3.133	1.64	9.133	4.05	15.133	3.79	21.13	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.200	1.64	9.200	4.05	15.200	3.79	21.20	1.52
3.233	1.64	9.233	4.05	15.233	3.79	21.23	1.52
3.267	1.64	9.267	4.05	15.267	3.79	21.27	1.52
3.300	1.64	9.300	4.05	15.300	3.79	21.30	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.367	1.64	9.367	4.05	15.367	3.79	21.37	1.52
3.400	1.64	9.400	4.05	15.400	3.79	21.40	1.52
3.433	1.64	9.433	4.05	15.433	3.79	21.43	1.52
3.467	1.64	9.467	4.05	15.467	3.79	21.47	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.533	1.64	9.533	4.55	15.533	3.79	21.53	1.52
3.567	1.64	9.567	4.55	15.567	3.79	21.57	1.52
3.600	1.64	9.600	4.55	15.600	3.79	21.60	1.52
3.633	1.64	9.633	4.55	15.633	3.79	21.63	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.700	1.64	9.700	4.55	15.700	3.79	21.70	1.52
3.733	1.64	9.733	4.55	15.733	3.79	21.73	1.52
3.767	1.64	9.767	4.55	15.767	3.79	21.77	1.52
3.800	1.64	9.800	4.55	15.800	3.79	21.80	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.867	1.64	9.867	4.55	15.867	3.79	21.87	1.52
3.900	1.64	9.900	4.55	15.900	3.79	21.90	1.52
3.933	1.64	9.933	4.55	15.933	3.79	21.93	1.52
3.967	1.64	9.967	4.55	15.967	3.79	21.97	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.033	2.02	10.033	5.82	16.033	2.28	22.03	1.52
4.067	2.02	10.067	5.82	16.067	2.28	22.07	1.52
4.100	2.02	10.100	5.82	16.100	2.28	22.10	1.52
4.133	2.02	10.133	5.82	16.133	2.28	22.13	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.200	2.02	10.200	5.82	16.200	2.28	22.20	1.52
4.233	2.02	10.233	5.82	16.233	2.28	22.23	1.52
4.267	2.02	10.267	5.82	16.267	2.28	22.27	1.52
4.300	2.02	10.300	5.82	16.300	2.28	22.30	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.367	2.02	10.367	5.82	16.367	2.28	22.37	1.52
4.400	2.02	10.400	5.82	16.400	2.28	22.40	1.52
4.433	2.02	10.433	5.82	16.433	2.28	22.43	1.52
4.467	2.02	10.467	5.82	16.467	2.28	22.47	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.533	2.02	10.533	7.84	16.533	2.28	22.53	1.52
4.567	2.02	10.567	7.84	16.567	2.28	22.57	1.52
4.600	2.02	10.600	7.84	16.600	2.28	22.60	1.52
4.633	2.02	10.633	7.84	16.633	2.28	22.63	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.700	2.02	10.700	7.84	16.700	2.28	22.70	1.52
4.733	2.02	10.733	7.84	16.733	2.28	22.73	1.52
4.767	2.02	10.767	7.84	16.767	2.28	22.77	1.52
4.800	2.02	10.800	7.84	16.800	2.28	22.80	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.867	2.02	10.867	7.84	16.867	2.28	22.87	1.52
4.900	2.02	10.900	7.84	16.900	2.28	22.90	1.52
4.933	2.02	10.933	7.84	16.933	2.28	22.93	1.52
4.967	2.02	10.967	7.84	16.967	2.28	22.97	1.52
5.000	2.02	11.000	7.85	17.000	2.28	23.00	1.52
5.033	2.02	11.033	12.14	17.033	2.28	23.03	1.52
5.067	2.02	11.067	12.14	17.067	2.28	23.07	1.52
5.100	2.02	11.100	12.14	17.100	2.28	23.10	1.52
5.133	2.02	11.133	12.14	17.133	2.28	23.13	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.200	2.02	11.200	12.14	17.200	2.28	23.20	1.52
5.233	2.02	11.233	12.14	17.233	2.28	23.23	1.52
5.267	2.02	11.267	12.14	17.267	2.28	23.27	1.52
5.300	2.02	11.300	12.14	17.300	2.28	23.30	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.367	2.02	11.367	12.14	17.367	2.28	23.37	1.52
5.400	2.02	11.400	12.14	17.400	2.28	23.40	1.52
5.433	2.02	11.433	12.14	17.433	2.28	23.43	1.52
5.467	2.02	11.467	12.14	17.467	2.28	23.47	1.52
5.500	2.02	11.500	12.19	17.500	2.28	23.50	1.52
5.533	2.02	11.533	52.62	17.533	2.28	23.53	1.52
5.567	2.02	11.567	52.62	17.567	2.28	23.57	1.52
5.600	2.02	11.600	52.62	17.600	2.28	23.60	1.52
5.633	2.02	11.633	52.62	17.633	2.28	23.63	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.700	2.02	11.700	52.62	17.700	2.28	23.70	1.52
5.733	2.02	11.733	52.62	17.733	2.28	23.73	1.52
5.767	2.02	11.767	96.25	17.767	2.28	23.77	1.52
5.800	2.02	11.800	139.64	17.800	2.28	23.80	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.867	2.02	11.867	139.64	17.867	2.28	23.87	1.52
5.900	2.02	11.900	139.64	17.900	2.28	23.90	1.52
5.933	2.02	11.933	139.64	17.933	2.28	23.93	1.52
5.967	2.02	11.967	139.64	17.967	2.28	23.97	1.52
6.000	2.02	12.000	139.47	18.000	2.28	24.00	1.52

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Unit Hyd Qpeak  (cms)=   0.929

PEAK FLOW       (cms)=   1.056 (i)
TIME TO PEAK    (hrs)=  12.200
RUNOFF VOLUME    (mm)=  72.856
TOTAL RAINFALL   (mm)= 126.489
RUNOFF COEFFICIENT   =   0.576

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0112) |   Area    (ha)=   1.07
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
Surface Area     (ha)=       0.54         0.54
Dep. Storage     (mm)=       1.00         5.00
Average Slope     (%)=       1.00         2.00
Length            (m)=      50.00        40.00
Mannings n           =      0.015        0.250

Max.Eff.Inten.(mm/hr)=     139.64        98.03
            over (min)        5.00         8.00
Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
Unit Hyd. Tpeak (min)=       4.00         8.00
Unit Hyd. peak  (cms)=       0.45         0.14
                                                        *TOTALS*
PEAK FLOW       (cms)=       0.21         0.12          0.323 (iii)
TIME TO PEAK    (hrs)=      12.00        12.03          12.00
RUNOFF VOLUME    (mm)=     125.49        73.17          99.33
TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
RUNOFF COEFFICIENT   =       0.99         0.58           0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0012):     8.03   1.056    12.20    72.86
        + ID2= 2 (0112):     1.07   0.323    12.00    99.33
          ================================================
          ID = 3 (5012):     9.10   1.143    12.17    75.97

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0011) |   Area    (ha)=   1.32   Curve Number   (CN)= 82.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.15

     Unit Hyd Qpeak  (cms)=   0.336

     PEAK FLOW       (cms)=   0.325 (i)
     TIME TO PEAK    (hrs)=  12.033
     RUNOFF VOLUME    (mm)=  84.868
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.671

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0111) |   Area    (ha)=   0.41
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
Surface Area     (ha)=       0.20         0.20
Dep. Storage     (mm)=       1.00         5.00
Average Slope     (%)=       1.00         2.00
Length            (m)=      50.00        40.00
Mannings n           =      0.015        0.250

Max.Eff.Inten.(mm/hr)=     139.64        64.58
            over (min)        5.00         8.00
Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
Unit Hyd. Tpeak (min)=       4.00         8.00
Unit Hyd. peak  (cms)=       0.45         0.14
                                                        *TOTALS*
PEAK FLOW       (cms)=       0.08         0.03          0.108 (iii)
TIME TO PEAK    (hrs)=      12.00        12.03          12.00
RUNOFF VOLUME    (mm)=     125.49        48.32          86.90
TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
RUNOFF COEFFICIENT   =       0.99         0.38           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (5011) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0011):     1.32   0.325    12.03    84.87
        + ID2= 2 (0111):     0.41   0.108    12.00    86.90
          ================================================
          ID = 3 (5011):     1.73   0.419    12.00    85.35

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| CALIB            |
| NASHYD    (0010) |   Area    (ha)=   1.04   Curve Number   (CN)= 67.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
-------------------   U.H. Tp(hrs)=   0.16

     Unit Hyd Qpeak  (cms)=   0.248

     PEAK FLOW       (cms)=   0.171 (i)
     TIME TO PEAK    (hrs)=  12.067
     RUNOFF VOLUME    (mm)=  59.846
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.473

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-------------------
| CALIB            |
| STANDHYD  (0110) |   Area    (ha)=   0.49
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
-------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.25         0.25
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        64.58
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.09         0.03          0.129 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.03          12.00
     RUNOFF VOLUME    (mm)=     125.49        48.32          86.90
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.38           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (5010) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0010):     1.04   0.171    12.07    59.85
        + ID2= 2 (0110):     0.49   0.129    12.00    86.90
          ================================================
          ID = 3 (5010):     1.53   0.289    12.00    68.51

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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-------------------
| CALIB            |
| NASHYD    (0009) |   Area    (ha)=   0.48   Curve Number   (CN)= 67.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
-------------------   U.H. Tp(hrs)=   0.15

     Unit Hyd Qpeak  (cms)=   0.122

     PEAK FLOW       (cms)=   0.082 (i)
     TIME TO PEAK    (hrs)=  12.033
     RUNOFF VOLUME    (mm)=  59.843
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.473

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-------------------
| CALIB            |
| STANDHYD  (0109) |   Area    (ha)=   0.33
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
-------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.17
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        64.58
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.02          0.087 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.03          12.00
     RUNOFF VOLUME    (mm)=     125.49        48.32          86.89
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.38           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-------------------
| ADD HYD   (5009) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0009):     0.48   0.082    12.03    59.84
        + ID2= 2 (0109):     0.33   0.087    12.00    86.89
          ================================================
          ID = 3 (5009):     0.81   0.164    12.00    70.86

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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-------------------
| CALIB            |
| NASHYD    (0008) |   Area    (ha)=   0.93   Curve Number   (CN)= 67.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
-------------------   U.H. Tp(hrs)=   0.23

     Unit Hyd Qpeak  (cms)=   0.154

     PEAK FLOW       (cms)=   0.125 (i)
     TIME TO PEAK    (hrs)=  12.100
     RUNOFF VOLUME    (mm)=  59.851
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.473

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-------------------
| CALIB            |
| STANDHYD  (0108) |   Area    (ha)=   0.53
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
-------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.26         0.26
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        64.58
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.10         0.04          0.139 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.03          12.00
     RUNOFF VOLUME    (mm)=     125.49        48.32          86.90
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.38           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-------------------
| ADD HYD   (5008) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0008):     0.93   0.125    12.10    59.85
        + ID2= 2 (0108):     0.53   0.139    12.00    86.90
          ================================================
          ID = 3 (5008):     1.46   0.242    12.00    69.67

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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-------------------
| CALIB            |
| NASHYD    (0007) |   Area    (ha)= 147.90   Curve Number   (CN)= 77.0
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|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   2.50
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NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	1.39	6.083	2.53	12.083	18.23	18.08	2.28
0.167	1.39	6.167	2.53	12.167	18.21	18.17	2.28
0.250	1.39	6.250	2.53	12.250	18.21	18.25	2.28
0.333	1.39	6.333	2.53	12.333	18.21	18.33	2.28
0.417	1.39	6.417	2.53	12.417	18.21	18.42	2.28
0.500	1.39	6.500	2.53	12.500	18.21	18.50	2.28
0.583	1.39	6.583	2.53	12.583	9.36	18.58	2.28
0.667	1.39	6.667	2.53	12.667	9.36	18.67	2.28
0.750	1.39	6.750	2.53	12.750	9.36	18.75	2.28
0.833	1.39	6.833	2.53	12.833	9.36	18.83	2.28
0.917	1.39	6.917	2.53	12.917	9.36	18.92	2.28
1.000	1.39	7.000	2.53	13.000	9.36	19.00	2.28
1.083	1.39	7.083	2.53	13.083	6.07	19.08	2.28
1.167	1.39	7.167	2.53	13.167	6.07	19.17	2.28
1.250	1.39	7.250	2.53	13.250	6.07	19.25	2.28
1.333	1.39	7.333	2.53	13.333	6.07	19.33	2.28
1.417	1.39	7.417	2.53	13.417	6.07	19.42	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.583	1.39	7.583	2.53	13.583	6.07	19.58	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.750	1.39	7.750	2.53	13.750	6.07	19.75	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.917	1.39	7.917	2.53	13.917	6.07	19.92	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.083	1.64	8.083	3.42	14.083	3.80	20.08	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.250	1.64	8.250	3.42	14.250	3.79	20.25	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.417	1.64	8.417	3.42	14.417	3.79	20.42	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.583	1.64	8.583	3.42	14.583	3.79	20.58	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.750	1.64	8.750	3.42	14.750	3.79	20.75	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.917	1.64	8.917	3.42	14.917	3.79	20.92	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.083	1.64	9.083	4.05	15.083	3.79	21.08	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.250	1.64	9.250	4.05	15.250	3.79	21.25	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.417	1.64	9.417	4.05	15.417	3.79	21.42	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.583	1.64	9.583	4.55	15.583	3.79	21.58	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.750	1.64	9.750	4.55	15.750	3.79	21.75	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.917	1.64	9.917	4.55	15.917	3.79	21.92	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.083	2.02	10.083	5.82	16.083	2.28	22.08	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.250	2.02	10.250	5.82	16.250	2.28	22.25	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.417	2.02	10.417	5.82	16.417	2.28	22.42	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.583	2.02	10.583	7.84	16.583	2.28	22.58	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.750	2.02	10.750	7.84	16.750	2.28	22.75	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.917	2.02	10.917	7.84	16.917	2.28	22.92	1.52
5.000	2.02	11.000	7.84	17.000	2.28	23.00	1.52
5.083	2.02	11.083	12.14	17.083	2.28	23.08	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.250	2.02	11.250	12.14	17.250	2.28	23.25	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.417	2.02	11.417	12.14	17.417	2.28	23.42	1.52
5.500	2.02	11.500	12.14	17.500	2.28	23.50	1.52
5.583	2.02	11.583	52.62	17.583	2.28	23.58	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.750	2.02	11.750	52.62	17.750	2.28	23.75	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.917	2.02	11.917	139.64	17.917	2.28	23.92	1.52
6.000	2.02	12.000	139.64	18.000	2.28	24.00	1.52

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Unit Hyd Qpeak  (cms)=   2.260

PEAK FLOW       (cms)=   4.454 (i)
TIME TO PEAK    (hrs)=  14.667
RUNOFF VOLUME    (mm)=  74.787
TOTAL RAINFALL   (mm)= 126.490
RUNOFF COEFFICIENT   =   0.591

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB            |
| NASHYD    (1013) |   Area    (ha)=  15.42   Curve Number   (CN)= 64.4
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.37
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NOTE: RAINFALL WAS TRANSFORMED TO 2.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.033	1.39	6.033	2.53	12.033	18.21	18.03	2.28
0.067	1.39	6.067	2.53	12.067	18.21	18.07	2.28
0.100	1.39	6.100	2.53	12.100	18.21	18.10	2.28
0.133	1.39	6.133	2.53	12.133	18.21	18.13	2.28
0.167	1.39	6.167	2.53	12.167	18.21	18.17	2.28
0.200	1.39	6.200	2.53	12.200	18.21	18.20	2.28
0.233	1.39	6.233	2.53	12.233	18.21	18.23	2.28
0.267	1.39	6.267	2.53	12.267	18.21	18.27	2.28
0.300	1.39	6.300	2.53	12.300	18.21	18.30	2.28
0.333	1.39	6.333	2.53	12.333	18.21	18.33	2.28
0.367	1.39	6.367	2.53	12.367	18.21	18.37	2.28
0.400	1.39	6.400	2.53	12.400	18.21	18.40	2.28
0.433	1.39	6.433	2.53	12.433	18.21	18.43	2.28
0.467	1.39	6.467	2.53	12.467	18.21	18.47	2.28
0.500	1.39	6.500	2.53	12.500	18.20	18.50	2.28
0.533	1.39	6.533	2.53	12.533	9.36	18.53	2.28
0.567	1.39	6.567	2.53	12.567	9.36	18.57	2.28
0.600	1.39	6.600	2.53	12.600	9.36	18.60	2.28
0.633	1.39	6.633	2.53	12.633	9.36	18.63	2.28
0.667	1.39	6.667	2.53	12.667	9.36	18.67	2.28
0.700	1.39	6.700	2.53	12.700	9.36	18.70	2.28
0.733	1.39	6.733	2.53	12.733	9.36	18.73	2.28
0.767	1.39	6.767	2.53	12.767	9.36	18.77	2.28
0.800	1.39	6.800	2.53	12.800	9.36	18.80	2.28
0.833	1.39	6.833	2.53	12.833	9.36	18.83	2.28
0.867	1.39	6.867	2.53	12.867	9.36	18.87	2.28
0.900	1.39	6.900	2.53	12.900	9.36	18.90	2.28
0.933	1.39	6.933	2.53	12.933	9.36	18.93	2.28
0.967	1.39	6.967	2.53	12.967	9.36	18.97	2.28
1.000	1.39	7.000	2.53	13.000	9.35	19.00	2.28
1.033	1.39	7.033	2.53	13.033	6.07	19.03	2.28
1.067	1.39	7.067	2.53	13.067	6.07	19.07	2.28
1.100	1.39	7.100	2.53	13.100	6.07	19.10	2.28
1.133	1.39	7.133	2.53	13.133	6.07	19.13	2.28
1.167	1.39	7.167	2.53	13.167	6.07	19.17	2.28
1.200	1.39	7.200	2.53	13.200	6.07	19.20	2.28
1.233	1.39	7.233	2.53	13.233	6.07	19.23	2.28
1.267	1.39	7.267	2.53	13.267	6.07	19.27	2.28
1.300	1.39	7.300	2.53	13.300	6.07	19.30	2.28
1.333	1.39	7.333	2.53	13.333	6.07	19.33	2.28
1.367	1.39	7.367	2.53	13.367	6.07	19.37	2.28
1.400	1.39	7.400	2.53	13.400	6.07	19.40	2.28
1.433	1.39	7.433	2.53	13.433	6.07	19.43	2.28
1.467	1.39	7.467	2.53	13.467	6.07	19.47	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.533	1.39	7.533	2.53	13.533	6.07	19.53	2.28
1.567	1.39	7.567	2.53	13.567	6.07	19.57	2.28
1.600	1.39	7.600	2.53	13.600	6.07	19.60	2.28
1.633	1.39	7.633	2.53	13.633	6.07	19.63	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.700	1.39	7.700	2.53	13.700	6.07	19.70	2.28
1.733	1.39	7.733	2.53	13.733	6.07	19.73	2.28
1.767	1.39	7.767	2.53	13.767	6.07	19.77	2.28
1.800	1.39	7.800	2.53	13.800	6.07	19.80	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.867	1.39	7.867	2.53	13.867	6.07	19.87	2.28
1.900	1.39	7.900	2.53	13.900	6.07	19.90	2.28
1.933	1.39	7.933	2.53	13.933	6.07	19.93	2.28
1.967	1.39	7.967	2.53	13.967	6.07	19.97	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.033	1.64	8.033	3.42	14.033	3.79	20.03	1.52
2.067	1.64	8.067	3.42	14.067	3.79	20.07	1.52
2.100	1.64	8.100	3.42	14.100	3.79	20.10	1.52
2.133	1.64	8.133	3.42	14.133	3.79	20.13	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.200	1.64	8.200	3.42	14.200	3.79	20.20	1.52
2.233	1.64	8.233	3.42	14.233	3.79	20.23	1.52
2.267	1.64	8.267	3.42	14.267	3.79	20.27	1.52
2.300	1.64	8.300	3.42	14.300	3.79	20.30	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.367	1.64	8.367	3.42	14.367	3.79	20.37	1.52
2.400	1.64	8.400	3.42	14.400	3.79	20.40	1.52
2.433	1.64	8.433	3.42	14.433	3.79	20.43	1.52
2.467	1.64	8.467	3.42	14.467	3.79	20.47	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.533	1.64	8.533	3.42	14.533	3.79	20.53	1.52
2.567	1.64	8.567	3.42	14.567	3.79	20.57	1.52
2.600	1.64	8.600	3.42	14.600	3.79	20.60	1.52
2.633	1.64	8.633	3.42	14.633	3.79	20.63	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.700	1.64	8.700	3.42	14.700	3.79	20.70	1.52
2.733	1.64	8.733	3.42	14.733	3.79	20.73	1.52
2.767	1.64	8.767	3.42	14.767	3.79	20.77	1.52
2.800	1.64	8.800	3.42	14.800	3.79	20.80	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.867	1.64	8.867	3.42	14.867	3.79	20.87	1.52
2.900	1.64	8.900	3.42	14.900	3.79	20.90	1.52
2.933	1.64	8.933	3.42	14.933	3.79	20.93	1.52
2.967	1.64	8.967	3.42	14.967	3.79	20.97	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.033	1.64	9.033	4.05	15.033	3.79	21.03	1.52
3.067	1.64	9.067	4.05	15.067	3.79	21.07	1.52
3.100	1.64	9.100	4.05	15.100	3.79	21.10	1.52
3.133	1.64	9.133	4.05	15.133	3.79	21.13	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.200	1.64	9.200	4.05	15.200	3.79	21.20	1.52
3.233	1.64	9.233	4.05	15.233	3.79	21.23	1.52
3.267	1.64	9.267	4.05	15.267	3.79	21.27	1.52
3.300	1.64	9.300	4.05	15.300	3.79	21.30	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.367	1.64	9.367	4.05	15.367	3.79	21.37	1.52
3.400	1.64	9.400	4.05	15.400	3.79	21.40	1.52
3.433	1.64	9.433	4.05	15.433	3.79	21.43	1.52
3.467	1.64	9.467	4.05	15.467	3.79	21.47	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.533	1.64	9.533	4.55	15.533	3.79	21.53	1.52
3.567	1.64	9.567	4.55	15.567	3.79	21.57	1.52
3.600	1.64	9.600	4.55	15.600	3.79	21.60	1.52
3.633	1.64	9.633	4.55	15.633	3.79	21.63	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.700	1.64	9.700	4.55	15.700	3.79	21.70	1.52
3.733	1.64	9.733	4.55	15.733	3.79	21.73	1.52
3.767	1.64	9.767	4.55	15.767	3.79	21.77	1.52
3.800	1.64	9.800	4.55	15.800	3.79	21.80	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52

3.867	1.64	9.867	4.55	15.867	3.79	21.87	1.52
3.900	1.64	9.900	4.55	15.900	3.79	21.90	1.52
3.933	1.64	9.933	4.55	15.933	3.79	21.93	1.52
3.967	1.64	9.967	4.55	15.967	3.79	21.97	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.033	2.02	10.033	5.82	16.033	2.28	22.03	1.52
4.067	2.02	10.067	5.82	16.067	2.28	22.07	1.52
4.100	2.02	10.100	5.82	16.100	2.28	22.10	1.52
4.133	2.02	10.133	5.82	16.133	2.28	22.13	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.200	2.02	10.200	5.82	16.200	2.28	22.20	1.52
4.233	2.02	10.233	5.82	16.233	2.28	22.23	1.52
4.267	2.02	10.267	5.82	16.267	2.28	22.27	1.52
4.300	2.02	10.300	5.82	16.300	2.28	22.30	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.367	2.02	10.367	5.82	16.367	2.28	22.37	1.52
4.400	2.02	10.400	5.82	16.400	2.28	22.40	1.52
4.433	2.02	10.433	5.82	16.433	2.28	22.43	1.52
4.467	2.02	10.467	5.82	16.467	2.28	22.47	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.533	2.02	10.533	7.84	16.533	2.28	22.53	1.52
4.567	2.02	10.567	7.84	16.567	2.28	22.57	1.52
4.600	2.02	10.600	7.84	16.600	2.28	22.60	1.52
4.633	2.02	10.633	7.84	16.633	2.28	22.63	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.700	2.02	10.700	7.84	16.700	2.28	22.70	1.52
4.733	2.02	10.733	7.84	16.733	2.28	22.73	1.52
4.767	2.02	10.767	7.84	16.767	2.28	22.77	1.52
4.800	2.02	10.800	7.84	16.800	2.28	22.80	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.867	2.02	10.867	7.84	16.867	2.28	22.87	1.52
4.900	2.02	10.900	7.84	16.900	2.28	22.90	1.52
4.933	2.02	10.933	7.84	16.933	2.28	22.93	1.52
4.967	2.02	10.967	7.84	16.967	2.28	22.97	1.52
5.000	2.02	11.000	7.85	17.000	2.28	23.00	1.52
5.033	2.02	11.033	12.14	17.033	2.28	23.03	1.52
5.067	2.02	11.067	12.14	17.067	2.28	23.07	1.52
5.100	2.02	11.100	12.14	17.100	2.28	23.10	1.52
5.133	2.02	11.133	12.14	17.133	2.28	23.13	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.200	2.02	11.200	12.14	17.200	2.28	23.20	1.52
5.233	2.02	11.233	12.14	17.233	2.28	23.23	1.52
5.267	2.02	11.267	12.14	17.267	2.28	23.27	1.52
5.300	2.02	11.300	12.14	17.300	2.28	23.30	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.367	2.02	11.367	12.14	17.367	2.28	23.37	1.52
5.400	2.02	11.400	12.14	17.400	2.28	23.40	1.52
5.433	2.02	11.433	12.14	17.433	2.28	23.43	1.52
5.467	2.02	11.467	12.14	17.467	2.28	23.47	1.52
5.500	2.02	11.500	12.19	17.500	2.28	23.50	1.52
5.533	2.02	11.533	52.62	17.533	2.28	23.53	1.52
5.567	2.02	11.567	52.62	17.567	2.28	23.57	1.52
5.600	2.02	11.600	52.62	17.600	2.28	23.60	1.52
5.633	2.02	11.633	52.62	17.633	2.28	23.63	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.700	2.02	11.700	52.62	17.700	2.28	23.70	1.52
5.733	2.02	11.733	52.62	17.733	2.28	23.73	1.52
5.767	2.02	11.767	96.25	17.767	2.28	23.77	1.52
5.800	2.02	11.800	139.64	17.800	2.28	23.80	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.867	2.02	11.867	139.64	17.867	2.28	23.87	1.52
5.900	2.02	11.900	139.64	17.900	2.28	23.90	1.52
5.933	2.02	11.933	139.64	17.933	2.28	23.93	1.52
5.967	2.02	11.967	139.64	17.967	2.28	23.97	1.52
6.000	2.02	12.000	139.47	18.000	2.28	24.00	1.52

```
     Unit Hyd Qpeak  (cms)=   1.592

     PEAK FLOW       (cms)=   1.411 (i)
     TIME TO PEAK    (hrs)=  12.267
     RUNOFF VOLUME    (mm)=  56.355
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.446

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (1113) |   Area    (ha)=   1.07
|ID= 1 DT= 2.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.54         0.54
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        98.03
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.61 (ii)    7.78 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.45         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.21         0.12          0.323 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.03          12.00
     RUNOFF VOLUME    (mm)=     125.49        73.17          99.33
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.58           0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (8113) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1013):    15.42   1.411    12.27    56.36
        + ID2= 2 (1113):     1.07   0.323    12.00    99.33
          ===============================================
          ID = 3 (8113):    16.49   1.487    12.23    59.14

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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FINISH==========================================================================
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==========================================================================
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       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    Company
        OOO     T      T    H   H    Y    M   M   OOO                 Serial

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                    *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual Otthymo 2.4\VO2\voin.dat
  Output  filename: C:\Users\Bill\AppData\Local\Temp\9a280e0d-940a-4819-b63b-
e1574339ffd3\Scenario.out
  Summary filename: C:\Users\Bill\AppData\Local\Temp\9a280e0d-940a-4819-b63b-
e1574339ffd3\Scenario.sum


DATE: 11/29/2013                           TIME: 05:06:37
```

Tiffany Creek
Future100-yr

```
  ****************************
  ** SIMULATION NUMBER:   6 **
  ****************************

--------------------
| MASS STORM       |    Filename: C:\Users\Bill\AppD
|                  |              ata\Local\Temp\
|                  |              9a280e0d-940a-4819-b63b-e1574339ffd3\b4dbaf59
| Ptotal=126.49 mm |    Comments: 24hr SCS Mass Storm
--------------------
                        Duration of storm    = 24.00 hrs
                        Mass curve time step = 15.00 min
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	1.39	6.25	2.53	12.25	18.21	18.25	2.28
0.50	1.39	6.50	2.53	12.50	18.21	18.50	2.28
0.75	1.39	6.75	2.53	12.75	9.36	18.75	2.28
1.00	1.39	7.00	2.53	13.00	9.36	19.00	2.28
1.25	1.39	7.25	2.53	13.25	6.07	19.25	2.28
1.50	1.39	7.50	2.53	13.50	6.07	19.50	2.28
1.75	1.39	7.75	2.53	13.75	6.07	19.75	2.28
2.00	1.39	8.00	2.53	14.00	6.07	20.00	2.28
2.25	1.64	8.25	3.42	14.25	3.79	20.25	1.52
2.50	1.64	8.50	3.42	14.50	3.79	20.50	1.52
2.75	1.64	8.75	3.42	14.75	3.79	20.75	1.52
3.00	1.64	9.00	3.42	15.00	3.79	21.00	1.52
3.25	1.64	9.25	4.05	15.25	3.79	21.25	1.52
3.50	1.64	9.50	4.05	15.50	3.79	21.50	1.52
3.75	1.64	9.75	4.55	15.75	3.79	21.75	1.52
4.00	1.64	10.00	4.55	16.00	3.79	22.00	1.52
4.25	2.02	10.25	5.82	16.25	2.28	22.25	1.52
4.50	2.02	10.50	5.82	16.50	2.28	22.50	1.52
4.75	2.02	10.75	7.84	16.75	2.28	22.75	1.52
5.00	2.02	11.00	7.84	17.00	2.28	23.00	1.52
5.25	2.02	11.25	12.14	17.25	2.28	23.25	1.52
5.50	2.02	11.50	12.14	17.50	2.28	23.50	1.52
5.75	2.02	11.75	52.62	17.75	2.28	23.75	1.52
6.00	2.02	12.00	139.64	18.00	2.28	24.00	1.52

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--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=   4.19
|ID= 1 DT= 5.0 min |   Total Imp(%)=  53.00   Dir. Conn.(%)=  41.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.22         1.97
     Dep. Storage     (mm)=       1.50         2.50
```

```
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.200

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    1.39 | 6.083    2.53 |12.083   18.23 | 18.08    2.28
                 0.167    1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
                 0.250    1.39 | 6.250    2.53 |12.250   18.21 | 18.25    2.28
                 0.333    1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
                 0.417    1.39 | 6.417    2.53 |12.417   18.21 | 18.42    2.28
                 0.500    1.39 | 6.500    2.53 |12.500   18.21 | 18.50    2.28
                 0.583    1.39 | 6.583    2.53 |12.583    9.36 | 18.58    2.28
                 0.667    1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
                 0.750    1.39 | 6.750    2.53 |12.750    9.36 | 18.75    2.28
                 0.833    1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
                 0.917    1.39 | 6.917    2.53 |12.917    9.36 | 18.92    2.28
                 1.000    1.39 | 7.000    2.53 |13.000    9.36 | 19.00    2.28
                 1.083    1.39 | 7.083    2.53 |13.083    6.07 | 19.08    2.28
                 1.167    1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
                 1.250    1.39 | 7.250    2.53 |13.250    6.07 | 19.25    2.28
                 1.333    1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
                 1.417    1.39 | 7.417    2.53 |13.417    6.07 | 19.42    2.28
                 1.500    1.39 | 7.500    2.53 |13.500    6.07 | 19.50    2.28
                 1.583    1.39 | 7.583    2.53 |13.583    6.07 | 19.58    2.28
                 1.667    1.39 | 7.667    2.53 |13.667    6.07 | 19.67    2.28
                 1.750    1.39 | 7.750    2.53 |13.750    6.07 | 19.75    2.28
                 1.833    1.39 | 7.833    2.53 |13.833    6.07 | 19.83    2.28
                 1.917    1.39 | 7.917    2.53 |13.917    6.07 | 19.92    2.28
                 2.000    1.39 | 8.000    2.53 |14.000    6.07 | 20.00    2.28
                 2.083    1.64 | 8.083    3.42 |14.083    3.80 | 20.08    1.52
                 2.167    1.64 | 8.167    3.42 |14.167    3.79 | 20.17    1.52
                 2.250    1.64 | 8.250    3.42 |14.250    3.79 | 20.25    1.52
                 2.333    1.64 | 8.333    3.42 |14.333    3.79 | 20.33    1.52
                 2.417    1.64 | 8.417    3.42 |14.417    3.79 | 20.42    1.52
                 2.500    1.64 | 8.500    3.42 |14.500    3.79 | 20.50    1.52
                 2.583    1.64 | 8.583    3.42 |14.583    3.79 | 20.58    1.52
                 2.667    1.64 | 8.667    3.42 |14.667    3.79 | 20.67    1.52
                 2.750    1.64 | 8.750    3.42 |14.750    3.79 | 20.75    1.52
                 2.833    1.64 | 8.833    3.42 |14.833    3.79 | 20.83    1.52
                 2.917    1.64 | 8.917    3.42 |14.917    3.79 | 20.92    1.52
                 3.000    1.64 | 9.000    3.42 |15.000    3.79 | 21.00    1.52
                 3.083    1.64 | 9.083    4.05 |15.083    3.79 | 21.08    1.52
                 3.167    1.64 | 9.167    4.05 |15.167    3.79 | 21.17    1.52
                 3.250    1.64 | 9.250    4.05 |15.250    3.79 | 21.25    1.52
                 3.333    1.64 | 9.333    4.05 |15.333    3.79 | 21.33    1.52
                 3.417    1.64 | 9.417    4.05 |15.417    3.79 | 21.42    1.52
                 3.500    1.64 | 9.500    4.05 |15.500    3.79 | 21.50    1.52
                 3.583    1.64 | 9.583    4.55 |15.583    3.79 | 21.58    1.52
                 3.667    1.64 | 9.667    4.55 |15.667    3.79 | 21.67    1.52
                 3.750    1.64 | 9.750    4.55 |15.750    3.79 | 21.75    1.52
                 3.833    1.64 | 9.833    4.55 |15.833    3.79 | 21.83    1.52
                 3.917    1.64 | 9.917    4.55 |15.917    3.79 | 21.92    1.52
                 4.000    1.64 |10.000    4.55 |16.000    3.79 | 22.00    1.52
                 4.083    2.02 |10.083    5.82 |16.083    2.28 | 22.08    1.52
                 4.167    2.02 |10.167    5.82 |16.167    2.28 | 22.17    1.52
                 4.250    2.02 |10.250    5.82 |16.250    2.28 | 22.25    1.52
                 4.333    2.02 |10.333    5.82 |16.333    2.28 | 22.33    1.52
                 4.417    2.02 |10.417    5.82 |16.417    2.28 | 22.42    1.52
                 4.500    2.02 |10.500    5.82 |16.500    2.28 | 22.50    1.52
                 4.583    2.02 |10.583    7.84 |16.583    2.28 | 22.58    1.52
                 4.667    2.02 |10.667    7.84 |16.667    2.28 | 22.67    1.52
                 4.750    2.02 |10.750    7.84 |16.750    2.28 | 22.75    1.52
                 4.833    2.02 |10.833    7.84 |16.833    2.28 | 22.83    1.52
                 4.917    2.02 |10.917    7.84 |16.917    2.28 | 22.92    1.52
                 5.000    2.02 |11.000    7.84 |17.000    2.28 | 23.00    1.52
                 5.083    2.02 |11.083   12.14 |17.083    2.28 | 23.08    1.52
                 5.167    2.02 |11.167   12.14 |17.167    2.28 | 23.17    1.52
                 5.250    2.02 |11.250   12.14 |17.250    2.28 | 23.25    1.52
                 5.333    2.02 |11.333   12.14 |17.333    2.28 | 23.33    1.52
                 5.417    2.02 |11.417   12.14 |17.417    2.28 | 23.42    1.52
                 5.500    2.02 |11.500   12.14 |17.500    2.28 | 23.50    1.52
                 5.583    2.02 |11.583   52.62 |17.583    2.28 | 23.58    1.52
                 5.667    2.02 |11.667   52.62 |17.667    2.28 | 23.67    1.52
                 5.750    2.02 |11.750   52.62 |17.750    2.28 | 23.75    1.52
                 5.833    2.02 |11.833  139.64 |17.833    2.28 | 23.83    1.52
                 5.917    2.02 |11.917  139.64 |17.917    2.28 | 23.92    1.52
                 6.000    2.02 |12.000  139.64 |18.000    2.28 | 24.00    1.52

     Max.Eff.Inten.(mm/hr)=     139.64       130.64
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.55 (ii)    9.35 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.65         0.55         1.196 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     124.99        79.25         98.00
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.99         0.63          0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
-------------------
| DUHYD     (8201) |
| Inlet Cap.=0.560 |
| #of Inlets=    1 |
| Total(cms)=  0.6 |      AREA     QPEAK     TPEAK    R.V.
-------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   4.19      1.20     12.00   98.00
     ==================================================
     MAJOR SYS.(ID= 2):   0.48      0.64     12.00   98.00
     MINOR SYS.(ID= 3):   3.71      0.56     11.83   98.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
-------------------
| ROUTE PIPE (1201)|     PIPE Number     =   1.00
| IN= 2---> OUT= 1 |     Diameter    (mm)=1650.00
| DT=  5.0 min     |     Length       (m)= 100.00
-------------------      Slope      (m/m)=  0.005
                         Manning n       =  0.013

     <---------------- TRAVEL TIME TABLE -------------------->
       DEPTH      VOLUME    FLOW RATE    VELOCITY    TRAV.TIME
        (m)      (cu.m.)      (cms)        (m/s)        min
       0.09     .431E+01       0.0          0.80         2.08
       0.17     .120E+02       0.1          1.25         1.33
       0.26     .217E+02       0.3          1.61         1.04
       0.35     .328E+02       0.6          1.91         0.87
       0.43     .449E+02       1.0          2.18         0.77
       0.52     .579E+02       1.4          2.41         0.69
       0.61     .715E+02       1.9          2.61         0.64
       0.69     .855E+02       2.4          2.79         0.60
       0.78     .998E+02       2.9          2.95         0.57
       0.87     .114E+03       3.5          3.08         0.54
       0.96     .128E+03       4.1          3.20         0.52
       1.04     .142E+03       4.7          3.29         0.51
       1.13     .156E+03       5.2          3.36         0.50
       1.22     .169E+03       5.8          3.41         0.49
       1.30     .181E+03       6.2          3.44         0.49
       1.39     .192E+03       6.6          3.43         0.49
       1.48     .202E+03       6.9          3.40         0.49
       1.56     .210E+03       6.9          3.31         0.50
       1.65     .214E+03       6.5          3.02         0.55
                                     <---- hydrograph ---->   <-pipe / channel->
                              AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                              (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (8201)    3.71     0.56   11.83  98.00      0.33      1.83
     OUTFLOW: ID= 1 (1201)    3.71     0.58   11.92  98.00      0.33      1.86


--------------------------------------------------------------------------------
-------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   3.55
|ID= 1 DT= 5.0 min |   Total Imp(%)=  58.00   Dir. Conn.(%)=  40.00
-------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.06         1.49
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       143.98
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.55 (ii)    9.68 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.11
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.54         0.45         0.985 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     124.49        75.94         95.36
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.98         0.60          0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
-------------------
| DUHYD     (8202) |
| Inlet Cap.=0.426 |
| #of Inlets=    1 |
| Total(cms)=  0.4 |      AREA     QPEAK     TPEAK    R.V.
-------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   3.55      0.99     12.00   95.36
     ==================================================
     MAJOR SYS.(ID= 2):   0.45      0.56     12.00   95.36
     MINOR SYS.(ID= 3):   3.10      0.43     11.83   95.36

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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-------------------
| ADD HYD   (5202) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
-------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (8201):     0.48   0.636    12.00    98.00
        + ID2= 2 (8202):     3.10   0.426    11.83    95.36
          ==============================================
```

```
          ID = 3 (5202):     3.58   1.062    12.00    95.72

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0203) |   Area    (ha)=   1.29
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.64         0.64
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=      30.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       153.96
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.46 (ii)    6.45 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.24         0.360 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     124.49        77.49         89.24
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.98         0.61          0.71

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5203) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0203):     1.29   0.360    12.00    89.24
        + ID2= 2 (8202):     0.45   0.559    12.00    95.36
          ================================================
          ID = 3 (5203):     1.74   0.919    12.00    90.83

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| ADD HYD   (6203) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5202):     3.58   1.062    12.00    95.72
        + ID2= 2 (5203):     1.74   0.919    12.00    90.83
          ================================================
          ID = 3 (6203):     5.32   1.982    12.00    94.12

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0204) |   Area    (ha)=   2.27
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  42.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.13         1.13
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       107.18
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.55 (ii)   10.32 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.23         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.36         0.23         0.570 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08         12.00
     RUNOFF VOLUME    (mm)=     124.49        69.10         92.36
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.98         0.55          0.73

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (5204) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0204):     2.27   0.570    12.00    92.36
        + ID2= 2 (6203):     5.32   1.982    12.00    94.12
          ================================================
          ID = 3 (5204):     7.59   2.552    12.00    93.59

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| CALIB            |
| STANDHYD  (0205) |   Area    (ha)=   1.39
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.53         0.86
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     200.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       113.89
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.55 (ii)   10.18 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.23         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.19         0.302 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08         12.00
     RUNOFF VOLUME    (mm)=     124.49        70.50         84.00
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.98         0.56          0.66

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (5205) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0205):     1.39   0.302    12.00    84.00
        + ID2= 2 (5204):     7.59   2.552    12.00    93.59
          ================================================
          ID = 3 (5205):     8.98   2.854    12.00    92.11

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0206) |   Area    (ha)=   1.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  38.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.74         0.83
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=      80.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       108.50
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.62 (ii)    8.37 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.29         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.23         0.20         0.427 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00         12.00
     RUNOFF VOLUME    (mm)=     124.49        69.39         90.32
     TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
     RUNOFF COEFFICIENT   =       0.98         0.55          0.71

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (5206) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0206):     1.57   0.427    12.00    90.32
        + ID2= 2 (5205):     8.98   2.854    12.00    92.11
          ================================================
          ID = 3 (5206):    10.55   3.281    12.00    91.84

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| CALIB            |
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| STANDHYD  (0208) |   Area    (ha)=   2.04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.92         1.12
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     150.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       108.57
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       3.82 (ii)    9.57 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.25         0.11
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.31         0.25          0.567 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        74.49          94.48
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.59           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  75.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR (9208) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0074      0.0296
                          0.0000     0.0000   |   0.2098      0.0377
                          0.0074     0.0134   |   0.5799      0.0468
                          0.0074     0.0192   |   0.8074      0.0518
                          0.0074     0.0259   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0208)      2.040     0.567     12.00      94.48
     OUTFLOW: ID= 1 (9208)      2.040     0.504     12.02      90.93

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 89.01
                   TIME SHIFT OF PEAK FLOW         (min)=  1.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0450

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--------------------
| CALIB            |
| STANDHYD  (0207) |   Area    (ha)=   1.20
|ID= 1 DT= 5.0 min |   Total Imp(%)=  64.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.77         0.43
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     100.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       111.38
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       3.00 (ii)    7.23 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.28         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.28         0.11          0.388 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        75.09         104.72
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.59           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  75.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5207) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0207):     1.20   0.388    12.00   104.72
        + ID2= 2 (9208):     2.04   0.504    12.02    90.93
          ================================================
          ID = 3 (5207):     3.24   0.881    12.00    96.04

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| RESERVOIR (9207) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.2093      0.0349
                          0.0069     0.0125   |   0.5794      0.0432
                          0.0069     0.0178   |   0.8069      0.0477
                          0.0069     0.0274   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (5207)      3.240     0.881     12.00      96.04
     OUTFLOW: ID= 1 (9207)      3.240     0.807     12.03      88.06

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 91.57
                   TIME SHIFT OF PEAK FLOW         (min)=  2.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0477

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| ADD HYD   (6206) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (5206):    10.55   3.281    12.00    91.84
        + ID2= 2 (9207):     3.24   0.807    12.03    88.06
          ================================================
          ID = 3 (6206):    13.79   4.055    12.00    90.95

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| RESERVOIR (9206) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.8563      0.4495
                          0.0133     0.0684   |   1.0165      0.5018
                          0.0173     0.1024   |   1.0497      0.5287
                          0.0567     0.1387   |   1.2259      0.5561
                          0.1258     0.1772   |   1.4142      0.5840
                          0.2142     0.2177   |   1.6430      0.6124
                          0.3181     0.2601   |   2.8864      0.6707
                          0.4356     0.3045   |   4.9224      0.7312
                          0.5651     0.3509   |   7.6130      0.7938
                          0.7056     0.3992   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (6206)     13.794     4.055     12.00      90.95
     OUTFLOW: ID= 1 (9206)     13.794     1.103     12.28      84.77

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 27.21
                   TIME SHIFT OF PEAK FLOW         (min)= 17.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.5371

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| CALIB            |
| STANDHYD  (0209) |   Area    (ha)=   0.89
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  45.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.40         0.49
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         2.00
     Length            (m)=     140.00         5.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64         5.40
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       3.67 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.25         0.16
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.15         0.01          0.160 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49         4.22          58.34
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.03           0.46

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =   7.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD   (9209) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0209):     0.89   0.160    12.00    58.34
        + ID2= 2 (9206):    13.79   1.103    12.28    84.77
          ================================================
          ID = 3 (9209):    14.68   1.127    12.28    83.17

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| CALIB            |
| STANDHYD  (0113) |   Area    (ha)=   0.83
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.62         0.21
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       118.42
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.32         0.16
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.24         0.06          0.302 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        92.00         117.11
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.73           0.93

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| DUHYD     (0196) |
| Inlet Cap.=0.134 |
| #of Inlets=    1 |
| Total(cms)=  0.1 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   0.83      0.30     12.00  117.11
     ==================================================
     MAJOR SYS.(ID= 2):   0.12      0.17     12.00  117.11
     MINOR SYS.(ID= 3):   0.71      0.13     11.83  117.11

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| ADD HYD   (9113) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 1 (0196):     0.71   0.134    11.83   117.11
       + ID2= 2 (9209):    14.68   1.127    12.28    83.17
         ================================================
         ID = 3 (9113):    15.40   1.173    12.28    84.74

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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| CALIB            |
| NASHYD    (0012) |   Area    (ha)=   5.32   Curve Number   (CN)= 75.8
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.33

          NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.033    1.39 | 6.033    2.53 |12.033   18.21 | 18.03    2.28
               0.067    1.39 | 6.067    2.53 |12.067   18.21 | 18.07    2.28
               0.100    1.39 | 6.100    2.53 |12.100   18.21 | 18.10    2.28
               0.133    1.39 | 6.133    2.53 |12.133   18.21 | 18.13    2.28
               0.167    1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
               0.200    1.39 | 6.200    2.53 |12.200   18.21 | 18.20    2.28
               0.233    1.39 | 6.233    2.53 |12.233   18.21 | 18.23    2.28
               0.267    1.39 | 6.267    2.53 |12.267   18.21 | 18.27    2.28
               0.300    1.39 | 6.300    2.53 |12.300   18.21 | 18.30    2.28
               0.333    1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
               0.367    1.39 | 6.367    2.53 |12.367   18.21 | 18.37    2.28
               0.400    1.39 | 6.400    2.53 |12.400   18.21 | 18.40    2.28
               0.433    1.39 | 6.433    2.53 |12.433   18.21 | 18.43    2.28
               0.467    1.39 | 6.467    2.53 |12.467   18.21 | 18.47    2.28
               0.500    1.39 | 6.500    2.53 |12.500   18.20 | 18.50    2.28
               0.533    1.39 | 6.533    2.53 |12.533    9.36 | 18.53    2.28
               0.567    1.39 | 6.567    2.53 |12.567    9.36 | 18.57    2.28
               0.600    1.39 | 6.600    2.53 |12.600    9.36 | 18.60    2.28
               0.633    1.39 | 6.633    2.53 |12.633    9.36 | 18.63    2.28
               0.667    1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
               0.700    1.39 | 6.700    2.53 |12.700    9.36 | 18.70    2.28
               0.733    1.39 | 6.733    2.53 |12.733    9.36 | 18.73    2.28
               0.767    1.39 | 6.767    2.53 |12.767    9.36 | 18.77    2.28
               0.800    1.39 | 6.800    2.53 |12.800    9.36 | 18.80    2.28
               0.833    1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
               0.867    1.39 | 6.867    2.53 |12.867    9.36 | 18.87    2.28
               0.900    1.39 | 6.900    2.53 |12.900    9.36 | 18.90    2.28
               0.933    1.39 | 6.933    2.53 |12.933    9.36 | 18.93    2.28
               0.967    1.39 | 6.967    2.53 |12.967    9.36 | 18.97    2.28
               1.000    1.39 | 7.000    2.53 |13.000    9.35 | 19.00    2.28
               1.033    1.39 | 7.033    2.53 |13.033    6.07 | 19.03    2.28
               1.067    1.39 | 7.067    2.53 |13.067    6.07 | 19.07    2.28
               1.100    1.39 | 7.100    2.53 |13.100    6.07 | 19.10    2.28
               1.133    1.39 | 7.133    2.53 |13.133    6.07 | 19.13    2.28
               1.167    1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
               1.200    1.39 | 7.200    2.53 |13.200    6.07 | 19.20    2.28
               1.233    1.39 | 7.233    2.53 |13.233    6.07 | 19.23    2.28
               1.267    1.39 | 7.267    2.53 |13.267    6.07 | 19.27    2.28
               1.300    1.39 | 7.300    2.53 |13.300    6.07 | 19.30    2.28
               1.333    1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
               1.367    1.39 | 7.367    2.53 |13.367    6.07 | 19.37    2.28
               1.400    1.39 | 7.400    2.53 |13.400    6.07 | 19.40    2.28
               1.433    1.39 | 7.433    2.53 |13.433    6.07 | 19.43    2.28
               1.467    1.39 | 7.467    2.53 |13.467    6.07 | 19.47    2.28
               1.500    1.39 | 7.500    2.53 |13.500    6.07 | 19.50    2.28
               1.533    1.39 | 7.533    2.53 |13.533    6.07 | 19.53    2.28
               1.567    1.39 | 7.567    2.53 |13.567    6.07 | 19.57    2.28
               1.600    1.39 | 7.600    2.53 |13.600    6.07 | 19.60    2.28
               1.633    1.39 | 7.633    2.53 |13.633    6.07 | 19.63    2.28
               1.667    1.39 | 7.667    2.53 |13.667    6.07 | 19.67    2.28
               1.700    1.39 | 7.700    2.53 |13.700    6.07 | 19.70    2.28
               1.733    1.39 | 7.733    2.53 |13.733    6.07 | 19.73    2.28
               1.767    1.39 | 7.767    2.53 |13.767    6.07 | 19.77    2.28
               1.800    1.39 | 7.800    2.53 |13.800    6.07 | 19.80    2.28
               1.833    1.39 | 7.833    2.53 |13.833    6.07 | 19.83    2.28
               1.867    1.39 | 7.867    2.53 |13.867    6.07 | 19.87    2.28
               1.900    1.39 | 7.900    2.53 |13.900    6.07 | 19.90    2.28
               1.933    1.39 | 7.933    2.53 |13.933    6.07 | 19.93    2.28
               1.967    1.39 | 7.967    2.53 |13.967    6.07 | 19.97    2.28
               2.000    1.39 | 8.000    2.53 |14.000    6.07 | 20.00    2.28
               2.033    1.64 | 8.033    3.42 |14.033    3.79 | 20.03    1.52
               2.067    1.64 | 8.067    3.42 |14.067    3.79 | 20.07    1.52
               2.100    1.64 | 8.100    3.42 |14.100    3.79 | 20.10    1.52
               2.133    1.64 | 8.133    3.42 |14.133    3.79 | 20.13    1.52
               2.167    1.64 | 8.167    3.42 |14.167    3.79 | 20.17    1.52
               2.200    1.64 | 8.200    3.42 |14.200    3.79 | 20.20    1.52
               2.233    1.64 | 8.233    3.42 |14.233    3.79 | 20.23    1.52
               2.267    1.64 | 8.267    3.42 |14.267    3.79 | 20.27    1.52
               2.300    1.64 | 8.300    3.42 |14.300    3.79 | 20.30    1.52
               2.333    1.64 | 8.333    3.42 |14.333    3.79 | 20.33    1.52
               2.367    1.64 | 8.367    3.42 |14.367    3.79 | 20.37    1.52
               2.400    1.64 | 8.400    3.42 |14.400    3.79 | 20.40    1.52
               2.433    1.64 | 8.433    3.42 |14.433    3.79 | 20.43    1.52
               2.467    1.64 | 8.467    3.42 |14.467    3.79 | 20.47    1.52
               2.500    1.64 | 8.500    3.42 |14.500    3.79 | 20.50    1.52
               2.533    1.64 | 8.533    3.42 |14.533    3.79 | 20.53    1.52
               2.567    1.64 | 8.567    3.42 |14.567    3.79 | 20.57    1.52
               2.600    1.64 | 8.600    3.42 |14.600    3.79 | 20.60    1.52
               2.633    1.64 | 8.633    3.42 |14.633    3.79 | 20.63    1.52
               2.667    1.64 | 8.667    3.42 |14.667    3.79 | 20.67    1.52
               2.700    1.64 | 8.700    3.42 |14.700    3.79 | 20.70    1.52
               2.733    1.64 | 8.733    3.42 |14.733    3.79 | 20.73    1.52
               2.767    1.64 | 8.767    3.42 |14.767    3.79 | 20.77    1.52
               2.800    1.64 | 8.800    3.42 |14.800    3.79 | 20.80    1.52
               2.833    1.64 | 8.833    3.42 |14.833    3.79 | 20.83    1.52
               2.867    1.64 | 8.867    3.42 |14.867    3.79 | 20.87    1.52
               2.900    1.64 | 8.900    3.42 |14.900    3.79 | 20.90    1.52
               2.933    1.64 | 8.933    3.42 |14.933    3.79 | 20.93    1.52
               2.967    1.64 | 8.967    3.42 |14.967    3.79 | 20.97    1.52
               3.000    1.64 | 9.000    3.42 |15.000    3.79 | 21.00    1.52
               3.033    1.64 | 9.033    4.05 |15.033    3.79 | 21.03    1.52
               3.067    1.64 | 9.067    4.05 |15.067    3.79 | 21.07    1.52
               3.100    1.64 | 9.100    4.05 |15.100    3.79 | 21.10    1.52
               3.133    1.64 | 9.133    4.05 |15.133    3.79 | 21.13    1.52
               3.167    1.64 | 9.167    4.05 |15.167    3.79 | 21.17    1.52
               3.200    1.64 | 9.200    4.05 |15.200    3.79 | 21.20    1.52
               3.233    1.64 | 9.233    4.05 |15.233    3.79 | 21.23    1.52
               3.267    1.64 | 9.267    4.05 |15.267    3.79 | 21.27    1.52
               3.300    1.64 | 9.300    4.05 |15.300    3.79 | 21.30    1.52
               3.333    1.64 | 9.333    4.05 |15.333    3.79 | 21.33    1.52
               3.367    1.64 | 9.367    4.05 |15.367    3.79 | 21.37    1.52
               3.400    1.64 | 9.400    4.05 |15.400    3.79 | 21.40    1.52
               3.433    1.64 | 9.433    4.05 |15.433    3.79 | 21.43    1.52
               3.467    1.64 | 9.467    4.05 |15.467    3.79 | 21.47    1.52
               3.500    1.64 | 9.500    4.05 |15.500    3.79 | 21.50    1.52
               3.533    1.64 | 9.533    4.55 |15.533    3.79 | 21.53    1.52
               3.567    1.64 | 9.567    4.55 |15.567    3.79 | 21.57    1.52
               3.600    1.64 | 9.600    4.55 |15.600    3.79 | 21.60    1.52
               3.633    1.64 | 9.633    4.55 |15.633    3.79 | 21.63    1.52
               3.667    1.64 | 9.667    4.55 |15.667    3.79 | 21.67    1.52
               3.700    1.64 | 9.700    4.55 |15.700    3.79 | 21.70    1.52
               3.733    1.64 | 9.733    4.55 |15.733    3.79 | 21.73    1.52
               3.767    1.64 | 9.767    4.55 |15.767    3.79 | 21.77    1.52
               3.800    1.64 | 9.800    4.55 |15.800    3.79 | 21.80    1.52
               3.833    1.64 | 9.833    4.55 |15.833    3.79 | 21.83    1.52
               3.867    1.64 | 9.867    4.55 |15.867    3.79 | 21.87    1.52
               3.900    1.64 | 9.900    4.55 |15.900    3.79 | 21.90    1.52
               3.933    1.64 | 9.933    4.55 |15.933    3.79 | 21.93    1.52
               3.967    1.64 | 9.967    4.55 |15.967    3.79 | 21.97    1.52
               4.000    1.64 |10.000    4.55 |16.000    3.79 | 22.00    1.52
               4.033    2.02 |10.033    5.82 |16.033    2.28 | 22.03    1.52
               4.067    2.02 |10.067    5.82 |16.067    2.28 | 22.07    1.52
               4.100    2.02 |10.100    5.82 |16.100    2.28 | 22.10    1.52
               4.133    2.02 |10.133    5.82 |16.133    2.28 | 22.13    1.52
               4.167    2.02 |10.167    5.82 |16.167    2.28 | 22.17    1.52
               4.200    2.02 |10.200    5.82 |16.200    2.28 | 22.20    1.52
               4.233    2.02 |10.233    5.82 |16.233    2.28 | 22.23    1.52
               4.267    2.02 |10.267    5.82 |16.267    2.28 | 22.27    1.52
               4.300    2.02 |10.300    5.82 |16.300    2.28 | 22.30    1.52
               4.333    2.02 |10.333    5.82 |16.333    2.28 | 22.33    1.52
               4.367    2.02 |10.367    5.82 |16.367    2.28 | 22.37    1.52
               4.400    2.02 |10.400    5.82 |16.400    2.28 | 22.40    1.52
               4.433    2.02 |10.433    5.82 |16.433    2.28 | 22.43    1.52
               4.467    2.02 |10.467    5.82 |16.467    2.28 | 22.47    1.52
               4.500    2.02 |10.500    5.82 |16.500    2.28 | 22.50    1.52
               4.533    2.02 |10.533    7.84 |16.533    2.28 | 22.53    1.52
               4.567    2.02 |10.567    7.84 |16.567    2.28 | 22.57    1.52
               4.600    2.02 |10.600    7.84 |16.600    2.28 | 22.60    1.52
               4.633    2.02 |10.633    7.84 |16.633    2.28 | 22.63    1.52
               4.667    2.02 |10.667    7.84 |16.667    2.28 | 22.67    1.52
               4.700    2.02 |10.700    7.84 |16.700    2.28 | 22.70    1.52
               4.733    2.02 |10.733    7.84 |16.733    2.28 | 22.73    1.52
               4.767    2.02 |10.767    7.84 |16.767    2.28 | 22.77    1.52
               4.800    2.02 |10.800    7.84 |16.800    2.28 | 22.80    1.52
               4.833    2.02 |10.833    7.84 |16.833    2.28 | 22.83    1.52
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              4.867    2.02 |10.867    7.84 |16.867    2.28 | 22.87    1.52
              4.900    2.02 |10.900    7.84 |16.900    2.28 | 22.90    1.52
              4.933    2.02 |10.933    7.84 |16.933    2.28 | 22.93    1.52
              4.967    2.02 |10.967    7.84 |16.967    2.28 | 22.97    1.52
              5.000    2.02 |11.000    7.85 |17.000    2.28 | 23.00    1.52
              5.033    2.02 |11.033   12.14 |17.033    2.28 | 23.03    1.52
              5.067    2.02 |11.067   12.14 |17.067    2.28 | 23.07    1.52
              5.100    2.02 |11.100   12.14 |17.100    2.28 | 23.10    1.52
              5.133    2.02 |11.133   12.14 |17.133    2.28 | 23.13    1.52
              5.167    2.02 |11.167   12.14 |17.167    2.28 | 23.17    1.52
              5.200    2.02 |11.200   12.14 |17.200    2.28 | 23.20    1.52
              5.233    2.02 |11.233   12.14 |17.233    2.28 | 23.23    1.52
              5.267    2.02 |11.267   12.14 |17.267    2.28 | 23.27    1.52
              5.300    2.02 |11.300   12.14 |17.300    2.28 | 23.30    1.52
              5.333    2.02 |11.333   12.14 |17.333    2.28 | 23.33    1.52
              5.367    2.02 |11.367   12.14 |17.367    2.28 | 23.37    1.52
              5.400    2.02 |11.400   12.14 |17.400    2.28 | 23.40    1.52
              5.433    2.02 |11.433   12.14 |17.433    2.28 | 23.43    1.52
              5.467    2.02 |11.467   12.14 |17.467    2.28 | 23.47    1.52
              5.500    2.02 |11.500   12.19 |17.500    2.28 | 23.50    1.52
              5.533    2.02 |11.533   52.62 |17.533    2.28 | 23.53    1.52
              5.567    2.02 |11.567   52.62 |17.567    2.28 | 23.57    1.52
              5.600    2.02 |11.600   52.62 |17.600    2.28 | 23.60    1.52
              5.633    2.02 |11.633   52.62 |17.633    2.28 | 23.63    1.52
              5.667    2.02 |11.667   52.62 |17.667    2.28 | 23.67    1.52
              5.700    2.02 |11.700   52.62 |17.700    2.28 | 23.70    1.52
              5.733    2.02 |11.733   52.62 |17.733    2.28 | 23.73    1.52
              5.767    2.02 |11.767   96.25 |17.767    2.28 | 23.77    1.52
              5.800    2.02 |11.800  139.64 |17.800    2.28 | 23.80    1.52
              5.833    2.02 |11.833  139.64 |17.833    2.28 | 23.83    1.52
              5.867    2.02 |11.867  139.64 |17.867    2.28 | 23.87    1.52
              5.900    2.02 |11.900  139.64 |17.900    2.28 | 23.90    1.52
              5.933    2.02 |11.933  139.64 |17.933    2.28 | 23.93    1.52
              5.967    2.02 |11.967  139.64 |17.967    2.28 | 23.97    1.52
              6.000    2.02 |12.000  139.47 |18.000    2.28 | 24.00    1.52

     Unit Hyd Qpeak  (cms)=   0.616

     PEAK FLOW       (cms)=   0.699 (i)
     TIME TO PEAK    (hrs)=  12.200
     RUNOFF VOLUME    (mm)=  72.856
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.576

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0112) |   Area    (ha)=   1.67
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.25         0.42
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        98.03
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.20
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.49         0.10          0.588 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        73.17         112.41
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.58           0.89

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (0197) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0112):     1.67   0.588    12.00   112.41
        + ID2= 2 (0196):     0.12   0.168    12.00   117.11
          ================================================
          ID = 3 (0197):     1.79   0.756    12.00   112.81

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (5012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0012):     5.32   0.699    12.20    72.86
        + ID2= 2 (0197):     1.79   0.756    12.00   112.81
          ================================================
          ID = 3 (5012):     7.11   1.240    12.00    82.90

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0011) |   Area    (ha)=   1.19   Curve Number   (CN)= 82.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.15

     Unit Hyd Qpeak  (cms)=   0.303

     PEAK FLOW       (cms)=   0.293 (i)
     TIME TO PEAK    (hrs)=  12.033
     RUNOFF VOLUME    (mm)=  84.868
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.671

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0111) |   Area    (ha)=   0.67
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        64.58
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.20
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.19         0.03          0.222 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        48.32         106.19
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.38           0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5011) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0011):     1.19   0.293    12.03    84.87
        + ID2= 2 (0111):     0.67   0.222    12.00   106.19
          ================================================
          ID = 3 (5011):     1.86   0.502    12.00    92.55

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0010) |   Area    (ha)=   0.88   Curve Number   (CN)= 67.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.16

     Unit Hyd Qpeak  (cms)=   0.210

     PEAK FLOW       (cms)=   0.145 (i)
     TIME TO PEAK    (hrs)=  12.067
     RUNOFF VOLUME    (mm)=  59.846
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.473

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0110) |   Area    (ha)=   0.40
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.30         0.10
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        64.58
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    5.59 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.20
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.12         0.02          0.132 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     125.49        48.32         106.19
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     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.99         0.38           0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (5010) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0010):     0.88   0.145    12.07    59.85
        + ID2= 2 (0110):     0.40   0.132    12.00   106.19
          ================================================
          ID = 3 (5010):     1.28   0.268    12.00    74.33

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0009) |   Area    (ha)=   0.35   Curve Number   (CN)= 67.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.15

     Unit Hyd Qpeak  (cms)=   0.089

     PEAK FLOW       (cms)=   0.060 (i)
     TIME TO PEAK    (hrs)=  12.033
     RUNOFF VOLUME    (mm)=  59.843
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.473

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0008) |   Area    (ha)=   0.77   Curve Number   (CN)= 67.0
|ID= 1 DT= 2.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.15

     Unit Hyd Qpeak  (cms)=   0.196

     PEAK FLOW       (cms)=   0.131 (i)
     TIME TO PEAK    (hrs)=  12.033
     RUNOFF VOLUME    (mm)=  59.843
     TOTAL RAINFALL   (mm)= 126.489
     RUNOFF COEFFICIENT   =   0.473

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0007) |   Area    (ha)= 146.90   Curve Number   (CN)= 77.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   2.50

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    1.39 | 6.083    2.53 |12.083   18.23 | 18.08    2.28
               0.167    1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
               0.250    1.39 | 6.250    2.53 |12.250   18.21 | 18.25    2.28
               0.333    1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
               0.417    1.39 | 6.417    2.53 |12.417   18.21 | 18.42    2.28
               0.500    1.39 | 6.500    2.53 |12.500   18.21 | 18.50    2.28
               0.583    1.39 | 6.583    2.53 |12.583    9.36 | 18.58    2.28
               0.667    1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
               0.750    1.39 | 6.750    2.53 |12.750    9.36 | 18.75    2.28
               0.833    1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
               0.917    1.39 | 6.917    2.53 |12.917    9.36 | 18.92    2.28
               1.000    1.39 | 7.000    2.53 |13.000    9.36 | 19.00    2.28
               1.083    1.39 | 7.083    2.53 |13.083    6.07 | 19.08    2.28
               1.167    1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
               1.250    1.39 | 7.250    2.53 |13.250    6.07 | 19.25    2.28
               1.333    1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
               1.417    1.39 | 7.417    2.53 |13.417    6.07 | 19.42    2.28
               1.500    1.39 | 7.500    2.53 |13.500    6.07 | 19.50    2.28
               1.583    1.39 | 7.583    2.53 |13.583    6.07 | 19.58    2.28
               1.667    1.39 | 7.667    2.53 |13.667    6.07 | 19.67    2.28
               1.750    1.39 | 7.750    2.53 |13.750    6.07 | 19.75    2.28
               1.833    1.39 | 7.833    2.53 |13.833    6.07 | 19.83    2.28
               1.917    1.39 | 7.917    2.53 |13.917    6.07 | 19.92    2.28
               2.000    1.39 | 8.000    2.53 |14.000    6.07 | 20.00    2.28
               2.083    1.64 | 8.083    3.42 |14.083    3.80 | 20.08    1.52
               2.167    1.64 | 8.167    3.42 |14.167    3.79 | 20.17    1.52
               2.250    1.64 | 8.250    3.42 |14.250    3.79 | 20.25    1.52
               2.333    1.64 | 8.333    3.42 |14.333    3.79 | 20.33    1.52
               2.417    1.64 | 8.417    3.42 |14.417    3.79 | 20.42    1.52
               2.500    1.64 | 8.500    3.42 |14.500    3.79 | 20.50    1.52
               2.583    1.64 | 8.583    3.42 |14.583    3.79 | 20.58    1.52
               2.667    1.64 | 8.667    3.42 |14.667    3.79 | 20.67    1.52
               2.750    1.64 | 8.750    3.42 |14.750    3.79 | 20.75    1.52
               2.833    1.64 | 8.833    3.42 |14.833    3.79 | 20.83    1.52
               2.917    1.64 | 8.917    3.42 |14.917    3.79 | 20.92    1.52
               3.000    1.64 | 9.000    3.42 |15.000    3.79 | 21.00    1.52
               3.083    1.64 | 9.083    4.05 |15.083    3.79 | 21.08    1.52
               3.167    1.64 | 9.167    4.05 |15.167    3.79 | 21.17    1.52
               3.250    1.64 | 9.250    4.05 |15.250    3.79 | 21.25    1.52
               3.333    1.64 | 9.333    4.05 |15.333    3.79 | 21.33    1.52
               3.417    1.64 | 9.417    4.05 |15.417    3.79 | 21.42    1.52
               3.500    1.64 | 9.500    4.05 |15.500    3.79 | 21.50    1.52
               3.583    1.64 | 9.583    4.55 |15.583    3.79 | 21.58    1.52
               3.667    1.64 | 9.667    4.55 |15.667    3.79 | 21.67    1.52
               3.750    1.64 | 9.750    4.55 |15.750    3.79 | 21.75    1.52
               3.833    1.64 | 9.833    4.55 |15.833    3.79 | 21.83    1.52
               3.917    1.64 | 9.917    4.55 |15.917    3.79 | 21.92    1.52
               4.000    1.64 |10.000    4.55 |16.000    3.79 | 22.00    1.52
               4.083    2.02 |10.083    5.82 |16.083    2.28 | 22.08    1.52
               4.167    2.02 |10.167    5.82 |16.167    2.28 | 22.17    1.52
               4.250    2.02 |10.250    5.82 |16.250    2.28 | 22.25    1.52
               4.333    2.02 |10.333    5.82 |16.333    2.28 | 22.33    1.52
               4.417    2.02 |10.417    5.82 |16.417    2.28 | 22.42    1.52
               4.500    2.02 |10.500    5.82 |16.500    2.28 | 22.50    1.52
               4.583    2.02 |10.583    7.84 |16.583    2.28 | 22.58    1.52
               4.667    2.02 |10.667    7.84 |16.667    2.28 | 22.67    1.52
               4.750    2.02 |10.750    7.84 |16.750    2.28 | 22.75    1.52
               4.833    2.02 |10.833    7.84 |16.833    2.28 | 22.83    1.52
               4.917    2.02 |10.917    7.84 |16.917    2.28 | 22.92    1.52
               5.000    2.02 |11.000    7.84 |17.000    2.28 | 23.00    1.52
               5.083    2.02 |11.083   12.14 |17.083    2.28 | 23.08    1.52
               5.167    2.02 |11.167   12.14 |17.167    2.28 | 23.17    1.52
               5.250    2.02 |11.250   12.14 |17.250    2.28 | 23.25    1.52
               5.333    2.02 |11.333   12.14 |17.333    2.28 | 23.33    1.52
               5.417    2.02 |11.417   12.14 |17.417    2.28 | 23.42    1.52
               5.500    2.02 |11.500   12.14 |17.500    2.28 | 23.50    1.52
               5.583    2.02 |11.583   52.62 |17.583    2.28 | 23.58    1.52
               5.667    2.02 |11.667   52.62 |17.667    2.28 | 23.67    1.52
               5.750    2.02 |11.750   52.62 |17.750    2.28 | 23.75    1.52
               5.833    2.02 |11.833  139.64 |17.833    2.28 | 23.83    1.52
               5.917    2.02 |11.917  139.64 |17.917    2.28 | 23.92    1.52
               6.000    2.02 |12.000  139.64 |18.000    2.28 | 24.00    1.52

     Unit Hyd Qpeak  (cms)=   2.244

     PEAK FLOW       (cms)=   4.424 (i)
     TIME TO PEAK    (hrs)=  14.667
     RUNOFF VOLUME    (mm)=  74.787
     TOTAL RAINFALL   (mm)= 126.490
     RUNOFF COEFFICIENT   =   0.591

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB            |
| STANDHYD  (1007) |   Area    (ha)=   1.53
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
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                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.15          0.38
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      50.00         30.00
     Mannings n          =       0.015         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.033    1.39 | 6.033    2.53 |12.033   18.21 | 18.03    2.28
               0.067    1.39 | 6.067    2.53 |12.067   18.21 | 18.07    2.28
               0.100    1.39 | 6.100    2.53 |12.100   18.21 | 18.10    2.28
               0.133    1.39 | 6.133    2.53 |12.133   18.21 | 18.13    2.28
               0.167    1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
               0.200    1.39 | 6.200    2.53 |12.200   18.21 | 18.20    2.28
               0.233    1.39 | 6.233    2.53 |12.233   18.21 | 18.23    2.28
               0.267    1.39 | 6.267    2.53 |12.267   18.21 | 18.27    2.28
               0.300    1.39 | 6.300    2.53 |12.300   18.21 | 18.30    2.28
               0.333    1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
               0.367    1.39 | 6.367    2.53 |12.367   18.21 | 18.37    2.28
               0.400    1.39 | 6.400    2.53 |12.400   18.21 | 18.40    2.28
               0.433    1.39 | 6.433    2.53 |12.433   18.21 | 18.43    2.28
               0.467    1.39 | 6.467    2.53 |12.467   18.21 | 18.47    2.28
               0.500    1.39 | 6.500    2.53 |12.500   18.20 | 18.50    2.28
               0.533    1.39 | 6.533    2.53 |12.533    9.36 | 18.53    2.28
               0.567    1.39 | 6.567    2.53 |12.567    9.36 | 18.57    2.28
               0.600    1.39 | 6.600    2.53 |12.600    9.36 | 18.60    2.28
               0.633    1.39 | 6.633    2.53 |12.633    9.36 | 18.63    2.28
               0.667    1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
               0.700    1.39 | 6.700    2.53 |12.700    9.36 | 18.70    2.28
               0.733    1.39 | 6.733    2.53 |12.733    9.36 | 18.73    2.28
               0.767    1.39 | 6.767    2.53 |12.767    9.36 | 18.77    2.28
               0.800    1.39 | 6.800    2.53 |12.800    9.36 | 18.80    2.28
               0.833    1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
               0.867    1.39 | 6.867    2.53 |12.867    9.36 | 18.87    2.28
               0.900    1.39 | 6.900    2.53 |12.900    9.36 | 18.90    2.28
               0.933    1.39 | 6.933    2.53 |12.933    9.36 | 18.93    2.28
               0.967    1.39 | 6.967    2.53 |12.967    9.36 | 18.97    2.28
               1.000    1.39 | 7.000    2.53 |13.000    9.35 | 19.00    2.28
               1.033    1.39 | 7.033    2.53 |13.033    6.07 | 19.03    2.28
               1.067    1.39 | 7.067    2.53 |13.067    6.07 | 19.07    2.28
               1.100    1.39 | 7.100    2.53 |13.100    6.07 | 19.10    2.28
               1.133    1.39 | 7.133    2.53 |13.133    6.07 | 19.13    2.28
               1.167    1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
               1.200    1.39 | 7.200    2.53 |13.200    6.07 | 19.20    2.28
               1.233    1.39 | 7.233    2.53 |13.233    6.07 | 19.23    2.28
               1.267    1.39 | 7.267    2.53 |13.267    6.07 | 19.27    2.28
               1.300    1.39 | 7.300    2.53 |13.300    6.07 | 19.30    2.28
               1.333    1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
               1.367    1.39 | 7.367    2.53 |13.367    6.07 | 19.37    2.28
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1.400	1.39	7.400	2.53	13.400	6.07	19.40	2.28
1.433	1.39	7.433	2.53	13.433	6.07	19.43	2.28
1.467	1.39	7.467	2.53	13.467	6.07	19.47	2.28
1.500	1.39	7.500	2.53	13.500	6.07	19.50	2.28
1.533	1.39	7.533	2.53	13.533	6.07	19.53	2.28
1.567	1.39	7.567	2.53	13.567	6.07	19.57	2.28
1.600	1.39	7.600	2.53	13.600	6.07	19.60	2.28
1.633	1.39	7.633	2.53	13.633	6.07	19.63	2.28
1.667	1.39	7.667	2.53	13.667	6.07	19.67	2.28
1.700	1.39	7.700	2.53	13.700	6.07	19.70	2.28
1.733	1.39	7.733	2.53	13.733	6.07	19.73	2.28
1.767	1.39	7.767	2.53	13.767	6.07	19.77	2.28
1.800	1.39	7.800	2.53	13.800	6.07	19.80	2.28
1.833	1.39	7.833	2.53	13.833	6.07	19.83	2.28
1.867	1.39	7.867	2.53	13.867	6.07	19.87	2.28
1.900	1.39	7.900	2.53	13.900	6.07	19.90	2.28
1.933	1.39	7.933	2.53	13.933	6.07	19.93	2.28
1.967	1.39	7.967	2.53	13.967	6.07	19.97	2.28
2.000	1.39	8.000	2.53	14.000	6.07	20.00	2.28
2.033	1.64	8.033	3.42	14.033	3.79	20.03	1.52
2.067	1.64	8.067	3.42	14.067	3.79	20.07	1.52
2.100	1.64	8.100	3.42	14.100	3.79	20.10	1.52
2.133	1.64	8.133	3.42	14.133	3.79	20.13	1.52
2.167	1.64	8.167	3.42	14.167	3.79	20.17	1.52
2.200	1.64	8.200	3.42	14.200	3.79	20.20	1.52
2.233	1.64	8.233	3.42	14.233	3.79	20.23	1.52
2.267	1.64	8.267	3.42	14.267	3.79	20.27	1.52
2.300	1.64	8.300	3.42	14.300	3.79	20.30	1.52
2.333	1.64	8.333	3.42	14.333	3.79	20.33	1.52
2.367	1.64	8.367	3.42	14.367	3.79	20.37	1.52
2.400	1.64	8.400	3.42	14.400	3.79	20.40	1.52
2.433	1.64	8.433	3.42	14.433	3.79	20.43	1.52
2.467	1.64	8.467	3.42	14.467	3.79	20.47	1.52
2.500	1.64	8.500	3.42	14.500	3.79	20.50	1.52
2.533	1.64	8.533	3.42	14.533	3.79	20.53	1.52
2.567	1.64	8.567	3.42	14.567	3.79	20.57	1.52
2.600	1.64	8.600	3.42	14.600	3.79	20.60	1.52
2.633	1.64	8.633	3.42	14.633	3.79	20.63	1.52
2.667	1.64	8.667	3.42	14.667	3.79	20.67	1.52
2.700	1.64	8.700	3.42	14.700	3.79	20.70	1.52
2.733	1.64	8.733	3.42	14.733	3.79	20.73	1.52
2.767	1.64	8.767	3.42	14.767	3.79	20.77	1.52
2.800	1.64	8.800	3.42	14.800	3.79	20.80	1.52
2.833	1.64	8.833	3.42	14.833	3.79	20.83	1.52
2.867	1.64	8.867	3.42	14.867	3.79	20.87	1.52
2.900	1.64	8.900	3.42	14.900	3.79	20.90	1.52
2.933	1.64	8.933	3.42	14.933	3.79	20.93	1.52
2.967	1.64	8.967	3.42	14.967	3.79	20.97	1.52
3.000	1.64	9.000	3.42	15.000	3.79	21.00	1.52
3.033	1.64	9.033	4.05	15.033	3.79	21.03	1.52
3.067	1.64	9.067	4.05	15.067	3.79	21.07	1.52
3.100	1.64	9.100	4.05	15.100	3.79	21.10	1.52
3.133	1.64	9.133	4.05	15.133	3.79	21.13	1.52
3.167	1.64	9.167	4.05	15.167	3.79	21.17	1.52
3.200	1.64	9.200	4.05	15.200	3.79	21.20	1.52
3.233	1.64	9.233	4.05	15.233	3.79	21.23	1.52
3.267	1.64	9.267	4.05	15.267	3.79	21.27	1.52
3.300	1.64	9.300	4.05	15.300	3.79	21.30	1.52
3.333	1.64	9.333	4.05	15.333	3.79	21.33	1.52
3.367	1.64	9.367	4.05	15.367	3.79	21.37	1.52
3.400	1.64	9.400	4.05	15.400	3.79	21.40	1.52
3.433	1.64	9.433	4.05	15.433	3.79	21.43	1.52
3.467	1.64	9.467	4.05	15.467	3.79	21.47	1.52
3.500	1.64	9.500	4.05	15.500	3.79	21.50	1.52
3.533	1.64	9.533	4.55	15.533	3.79	21.53	1.52
3.567	1.64	9.567	4.55	15.567	3.79	21.57	1.52
3.600	1.64	9.600	4.55	15.600	3.79	21.60	1.52
3.633	1.64	9.633	4.55	15.633	3.79	21.63	1.52
3.667	1.64	9.667	4.55	15.667	3.79	21.67	1.52
3.700	1.64	9.700	4.55	15.700	3.79	21.70	1.52
3.733	1.64	9.733	4.55	15.733	3.79	21.73	1.52
3.767	1.64	9.767	4.55	15.767	3.79	21.77	1.52
3.800	1.64	9.800	4.55	15.800	3.79	21.80	1.52
3.833	1.64	9.833	4.55	15.833	3.79	21.83	1.52
3.867	1.64	9.867	4.55	15.867	3.79	21.87	1.52
3.900	1.64	9.900	4.55	15.900	3.79	21.90	1.52
3.933	1.64	9.933	4.55	15.933	3.79	21.93	1.52
3.967	1.64	9.967	4.55	15.967	3.79	21.97	1.52
4.000	1.64	10.000	4.55	16.000	3.79	22.00	1.52
4.033	2.02	10.033	5.82	16.033	2.28	22.03	1.52
4.067	2.02	10.067	5.82	16.067	2.28	22.07	1.52
4.100	2.02	10.100	5.82	16.100	2.28	22.10	1.52
4.133	2.02	10.133	5.82	16.133	2.28	22.13	1.52
4.167	2.02	10.167	5.82	16.167	2.28	22.17	1.52
4.200	2.02	10.200	5.82	16.200	2.28	22.20	1.52
4.233	2.02	10.233	5.82	16.233	2.28	22.23	1.52
4.267	2.02	10.267	5.82	16.267	2.28	22.27	1.52
4.300	2.02	10.300	5.82	16.300	2.28	22.30	1.52
4.333	2.02	10.333	5.82	16.333	2.28	22.33	1.52
4.367	2.02	10.367	5.82	16.367	2.28	22.37	1.52
4.400	2.02	10.400	5.82	16.400	2.28	22.40	1.52
4.433	2.02	10.433	5.82	16.433	2.28	22.43	1.52
4.467	2.02	10.467	5.82	16.467	2.28	22.47	1.52
4.500	2.02	10.500	5.82	16.500	2.28	22.50	1.52
4.533	2.02	10.533	7.84	16.533	2.28	22.53	1.52
4.567	2.02	10.567	7.84	16.567	2.28	22.57	1.52
4.600	2.02	10.600	7.84	16.600	2.28	22.60	1.52
4.633	2.02	10.633	7.84	16.633	2.28	22.63	1.52
4.667	2.02	10.667	7.84	16.667	2.28	22.67	1.52
4.700	2.02	10.700	7.84	16.700	2.28	22.70	1.52
4.733	2.02	10.733	7.84	16.733	2.28	22.73	1.52
4.767	2.02	10.767	7.84	16.767	2.28	22.77	1.52
4.800	2.02	10.800	7.84	16.800	2.28	22.80	1.52
4.833	2.02	10.833	7.84	16.833	2.28	22.83	1.52
4.867	2.02	10.867	7.84	16.867	2.28	22.87	1.52
4.900	2.02	10.900	7.84	16.900	2.28	22.90	1.52
4.933	2.02	10.933	7.84	16.933	2.28	22.93	1.52
4.967	2.02	10.967	7.84	16.967	2.28	22.97	1.52
5.000	2.02	11.000	7.85	17.000	2.28	23.00	1.52
5.033	2.02	11.033	12.14	17.033	2.28	23.03	1.52
5.067	2.02	11.067	12.14	17.067	2.28	23.07	1.52
5.100	2.02	11.100	12.14	17.100	2.28	23.10	1.52
5.133	2.02	11.133	12.14	17.133	2.28	23.13	1.52
5.167	2.02	11.167	12.14	17.167	2.28	23.17	1.52
5.200	2.02	11.200	12.14	17.200	2.28	23.20	1.52
5.233	2.02	11.233	12.14	17.233	2.28	23.23	1.52
5.267	2.02	11.267	12.14	17.267	2.28	23.27	1.52
5.300	2.02	11.300	12.14	17.300	2.28	23.30	1.52
5.333	2.02	11.333	12.14	17.333	2.28	23.33	1.52
5.367	2.02	11.367	12.14	17.367	2.28	23.37	1.52
5.400	2.02	11.400	12.14	17.400	2.28	23.40	1.52
5.433	2.02	11.433	12.14	17.433	2.28	23.43	1.52
5.467	2.02	11.467	12.14	17.467	2.28	23.47	1.52
5.500	2.02	11.500	12.19	17.500	2.28	23.50	1.52
5.533	2.02	11.533	52.62	17.533	2.28	23.53	1.52
5.567	2.02	11.567	52.62	17.567	2.28	23.57	1.52
5.600	2.02	11.600	52.62	17.600	2.28	23.60	1.52
5.633	2.02	11.633	52.62	17.633	2.28	23.63	1.52
5.667	2.02	11.667	52.62	17.667	2.28	23.67	1.52
5.700	2.02	11.700	52.62	17.700	2.28	23.70	1.52
5.733	2.02	11.733	52.62	17.733	2.28	23.73	1.52
5.767	2.02	11.767	96.25	17.767	2.28	23.77	1.52
5.800	2.02	11.800	139.64	17.800	2.28	23.80	1.52
5.833	2.02	11.833	139.64	17.833	2.28	23.83	1.52
5.867	2.02	11.867	139.64	17.867	2.28	23.87	1.52
5.900	2.02	11.900	139.64	17.900	2.28	23.90	1.52
5.933	2.02	11.933	139.64	17.933	2.28	23.93	1.52
5.967	2.02	11.967	139.64	17.967	2.28	23.97	1.52
6.000	2.02	12.000	139.47	18.000	2.28	24.00	1.52

```
     Max.Eff.Inten.(mm/hr)=     139.64     ********
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    4.96 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.21
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.44         0.06          0.508 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        48.32         105.45
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.38           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| DUHYD     (8118) |
| Inlet Cap.=0.278 |
| #of Inlets=    1 |
| Total(cms)=  0.3 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   1.53      0.51     12.00  105.45
     ====================================================
     MAJOR SYS.(ID= 2):   0.16      0.23     12.00  105.45
     MINOR SYS.(ID= 3):   1.37      0.28     11.80  105.45

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (2007) |   Area    (ha)=   1.53
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.15         0.38
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        30.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        64.58
                over (min)        5.00         6.00
     Storage Coeff.  (min)=       1.61 (ii)    4.96 (ii)
     Unit Hyd. Tpeak (min)=       4.00         6.00
     Unit Hyd. peak  (cms)=       0.45         0.21
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.44         0.06          0.508 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        48.32         105.45
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.38           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  58.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------


--------------------
| ADD HYD   (5117) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (2007):     1.53    0.508    12.00   105.45
        + ID2= 2 (8118):     0.16    0.230    12.00   105.45
```

```
          ================================================
          ID = 3 (5117):     1.69   0.737    12.00   105.45

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (9007) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0007):   146.90   4.424    14.67    74.79
         + ID2= 2 (5117):     1.69   0.737    12.00   105.45
          ================================================
          ID = 3 (9007):   148.59   4.438    14.67    75.14

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| ROUTE PIPE (6118)|     PIPE Number     =   1.00
| IN= 2---> OUT= 1 |     Diameter    (mm)=1650.00
| DT=  1.0 min     |     Length       (m)= 500.00
--------------------     Slope      (m/m)=  0.005
                         Manning n       =  0.013

     <----------------- TRAVEL TIME TABLE -------------------->
       DEPTH      VOLUME    FLOW RATE    VELOCITY    TRAV.TIME
        (m)      (cu.m.)      (cms)        (m/s)        min
       0.09     .216E+02       0.0          0.80        10.40
       0.17     .600E+02       0.1          1.25         6.67
       0.26     .108E+03       0.3          1.61         5.18
       0.35     .164E+03       0.6          1.91         4.36
       0.43     .225E+03       1.0          2.18         3.83
       0.52     .290E+03       1.4          2.41         3.46
       0.61     .358E+03       1.9          2.61         3.19
       0.69     .428E+03       2.4          2.79         2.99
       0.78     .499E+03       2.9          2.95         2.83
       0.87     .570E+03       3.5          3.08         2.70
       0.96     .642E+03       4.1          3.20         2.61
       1.04     .712E+03       4.7          3.29         2.53
       1.13     .780E+03       5.2          3.36         2.48
       1.22     .844E+03       5.8          3.41         2.44
       1.30     .905E+03       6.2          3.44         2.43
       1.39     .961E+03       6.6          3.43         2.43
       1.48     .101E+04       6.9          3.40         2.45
       1.56     .105E+04       6.9          3.31         2.52
       1.65     .107E+04       6.5          3.02         2.76
                                     <---- hydrograph ---->   <-pipe / channel->
                                AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                                (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (8118)    1.37     0.28   11.80 105.45      0.23      1.46
     OUTFLOW: ID= 1 (6118)    1.37     0.27   12.03 105.40      0.23      1.45


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 FINISH
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Appendix D

Culvert Analysis Data

Culvert Designer/Analyzer Report
C7_Exist_100Yr

Analysis Component			
Storm Event	Design	Discharge	4.4540 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.4540 m³/s	Check Discharge	10.5060 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	4.4540 m³/s	Bottom Elevation	228.90 m
Depth	0.24 m	Velocity	6.65 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1830 x 910 mm Box	4.4544 m³/s	230.46 m	2.88 m/s
Weir	Roadway	0.0000 m³/s	230.46 m	N/A
Total	----------	4.4544 m³/s	230.46 m	N/A

Culvert Designer/Analyzer Report
C7_Exist_100Yr

Component:Culvert-1

Culvert Summary

Computed Headwater Elev:	230.46 m	Discharge	4.4544 m³/s
Inlet Control HW Elev.	230.46 m	Tailwater Elevation	229.14 m
Outlet Control HW Elev.	230.41 m	Control Type	Inlet Control
Headwater Depth/Height	1.62		

Grades

Upstream Invert	228.98 m	Downstream Invert	228.90 m
Length	31.00 m	Constructed Slope	0.002581 m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile	Depth, Downstream	0.85 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.85 m
Velocity Downstream	2.88 m/s	Critical Slope	0.004196 m/m

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	230.41 m	Upstream Velocity Head	0.36 m
Ke	0.20	Entrance Loss	0.07 m

Inlet Control Properties

Inlet Control HW Elev.	230.46 m	Flow Control	Submerged
Inlet Type	90° headwall w 45° bevels	Area Full	1.7 m²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report
C7_Exist_100Yr

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m³/s	Allowable HW Elevation	230.46 m
Roadway Width	23.00 m	Overtopping Coefficient	1.60 SI
Low Point	230.76 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	229.14 m		

Sta (m)	Elev. (m)
-20.00	230.76
0.00	230.76
20.00	230.76

Culvert Designer/Analyzer Report

C7_Exist_~~100Yr~~ REG. ST.

Analysis Component			
Storm Event	Check	Discharge	10.5060 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.4540 m³/s	Check Discharge	10.5060 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.			
Discharge	10.5060 m³/s	Bottom Elevation	228.90 m
Depth	0.39 m	Velocity	8.56 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1830 x 910 mm Box	5.7179 m³/s	230.93 m	3.42 m/s
Weir	Roadway	4.7927 m³/s	230.93 m	N/A
Total	----------	10.5105 m³/s	230.93 m	N/A

Culvert Designer/Analyzer Report
C7_Exist_~~100Yr~~ REG. ST.

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	230.93 m	Discharge	5.7179 m³/s
Inlet Control HW Elev.	230.93 m	Tailwater Elevation	229.29 m
Outlet Control HW Elev.	230.83 m	Control Type	Inlet Control
Headwater Depth/Height	2.14		

Grades			
Upstream Invert	228.98 m	Downstream Invert	228.90 m
Length	31.00 m	Constructed Slope	0.002581 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	0.91 m
Slope Type	N/A	Normal Depth	N/A m
Flow Regime	N/A	Critical Depth	0.91 m
Velocity Downstream	3.42 m/s	Critical Slope	0.009632 m/m

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 910 mm	Rise	0.91 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	230.83 m	Upstream Velocity Head	0.60 m
Ke	0.20	Entrance Loss	0.12 m

Inlet Control Properties			
Inlet Control HW Elev.	230.93 m	Flow Control	Submerged
Inlet Type	90° headwall w 45° bevels	Area Full	1.7 m²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

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Culvert Designer/Analyzer Report

C7_Exist_~~100Yr~~ REG. ST

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	4.7927	m³/s	Allowable HW Elevation	230.93	m
Roadway Width	23.00	m	Overtopping Coefficient	1.66	SI
Low Point	230.76	m	Headwater Elevation	230.93	m
Discharge Coefficient (Cr)	3.01		Submergence Factor (Kt)	1.00	
Tailwater Elevation	229.29	m			

Sta (m)	Elev. (m)
-20.00	230.76
0.00	230.76
20.00	230.76

Culvert Designer/Analyzer Report
C7_Fut_100Yr

Analysis Component			
Storm Event	Design	Discharge	4.4240 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.4240 m³/s	Check Discharge	3.8320 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	4.4240 m³/s	Bottom Elevation	228.75 m
Depth	0.24 m	Velocity	6.63 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440mm x 900mm Box	4.4245 m³/s	229.97 m	2.61 m/s
Weir	Roadway	0.0000 m³/s	229.97 m	N/A
Total	----------	4.4245 m³/s	229.97 m	N/A

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Culvert Designer/Analyzer Report
C7_Fut_100Yr

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	229.97	m	Discharge	4.4245	m³/s
Inlet Control HW Elev.	229.97	m	Tailwater Elevation	228.99	m
Outlet Control HW Elev.	229.95	m	Control Type	Inlet Control	
Headwater Depth/Height	1.27				

Grades					
Upstream Invert	228.83	m	Downstream Invert	228.75	m
Length	40.00	m	Constructed Slope	0.002000	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.69	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.69	m
Velocity Downstream	2.61	m/s	Critical Slope	0.003413	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440mm x 900mm		Rise	0.90	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	229.95	m	Upstream Velocity Head	0.26	m
Ke	0.20		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	229.97	m	Flow Control	Transition	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
C7_Fut_100Yr

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.0000	m³/s	Allowable HW Elevation	229.97	m
Roadway Width	23.00	m	Overtopping Coefficient	1.60	SI
Low Point	230.76	m	Headwater Elevation	N/A	m
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	228.99	m			

Sta (m)	Elev. (m)
-20.00	230.76
0.00	230.76
20.00	230.76

Culvert Designer/Analyzer Report

C7_Fut_~~100Yr~~ REG. ST.

Analysis Component			
Storm Event	Check	Discharge	10.4350 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	4.4240 m³/s	Check Discharge	10.4350 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.			
Discharge	10.4350 m³/s	Bottom Elevation	228.75 m
Depth	0.39 m	Velocity	8.54 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2440mm x 900mm Box	7.8269 m³/s	230.88 m	3.56 m/s
Weir	Roadway	2.6024 m³/s	230.88 m	N/A
Total	----------	10.4294 m³/s	230.88 m	N/A

Culvert Designer/Analyzer Report
C7_Fut_100Yr REG. ST.

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	230.88	m	Discharge	7.8269	m³/s
Inlet Control HW Elev.	230.88	m	Tailwater Elevation	229.14	m
Outlet Control HW Elev.	230.81	m	Control Type	Inlet Control	
Headwater Depth/Height	2.27				

Grades					
Upstream Invert	228.83	m	Downstream Invert	228.75	m
Length	40.00	m	Constructed Slope	0.002000	m/m

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	0.90	m
Slope Type	N/A		Normal Depth	N/A	m
Flow Regime	N/A		Critical Depth	0.90	m
Velocity Downstream	3.56	m/s	Critical Slope	0.009462	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440mm x 900mm		Rise	0.90	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	230.81	m	Upstream Velocity Head	0.65	m
Ke	0.20		Entrance Loss	0.13	m

Inlet Control Properties					
Inlet Control HW Elev.	230.88	m	Flow Control	Submerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report

C7_Fut_~~100Yr~~ REG ST.

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	2.6024	m³/s	Allowable HW Elevation	230.88	m
Roadway Width	23.00	m	Overtopping Coefficient	1.65	SI
Low Point	230.76	m	Headwater Elevation	230.88	m
Discharge Coefficient (Cr)	2.99		Submergence Factor (Kt)	1.00	
Tailwater Elevation	229.14	m			

Sta (m)	Elev. (m)
-20.00	230.76
0.00	230.76
20.00	230.76

Culvert Designer/Analyzer Report
C15_EX

Q100

Analysis Component			
Storm Event	Design	Discharge	1.6730 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.6730 m³/s	Check Discharge	1.4320 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	1.6730 m³/s	Bottom Elevation	245.47 m
Depth	0.67 m	Velocity	1.08 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-800 mm Circular	1.5152 m³/s	248.52 m	3.17 m/s
Weir	Roadway	0.1597 m³/s	248.52 m	N/A
Total	----------	1.6749 m³/s	248.52 m	N/A

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Culvert Designer/Analyzer Report
C15_EX

Q 100

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	248.52 m	Discharge	1.5152 m³/s
Inlet Control HW Elev.	247.73 m	Tailwater Elevation	246.14 m
Outlet Control HW Elev.	248.52 m	Control Type	Outlet Control
Headwater Depth/Height	3.59		

Grades			
Upstream Invert	245.65 m	Downstream Invert	245.47 m
Length	31.27 m	Constructed Slope	0.005756 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.72 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.72 m
Velocity Downstream	3.17 m/s	Critical Slope	0.039212 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.80 m
Section Size	800 mm	Rise	0.80 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	248.52 m	Upstream Velocity Head	0.46 m
Ke	0.90	Entrance Loss	0.42 m

Inlet Control Properties			
Inlet Control HW Elev.	247.73 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Designer/Analyzer Report
C15_EX

Q100

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.1597 m³/s	Allowable HW Elevation	248.52 m
Roadway Width	8.80 m	Overtopping Coefficient	1.61 SI
Low Point	248.50 m	Headwater Elevation	248.52 m
Discharge Coefficient (Cr)	2.92	Submergence Factor (Kt)	1.00
Tailwater Elevation	246.14 m		

Sta (m)	Elev. (m)
-20.00	248.50
0.00	248.50
20.00	248.50

Culvert Designer/Analyzer Report
C15_Future

Q100

Analysis Component			
Storm Event	Design	Discharge	1.6440 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.6440 m³/s	Check Discharge	1.4050 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	1.6440 m³/s	Bottom Elevation	245.47 m
Depth	0.66 m	Velocity	1.07 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-800 mm Circular	1.3537 m³/s	248.53 m	2.91 m/s
Weir	Roadway	0.2921 m³/s	248.53 m	N/A
Total	----------	1.6458 m³/s	248.53 m	N/A

Culvert Designer/Analyzer Report
C15_Future

Q100

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	248.53 m	Discharge	1.3537 m³/s
Inlet Control HW Elev.	247.40 m	Tailwater Elevation	246.13 m
Outlet Control HW Elev.	248.53 m	Control Type	Outlet Control
Headwater Depth/Height	3.60		

Grades			
Upstream Invert	245.65 m	Downstream Invert	245.47 m
Length	44.80 m	Constructed Slope	0.004018 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.70 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.70 m
Velocity Downstream	2.91 m/s	Critical Slope	0.032542 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.80 m
Section Size	800 mm	Rise	0.80 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	248.53 m	Upstream Velocity Head	0.37 m
Ke	0.90	Entrance Loss	0.33 m

Inlet Control Properties			
Inlet Control HW Elev.	247.40 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
C15_Future

Q100

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.2921	m³/s	Allowable HW Elevation	248.53	m
Roadway Width	8.80	m	Overtopping Coefficient	1.62	SI
Low Point	248.50	m	Headwater Elevation	248.53	m
Discharge Coefficient (Cr)	2.93		Submergence Factor (Kt)	1.00	
Tailwater Elevation	246.13	m			

Sta (m)	Elev. (m)
-20.00	248.50
0.00	248.50
20.00	248.50

Culvert Designer/Analyzer Report
C15_Future Proposed Option 2 (Storm Sewers)

1000 Ø CONC

Q100

Analysis Component			
Storm Event	Design	Discharge	1.7440 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.7440 m³/s	Check Discharge	1.4950 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	1.7440 m³/s	Bottom Elevation	245.47 m
Depth	0.68 m	Velocity	1.09 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1000mm Circular	1.7438 m³/s	246.89 m	2.72 m/s
Weir	Roadway	0.0000 m³/s	246.89 m	N/A
Total	----------	1.7438 m³/s	246.89 m	N/A

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Culvert Designer/Analyzer Report
C15_Future Proposed Option 2 (Storm Sewers)

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev:	246.89 m	Discharge	1.7438 m³/s
Inlet Control HW Elev.	246.87 m	Tailwater Elevation	246.15 m
Outlet Control HW Elev.	246.89 m	Control Type	Outlet Control
Headwater Depth/Height	1.24		

Grades			
Upstream Invert	245.65 m	Downstream Invert	245.47 m
Length	44.80 m	Constructed Slope	0.004018 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.76 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.76 m
Velocity Downstream	2.72 m/s	Critical Slope	0.006143 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.00 m
Section Size	1000mm	Rise	1.00 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	246.89 m	Upstream Velocity Head	0.28 m
Ke	0.20	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	246.87 m	Flow Control	Submerged
Inlet Type	Beveled ring, 33.7° bevels	Area Full	0.8 m²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

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Culvert Designer/Analyzer Report
C15_Future Proposed Option 2 (Storm Sewers)

Component:Weir

Hydraulic Component(s): Roadway

Discharge	0.0000 m³/s	Allowable HW Elevation	246.89 m
Roadway Width	8.80 m	Overtopping Coefficient	1.60 SI
Low Point	248.50 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	246.15 m		

Sta (m)	Elev. (m)
-20.00	248.50
0.00	248.50
20.00	248.50

Culvert Designer/Analyzer Report
C19_Existing

Q100

Analysis Component			
Storm Event	Design	Discharge	7.9360 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	7.9360 m³/s	Check Discharge	6.7940 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	7.9360 m³/s	Bottom Elevation	239.23 m
Depth	1.16 m	Velocity	1.59 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2490 x 1750 mm Arch	7.9368 m³/s	241.85 m	3.04 m/s
Weir	Roadway	0.0000 m³/s	241.85 m	N/A
Total	----------	7.9368 m³/s	241.85 m	N/A

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Culvert Designer/Analyzer Report
C19_Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev.	241.85 m	Discharge	7.9368 m³/s
Inlet Control HW Elev.	241.72 m	Tailwater Elevation	240.39 m
Outlet Control HW Elev.	241.85 m	Control Type	Outlet Control
Headwater Depth/Height	1.15		

Grades			
Upstream Invert	239.83 m	Downstream Invert	239.23 m
Length	34.40 m	Constructed Slope	0.017442 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.16 m
Slope Type	Mild	Normal Depth	1.29 m
Flow Regime	Subcritical	Critical Depth	1.07 m
Velocity Downstream	3.04 m/s	Critical Slope	0.026648 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.035
Section Material	Steel structural plate 18 In CR	Span	2.48 m
Section Size	2490 x 1750 mm	Rise	1.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	241.85 m	Upstream Velocity Head	0.39 m
Ke	0.90	Entrance Loss	0.35 m

Inlet Control Properties			
Inlet Control HW Elev.	241.72 m	Flow Control	Unsubmerged
Inlet Type	18 In CR structural plate, projecting	Area Full	3.5 m²
K	0.03000	HDS 5 Chart	35
M	1.50000	HDS 5 Scale	1
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report
C19_Existing

Component:Weir

Hydraulic Component(s): Roadway

Discharge	0.0000 m³/s	Allowable HW Elevation	241.85 m
Roadway Width	8.80 m	Overtopping Coefficient	1.60 SI
Low Point	242.00 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	240.39 m		

Sta (m)	Elev. (m)
-20.00	242.00
0.00	242.00
20.00	242.00

Culvert Designer/Analyzer Report
C19_Future

Q100

Analysis Component			
Storm Event	Design	Discharge	7.9060 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	7.9060 m³/s	Check Discharge	11.4500 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	7.9060 m³/s	Bottom Elevation	239.23 m
Depth	1.16 m	Velocity	1.59 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-2490 x 1750 mm Arch	7.9052 m³/s	241.86 m	3.03 m/s
Weir	Roadway	0.0000 m³/s	241.86 m	N/A
Total	----------	7.9052 m³/s	241.86 m	N/A

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Culvert Designer/Analyzer Report
C19_Future

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	241.86 m	Discharge	7.9052 m³/s
Inlet Control HW Elev.	241.71 m	Tailwater Elevation	240.39 m
Outlet Control HW Elev.	241.86 m	Control Type	Outlet Control
Headwater Depth/Height	1.15		

Grades			
Upstream Invert	239.83 m	Downstream Invert	239.23 m
Length	42.00 m	Constructed Slope	0.014286 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.16 m
Slope Type	Mild	Normal Depth	1.45 m
Flow Regime	Subcritical	Critical Depth	1.07 m
Velocity Downstream	3.03 m/s	Critical Slope	0.026591 m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.035
Section Material	Steel structural plate 18 In CR	Span	2.48 m
Section Size	2490 x 1750 mm	Rise	1.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	241.86 m	Upstream Velocity Head	0.34 m
Ke	0.90	Entrance Loss	0.30 m

Inlet Control Properties			
Inlet Control HW Elev.	241.71 m	Flow Control	Unsubmerged
Inlet Type	18 In CR structural plate, projecting	Area Full	3.5 m²
K	0.03000	HDS 5 Chart	35
M	1.50000	HDS 5 Scale	1
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Designer/Analyzer Report
C19_Future

Component:Weir

Hydraulic Component(s): Roadway

Discharge	0.0000 m³/s	Allowable HW Elevation	241.86 m
Roadway Width	8.80 m	Overtopping Coefficient	1.60 SI
Low Point	242.00 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	240.39 m		

Sta (m)	Elev. (m)
-20.00	242.00
0.00	242.00
20.00	242.00

Culvert Designer/Analyzer Report
C19_Future Proposed

3660 X 1220 CONC. BOX Q100

Analysis Component			
Storm Event	Design	Discharge	7.9240 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	7.9240 m³/s	Check Discharge	6.7240 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	7.9240 m³/s	Bottom Elevation	239.23 m
Depth	1.16 m	Velocity	1.59 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-1830 x 1220 mm Box	7.9226 m³/s	241.13 m	4.11 m/s
Weir	Roadway	0.0000 m³/s	241.13 m	N/A
Total	----------	7.9226 m³/s	241.13 m	N/A

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Culvert Designer/Analyzer Report
C19_Future Proposed

Component:Culvert-1

Culvert Summary

Computed Headwater Elev	241.13 m	Discharge	7.9226 m³/s
Inlet Control HW Elev.	241.13 m	Tailwater Elevation	240.39 m
Outlet Control HW Elev.	241.10 m	Control Type	Inlet Control
Headwater Depth/Height	1.05		

Grades

Upstream Invert	239.85 m	Downstream Invert	239.23 m
Length	42.00 m	Constructed Slope	0.014762 m/m

Hydraulic Profile

Profile	CompositeS1S2	Depth, Downstream	0.53 m
Slope Type	Steep	Normal Depth	0.49 m
Flow Regime	N/A	Critical Depth	0.78 m
Velocity Downstream	4.11 m/s	Critical Slope	0.004101 m/m

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.83 m
Section Size	1830 x 1220 mm	Rise	1.22 m
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	241.10 m	Upstream Velocity Head	0.39 m
Ke	0.20	Entrance Loss	0.08 m

Inlet Control Properties

Inlet Control HW Elev.	241.13 m	Flow Control	Unsubmerged
Inlet Type	headwall w 3/4 inch chamfers	Area Full	4.5 m²
K	0.51500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	1
C	0.03750	Equation Form	2
Y	0.79000		

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Culvert Designer/Analyzer Report
C19_Future Proposed

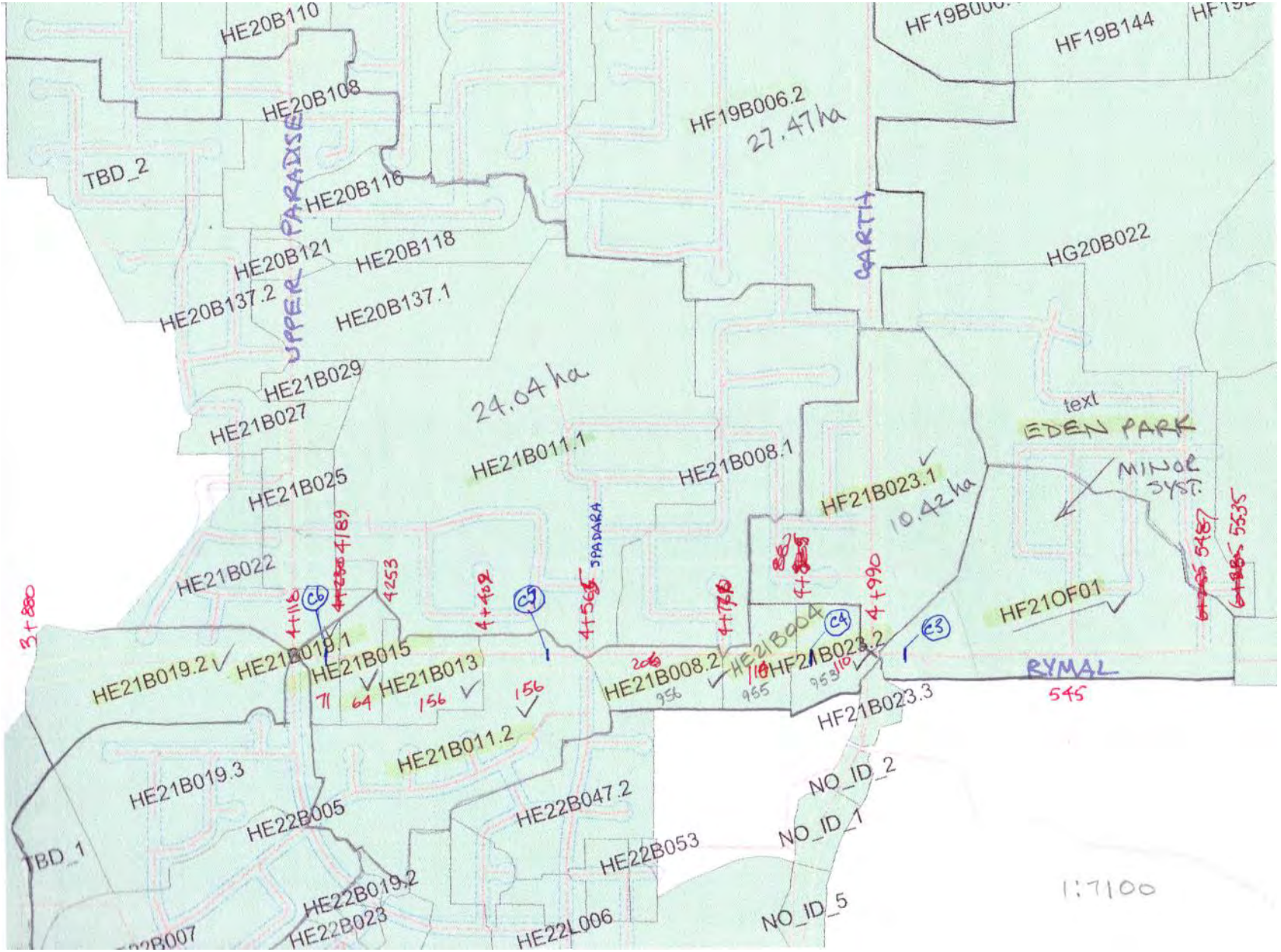
Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.0000 m³/s	Allowable HW Elevation	241.13 m
Roadway Width	8.80 m	Overtopping Coefficient	1.60 SI
Low Point	242.00 m	Headwater Elevation	N/A m
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	240.39 m		

Sta (m)	Elev. (m)
-20.00	242.00
0.00	242.00
20.00	242.00

Appendix E

St. Elizabeth Pond C Analysis Data


HE20B110
HE20B108
HE20B116
HE20B121
HE20B118
HE20B137.2
HE20B137.1
TBD_2
UPPER PARADISE
HF19B006.2
27.47ha
HF19B144
CARTIA
HG20B022
HE21B029
HE21B027
24.04ha
HE21B011.1
HE21B008.1
HE21B025
HF21B023.1
10.42ha
text
EDEN PARK
MINOR SYST.
HE21B022
SPADARA
HF21OF01
HE21B019.2
HE21B019.1
HE21B015
HE21B013
HE21B008.2
HE21B004
HF21B023.2
BYMAL
HF21B023.3
HE21B011.2
HE21B019.3
HE22B005
HE22B047.2
NO_ID_2
NO_ID_1
TBD_1
HE22B053
HE22B019.2
HE22B023
HE22L006
NO_ID_5
1:7100

St. Eliz. Ponds


```
2   Metric Units
*****************************************************************
*
*   ST. Elizabeth Village   - City of Hamilton
*   PN  60287071
*
*   Modeler:  B. Richert, AECOM
*   July 2013
*****************************************************************
*
START                 TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[5]
                      H5_12.stm
*%-----------------|-------------------------------------------------------|
READ STORM            "STORM.001"
*%-----------------|-------------------------------------------------------|
*
*********************************
*   Catchment to St. Elizabeth Pond C
*********************************
CALIB STANDHYD        ID=  3      NHYD= "B116"  DT=  5     AREA=  4.28
                      XIMP=0.30   TIMP= 0.38    DWF= 0     LOSS=  2
                      CN=  50
                      DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                      DPSI=2      SLPI= 0.5     LGI= 170   MNI=   0.013 SCP= 0
                      -1
CALIB STANDHYD        ID=  1      NHYD= "B118"  DT=  5     AREA=  2.20
                      XIMP=0.43   TIMP= 0.54    DWF= 0     LOSS=  2
                      CN=  50
                      DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                      DPSI=2      SLPI= 0.5     LGI= 120   MNI=   0.013 SCP= 0
                      -1
*%-----------------|-------------------------------------------------------
ADD HYD               Idsum2      NYD=  "101"   IDS to add1 + 3
*%-----------------|-------------------------------------------------------|
CALIB STANDHYD        ID=  1      NHYD= "B121"  DT=  5     AREA=  0.58
                      XIMP=0.43   TIMP= 0.54    DWF= 0     LOSS=  2
                      CN=  50
                      DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                      DPSI=2      SLPI= 0.5     LGI= 60    MNI=   0.013 SCP= 0
                      -1
*%-----------------|-------------------------------------------------------
ADD HYD               Idsum3      NYD=  "101"   IDS to add1 + 2
*%-----------------|-------------------------------------------------------|
CALIB STANDHYD        ID=  4      NHYD= "TBD_2" DT=  5     AREA=  7.65
                      XIMP=0.30   TIMP= 0.38    DWF= 0     LOSS=  2
                      CN=  50
                      DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                      DPSI=2      SLPI= 0.5     LGI= 230   MNI=   0.013 SCP= 0
                      -1
CALIB STANDHYD        ID=  5      NHYD= "B137.2"DT=  5     AREA=  3.37
                      XIMP=0.25   TIMP= 0.31    DWF= 0     LOSS=  2
                      CN=  50
                      DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                      DPSI=2      SLPI= 0.5     LGI= 150   MNI=   0.013 SCP= 0
                      -1
CALIB STANDHYD        ID=  1      NHYD= "B137.1"DT=  5     AREA=  5.08
                      XIMP=0.43   TIMP= 0.54    DWF= 0     LOSS=  2
                      CN=  50
                      DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                      DPSI=2      SLPI= 0.5     LGI= 180   MNI=   0.013 SCP= 0
                      -1
*%-----------------|-------------------------------------------------------
ADD HYD               Idsum2      NYD=  "101"   IDS to add1 + 3 + 4 + 5
*%-----------------|-------------------------------------------------------|
```

```
ROUTE CHANNEL          IDOUT4      NHYD= 101      IDIN=2
                       RDT= 2
                       CHLGTH=     600      CHSLOPE=    0.2
                       FPSLOPE=    0.2
                       SECNUM=     100    NSEG=         3
                       N     DIST
                       0.05 5
                       0.02 15
                       0.05 20
                       DISTANCE (m), ELEVATION (m)
                       0     11
                       0.1   10
                       5     9.9
                       5.1   9.75
                       9.4   9.83
                       9.5   8.83
                       10.5 8.83
                       10.6 9.83
                       14.9 9.75
                       15    9.9
                       19.9 10
                       20    11
*%-----------------|-------------------------------------------------------------|
DESIGN NASHYD          ID=  1      NHYD= "B029"  DT=  5     AREA=  0.83
                       DWF= 0.00   CN=   50      TP=  0.5
                       END  -1
*
*
*
*%-----------------|-------------------------------------------------------------
ADD HYD                Idsum8      NYD=  "101"   IDS to add1 + 4
*%-----------------|-------------------------------------------------------------|
*
*  Minor flows to stm sewer, major flows to William Schewenger Park dry pond
*
COMPUTE DUALHYD        IDin=8      CINLET1.31     NINLET=    1
                       MAJID7      MajNHYD=       "maj"
                       MINID3      MinNHYD=       "min"
                       TMJSTO=[0](cu-m)
*
* William Schwenger Park dry pond
ROUTE RESERVOIR        ID=  9      NHYD= 101      IDIN=7     DT=     1
                       DISCH (cms)STORAGE (ha m)
                       0           0
                       0.1         0.001
                       0.2         0.022
                       0.3         0.073
                       0.49        0.161
                       0.62        0.291
                       0.72        0.468
                       0.85        0.803
                       1.4         2.14
*
CALIB STANDHYD         ID=  1      NHYD= "B027"  DT=  5     AREA=  1.93
                       XIMP=0.12   TIMP= 0.15    DWF= 0     LOSS=  2
                       CN=  62
                       DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                       DPSI=2      SLPI= 0.5     LGI= 110   MNI=   0.013 SCP= 0
                       -1
*%-----------------|-------------------------------------------------------------
ADD HYD                Idsum2      NYD=  "101"   IDS to add1 + 3
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD         ID=  1      NHYD= "B025"  DT=  5     AREA=  1.35
                       XIMP=0.30   TIMP= 0.38    DWF= 0     LOSS=  2
```

Save 9

```
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 90    MNI=    0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum3      NYD=  "101"    IDS to add1 + 2
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  1      NHYD= "B023"   DT=  5     AREA=  1.19
                    XIMP=0.30   TIMP= 0.38     DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 90    MNI=    0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum2      NYD=  "101"    IDS to add1 + 3
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  1      NHYD= "B022"   DT=  5     AREA=  4.05
                    XIMP=0.55   TIMP= 0.69     DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 160   MNI=    0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum3      NYD=  "101"    IDS to add1 + 2
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  4      NHYD= "TBD_1"  DT=  5     AREA=  1.99
                    XIMP=0.28   TIMP= 0.35     DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 120   MNI=    0.013 SCP= 0
                    -1
CALIB STANDHYD      ID=  5      NHYD= "B019.3" DT=  5     AREA=  7.28
                    XIMP=0.37   TIMP= 0.46     DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 220   MNI=    0.013 SCP= 0
                    -1
CALIB STANDHYD      ID=  6      NHYD= "B019.2" DT=  5     AREA=  5.60
RYMAL (WEST)        XIMP=0.16   TIMP= 0.20     DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 190   MNI=    0.013 SCP= 0
                    -1
CALIB STANDHYD      ID=  1      NHYD= "B019.1" DT=  5     AREA=  0.10  0.71
RYMAL (WEST)        XIMP=0.79   TIMP= 0.99     DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5      LGP= 50    MNP=    0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 30    MNI=    0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum2      NYD=  "101"    IDS to add1 + 3 + 4 + 5 + 6
*%-----------------|-------------------------------------------------------------|
ROUTE CHANNEL       IDOUT4      NHYD= 101      IDIN=2
                    RDT= 2
                    CHLGTH=     600      CHSLOPE=    0.2
                    FPSLOPE=    0.2
                    SECNUM=     100    NSEG=         3
                    N    DIST
                    0.05 5
                    0.02 15
                    0.05 20
                    DISTANCE (m), ELEVATION (m)
                    0    11
                    0.1  10
```

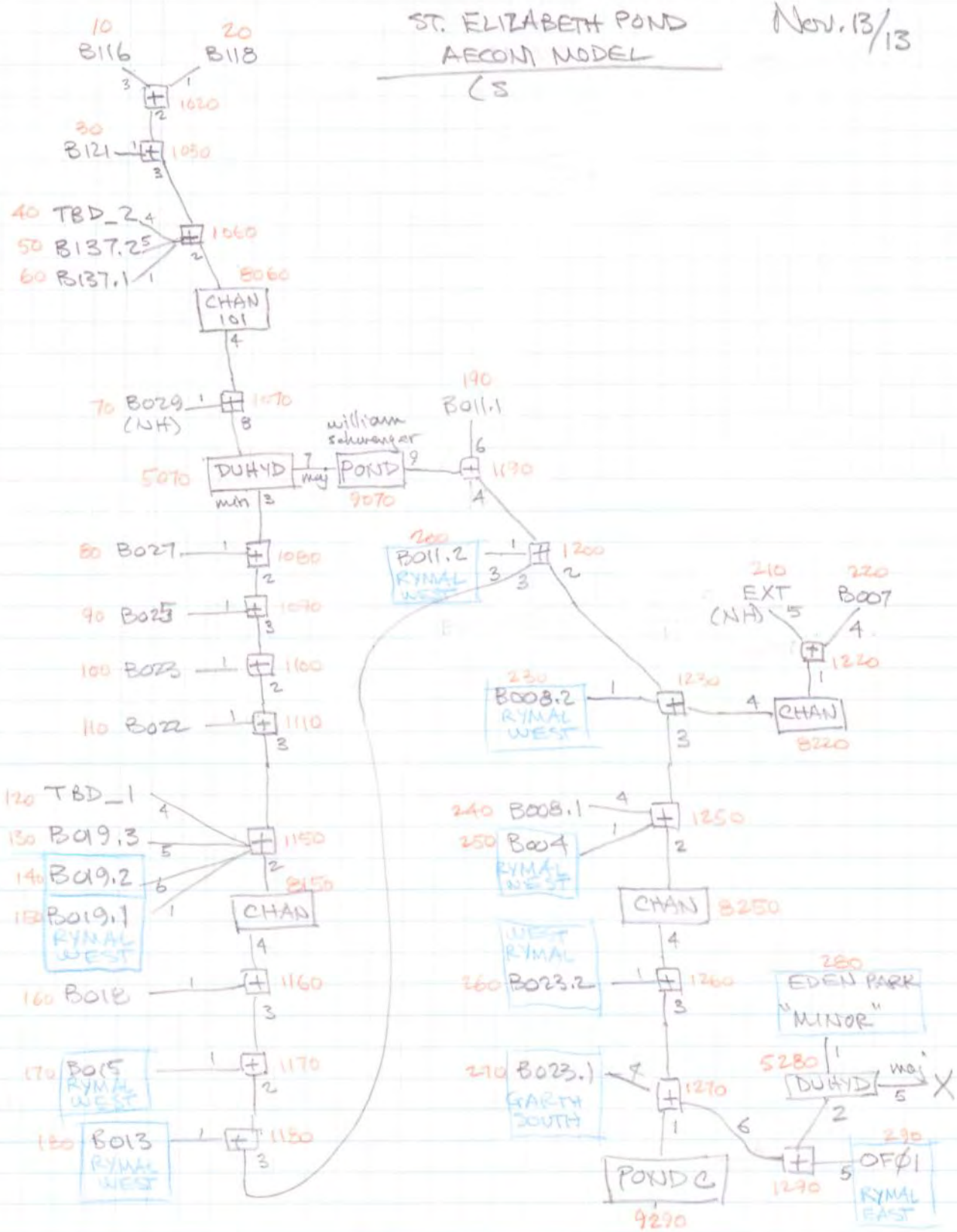
```
                    5     9.9
                    5.1   9.75
                    9.4   9.83
                    9.5   8.83
                    10.5  8.83
                    10.6  9.83
                    14.9  9.75
                    15    9.9
                    19.9  10
                    20    11
CALIB STANDHYD      ID=  1      NHYD= "B018"  DT=  5     AREA=  0.69
                    XIMP=0.46   TIMP= 0.57    DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 70    MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum3      NYD=  "101"   IDS to add1 + 4
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  1      NHYD= "B015"  DT=  5     AREA=  1.18
RYMAL (WEST)        XIMP=0.46   TIMP= 0.57    DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 90    MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum2      NYD=  "101"   IDS to add1 + 3
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  1      NHYD= "B013"  DT=  5     AREA=  1.91
RYMAL (WEST)        XIMP=0.30   TIMP= 0.38    DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 110   MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum3      NYD=  "101"   IDS to add1 + 2
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  6      NHYD= "B011.1"DT=  5     AREA=  24.04
                    XIMP=0.12   TIMP= 0.15    DWF= 0     LOSS=  2
                    CN=  60
                    DPSP=5      SLPP= 1.5     LGP= 100   MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 400   MNI=   0.013 SCP= 0
                    -1
*  add outflow from William Schwenger Park dry pond
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum4      NYD=  "101"   IDS to add6 + 9
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  1      NHYD= "B011.2"DT=  5     AREA=  7.80
RYMAL (WEST)        XIMP=0.12   TIMP= 0.15    DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 230   MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum2      NYD=  "101"   IDS to add1 + 3 + 4
*%-----------------|-------------------------------------------------------------|
DESIGN NASHYD       ID=  5      NHYD= "Ext"   DT=  5     AREA=  29.20
                    DWF= 0.00   CN=   82      TP=  1.00
                    END  -1
*
CALIB STANDHYD      ID=  4      NHYD= "B007"  DT=  5     AREA=  10.76
                    XIMP=0.30   TIMP= 0.38    DWF= 0     LOSS=  2
                    CN=  66
                    DPSP=5      SLPP= 1.5     LGP= 100   MNP=   0.25  SCP= 0
```

```
                    DPSI=2      SLPI= 0.5      LGI= 270  MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum1      NYD=  "101"    IDS to add4 + 5
*%-----------------|-------------------------------------------------------------|
ROUTE CHANNEL       IDOUT4      NHYD= 101      IDIN=1
                    RDT= 2
                    CHLGTH=     600      CHSLOPE=   0.2
                    FPSLOPE=    0.2
                    SECNUM=     100    NSEG=        3
                    N    DIST
                    0.05 5
                    0.02 15
                    0.05 20
                    DISTANCE (m), ELEVATION (m)
                    0    11
                    0.1  10
                    5    9.9
                    5.1  9.75
                    9.4  9.83
                    9.5  8.83
                    10.5 8.83
                    10.6 9.83
                    14.9 9.75
                    15   9.9
                    19.9 10
                    20   11
CALIB STANDHYD      ID=  1      NHYD= "B008.2"DT=  5     AREA=  1.76
R-MAL (WEST)        XIMP=0.30   TIMP= 0.38 ✓  DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5      LGP= 50   MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 110  MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum3      NYD=  "101"    IDS to add1 + 2 + 4
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  4      NHYD= "B008.1"DT=  5     AREA=  9.82
                    XIMP=0.25   TIMP= 0.31 ✓  DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 100  MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 260  MNI=   0.013 SCP= 0
                    -1
CALIB STANDHYD      ID=  1      NHYD= "B004"   DT=  5     AREA=  1.43
R-MAL (WEST)        XIMP=0.52   TIMP= 0.65 ✓  DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5      LGP= 50   MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5      LGI= 100  MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum2      NYD=  "101"    IDS to add1 + 3 + 4
*%-----------------|-------------------------------------------------------------|
ROUTE CHANNEL       IDOUT4      NHYD= 101      IDIN=2
                    RDT= 2
                    CHLGTH=     400      CHSLOPE=   0.2
                    FPSLOPE=    0.2
                    SECNUM=     100    NSEG=        3
                    N    DIST
                    0.05 5
                    0.02 15
                    0.05 20
                    DISTANCE (m), ELEVATION (m)
                    0    11
                    0.1  10
                    5    9.9
```

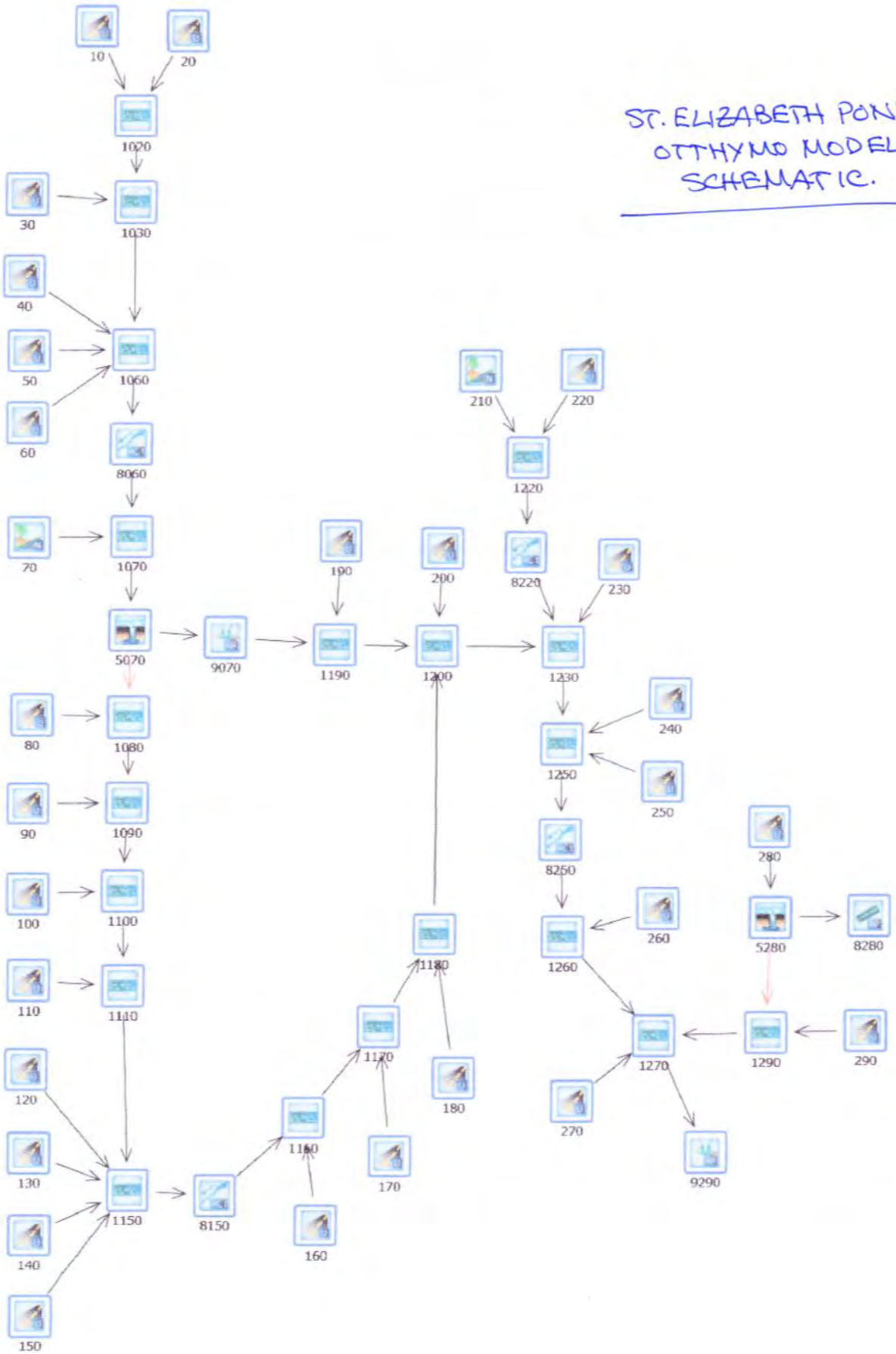
```
                    5.1  9.75
                    9.4  9.83
                    9.5  8.83
                    10.5 8.83
                    10.6 9.83
                    14.9 9.75
                    15   9.9
                    19.9 10
                    20   11
CALIB STANDHYD      ID=  1      NHYD= "B023.2"DT=  5     AREA=  1.51
  RYMAL - (WEST)    XIMP=0.59   TIMP= 0.74   DWF= 0     LOSS=  2
                    CN=  62
                    DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 100   MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum3      NYD=  "101"   IDS to add1 + 4
*%-----------------|-------------------------------------------------------------|
CALIB STANDHYD      ID=  4      NHYD= "B023.1"DT=  5     AREA=  10.42
  GARTH (SOUTH)     XIMP=0.40   TIMP= 0.50   DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 100   MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 260   MNI=   0.013 SCP= 0
                    -1
CALIB STANDHYD      ID=  1      NHYD= "Minor" DT=  5     AREA=  11.60
  EDEN PARK- PART   XIMP=0.32   TIMP= 0.40    DWF= 0     LOSS=  2
  MINOR SYSTEM      CN=  76
  TO POND C         DPSP=5      SLPP= 1.5     LGP= 100   MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 280   MNI=   0.013 SCP= 0
                    -1
*  Minor system to St. Elizabeth,  Major system to different watershed
COMPUTE DUALHYD     IDin=1      CINLET1.13    NINLET=    1
                    MAJID5      MajNHYD=      "maj"
                    MINID2      MinNHYD=      "min"
                    TMJSTO=[0](cu-m)
CALIB STANDHYD      ID=  5      NHYD= "OF01"  DT=  5     AREA=  11.24
  RYMAL (EAST)      XIMP=0.43   TIMP= 0.54   DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 100   MNP=   0.25  SCP= 0
                    DPSI=2      SLPI= 0.5     LGI= 270   MNI=   0.013 SCP= 0
                    -1
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum6      NYD=  "101"   IDS to add2 + 5
*%-----------------|-------------------------------------------------------------|
*%-----------------|-------------------------------------------------------------
ADD HYD             Idsum1      NYD=  "101"   IDS to add3 + 4 + 6
*%-----------------|-------------------------------------------------------------|
* Total flow to Pond C
ROUTE RESERVOIR     ID=  8      NHYD= 101     IDIN=1     DT=          1
                    DISCH (cms)STORAGE (ha m)
                    0           0
                    4.416       0.2928
                    6.895       0.7061
                    13.36       0.8053
                    24.86       0.9045
                    END -1
*
*********************************
*   Catchment to St. Elizabeth Pond A
*********************************
CALIB STANDHYD      ID=  4      NHYD= "B046.1"DT=  5     AREA=  0.51
                    XIMP=0.248  TIMP= 0.31    DWF= 0     LOSS=  2
                    CN=  76
                    DPSP=5      SLPP= 1.5     LGP= 50    MNP=   0.25  SCP= 0
```

ST. ELIZABETH POND
AECOM MODEL
CS

Nov. 13/13



ST. ELIZABETH POND 'C'
OTTHYMO MODEL
SCHEMATIC.



ST. ELIZABETH POND 'C'
FUTURE IMPERVIOUS AREAS

	AREA (ha)	TIMP Ratio	XIMP Ratio	ROAD L (m)	EXIST RD TIMP (ha)	EXIST RD XIMP (ha)	FUT. RD XIMP & TIMP (ha) (pavement sidewalk)	FUT TIMP Ratio	FUT XIMP. Ratio
B019.2	5.60	0.20	0.16	238	0.369	0.315	0.615		
140 IMP. A =		1.12	0.896					0.24	0.21
B019.1	~~0.10~~ 0.71	~~0.99~~ 0.39	~~0.79~~ 0.22	71	0.123	0.116	0.181		
150 IMP. A =		0.277	0.156					0.47	0.31
B015	1.18	0.57	0.46	64	0.098	0.091	0.163		
170 IMP. A =		0.67	0.54					0.62	0.52
B013	1.91	0.38	0.30	156	0.213	0.164	0.398		
180 IMP A =		0.725	0.357					0.48	0.31
B011.2	7.80	0.15	0.12	156	0.204	0.168	0.398		
200 IMP A =		1.17	0.936					0.17	0.15
B008.2	1.76	0.38	0.30	200	0.258	0.212	0.510		
230 IMP. A =		0.668	0.528					0.52	0.47
B004	1.43	0.65	0.52	110	0.116	0.108	0.281		
250 IMP A =		0.93	0.744					0.77	0.64
B023.2	1.51	0.74	0.59	110	0.180	0.150	0.33		
260 IMP. A =		1.12	0.89					0.84	0.71
OF01	11.24	0.54	0.48	545	0.563	0.498	1.554		
290		6.06	4.83					0.63	0.52
B023.1 (GARTH)	10.42	0.50	0.40	485	0.527	0.463	1.212		
270		5.21	4.16					0.57	0.47
	38.52 ha				Tot. Add Imp. A		2.285 5.634 Δ = 3.35 ha		

For R.O.W.
ASSUME: Existing XIMP = Road area + connected driveways
TIMP = XIMP + Sidewalks
Future XIMP = Road area + sidewalks
TIMP = XIMP

Total Future XIMP = Ex. XIMP − Ex. RD XIMP + Fut. Rd. XIMP
TIMP = Ex. TIMP − Ex. RD. TIMP + Fut. RD TIMP.

Total Area = 170.26 ha
Inc XIMP = 3.35 ha → 2.0 %

ST. ELIZABETH POND C
EXISTING

```
****************************
** SIMULATION NUMBER:   1 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)    171.450     5.161     12.00      24.92
     OUTFLOW: ID= 1 (9290)    171.450     4.235     12.25      24.91

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 82.04
                   TIME SHIFT OF PEAK FLOW         (min)= 15.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2808

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****************************
** SIMULATION NUMBER:   2 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)    171.450     8.596     12.01      39.09
     OUTFLOW: ID= 1 (9290)    171.450     6.304     12.43      39.08

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 73.34
                   TIME SHIFT OF PEAK FLOW         (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.6077

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------
****************************
** SIMULATION NUMBER:   3 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
```

```
                                (ha)      (cms)      (hrs)        (mm)
     INFLOW : ID= 2 (1270)    171.368     11.362      12.01       48.98
     OUTFLOW: ID= 1 (9290)    171.368      9.354      12.24       48.97

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 82.32
                    TIME SHIFT OF PEAK FLOW         (min)= 13.33
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.7438

-----------------------------------------------------------------------------
------
****************************
** SIMULATION NUMBER:   4 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK        R.V.
                                 (ha)     (cms)     (hrs)        (mm)
     INFLOW : ID= 2 (1270)    170.939     14.702      12.01       62.28
     OUTFLOW: ID= 1 (9290)    170.939     13.303      12.14       62.27

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 90.48
                    TIME SHIFT OF PEAK FLOW         (min)=  7.50
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.8045

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****************************
** SIMULATION NUMBER:   5 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK        R.V.
                                 (ha)     (cms)     (hrs)        (mm)
     INFLOW : ID= 2 (1270)    170.583     17.137      12.01       71.60
     OUTFLOW: ID= 1 (9290)    170.583     16.367      12.07       71.58

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 95.51
                    TIME SHIFT OF PEAK FLOW         (min)=  3.33
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.8314

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****************************
** SIMULATION NUMBER:   6 **
****************************
```

```
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   | 13.3600      0.8053
                          4.4160     0.2928   | 24.8600      0.9045
                          6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)     170.259    19.552     12.01      81.16
     OUTFLOW: ID= 1 (9290)     170.259    19.070     12.06      81.15

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 97.53
                   TIME SHIFT OF PEAK FLOW         (min)=  2.50
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.8546

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ST. ELIZABETH POND C
FUTURE

```
****************************
** SIMULATION NUMBER:   1 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)     171.450     5.567     12.00      25.58
     OUTFLOW: ID= 1 (9290)     171.450     4.430     12.22      25.58

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 79.56
                    TIME SHIFT OF PEAK FLOW         (min)= 13.33
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.2951

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------
****************************
** SIMULATION NUMBER:   2 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)     171.450     9.124     12.00      39.90
     OUTFLOW: ID= 1 (9290)     171.450     6.429     12.40      39.89

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 70.46
                    TIME SHIFT OF PEAK FLOW         (min)= 24.17
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.6285

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------
****************************
** SIMULATION NUMBER:   3 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
```

```
                                (ha)      (cms)      (hrs)        (mm)
     INFLOW : ID= 2 (1270)    171.368     11.931     12.00       49.86
     OUTFLOW: ID= 1 (9290)    171.368      9.645     12.21       49.85

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 80.84
                    TIME SHIFT OF PEAK FLOW         (min)= 12.50
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.7484

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****************************
** SIMULATION NUMBER:   4 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)    170.939     15.283     12.01       63.26
     OUTFLOW: ID= 1 (9290)    170.939     13.797     12.10       63.25

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 90.27
                    TIME SHIFT OF PEAK FLOW         (min)=  5.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.8092

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****************************
** SIMULATION NUMBER:   5 **
****************************
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   | 13.3600      0.8053
                           4.4160     0.2928   | 24.8600      0.9045
                           6.8950     0.7061   |  0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)    170.583     17.753     12.01       72.63
     OUTFLOW: ID= 1 (9290)    170.583     16.981     12.06       72.62

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 95.65
                    TIME SHIFT OF PEAK FLOW         (min)=  2.50
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.8367

-----------------------------------------------------------------------------
------
****************************
** SIMULATION NUMBER:   6 **
****************************
```

```
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |      OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------       (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   |  13.3600      0.8053
                           4.4160     0.2928   |  24.8600      0.9045
                           6.8950     0.7061   |   0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)    170.259     20.222     12.00      82.25
     OUTFLOW: ID= 1 (9290)    170.259     19.713     12.04      82.24

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 97.48
                    TIME SHIFT OF PEAK FLOW         (min)=  2.50
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.8602

-----------------------------------------------------------------------
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```

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================================================================================
======================

       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    Company
        OOO     T      T    H   H    Y    M   M   OOO                 Serial

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                    *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual Otthymo 2.4\VO2\voin.dat
  Output  filename: C:\Users\Bill\AppData\Local\Temp\320ed92c-a0e9-4f82-9493-
585649b084a1\Scenario.out
  Summary filename: C:\Users\Bill\AppData\Local\Temp\320ed92c-a0e9-4f82-9493-
585649b084a1\Scenario.sum


DATE: 11/20/2013                          TIME: 09:20:05

  ****************************
  ** SIMULATION NUMBER:   6 **   100-yr Future
  ****************************

--------------------
| MASS STORM       |    Filename: C:\Users\Bill\AppD
|                  |              ata\Local\Temp\
|                  |              320ed92c-a0e9-4f82-9493-585649b084a1\b4dbaf59
| Ptotal=126.49 mm |    Comments: 24hr SCS Mass Storm
--------------------
                        Duration of storm    = 24.00 hrs
                        Mass curve time step = 15.00 min

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.25    1.39 |  6.25    2.53 | 12.25   18.21 | 18.25    2.28
                0.50    1.39 |  6.50    2.53 | 12.50   18.21 | 18.50    2.28
                0.75    1.39 |  6.75    2.53 | 12.75    9.36 | 18.75    2.28
                1.00    1.39 |  7.00    2.53 | 13.00    9.36 | 19.00    2.28
                1.25    1.39 |  7.25    2.53 | 13.25    6.07 | 19.25    2.28
                1.50    1.39 |  7.50    2.53 | 13.50    6.07 | 19.50    2.28
                1.75    1.39 |  7.75    2.53 | 13.75    6.07 | 19.75    2.28
                2.00    1.39 |  8.00    2.53 | 14.00    6.07 | 20.00    2.28
                2.25    1.64 |  8.25    3.42 | 14.25    3.79 | 20.25    1.52
                2.50    1.64 |  8.50    3.42 | 14.50    3.79 | 20.50    1.52
                2.75    1.64 |  8.75    3.42 | 14.75    3.79 | 20.75    1.52
                3.00    1.64 |  9.00    3.42 | 15.00    3.79 | 21.00    1.52
                3.25    1.64 |  9.25    4.05 | 15.25    3.79 | 21.25    1.52
                3.50    1.64 |  9.50    4.05 | 15.50    3.79 | 21.50    1.52
                3.75    1.64 |  9.75    4.55 | 15.75    3.79 | 21.75    1.52
                4.00    1.64 | 10.00    4.55 | 16.00    3.79 | 22.00    1.52
                4.25    2.02 | 10.25    5.82 | 16.25    2.28 | 22.25    1.52
                4.50    2.02 | 10.50    5.82 | 16.50    2.28 | 22.50    1.52
                4.75    2.02 | 10.75    7.84 | 16.75    2.28 | 22.75    1.52
                5.00    2.02 | 11.00    7.84 | 17.00    2.28 | 23.00    1.52
                5.25    2.02 | 11.25   12.14 | 17.25    2.28 | 23.25    1.52
                5.50    2.02 | 11.50   12.14 | 17.50    2.28 | 23.50    1.52
                5.75    2.02 | 11.75   52.62 | 17.75    2.28 | 23.75    1.52
                6.00    2.02 | 12.00  139.64 | 18.00    2.28 | 24.00    1.52

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0280) |   Area    (ha)=  11.60
|ID= 1 DT= 5.0 min |   Total Imp(%)=  40.00   Dir. Conn.(%)=  32.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       4.64          6.96
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       0.50          1.50
     Length            (m)=     280.00        100.00
     Mannings n           =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                          ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083   1.39 | 6.083    2.53 |12.083   18.23 | 18.08    2.28
                0.167   1.39 | 6.167    2.53 |12.167   18.21 | 18.17    2.28
                0.250   1.39 | 6.250    2.53 |12.250   18.21 | 18.25    2.28
                0.333   1.39 | 6.333    2.53 |12.333   18.21 | 18.33    2.28
                0.417   1.39 | 6.417    2.53 |12.417   18.21 | 18.42    2.28
                0.500   1.39 | 6.500    2.53 |12.500   18.21 | 18.50    2.28
                0.583   1.39 | 6.583    2.53 |12.583    9.36 | 18.58    2.28
                0.667   1.39 | 6.667    2.53 |12.667    9.36 | 18.67    2.28
                0.750   1.39 | 6.750    2.53 |12.750    9.36 | 18.75    2.28
                0.833   1.39 | 6.833    2.53 |12.833    9.36 | 18.83    2.28
                0.917   1.39 | 6.917    2.53 |12.917    9.36 | 18.92    2.28
                1.000   1.39 | 7.000    2.53 |13.000    9.36 | 19.00    2.28
                1.083   1.39 | 7.083    2.53 |13.083    6.07 | 19.08    2.28
                1.167   1.39 | 7.167    2.53 |13.167    6.07 | 19.17    2.28
                1.250   1.39 | 7.250    2.53 |13.250    6.07 | 19.25    2.28
                1.333   1.39 | 7.333    2.53 |13.333    6.07 | 19.33    2.28
                1.417   1.39 | 7.417    2.53 |13.417    6.07 | 19.42    2.28
                1.500   1.39 | 7.500    2.53 |13.500    6.07 | 19.50    2.28
                1.583   1.39 | 7.583    2.53 |13.583    6.07 | 19.58    2.28
                1.667   1.39 | 7.667    2.53 |13.667    6.07 | 19.67    2.28
                1.750   1.39 | 7.750    2.53 |13.750    6.07 | 19.75    2.28
                1.833   1.39 | 7.833    2.53 |13.833    6.07 | 19.83    2.28
                1.917   1.39 | 7.917    2.53 |13.917    6.07 | 19.92    2.28
                2.000   1.39 | 8.000    2.53 |14.000    6.07 | 20.00    2.28
                2.083   1.64 | 8.083    3.42 |14.083    3.80 | 20.08    1.52
                2.167   1.64 | 8.167    3.42 |14.167    3.79 | 20.17    1.52
                2.250   1.64 | 8.250    3.42 |14.250    3.79 | 20.25    1.52
                2.333   1.64 | 8.333    3.42 |14.333    3.79 | 20.33    1.52
                2.417   1.64 | 8.417    3.42 |14.417    3.79 | 20.42    1.52
                2.500   1.64 | 8.500    3.42 |14.500    3.79 | 20.50    1.52
                2.583   1.64 | 8.583    3.42 |14.583    3.79 | 20.58    1.52
                2.667   1.64 | 8.667    3.42 |14.667    3.79 | 20.67    1.52
                2.750   1.64 | 8.750    3.42 |14.750    3.79 | 20.75    1.52
                2.833   1.64 | 8.833    3.42 |14.833    3.79 | 20.83    1.52
                2.917   1.64 | 8.917    3.42 |14.917    3.79 | 20.92    1.52
                3.000   1.64 | 9.000    3.42 |15.000    3.79 | 21.00    1.52
                3.083   1.64 | 9.083    4.05 |15.083    3.79 | 21.08    1.52
                3.167   1.64 | 9.167    4.05 |15.167    3.79 | 21.17    1.52
                3.250   1.64 | 9.250    4.05 |15.250    3.79 | 21.25    1.52
                3.333   1.64 | 9.333    4.05 |15.333    3.79 | 21.33    1.52
                3.417   1.64 | 9.417    4.05 |15.417    3.79 | 21.42    1.52
                3.500   1.64 | 9.500    4.05 |15.500    3.79 | 21.50    1.52
                3.583   1.64 | 9.583    4.55 |15.583    3.79 | 21.58    1.52
                3.667   1.64 | 9.667    4.55 |15.667    3.79 | 21.67    1.52
                3.750   1.64 | 9.750    4.55 |15.750    3.79 | 21.75    1.52
                3.833   1.64 | 9.833    4.55 |15.833    3.79 | 21.83    1.52
                3.917   1.64 | 9.917    4.55 |15.917    3.79 | 21.92    1.52
                4.000   1.64 |10.000    4.55 |16.000    3.79 | 22.00    1.52
                4.083   2.02 |10.083    5.82 |16.083    2.28 | 22.08    1.52
                4.167   2.02 |10.167    5.82 |16.167    2.28 | 22.17    1.52
                4.250   2.02 |10.250    5.82 |16.250    2.28 | 22.25    1.52
                4.333   2.02 |10.333    5.82 |16.333    2.28 | 22.33    1.52
                4.417   2.02 |10.417    5.82 |16.417    2.28 | 22.42    1.52
                4.500   2.02 |10.500    5.82 |16.500    2.28 | 22.50    1.52
                4.583   2.02 |10.583    7.84 |16.583    2.28 | 22.58    1.52
                4.667   2.02 |10.667    7.84 |16.667    2.28 | 22.67    1.52
                4.750   2.02 |10.750    7.84 |16.750    2.28 | 22.75    1.52
                4.833   2.02 |10.833    7.84 |16.833    2.28 | 22.83    1.52
                4.917   2.02 |10.917    7.84 |16.917    2.28 | 22.92    1.52
                5.000   2.02 |11.000    7.84 |17.000    2.28 | 23.00    1.52
                5.083   2.02 |11.083   12.14 |17.083    2.28 | 23.08    1.52
                5.167   2.02 |11.167   12.14 |17.167    2.28 | 23.17    1.52
                5.250   2.02 |11.250   12.14 |17.250    2.28 | 23.25    1.52
                5.333   2.02 |11.333   12.14 |17.333    2.28 | 23.33    1.52
                5.417   2.02 |11.417   12.14 |17.417    2.28 | 23.42    1.52
                5.500   2.02 |11.500   12.14 |17.500    2.28 | 23.50    1.52
                5.583   2.02 |11.583   52.62 |17.583    2.28 | 23.58    1.52
                5.667   2.02 |11.667   52.62 |17.667    2.28 | 23.67    1.52
                5.750   2.02 |11.750   52.62 |17.750    2.28 | 23.75    1.52
                5.833   2.02 |11.833  139.64 |17.833    2.28 | 23.83    1.52
                5.917   2.02 |11.917  139.64 |17.917    2.28 | 23.92    1.52
                6.000   2.02 |12.000  139.64 |18.000    2.28 | 24.00    1.52

    Max.Eff.Inten.(mm/hr)=     139.64       112.50
               over (min)        5.00        20.00
    Storage Coeff.  (min)=       5.10 (ii)   17.82 (ii)
    Unit Hyd. Tpeak (min)=       5.00        20.00
    Unit Hyd. peak  (cms)=       0.21         0.06
                                                          *TOTALS*
    PEAK FLOW       (cms)=       1.39         1.20          2.278 (iii)
    TIME TO PEAK    (hrs)=      12.00        12.17         12.00
    RUNOFF VOLUME    (mm)=     124.49        77.28         92.38
    TOTAL RAINFALL   (mm)=     126.49       126.49        126.49
    RUNOFF COEFFICIENT   =       0.98         0.61          0.73


      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  76.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| DUHYD     (5280) |
| Inlet Cap.=1.130 |
| #of Inlets=    1 |
| Total(cms)=  1.1 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
    TOTAL HYD.(ID= 1):  11.60      2.28     12.00   92.38
    ==================================================
    MAJOR SYS.(ID= 2):   1.19      1.15     12.00   92.38
    MINOR SYS.(ID= 3):  10.41      1.13     11.83   92.38

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| ROUTE PIPE (8280)|     PIPE Number     =   1.00
| IN= 2---> OUT= 1 |     Diameter    (mm)=1650.00
| DT=  5.0 min     |     Length       (m)= 500.00
--------------------     Slope      (m/m)=  0.005
                         Manning n       =  0.013

    <----------------- TRAVEL TIME TABLE -------------------->
      DEPTH      VOLUME    FLOW RATE    VELOCITY    TRAV.TIME
       (m)      (cu.m.)      (cms)        (m/s)        min
      0.09     .216E+02       0.0         0.80        10.40
      0.17     .600E+02       0.1         1.25         6.67
      0.26     .108E+03       0.3         1.61         5.18
      0.35     .164E+03       0.6         1.91         4.36
      0.43     .225E+03       1.0         2.18         3.83
```

```
      0.52     .290E+03       1.4          2.41         3.46
      0.61     .358E+03       1.9          2.61         3.19
      0.69     .428E+03       2.4          2.79         2.99
      0.78     .499E+03       2.9          2.95         2.83
      0.87     .570E+03       3.5          3.08         2.70
      0.96     .642E+03       4.1          3.20         2.61
      1.04     .712E+03       4.7          3.29         2.53
      1.13     .780E+03       5.2          3.36         2.48
      1.22     .844E+03       5.8          3.41         2.44
      1.30     .905E+03       6.2          3.44         2.43
      1.39     .961E+03       6.6          3.43         2.43
      1.48     .101E+04       6.9          3.40         2.45
      1.56     .105E+04       6.9          3.31         2.52
      1.65     .107E+04       6.5          3.02         2.76
                                  <---- hydrograph ---->   <-pipe / channel->
                              AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                              (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (5280)    1.19     1.15   12.00  92.38      0.47      2.27
     OUTFLOW: ID= 1 (8280)    1.19     0.94   12.00  92.38      0.43      2.15

     **** WARNING:  COMPUTATIONS FAILED TO CONVERGE.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0070) |   Area    (ha)=   0.83   Curve Number   (CN)= 50.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.50

     Unit Hyd Qpeak  (cms)=   0.063

     PEAK FLOW       (cms)=   0.041 (i)
     TIME TO PEAK    (hrs)=  12.417
     RUNOFF VOLUME    (mm)=  39.305
     TOTAL RAINFALL   (mm)= 126.490
     RUNOFF COEFFICIENT   =   0.311

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0010) |   Area    (ha)=   4.28
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.63         2.65
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     170.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        60.39
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       3.78 (ii)   14.55 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.25         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.49         0.28          0.730 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        42.93          67.40
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.34           0.53

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  50.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0020) |   Area    (ha)=   2.20
|ID= 1 DT= 5.0 min |   Total Imp(%)=  54.00   Dir. Conn.(%)=  43.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.19         1.01
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     120.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        75.43
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       3.07 (ii)   12.92 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.27         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.37         0.13          0.479 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        45.80          79.63
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.36           0.63

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  50.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1020) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0010):     4.28   0.730    12.00    67.40
        + ID2= 2 (0020):     2.20   0.479    12.00    79.63
          ================================================
          ID = 3 (1020):     6.48   1.209    12.00    71.55

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0030) |   Area    (ha)=   0.58
|ID= 1 DT= 5.0 min |   Total Imp(%)=  54.00   Dir. Conn.(%)=  43.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.31         0.27
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=      60.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        75.43
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.03 (ii)   11.87 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.31         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.10         0.04          0.128 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        45.80          79.62
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.36           0.63

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  50.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1030) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0030):     0.58   0.128    12.00    79.62
        + ID2= 2 (1020):     6.48   1.209    12.00    71.55
          ================================================
          ID = 3 (1030):     7.06   1.337    12.00    72.21

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0040) |   Area    (ha)=   7.65
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.91         4.74
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     230.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        60.39
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       4.54 (ii)   15.30 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.23         0.07
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.87         0.46          1.198 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.17          12.00
     RUNOFF VOLUME    (mm)=     124.49        42.93          67.40
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.34           0.53

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  50.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0050) |   Area    (ha)=   3.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
```

```
     Surface Area     (ha)=       1.04         2.33
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     149.89        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        56.52
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       3.51 (ii)   14.56 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.26         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.32         0.23         0.519 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        41.78        62.46
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.33         0.49

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  50.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0060) |   Area    (ha)=   5.08
|ID= 1 DT= 5.0 min |   Total Imp(%)=  54.00   Dir. Conn.(%)=  43.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.74         2.34
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     180.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       165.43
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       3.92 (ii)   11.11 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.25         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.84         0.75         1.531 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        51.94        83.13
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.41         0.66

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1060) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0040):     7.65   1.198    12.00    67.40
        + ID2= 2 (0050):     3.37   0.519    12.00    62.46
          ================================================
          ID = 3 (1060):    11.02   1.716    12.00    65.89

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (1060) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1060):    11.02   1.716    12.00    65.89
        + ID2= 2 (0060):     5.08   1.531    12.00    83.13
          ================================================
          ID = 1 (1060):    16.10   3.248    12.00    71.33

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1060) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1060):    16.10   3.248    12.00    71.33
        + ID2= 2 (1030):     7.06   1.337    12.00    72.21
          ================================================
          ID = 3 (1060):    23.16   4.585    12.00    71.60

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| ROUTE CHN (8060) |
| IN= 2---> OUT= 1 |     Routing time step (min)'=  2.00
--------------------
              <------ DATA FOR SECTION (   1.1) ------>
              Distance      Elevation       Manning
                  0.00         11.00        0.0500
                  0.10         10.00        0.0500
                  5.00          9.90    0.0500 /0.0200  Main Channel
                  5.10          9.75        0.0200      Main Channel
                  9.40          9.83        0.0200      Main Channel
                  9.50          9.83        0.0200      Main Channel
                 10.50          9.83        0.0200      Main Channel
                 10.60          9.83        0.0200      Main Channel
                 14.90          9.75        0.0200      Main Channel
                 15.00          9.90    0.0200 /0.0500  Main Channel
                 19.90         10.00        0.0500
                 20.00         11.00        0.0500

     <--------------------- TRAVEL TIME TABLE ---------------------->
      DEPTH    ELEV      VOLUME    FLOW RATE    VELOCITY   TRAV.TIME
       (m)      (m)     (cu.m.)      (cms)        (m/s)      (min)
      0.05     9.80    .816E+02       0.0          0.19      52.65
      0.10     9.85    .328E+03       0.2          0.32      31.13
      0.15     9.90    .627E+03       0.5          0.49      20.37
      0.22     9.97    .118E+04       1.2          0.62      16.19
      0.29    10.04    .197E+04       2.2          0.68      14.70
      0.36    10.11    .278E+04       3.5          0.76      13.08
      0.43    10.18    .360E+04       5.1          0.85      11.74
      0.49    10.24    .442E+04       6.9          0.94      10.66
      0.56    10.31    .524E+04       8.9          1.02       9.78
      0.63    10.38    .606E+04      11.1          1.10       9.07
      0.70    10.45    .688E+04      13.5          1.18       8.47
      0.77    10.52    .770E+04      16.1          1.26       7.96
      0.84    10.59    .852E+04      18.9          1.33       7.53
      0.91    10.66    .934E+04      21.8          1.40       7.15
      0.98    10.73    .102E+05      24.9          1.47       6.81
      1.04    10.79    .110E+05      28.1          1.53       6.52
      1.11    10.86    .118E+05      31.5          1.60       6.25
      1.18    10.93    .126E+05      35.0          1.66       6.01
      1.25    11.00    .135E+05      38.7          1.72       5.80

                                  <---- hydrograph ---->   <-pipe / channel->
                             AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                             (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (1060)   23.16     4.58   12.00  71.60      0.40      0.82
     OUTFLOW: ID= 1 (8060)   23.16     3.16   12.03  71.59      0.34      0.74

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--------------------
| ADD HYD   (1070) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0070):     0.83   0.041    12.42    39.31
        + ID2= 2 (8060):    23.16   3.159    12.03    71.59
          ================================================
          ID = 3 (1070):    23.99   3.184    12.03    70.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| DUHYD     (5070) |
| Inlet Cap.=1.310 |
| #of Inlets=    1 |
| Total(cms)=  1.3 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):  23.99      3.18     12.03   70.47
     ================================================
     MAJOR SYS.(ID= 2):   4.05      1.87     12.03   70.47
     MINOR SYS.(ID= 3):  19.94      1.31     11.83   70.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| RESERVOIR (9070) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.6200      0.2910
                          0.1000     0.0010   |   0.7200      0.4680
                          0.2000     0.0220   |   0.8500      0.8030
                          0.3000     0.0730   |   1.4000      2.1400
                          0.4900     0.1610   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (5070)      4.053      1.874     12.03      70.47
     OUTFLOW: ID= 1 (9070)      4.053      0.515     12.47      70.47

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 27.48
                   TIME SHIFT OF PEAK FLOW         (min)= 26.67
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1859

     **** WARNING : HYDROGRAPH WAS CUT. CHECK VOLUME.
--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0190) |   Area    (ha)=  24.04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  30.00
--------------------
```

```
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       9.14        14.90
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     400.00       100.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        78.18
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       6.32 (ii)   21.03 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.19         0.05
                                                          *TOTALS*
     PEAK FLOW       (cms)=       2.63         1.57        3.592 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.25        12.00
     RUNOFF VOLUME    (mm)=     124.49        54.77        75.68
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.43         0.60


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  60.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1190) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0190):    24.04   3.592    12.00    75.68
        + ID2= 2 (9070):     4.05   0.515    12.47    70.47
          ==============================================
          ID = 3 (1190):    28.09   3.841    12.00    74.93

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0080) |   Area    (ha)=   1.93
|ID= 1 DT= 5.0 min |   Total Imp(%)=  15.00   Dir. Conn.(%)=  12.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         1.64
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     110.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        75.44
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.91 (ii)   12.76 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.28         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.09         0.21        0.277 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        54.41        62.82
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.43         0.50

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1080) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0080):     1.93   0.277    12.00    62.82
        + ID2= 2 (5070):    19.94   1.310    11.83    70.47
          ==============================================
          ID = 3 (1080):    21.87   1.587    12.00    69.79

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0090) |   Area    (ha)=   1.35
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.51         0.84
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=      90.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        86.58
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.58 (ii)   11.90 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.29         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.16         0.13        0.271 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        57.32        77.46
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.45         0.61

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1090) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0090):     1.35   0.271    12.00    77.46
        + ID2= 2 (1080):    21.87   1.587    12.00    69.79
          ==============================================
          ID = 3 (1090):    23.22   1.858    12.00    70.24

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0100) |   Area    (ha)=   1.19
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.45         0.74
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=      90.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        86.58
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.58 (ii)   11.90 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.29         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.14         0.11        0.239 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        57.32        77.46
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.45         0.61

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1100) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0100):     1.19   0.239    12.00    77.46
        + ID2= 2 (1090):    23.22   1.858    12.00    70.24
          ==============================================
          ID = 3 (1100):    24.41   2.097    12.00    70.59

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0110) |   Area    (ha)=   4.05
|ID= 1 DT= 5.0 min |   Total Imp(%)=  69.00   Dir. Conn.(%)=  55.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.79         1.26
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     160.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       127.13
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       3.65 (ii)   11.64 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.25         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.86         0.29        1.114 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        65.74        98.05
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.52         0.78
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***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1110) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0110):     4.05   1.114    12.00    98.05
        + ID2= 2 (1100):    24.41   2.097    12.00    70.59
          ================================================
          ID = 3 (1110):    28.46   3.212    12.00    74.50

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0130) |   Area    (ha)=   7.28
|ID= 1 DT= 5.0 min |   Total Imp(%)=  46.00   Dir. Conn.(%)=  37.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.35         3.93
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     220.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        91.15
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.42 (ii)   13.55 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.23         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.02         0.61          1.556 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        58.42          82.86
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.46           0.66

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0120) |   Area    (ha)=   1.99
|ID= 1 DT= 5.0 min |   Total Imp(%)=  35.00   Dir. Conn.(%)=  28.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.70         1.29
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     120.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       113.09
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       3.07 (ii)   11.44 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.27         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.22         0.27          0.460 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        76.54          89.96
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.61           0.71

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0140) |   Area    (ha)=   5.80
|ID= 1 DT= 5.0 min |   Total Imp(%)=  33.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91         3.89
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     190.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        76.55
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.04 (ii)   13.83 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.24         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.66         0.50          1.099 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        54.72          75.65
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.43           0.60

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0150) |   Area    (ha)=   0.71
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  31.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.33         0.38
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=      30.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       140.63
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.34 (ii)    9.01 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.09         0.11          0.199 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.00          12.00
     RUNOFF VOLUME    (mm)=     124.49        81.64          94.91
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.65           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1150) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0120):     1.99   0.460    12.00    89.96
        + ID2= 2 (0130):     7.28   1.556    12.00    82.86
          ================================================
          ID = 3 (1150):     9.27   2.016    12.00    84.39

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (1150) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1150):     9.27   2.016    12.00    84.39
        + ID2= 2 (0140):     5.80   1.099    12.00    75.65
          ================================================
          ID = 1 (1150):    15.07   3.115    12.00    81.02

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (1150) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (1150):    15.07   3.115    12.00    81.02
        + ID2= 2 (0150):     0.71   0.199    12.00    94.91
          ================================================
          ID = 3 (1150):    15.78   3.314    12.00    81.65

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (1150) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1150):    15.78   3.314    12.00    81.65
        + ID2= 2 (1110):    28.46   3.212    12.00    74.50
          ================================================
          ID = 1 (1150):    44.24   6.526    12.00    77.05

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| ROUTE CHN (8150) |
| IN= 2---> OUT= 1 |     Routing time step (min)'=  2.00
--------------------
               <------ DATA FOR SECTION (   1.1) ------>
               Distance      Elevation       Manning
                   0.00         11.00        0.0500
                   0.10         10.00        0.0500
                   5.00          9.90    0.0500 /0.0200  Main Channel
                   5.10          9.75        0.0200      Main Channel
                   9.40          9.83        0.0200      Main Channel
                   9.50          9.83        0.0200      Main Channel
                  10.50          9.83        0.0200      Main Channel
                  10.60          9.83        0.0200      Main Channel
                  14.90          9.75        0.0200      Main Channel
                  15.00          9.90    0.0200 /0.0500  Main Channel
                  19.90         10.00        0.0500
                  20.00         11.00        0.0500

      <--------------------- TRAVEL TIME TABLE ---------------------->
       DEPTH    ELEV      VOLUME    FLOW RATE    VELOCITY   TRAV.TIME
        (m)      (m)     (cu.m.)      (cms)        (m/s)      (min)
       0.05     9.80    .816E+02       0.0         0.19      52.65
       0.10     9.85    .328E+03       0.2         0.32      31.13
       0.15     9.90    .627E+03       0.5         0.49      20.37
       0.22     9.97    .118E+04       1.2         0.62      16.19
       0.29    10.04    .197E+04       2.2         0.68      14.70
       0.36    10.11    .278E+04       3.5         0.76      13.08
       0.43    10.18    .360E+04       5.1         0.85      11.74
       0.49    10.24    .442E+04       6.9         0.94      10.66
       0.56    10.31    .524E+04       8.9         1.02       9.78
       0.63    10.38    .606E+04      11.1         1.10       9.07
       0.70    10.45    .688E+04      13.5         1.18       8.47
       0.77    10.52    .770E+04      16.1         1.26       7.96
       0.84    10.59    .852E+04      18.9         1.33       7.53
       0.91    10.66    .934E+04      21.8         1.40       7.15
       0.98    10.73    .102E+05      24.9         1.47       6.81
       1.04    10.79    .110E+05      28.1         1.53       6.52
       1.11    10.86    .118E+05      31.5         1.60       6.25
       1.18    10.93    .126E+05      35.0         1.66       6.01
       1.25    11.00    .135E+05      38.7         1.72       5.80

                                     <---- hydrograph ---->   <-pipe / channel->
                                AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                                (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (1150)   44.24     6.53   12.00  77.05      0.48      0.92
     OUTFLOW: ID= 1 (8150)   44.24     4.95   12.03  77.05      0.42      0.84


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0160) |   Area    (ha)=   0.69
|ID= 1 DT= 5.0 min |   Total Imp(%)=  57.00   Dir. Conn.(%)=  46.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.39         0.30
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=      70.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       134.06
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.22 (ii)   10.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.30         0.10
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.12         0.08          0.194 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        80.53         100.74
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.64           0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1160) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0160):     0.69   0.194    12.00   100.74
        + ID2= 2 (8150):    44.24   4.954    12.03    77.05
          ================================================
          ID = 3 (1160):    44.93   5.119    12.03    77.41

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0170) |   Area    (ha)=   1.18
|ID= 1 DT= 5.0 min |   Total Imp(%)=  62.00   Dir. Conn.(%)=  52.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.73         0.45
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=      90.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       135.11
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.58 (ii)   10.38 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.29         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.24         0.12          0.344 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        80.71         103.47
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.64           0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1170) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0170):     1.18   0.344    12.00   103.47
        + ID2= 2 (1160):    44.93   5.119    12.03    77.41
          ================================================
          ID = 3 (1170):    46.11   5.407    12.03    78.08

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0180) |   Area    (ha)=   1.91
|ID= 1 DT= 5.0 min |   Total Imp(%)=  48.00   Dir. Conn.(%)=  31.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.92         0.99
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     110.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       144.22
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.91 (ii)   10.51 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.28         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.23         0.28          0.481 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        82.22          95.32
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.65           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1180) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0180):     1.91   0.481    12.00    95.32
        + ID2= 2 (1170):    46.11   5.407    12.03    78.08
          ================================================
          ID = 3 (1180):    48.02   5.842    12.03    78.76

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0200) |   Area    (ha)=   7.80
|ID= 1 DT= 5.0 min |   Total Imp(%)=  17.00   Dir. Conn.(%)=  15.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.33         6.47
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     230.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       101.40
                over (min)        5.00        15.00
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     Storage Coeff.  (min)=       4.54 (ii)   13.28 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.23         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.44         1.15          1.463 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        73.97          81.54
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.58           0.64

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
             YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1200) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0200):     0.80   1.463    12.00    81.54
        + ID2= 2 (1180):    48.02   5.842    12.03    78.76
          ================================================
          ID = 3 (1200):    55.82   7.261    12.03    79.15

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (1200) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1200):    55.82   7.261    12.03    79.15
        + ID2= 2 (1190):    28.09   3.841    12.00    74.93
          ================================================
          ID = 1 (1200):    83.91  11.086    12.00    77.72

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| NASHYD    (0210) |   Area    (ha)=  29.20   Curve Number   (CN)= 82.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   1.00

     Unit Hyd Qpeak  (cms)=   1.115

     PEAK FLOW       (cms)=   2.002 (i)
     TIME TO PEAK    (hrs)=  12.917
     RUNOFF VOLUME    (mm)=  83.273
     TOTAL RAINFALL   (mm)= 126.490
     RUNOFF COEFFICIENT   =   0.658

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0220) |   Area    (ha)=  10.76
|ID= 1 DT= 5.0 min |   Total Imp(%)=  38.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       4.09         6.67
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     270.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        94.65
                over (min)        5.00        5.00
     Storage Coeff.  (min)=       4.99 (ii)   13.99 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.21         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.21         1.06          2.146 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        62.61          81.18
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.49           0.64

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  66.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (1220) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0210):    29.20   2.002    12.92    83.27
        + ID2= 2 (0220):    10.76   2.146    12.00    81.18
          ================================================
          ID = 3 (1220):    39.96   2.809    12.00    82.71

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ROUTE CHN (8220) |
| IN= 2---> OUT= 1 |     Routing time step (min)'=  2.00
--------------------
                <------ DATA FOR SECTION (   1.1) ------>
                Distance      Elevation       Manning
                    0.00         11.00        0.0500
                    0.10         10.00        0.0500
                    5.00          9.90    0.0500 /0.0200  Main Channel
                    5.10          9.75        0.0200      Main Channel
                    9.40          9.83        0.0200      Main Channel
                    9.50          9.83        0.0200      Main Channel
                   10.50          9.83        0.0200      Main Channel
                   10.60          9.83        0.0200      Main Channel
                   14.90          9.75        0.0200      Main Channel
                   15.00          9.90    0.0200 /0.0500  Main Channel
                   19.90         10.00        0.0500
                   20.00         11.00        0.0500

      <--------------------- TRAVEL TIME TABLE ---------------------->
       DEPTH    ELEV      VOLUME    FLOW RATE    VELOCITY   TRAV.TIME
        (m)      (m)     (cu.m.)      (cms)        (m/s)      (min)
       0.05     9.80    .816E+02       0.0          0.19      52.65
       0.10     9.85    .328E+03       0.2          0.32      31.13
       0.15     9.90    .627E+03       0.5          0.49      20.37
       0.22     9.97    .118E+04       1.2          0.62      16.19
       0.29    10.04    .197E+04       2.2          0.68      14.70
       0.36    10.11    .278E+04       3.5          0.76      13.08
       0.43    10.18    .360E+04       5.1          0.85      11.74
       0.49    10.24    .442E+04       6.9          0.94      10.66
       0.56    10.31    .524E+04       8.9          1.02       9.78
       0.63    10.38    .606E+04      11.1          1.10       9.07
       0.70    10.45    .688E+04      13.5          1.18       8.47
       0.77    10.52    .770E+04      16.1          1.26       7.96
       0.84    10.59    .852E+04      18.9          1.33       7.53
       0.91    10.66    .934E+04      21.8          1.40       7.15
       0.98    10.73    .102E+05      24.9          1.47       6.81
       1.04    10.79    .110E+05      28.1          1.53       6.52
       1.11    10.86    .118E+05      31.5          1.60       6.25
       1.18    10.93    .126E+05      35.0          1.66       6.01
       1.25    11.00    .135E+05      38.7          1.72       5.80

                                   <---- hydrograph ---->   <-pipe / channel->
                              AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                              (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
     INFLOW : ID= 2 (1220)   39.96     2.81   12.00  82.71      0.32      0.71
     OUTFLOW: ID= 1 (8220)   39.96     2.29   12.83  82.70      0.29      0.68

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0230) |   Area    (ha)=   1.76
|ID= 1 DT= 5.0 min |   Total Imp(%)=  52.00   Dir. Conn.(%)=  47.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.92         0.84
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     110.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       112.59
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.91 (ii)   11.30 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.28         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.32         0.18          0.480 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        76.43          99.02
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.60           0.78

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1230) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0230):     1.76   0.480    12.00    99.02
        + ID2= 2 (1200):    83.91  11.086    12.00    77.72
          ================================================
          ID = 3 (1230):    85.67  11.566    12.00    78.16

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

```
--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1230) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1230):    85.67  11.566    12.00    78.16
        + ID2= 2 (8220):    39.96   2.293    12.83    82.70
          ================================================
          ID = 1 (1230):   125.63  13.303    12.00    79.57

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0240) |   Area    (ha)=   9.82
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.04         6.78
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     260.00       100.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64        77.18
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       4.88 (ii)   19.67 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.22         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.92         0.76         1.463 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.17        12.00
     RUNOFF VOLUME    (mm)=     124.49        56.04        73.15
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.44         0.58

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0250) |   Area    (ha)=   1.43
|ID= 1 DT= 5.0 min |   Total Imp(%)=  77.00   Dir. Conn.(%)=  64.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.10         0.33
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     100.00        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       142.05
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.75 (ii)   10.40 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.28         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.35         0.09         0.434 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        68.24       104.24
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.54         0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  62.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1250) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0240):     9.82   1.463    12.00    73.15
        + ID2= 2 (0250):     1.43   0.434    12.00   104.24
          ================================================
          ID = 3 (1250):    11.25   1.897    12.00    77.10

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1250) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1250):    11.25   1.897    12.00    77.10
        + ID2= 2 (1230):   125.63  13.303    12.00    79.57
          ================================================
          ID = 1 (1250):   136.88  15.200    12.00    79.37

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| ROUTE CHN (8250) |
| IN= 2---> OUT= 1 |     Routing time step (min)'=  1.00
--------------------
                <------ DATA FOR SECTION (   1.1) ------>
                Distance      Elevation       Manning
                    0.00         11.00        0.0500
                    0.10         10.00        0.0500
                    5.00          9.90    0.0500 /0.0200  Main Channel
                    5.10          9.75        0.0200      Main Channel
                    9.40          9.83        0.0200      Main Channel
                    9.50          9.83        0.0200      Main Channel
                   10.50          9.83        0.0200      Main Channel
                   10.60          9.83        0.0200      Main Channel
                   14.90          9.75        0.0200      Main Channel
                   15.00          9.90    0.0200 /0.0500  Main Channel
                   19.90         10.00        0.0500
                   20.00         11.00        0.0500

      <--------------------- TRAVEL TIME TABLE ---------------------->
       DEPTH    ELEV      VOLUME    FLOW RATE    VELOCITY   TRAV.TIME
        (m)      (m)     (cu.m.)      (cms)        (m/s)      (min)
       0.05     9.80    .544E+02       0.0         0.19      35.10
       0.10     9.85    .219E+03       0.2         0.32      20.76
       0.15     9.90    .418E+03       0.5         0.49      13.58
       0.22     9.97    .786E+03       1.2         0.62      10.79
       0.29    10.04    .131E+04       2.2         0.68       9.80
       0.36    10.11    .186E+04       3.5         0.76       8.72
       0.43    10.18    .240E+04       5.1         0.85       7.82
       0.49    10.24    .295E+04       6.9         0.94       7.10
       0.56    10.31    .349E+04       8.9         1.02       6.52
       0.63    10.38    .404E+04      11.1         1.10       6.05
       0.70    10.45    .459E+04      13.5         1.18       5.65
       0.77    10.52    .513E+04      16.1         1.26       5.31
       0.84    10.59    .568E+04      18.9         1.33       5.02
       0.91    10.66    .623E+04      21.8         1.40       4.76
       0.98    10.73    .678E+04      24.9         1.47       4.54
       1.04    10.79    .733E+04      28.1         1.53       4.34
       1.11    10.86    .787E+04      31.5         1.60       4.17
       1.18    10.93    .842E+04      35.0         1.66       4.01
       1.25    11.00    .897E+04      38.7         1.72       3.86

                                   <---- hydrograph ---->   <-pipe / channel->
                              AREA    QPEAK   TPEAK   R.V.   MAX DEPTH  MAX VEL
                              (ha)    (cms)   (hrs)   (mm)      (m)      (m/s)
    INFLOW : ID= 2 (1250)  136.88    15.20   12.00  79.37      0.74      1.23
    OUTFLOW: ID= 1 (8250)  136.88    13.40   12.06  79.32      0.69      1.17


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0260) |   Area    (ha)=   1.51
|ID= 1 DT= 5.0 min |   Total Imp(%)=  84.00   Dir. Conn.(%)=  71.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.27         0.24
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     260.00       100.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       214.37
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.88 (ii)   14.71 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.22         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.40         0.09         0.484 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08        12.00
     RUNOFF VOLUME    (mm)=     124.49        91.14       114.81
     TOTAL RAINFALL   (mm)=     126.49       126.49       126.49
     RUNOFF COEFFICIENT   =       0.98         0.72         0.91

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1260) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0260):     1.51   0.484    12.00   114.81
        + ID2= 2 (8250):   136.88  13.402    12.06    79.32
          ================================================
          ID = 3 (1260):   138.39  13.775    12.04    79.71

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
```

```
| CALIB            |
| STANDHYD  (0270) |   Area    (ha)=  10.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  57.00   Dir. Conn.(%)=  47.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.94         4.48
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     263.57        50.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       164.50
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.92 (ii)   12.13 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.22         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.84         1.38          3.115 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.08          12.00
     RUNOFF VOLUME    (mm)=     124.49        51.79          85.96
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.41           0.68

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0290) |   Area    (ha)=  11.24
|ID= 1 DT= 5.0 min |   Total Imp(%)=  63.00   Dir. Conn.(%)=  52.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       7.08         4.16
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       0.50         1.50
     Length            (m)=     270.00       100.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     139.64       135.49
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       4.99 (ii)   16.80 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.21         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       2.20         0.89          2.859 (iii)
     TIME TO PEAK    (hrs)=      12.00        12.17          12.00
     RUNOFF VOLUME    (mm)=     124.49        81.53         103.87
     TOTAL RAINFALL   (mm)=     126.49       126.49         126.49
     RUNOFF COEFFICIENT   =       0.98         0.64           0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1290) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0290):    11.24   2.859    12.00   103.87
        + ID2= 2 (5280):    10.41   1.130    11.83    92.38
          ================================================
          ID = 3 (1290):    21.65   3.989    12.00    98.35

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1270) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0270):    10.42   3.115    12.00    85.96
        + ID2= 2 (1260):   138.39  13.775    12.04    79.71
          ================================================
          ID = 3 (1270):   148.81  16.556    12.01    80.14

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (1270) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (1270):   148.81  16.556    12.01    80.14
        + ID2= 2 (1290):    21.65   3.989    12.00    98.35
          ================================================
          ID = 1 (1270):   170.46  20.371    12.01    82.46

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (9290) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |  13.3600      0.8053
                          4.4160     0.2928   |  24.8600      0.9045
                          6.8950     0.7061   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (1270)    170.459     20.371     12.01      82.46
     OUTFLOW: ID= 1 (9290)    170.459     19.872     12.04      82.44

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 97.55
                   TIME SHIFT OF PEAK FLOW         (min)=  1.67
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.8615

--------------------------------------------------------------------------------

 FINISH
================================================================================
======================
```

Appendix F

Ancaster Glen South Pond Analysis Data

M3.1

Date: DEC.13/12
Scale: N.T.S.

ANCASTER GLEN PH. 2 POST DEVELOPMENT STORM DRAINAGE PLAN

MTE

25 YEARS 1985-2010

Project No.: 10467-400

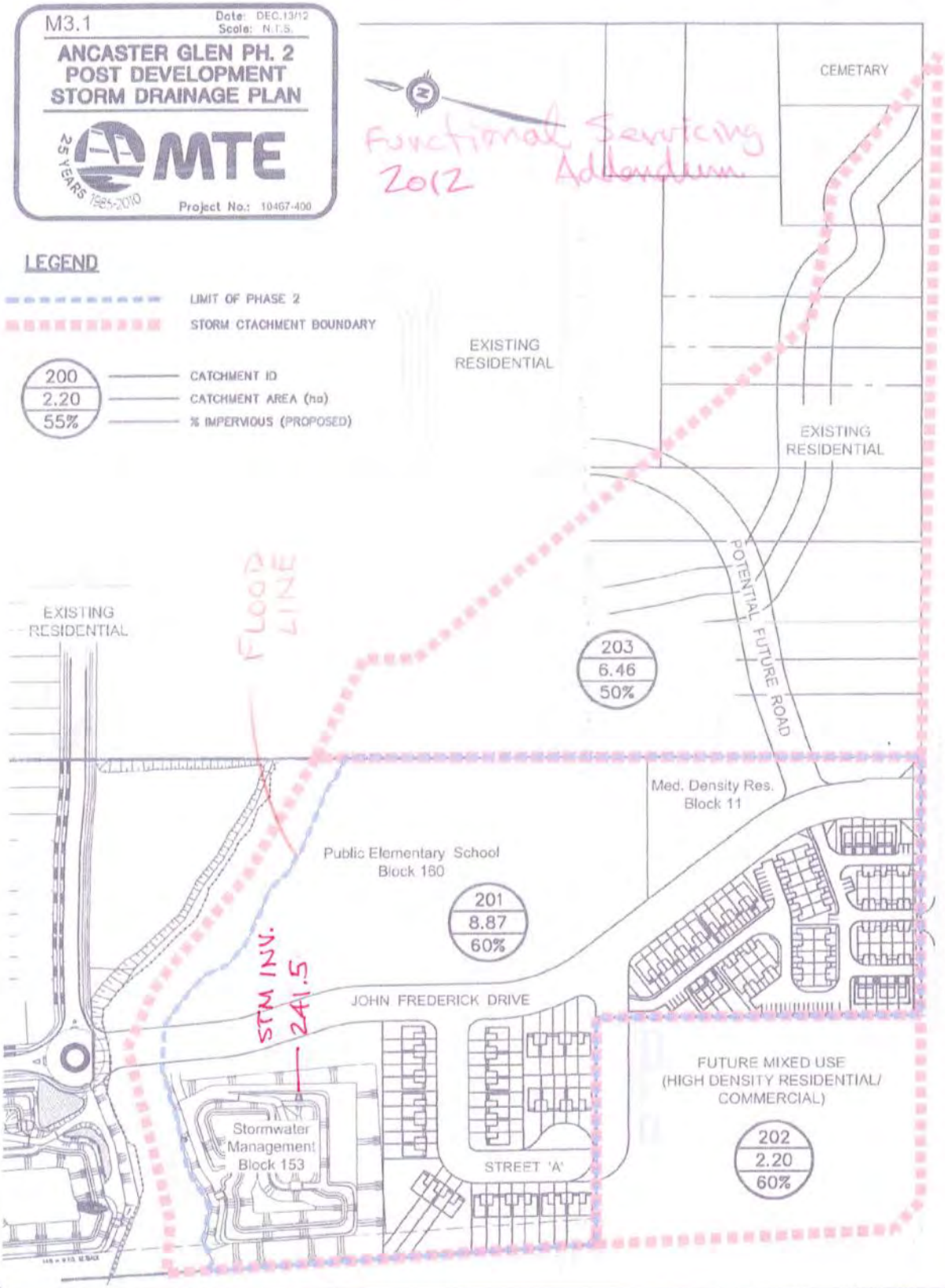
Functional Servicing Addendum 2012

LEGEND

LIMIT OF PHASE 2

STORM CTACHMENT BOUNDARY

200 — CATCHMENT ID
2.20 — CATCHMENT AREA (ha)
55% — % IMPERVIOUS (PROPOSED)



KEY PLAN

NOTE TO CONTRACTOR :

DO NOT SCALE DRAWINGS.

CONTRACTORS MUST CHECK AND VERIFY ALL DIMENSIONS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING INTO THE WORK.

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

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

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

MTE

BURLINGTON SITE DIVISION

(905)639-2552 www.mte85.com

CLIENT

ONTARIO REALTY CORPORATION

1 DUNDAS STREET WEST, SUITE 2000, TORONTO, ONTARIO

PROJECT

ORC GARNER ROAD EAST

HAMILTON, ONTARIO

DRAWING

STORM WATER MANAGEMENT POND PLAN FACILITY No. 2 - SOUTH POND

Project Manager	SW	Project No.	10467-100
Design By	JGG	Checked By	JGG/SW
Drawn By	REB/AJG	Checked By	JGG/SW
Surveyed By	OTHERS	Drawing No.	SW1.1
Date	JUL 20/10		
Scale	1:300	Sheet 1 of 3	

```
*#
*This run corresponds to the South Pond for the ORC lands in Ancaster.
*The pond is a quality facility only but will be able to store the 2 year
*storm event without overtopping.
*
*
* 2 Year Storm
* A=646
* B=6
* C=0.781
*
*
--------------------
| START            |  Project  dir.: Q:\10467\10467-~3\UPDATE~1\SWMHYMO\
--------------------  Rainfall dir.: Q:\10467\10467-~3\UPDATE~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   0
--------------------------------------------------------------------------------
001:0002----------------------------------------------------------------------
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 646.000
| Ptotal= 35.07 mm |                          B=   6.000
--------------------                          C=    .781
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    =  5.00 min
                        Time to peak ratio =   .33
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	2.223	1.08	9.927	2.08	6.270	3.08	2.969
.17	2.359	1.17	15.281	2.17	5.700	3.17	2.853
.25	2.514	1.25	34.509	2.25	5.232	3.25	2.747
.33	2.695	1.33	99.290	2.33	4.841	3.33	2.649
.42	2.907	1.42	44.074	2.42	4.508	3.42	2.559
.50	3.162	1.50	24.988	2.50	4.223	3.50	2.476
.58	3.472	1.58	17.327	2.58	3.974	3.58	2.398
.67	3.860	1.67	13.271	2.67	3.756	3.67	2.326
.75	4.360	1.75	10.780	2.75	3.563	3.75	2.258
.83	5.030	1.83	9.099	2.83	3.391	3.83	2.195
.92	5.978	1.92	7.891	2.92	3.236	3.92	2.135
1.00	7.427	2.00	6.981	3.00	3.096	4.00	2.079

```
--------------------------------------------------------------------------------
001:0003----------------------------------------------------------------------
*This is the area south of the Odan-Detech Lands.
*Data taken assumed to be the same as the Odan-Detech developed lands.
*This imperviousness was revised to 50% by City Of Hamilton.
*
*
----------------------
| DESIGN STANDHYD    |   Area    (ha)=    6.46
| 01:000203 DT= 1.00 |   Total Imp(%)=   55.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=       3.55          2.91
    Dep. Storage      (mm)=        .80          1.50
    Average Slope      (%)=       2.00          2.00
    Length             (m)=     207.53         40.00
    Mannings n            =       .013          .250

    Max.eff.Inten.(mm/hr)=      99.29         27.49
```

```
            over (min)        3.00          15.00
Storage Coeff.  (min)=        3.22 (ii)     15.05 (ii)
Unit Hyd. Tpeak (min)=        3.00          15.00
Unit Hyd. peak  (cms)=         .36            .08
                                                          *TOTALS*
PEAK FLOW       (cms)=         .43            .13            .465 (iii)
TIME TO PEAK    (hrs)=        1.35           1.60           1.350
RUNOFF VOLUME    (mm)=       34.27          11.17          18.104
TOTAL RAINFALL   (mm)=       35.07          35.07          35.070
RUNOFF COEFFICIENT   =         .98            .32            .516
```

203

```
  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
      CN* =  70.0    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0004-------------------------------------------------------------------------
*This is the ORC site under proposed development conditions. All data was
*calculated in the R.J Burnside design sheet. Proportions of our total area was
*used because there are two proposed SWM Ponds located on the ORC site.
*The land owner located on the south-west side of the ORC property was assumed
*as 100 % High-Density lands with an imperviousness of 55%.
*
----------------------
| DESIGN STANDHYD    |   Area     (ha)=    8.87
| 02:000201 DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   35.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
Surface Area      (ha)=         5.77          3.10
Dep. Storage      (mm)=          .80          1.50
Average Slope      (%)=         2.00          2.00
Length             (m)=       243.17         40.00
Mannings n            =         .013          .250

Max.eff.Inten.(mm/hr)=        99.29         38.70
            over (min)         4.00         14.00
Storage Coeff.  (min)=         3.55 (ii)    13.86 (ii)
Unit Hyd. Tpeak (min)=         4.00         14.00
Unit Hyd. peak  (cms)=          .31           .08
                                                          *TOTALS*
PEAK FLOW       (cms)=          .65           .20            .723 (iii)
TIME TO PEAK    (hrs)=         1.37          1.58           1.367
RUNOFF VOLUME    (mm)=        34.27         12.64          20.210
TOTAL RAINFALL   (mm)=        35.07         35.07          35.070
RUNOFF COEFFICIENT   =          .98           .36            .576
```

201

```
  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
      CN* =  70.0    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0005-------------------------------------------------------------------------
*Lands southwest of ORC property.  Assumed imperviousness of 55%.
*
----------------------
| DESIGN STANDHYD    |   Area     (ha)=    2.20
| 03:000202 DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   35.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
Surface Area      (ha)=         1.43           .77
Dep. Storage      (mm)=          .80          1.50
```

```
Average Slope      (%)=       2.00          2.00
Length             (m)=     121.11         40.00
Mannings n            =       .013          .250

Max.eff.Inten.(mm/hr)=      99.29         41.58
           over (min)        2.00         12.00
Storage Coeff.  (min)=       2.33 (ii)    12.36 (ii)
Unit Hyd. Tpeak (min)=       2.00         12.00
Unit Hyd. peak  (cms)=        .50           .09
                                                        *TOTALS*
PEAK FLOW       (cms)=        .19           .05           .206 (iii)
TIME TO PEAK    (hrs)=       1.33          1.55          1.333
RUNOFF VOLUME    (mm)=      34.27         12.64         20.210
TOTAL RAINFALL   (mm)=      35.07         35.07         35.070
RUNOFF COEFFICIENT   =        .98           .36           .576
```

202

```
  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
      CN* =  70.0     Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0006----------------------------------------------------------------------
*
--------------------
| ADD HYD (000202) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)    (cms)
                 ID1 01:000203     6.46      .465    1.35  18.10     .000
                +ID2 02:000201     8.87      .723    1.37  20.21     .000
                +ID3 03:000202     2.20      .206    1.33  20.21     .000
                 ==================================================
                 SUM 04:000202    17.53     1.372    1.35  19.43     .000

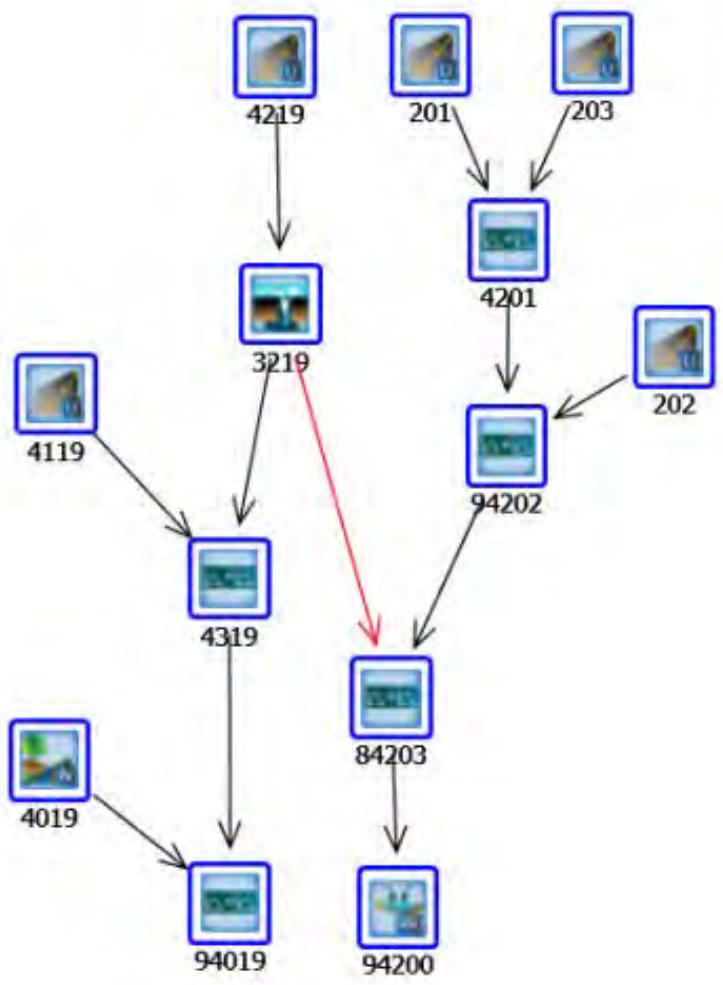
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
001:0007----------------------------------------------------------------------
*Proposed SWM Facility #2 (South Pond)
*It was routed with a 150mm diameter orifice control and 3m wide weir
*
--------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(000202)   |
| OUT<05:(South )   |    =========  OUTLFOW STORAGE TABLE  =========
--------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .040  .3345E+00
                           .017  .6950E-01   |     .043  .3848E+00
                           .022  .1086E+00   |     .045  .4369E+00
                           .027  .1504E+00   |     .206  .4908E+00
                           .031  .1939E+00   |     .498  .5464E+00
                           .034  .2390E+00   |     .875  .6042E+00
                           .037  .2859E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (000202)      17.53     1.372     1.350     19.434
     OUTFLOW<05: (South )      17.53      .038     4.167     19.434

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.772
                   TIME SHIFT OF PEAK FLOW         (min)=   169.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3015E+00

--------------------------------------------------------------------------------
```



Model with Garner Road Drainage

MTE Model

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

       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    Company
        OOO     T      T    H   H    Y    M   M   OOO                 Serial

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                  *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual Otthymo 2.4\VO2\voin.dat
  Output  filename: C:\Users\Bill\AppData\Local\Temp\11ffec6f-edc3-4a51-87c7-
be84cccb83a4\Scenario.out
  Summary filename: C:\Users\Bill\AppData\Local\Temp\11ffec6f-edc3-4a51-87c7-
be84cccb83a4\Scenario.sum


DATE: 11/28/2013                          TIME: 10:21:08

  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************


--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 646.000
| Ptotal= 35.07 mm |                          B=   6.000
--------------------                          C=   0.781
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    =  5.00 min
                        Time to peak ratio =  0.33

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.08    2.22 |  1.08    9.93 |  2.08    6.27 |  3.08    2.97
                0.17    2.36 |  1.17   15.28 |  2.17    5.70 |  3.17    2.85
                0.25    2.51 |  1.25   34.51 |  2.25    5.23 |  3.25    2.75
                0.33    2.69 |  1.33   99.29 |  2.33    4.84 |  3.33    2.65
                0.42    2.91 |  1.42   44.07 |  2.42    4.51 |  3.42    2.56
                0.50    3.16 |  1.50   24.99 |  2.50    4.22 |  3.50    2.48
                0.58    3.47 |  1.58   17.33 |  2.58    3.97 |  3.58    2.40
                0.67    3.86 |  1.67   13.27 |  2.67    3.76 |  3.67    2.33
                0.75    4.36 |  1.75   10.78 |  2.75    3.56 |  3.75    2.26
                0.83    5.03 |  1.83    9.10 |  2.83    3.39 |  3.83    2.19
                0.92    5.98 |  1.92    7.89 |  2.92    3.24 |  3.92    2.14
                1.00    7.43 |  2.00    6.98 |  3.00    3.10 |  4.00    2.08


------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=   8.87
|ID= 1 DT= 2.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  35.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.77         3.10
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     243.17        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.033    2.22 | 1.033    9.93 | 2.033    6.27 |  3.03    2.97
               0.067    2.22 | 1.067    9.93 | 2.067    6.27 |  3.07    2.97
               0.100    2.29 | 1.100   12.60 | 2.100    5.99 |  3.10    2.91
               0.133    2.36 | 1.133   15.28 | 2.133    5.70 |  3.13    2.85
               0.167    2.36 | 1.167   15.28 | 2.167    5.70 |  3.17    2.85
               0.200    2.51 | 1.200   34.51 | 2.200    5.23 |  3.20    2.75
               0.233    2.51 | 1.233   34.51 | 2.233    5.23 |  3.23    2.75
               0.267    2.60 | 1.267   66.90 | 2.267    5.04 |  3.27    2.70
               0.300    2.69 | 1.300   99.29 | 2.300    4.84 |  3.30    2.65
               0.333    2.69 | 1.333   99.29 | 2.333    4.84 |  3.33    2.65
               0.367    2.91 | 1.367   44.07 | 2.367    4.51 |  3.37    2.56
               0.400    2.91 | 1.400   44.07 | 2.400    4.51 |  3.40    2.56
               0.433    3.03 | 1.433   34.53 | 2.433    4.37 |  3.43    2.52
               0.467    3.16 | 1.467   24.99 | 2.467    4.22 |  3.47    2.48
               0.500    3.16 | 1.500   24.99 | 2.500    4.22 |  3.50    2.48
               0.533    3.47 | 1.533   17.33 | 2.533    3.97 |  3.53    2.40
               0.567    3.47 | 1.567   17.33 | 2.567    3.97 |  3.57    2.40
               0.600    3.67 | 1.600   15.30 | 2.600    3.87 |  3.60    2.36
               0.633    3.86 | 1.633   13.27 | 2.633    3.76 |  3.63    2.33
               0.667    3.86 | 1.667   13.27 | 2.667    3.76 |  3.67    2.33
               0.700    4.36 | 1.700   10.78 | 2.700    3.56 |  3.70    2.26
               0.733    4.36 | 1.733   10.78 | 2.733    3.56 |  3.73    2.26
               0.767    4.69 | 1.767    9.94 | 2.767    3.48 |  3.77    2.23
               0.800    5.03 | 1.800    9.10 | 2.800    3.39 |  3.80    2.19
               0.833    5.03 | 1.833    9.10 | 2.833    3.39 |  3.83    2.19
               0.867    5.98 | 1.867    7.89 | 2.867    3.24 |  3.87    2.14
               0.900    5.98 | 1.900    7.89 | 2.900    3.24 |  3.90    2.14
               0.933    6.70 | 1.933    7.44 | 2.933    3.17 |  3.93    2.11
               0.967    7.43 | 1.967    6.98 | 2.967    3.10 |  3.97    2.08
               1.000    7.43 | 2.000    6.98 | 3.000    3.10 |  4.00    2.08

     Max.Eff.Inten.(mm/hr)=      88.49        43.55
                over (min)        5.00        12.00
     Storage Coeff.  (min)=       4.57 (ii)   11.98 (ii)
     Unit Hyd. Tpeak (min)=       4.00        12.00
     Unit Hyd. peak  (cms)=       0.26         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.60         0.22         0.707 (iii)
     TIME TO PEAK    (hrs)=       1.37         1.53          1.37
     RUNOFF VOLUME    (mm)=      34.07        12.64         20.14
     TOTAL RAINFALL   (mm)=      35.07        35.07         35.07
     RUNOFF COEFFICIENT   =       0.97         0.36          0.57


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0203) |   Area    (ha)=   6.46
|ID= 1 DT= 2.0 min |   Total Imp(%)=  55.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.55         2.91
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     207.53        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      88.49        29.90
                over (min)        5.00        16.00
     Storage Coeff.  (min)=       4.16 (ii)   15.60 (ii)
     Unit Hyd. Tpeak (min)=       4.00        16.00
     Unit Hyd. peak  (cms)=       0.27         0.07
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.39         0.13         0.430 (iii)
     TIME TO PEAK    (hrs)=       1.37         1.60          1.37
     RUNOFF VOLUME    (mm)=      34.07        11.18         18.04
     TOTAL RAINFALL   (mm)=      35.07        35.07         35.07
     RUNOFF COEFFICIENT   =       0.97         0.32          0.51


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------

--------------------
| ADD HYD   (4201) |
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0201):     8.87   0.707     1.37    20.14
        + ID2= 2 (0203):     6.46   0.430     1.37    18.04
          ==============================================
          ID = 3 (4201):    15.33   1.138     1.37    19.26

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   2.20
|ID= 1 DT= 2.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  35.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.43         0.77
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     121.11        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      88.49     ********
                over (min)        5.00        12.00
     Storage Coeff.  (min)=       3.01 (ii)   10.42 (ii)
     Unit Hyd. Tpeak (min)=       4.00        12.00
     Unit Hyd. peak  (cms)=       0.33         0.10
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.17         0.06         0.193 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50          1.37
     RUNOFF VOLUME    (mm)=      34.07        12.64         20.14
     TOTAL RAINFALL   (mm)=      35.07        35.07         35.07
     RUNOFF COEFFICIENT   =       0.97         0.36          0.57


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     2.20   0.193     1.37    20.14
        + ID2= 2 (4201):    15.33   1.138     1.37    19.26
          ================================================
          ID = 3 (****):    17.53   1.331     1.37    19.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (4219) |   Area    (ha)=   1.57
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.18         0.39
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      50.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=      88.49     ********
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       1.93 (ii)    6.70 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.41         0.16
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.29         0.03         0.294 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.43          1.33
     RUNOFF VOLUME    (mm)=      34.07         5.17         26.84
     TOTAL RAINFALL   (mm)=      35.07        35.07         35.07
     RUNOFF COEFFICIENT   =       0.97         0.15          0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| DUHYD     (3219) |
| Inlet Cap.=0.434 |
| #of Inlets=    1 |
| Total(cms)=  0.4 |      AREA     QPEAK     TPEAK    R.V.
--------------------      (ha)     (cms)     (hrs)    (mm)
     TOTAL HYD.(ID= 1):   1.57      0.29      1.33   26.84
     ===================================================
     MAJOR SYS.(ID= 2):   0.00      0.00      0.00    0.00
     MINOR SYS.(ID= 3):   1.57      0.29      1.33   26.84

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (3219):     1.57   0.294     1.33    26.84
        + ID2= 2 (****):    17.53   1.331     1.37    19.37
          ================================================
          ID = 3 (****):    19.10   1.613     1.37    19.98

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (****) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0400      0.3345
                          0.0166     0.0695   |   0.0427      0.3848
                          0.0223     0.1086   |   0.0452      0.4369
                          0.0268     0.1504   |   0.2060      0.4908
                          0.0306     0.1939   |   0.4979      0.5464
                          0.0340     0.2390   |   0.8752      0.6042
                          0.0371     0.2859   |   0.0000      0.0000

                             AREA     QPEAK     TPEAK       R.V.
                             (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (****)     19.100      1.613      1.37      19.98
     OUTFLOW: ID= 1 (****)     19.100      0.040      4.15      17.15

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.50
                   TIME SHIFT OF PEAK FLOW         (min)=167.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3404

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (4019) |   Area    (ha)= 119.82   Curve Number   (CN)= 66.9
|ID= 1 DT= 2.0 min |   Ia      (mm)=   9.90   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.60

     Unit Hyd Qpeak  (cms)=   7.628

     PEAK FLOW       (cms)=   0.652 (i)
     TIME TO PEAK    (hrs)=   2.333
     RUNOFF VOLUME    (mm)=   4.200
     TOTAL RAINFALL   (mm)=  35.070
     RUNOFF COEFFICIENT   =   0.120

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (4119) |   Area    (ha)=   2.43
|ID= 1 DT= 2.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.82         0.61
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      75.00        40.00
     Mannings n           =      0.015        0.250

     Max.Eff.Inten.(mm/hr)=      88.49        31.03
                over (min)        5.00         8.00
     Storage Coeff.  (min)=       2.46 (ii)    7.24 (ii)
     Unit Hyd. Tpeak (min)=       4.00         8.00
     Unit Hyd. peak  (cms)=       0.37         0.15
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.42         0.04         0.430 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.43          1.33
     RUNOFF VOLUME    (mm)=      34.07         5.17         26.84
     TOTAL RAINFALL   (mm)=      35.07        35.07         35.07
     RUNOFF COEFFICIENT   =       0.97         0.15          0.77

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (4319) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
*** W A R N I N G :  HYDROGRAPH 3219 <ID= 1> IS DRY.
*** W A R N I N G :  HYDROGRAPH 4319 = HYDROGRAPH 4119
*** W A R N I N G :  HYDROGRAPH 4319 = HYDROGRAPH 4119
          ID1= 1 (3219):     0.00   0.000     0.00     0.00
        + ID2= 2 (4119):     2.43   0.430     1.33    26.84
          ================================================
          ID = 3 (4319):     2.43   0.430     1.33    26.84

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (****) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (4019):   119.82   0.652     2.33     4.20
        + ID2= 2 (4319):     2.43   0.430     1.33    26.84
          ================================================
          ID = 3 (****):   122.25   0.678     2.30     4.65

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (8201) |   Area    (ha)=   8.87
|ID= 1 DT= 2.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  35.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.77         3.10
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     243.17        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      88.49     ********
                over (min)        5.00        12.00
     Storage Coeff.  (min)=       4.57 (ii)   11.98 (ii)
     Unit Hyd. Tpeak (min)=       4.00        12.00
     Unit Hyd. peak  (cms)=       0.26         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.60         0.22         0.707 (iii)
     TIME TO PEAK    (hrs)=       1.37         1.53          1.37
     RUNOFF VOLUME    (mm)=      34.07        12.64         20.14
     TOTAL RAINFALL   (mm)=      35.07        35.07         35.07
     RUNOFF COEFFICIENT   =       0.97         0.36          0.57

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
```

```
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (8203) |   Area    (ha)=   6.46
|ID= 1 DT= 2.0 min |   Total Imp(%)=  55.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.55         2.91
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     207.53        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      88.49        29.90
                over (min)        5.00        16.00
     Storage Coeff.  (min)=       4.16 (ii)   15.60 (ii)
     Unit Hyd. Tpeak (min)=       4.00        16.00
     Unit Hyd. peak  (cms)=       0.27         0.07
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.39         0.13          0.430 (iii)
     TIME TO PEAK    (hrs)=       1.37         1.60           1.37
     RUNOFF VOLUME    (mm)=      34.07        11.18          18.04
     TOTAL RAINFALL   (mm)=      35.07        35.07          35.07
     RUNOFF COEFFICIENT   =       0.97         0.32           0.51


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------


--------------------
| ADD HYD   (9201) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (8201):     8.87   0.707     1.37    20.14
        + ID2= 2 (8203):     6.46   0.430     1.37    18.04
          ===============================================
          ID = 3 (9201):    15.33   1.138     1.37    19.26

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (8202) |   Area    (ha)=   2.20
|ID= 1 DT= 2.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  35.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.43         0.77
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     121.11        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      88.49        43.55
                over (min)        5.00        12.00
     Storage Coeff.  (min)=       3.01 (ii)   10.42 (ii)
     Unit Hyd. Tpeak (min)=       4.00        12.00
     Unit Hyd. peak  (cms)=       0.33         0.10
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.17         0.06          0.193 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50           1.37
     RUNOFF VOLUME    (mm)=      34.07        12.64          20.14
     TOTAL RAINFALL   (mm)=      35.07        35.07          35.07
     RUNOFF COEFFICIENT   =       0.97         0.36           0.57


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------


--------------------
| ADD HYD   (9202) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (8202):     2.20   0.193     1.37    20.14
        + ID2= 2 (9201):    15.33   1.138     1.37    19.26
          ===============================================
          ID = 3 (9202):    17.53   1.331     1.37    19.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (8200) |
| IN= 2---> OUT= 1 |
| DT=  1.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0400      0.3345
                          0.0166     0.0695   |   0.0427      0.3848
                          0.0223     0.1086   |   0.0452      0.4369
                          0.0268     0.1504   |   0.2060      0.4908
                          0.0306     0.1939   |   0.4979      0.5464
                          0.0340     0.2390   |   0.8752      0.6042
                          0.0371     0.2859   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (9202)     17.530     1.331      1.37      19.37
     OUTFLOW: ID= 1 (8200)     17.530     0.038      4.15      16.94

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.85
                   TIME SHIFT OF PEAK FLOW         (min)=167.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3009

FINISH
================================================================================
========================
```

Appendix G

Storm Sewer Design Data

Nov. 20/13

RYNAL RD. STM
EXTERNAL AREAS - EXISTING CONDITIONS

C6 A = 1.56 ha C = 0.4
T_c = 22.6 mins.

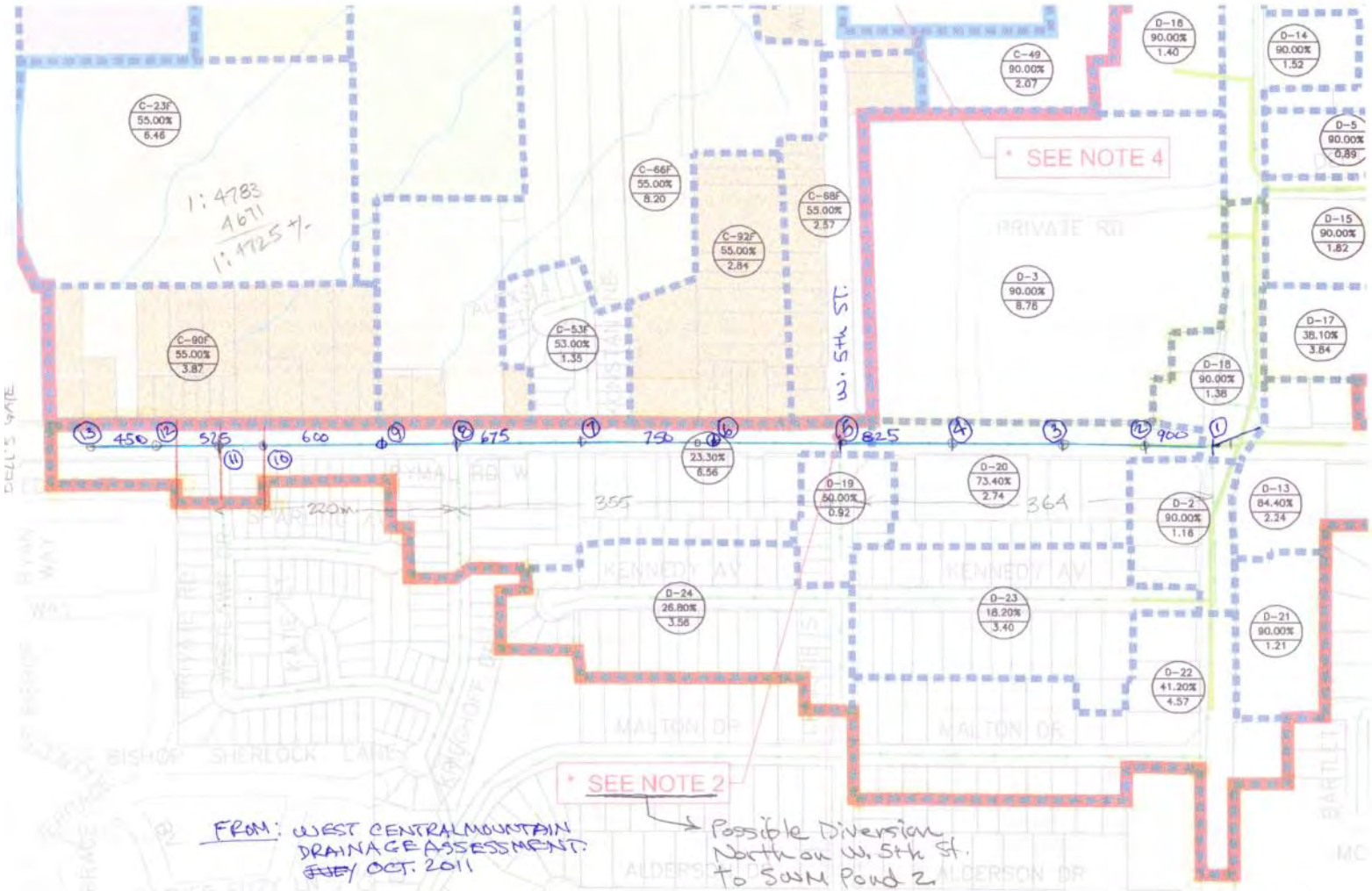
C5 A = 7.38 ha C = (1.83 × 0.5) + (5.98 × 0.2) / 7.81
= 0.27
T_c = 59.5 mins.

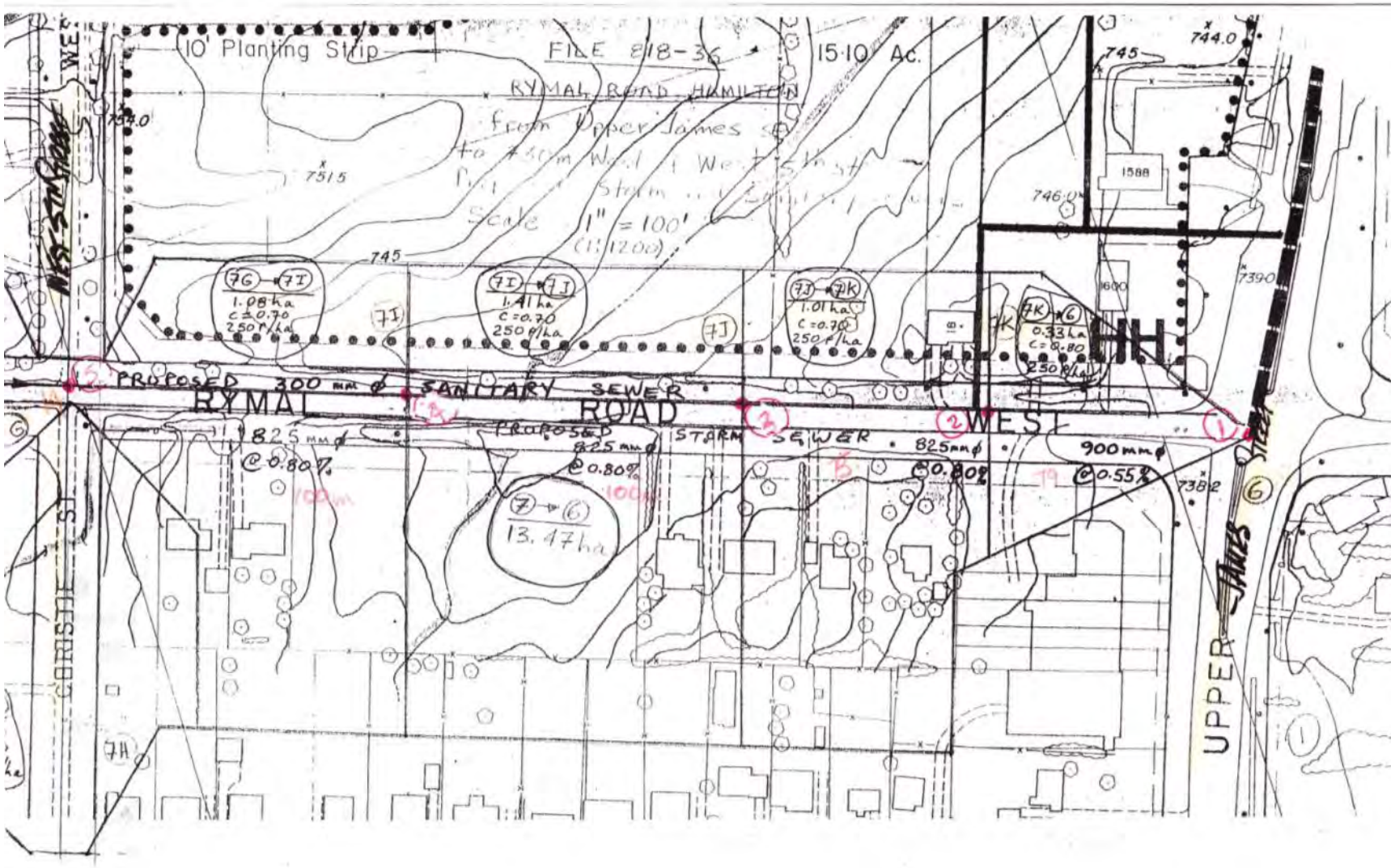
C4 A = 2.20 ha C = (1.47 × 0.5) + (1.5 × 0.2) / 2.97
= 0.35
T_c = 42.8 mins

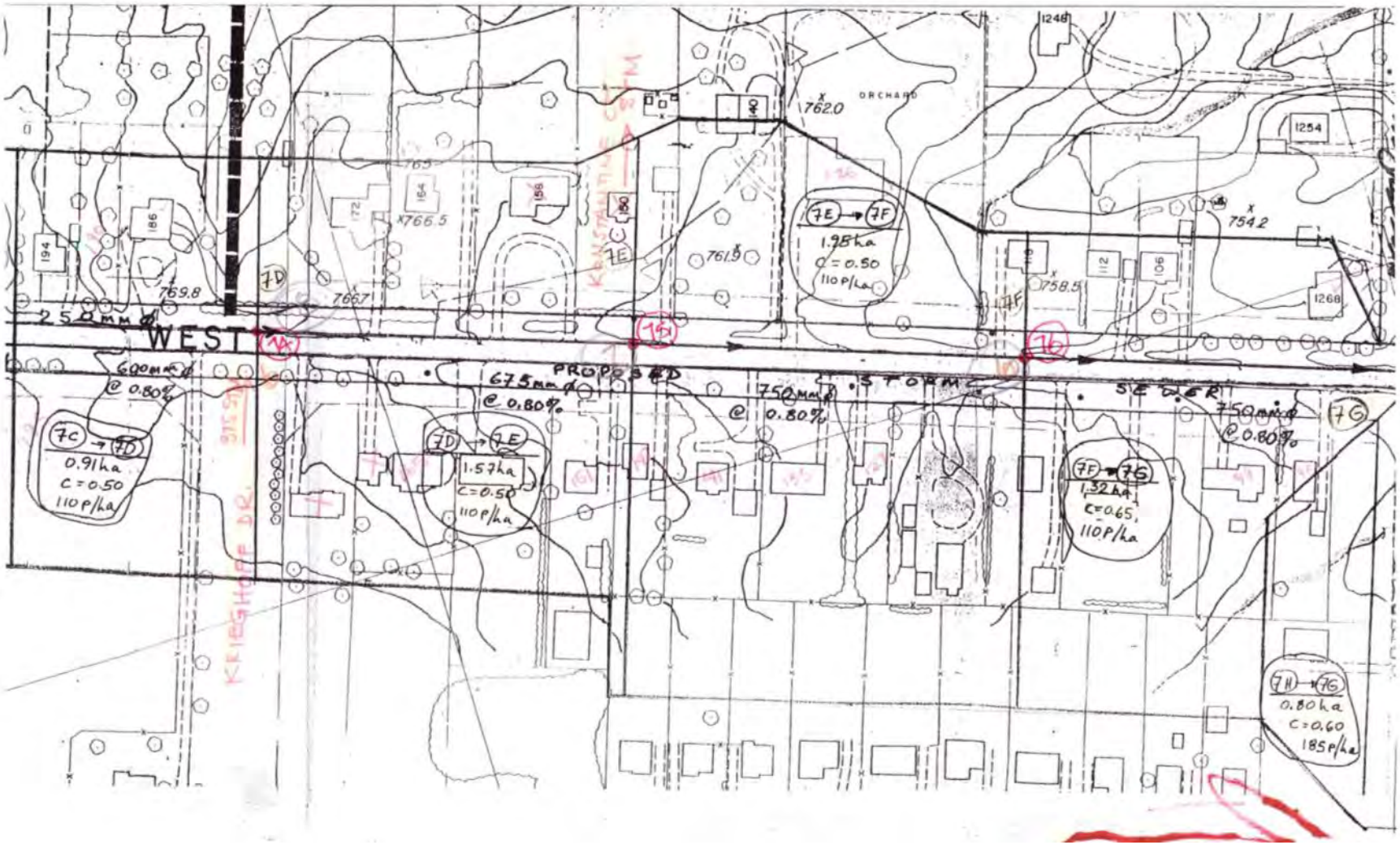
C3 A = 10.41 ha C = 0.25
T_c = 40.9 mins.

C2 A = 2.36 ha C = 0.20
T_c = 25 mins.

C1 A = 1.61 ha C = 0.40
T_c = 25 mins


C-23F 55.00% 6.46
1: 4783
4671
1: 4725 +/-
C-90F 55.00% 3.87
C-66F 55.00% 8.20
C-92F 55.00% 2.84
C-53F 53.00% 1.35
C-68F 55.00% 2.57
W. 5th ST.
C-49 90.00% 2.07
D-18 90.00% 1.40
D-14 90.00% 1.52
D-5 90.00% 0.89
D-15 90.00% 1.82
D-3 90.00% 8.76
D-17 38.10% 3.84
D-18 90.00% 1.38
* SEE NOTE 4
PRIVATE RD
450
525
600
675
750
825
900
23.30% 6.56
D-19 50.00% 0.92
D-20 73.40% 2.74
D-2 90.00% 1.18
D-13 84.40% 2.24
220m
355
364
KENNEDY AV
D-24 26.80% 3.58
D-23 18.20% 3.40
D-21 90.00% 1.21
D-22 41.20% 4.57
MALTON DR
* SEE NOTE 2
FROM: WEST CENTRAL MOUNTAIN DRAINAGE ASSESSMENT. ~~EJE~~ OCT. 2011
Possible Diversion North on W. 5th St. To SWM Pond 2
CATCHMENT D = 100.5ha total


10' Planting Strip
FILE 818-36
15.10 Ac.
RYMAL ROAD HAMILTON
Scale 1" = 100'
(1:1200)
WESTSIDE
CORSTIE ST
RYMAL ROAD WEST
UPPER JAMES
PROPOSED 300 mm ø SANITARY SEWER
PROPOSED STORM SEWER
825 mm ø @ 0.80%
900 mm ø @ 0.55%
1.08 ha C=0.70 250 p/ha
1.41 ha C=0.70 250 p/ha
1.01 ha C=0.70 250 p/ha
0.33 ha C=0.80 250 p/ha
13.47 ha
1588
1600
744.0
745
746.0
739.0
738.2
751.5


WEST
PROPOSED STORM SEWER
250mm ø
600mm ø @ 0.80%
675mm ø @ 0.80%
750mm ø @ 0.80%
750mm ø @ 0.80%
7C → 7D
0.91ha
C = 0.50
110 P/ha
7D → 7E
1.57ha
C = 0.50
110 P/ha
7E → 7F
1.98ha
C = 0.50
110 P/ha
7F → 7G
1.32ha
C = 0.65
110 P/ha
7H → 7G
0.80ha
C = 0.60
185 P/ha
ORCHARD
KRIEGHOFF DR.
762.0
766.5
769.8
766.7
761.9
758.5
754.2

STM to UPPER JAMES

Google earth feet 900 meters 200

1:3000

Google earth feet 900 meters 200

Google earth

feet 900

meters 200

DESIGN PARAMETERS.
RYMAL STORM SEWERS
FROM WEST TO UPPER JAMES.

Nov. 20/12

1

SEWER DATA FROM ORIGINAL DESIGN
SKETCH - CATCHMENT BOUNDARIES
FROM UCM DRAINAGE STUDY

$\boxed{2-1}$ Area = 0.184 ha 60 m 900 ø @ 0.55 %

c = 0.9

[c values estimated from Google photo.]

$\boxed{3-2}$ A = 0.828 ha 75 m 825 ø @ 0.8 %

$c = (0.29 \times .2) + (0.71 \times .9) = 0.70.$

$\boxed{4-3}$ A = 1.143 ha 100 m 825 ø @ 0.8 %

$c = (0.24 \times .2) + (0.76 \times 0.9) = 0.73$

$\boxed{5-4}$ A = 1.598 ha 100 m 825 ø @ 0.8 %

$c = \frac{(110 \times 50) \times 0.5 + (90 \times 113) \times 0.8}{15980} = 0.68$

SEWER DATA FROM SURVEY
DRAINAGE BOUNDARIES FROM
WEST CENTRAL MOUNTAIN
DRAINAGE STUDY.

$\boxed{6-5}$ A = 1.067 ha 120 m 750 ø @ 0.98 %

$c = (0.68 \times 0.5) + (0.32 \times 0.75) = 0.58$

(Assume residential 0.5, road 0.75).

$\boxed{7-6}$ 13 x 113 + 110 x 113 120 m 750 ø @ 0.91 %
A = 1.390 ha

c = 0.58.

Nov 20/12

(2)

$\boxed{8-7}$ $A = 1.283\ ha$ 115m 675 Ø @ 0.87%

$C = 0.58$

$\boxed{9-8}$ $A = 1.188\ ha$ 70m 600 Ø @ 0.72%

$$C = \frac{\overset{0.324}{(36 \times 90)} \times 0.75 + (0.864 \times 0.5)}{1.188} = 0.57.$$

$\boxed{10-9}$ $A = 105 \times 54 = 0.567\ ha$ 105m 600 Ø @ 2.14%

$C = 0.80$

$\boxed{11-10}$ $A = 0.225\ ha$ 45m 525 Ø @ 0.47%

$C = 0.75$

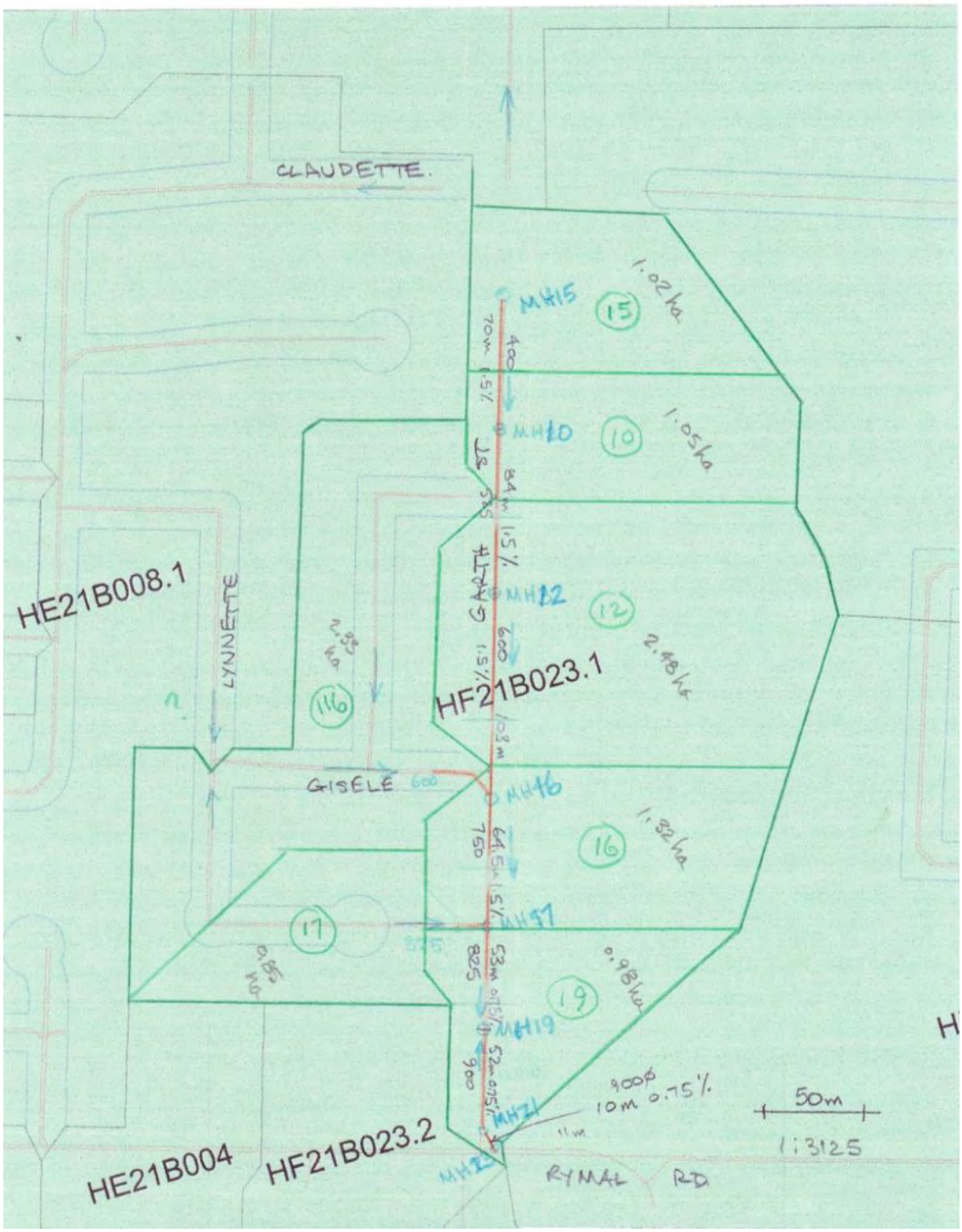
$\boxed{12-11}$ $A = 0.482\ ha$ 60m 525 Ø @ 0.64%

$$C = \overset{0.234}{(36 \times 65)} \times 0.75 + (0.248 \times 0.6) = 0.67.$$

$\boxed{13-12}$ $A = (21 + 80) \times 55 = 0.556\ ha$ 90m 450 Ø @ 0.54%

$$C = \frac{(36 \times 101) \times 0.75 + (20 \times 101) \times 0.2}{5560} = 0.56$$

STM CATCHMENTS.
GARTH SOUTH



Google earth

feet 1000

meters 500

1:3185

GARTH 'C' VALUES

Nov. 13/13

SOUTH (CLAUDETTE TO RYMAL)

AREA 15 1.02 ha

Pavement 83 X 80 = 0.661 ha

Garth St. 83m X 8.44 = 0.070 ha

Exist. Wtd C : = (0.731 @ 0.9 + 0.289 X 0.2)/1.02
= 0.71

Future Garth 83m X 25 = 0.2075
+ 0.661
Fut. Wtd C : (0.869 X 0.9 + 0.151 X 0.2)/1.02
= 0.79

AREA 10 1.05 ha

Pavement 99m X 54m = 0.536 ha

Garth St. 67 X 8.44 = 0.0565
(0.593 X 0.9 + 0.457 X 0.2)/1.05
Exist. Wtd. C = 0.61

Future Garth 67m X 25 = 0.168
+ 0.536
(0.704 X 0.9 + 0.347 X 0.2)/1.05
Fut. Wtd. C = 0.67

Area (12) 2.48 ha

Residential 0.219 ha @ 0.5
Garth St. 137m x 8.44 = 0.116 ha @ 0.9
Grass 2.145 @ 0.2

Exist. Wtd C = 0.26

Future Garth 137m X 25 = 0.343 @ 0.9
Future Grass 1.92 @ 0.2
Fut. Wtd. C = 0.32

Area (16) + (116) 3.65 ha

Residential 2.45 @ 0.55
Garth St. 76m x 8.44 = 0.065 @ 0.9
Grass 1.135 @ 0.2

Exist. Wtd C = 0.45

Fut. Garth 76m x 25m = 0.19 m @ 0.9
Fut. Grass 1.01 @ 0.2
Fut. Wtd C = 0.47

Area (17) 0.85 ha @ 0.55 (Residential)

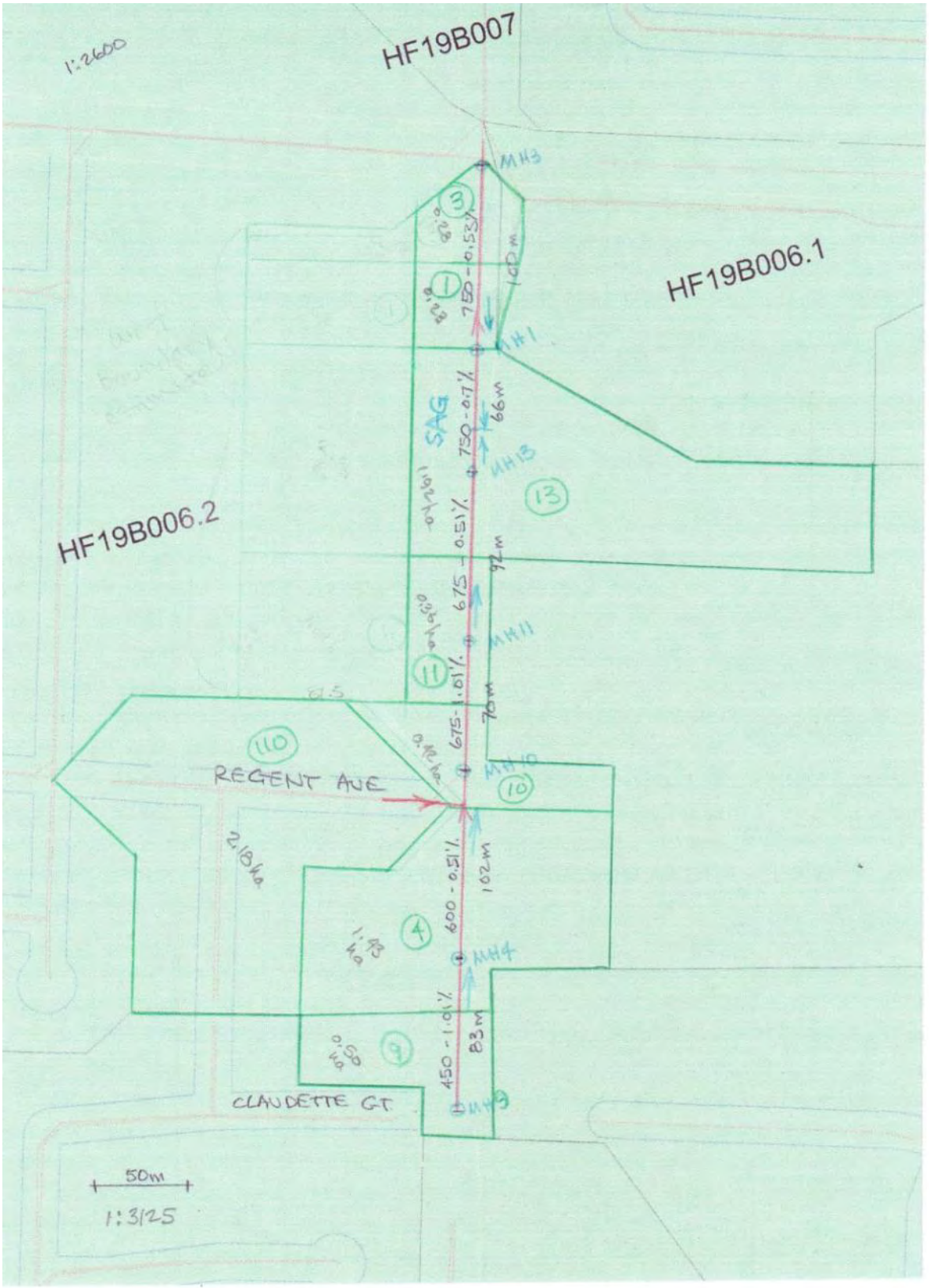
Area (19) 0.98 ha

Exist. Garth 127m x 8.5 = 0.108 @ 0.9
Grass 0.872 @ 0.2

Ex. Wtd C = 0.28

Future Garth = 127 x 26 = 0.33 @ 0.9
Grass = 0.65 @ 0.2

Fut Wtd. C = 0.44



GARTH ST. NORTH
STM CATCHMENTS

Google earth

feet 1000

meters 500

1: 3175

Nov. 13/13

(3)

NORTH (CLAUDETTE TO STONE CHURCH)

AREA (9) 0.50 ha

Town House 0.218 ha @ 0.60 Exist. C = 0.56
Grass + 67 x 14 0.092 + 0.056 = 0.148 @ 0.2
Garth St. 67m x 8.5 0.057 @ 0.9
Other pavement 0.077 @ 0.9
.134

Future Garth 67m x 26 = 0.174 @ 0.9
Grass 0.008 @ 0.2
Other pavement 0.008 @ 0.9
Town House 0.310 @ 0.6.

Future C = 0.70

AREA (4) 1.43 ha

Town House (0.48 + 0.48) @ 0.6 (0.96)
Garth St. 108m x 8.44 = 0.091 @ 0.9 (0.156) Exist. C = 0.51 (0.54)
Unpaved/Grass 0.25 @ 0.2 (0.31)

Future Garth 108m x 26 = 0.28 @ 0.9
Grass 0.041 @ 0.2 Fut C = 0.65
Town house 1.11 @ 0.6

Area (10) + (11) 2.60 ha

Garth 64m x 8.5 = 0.054 ha @ 0.9 Exist C = 0.55
Grass + 64 x 27.5 (0.176 + 0.166) @ 0.2
Town house 2.20 @ 0.6

Future Garth 64 x 26 = 0.166 @ 0.9 Fut. C = 0.61
Grass 0.054 @ 0.2
Town house 2.38 @ 0.6

Nov 13/13 (4)

AREA (13) ~~2.88~~ 1.92 ha

Townhouses ~~1.10~~ 0.14 ha @0.6
Grass +117+27.5 1.36 + 0.32 = 1.68 @0.2 C = ~~0.38~~ 0.27
Garner 117 x 8.5 ~~0.10~~ @0.9

Future Garner 117 x 26 0.30 x 0.9
Townhouses ~~1.42~~ 0.40 @0.6 Fut. C = ~~0.47~~ 0.40
Grass 1.16 @0.2

Area (1) ~~0.62~~ 0.23 ha

Garth St. ~~41m x 19.2~~ = ~~0.079~~ 0.1050 @0.9 Exist C = ~~0.63~~ 0.74
Town houses ~~0.541~~ 0.125 @0.6

Future Garth 60 x 26 = ~~0.107~~ 0.156 x 0.9 Future C = ~~0.65~~ 0.77
Town houses ~~0.541~~ 0.125 x 0.6
Now Tot. Area ~~0.648~~ 0.281

Area (3) ~~0.44~~ 0.28 ha

Garth St. 64m x 32 = ~~0.202~~ 0.187 x 0.9 Exist C = ~~0.73~~ 0.79
Townhouses 0.238 x 0.6
0.09 Fut C = ~~0.73~~ 0.79

Area (11) ~~1.04~~ 0.36 ha

Garth St. 79m x 8.5 0.067 @0.9
Townhouses ~~0.951~~ 0.22 @0.6 Exist. C = ~~0.61~~ 0.63
Grass 79m x 27.5 0.022 @0.2

Future Garth
Garth St 79 x 27 0.205 @0.9
Grass 79 x 9 0.071 @0.2 Fut C = ~~0.66~~ 0.69
Town houses ~~0.764~~ 0.084 @0.6

Appendix H

Preliminary Design Plates and SWM Plan

For the purposes of this Environmental Study Report, the Draft Drainage and Stormwater Management Report excludes the Preliminary Design plates. Design plates, with the drainage facilities shown, can be found in Appendix C of this ESR.

APPENDIX D.3

NATURAL ENVIRONMENT REPORT

Garner Road/Rymal Road and Garth Street

Class Environmental Assessment

DRAFT
NATURAL ENVIRONMENTAL REPORT

NOVEMBER 2013

Prepared for:
City of Hamilton
400 - 77 James Street North
Hamilton, ON L8R 2K3

128039-4E-Rev PA

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Figure 2: Fish habitat sensitivity and constraints

Figure 3: Ecological land classification (ELC) mapping for the study area

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Appendix B: Vascular Plants found in the study area

Appendix C: Photos of typical vegetation found in the study area

Appendix D: Tree Inventory

1.0 INTRODUCTION

SNC-Lavalin Environment (SLE) was retained by the City of Hamilton to carry out a review of the aquatic, wildlife and terrestrial habitat conditions in support of the Environmental Assessment Study (EA) Phase 3 and 4 for the Garner Road East/ Rymal Road corridor between Highway 6 and West 5th Street; and Garth Street between Rymal Road West to and beyond Stone Church Road. The Background Study for the Meadowlands Neighbourhoods 3, 4 and 5, Class Environmental Assessment Master Plan recommended improving Garner Road East, stretching from Southcote Road to Glancaster Road.

The purpose of this report is to document the existing conditions of the habitat within the study area for the EA. The study area is located within three watersheds: Twenty Mile Creek watershed (Upper Twenty Mile Creek), Red Hill Creek watershed (Upper Ottawa Creek) and Spencer Creek watershed (Tiffany Creek and Ancaster Creek).

Initial review of the aerial photography available indicates that the corridor is composed of two broad areas with respect to development and vegetation. East of the Tiffany Creek ESA, most of the project area has been developed for residential purposes with vegetation consisting principally of manicured open space, lawns and planted streetscape trees. One notable exception is the remnant woodlot located on the east side of Garth Street, just north of Rymal Road. West of Tiffany Creek the corridor is largely characterized by agricultural fields, and meadow communities in former fields interspersed with residential homes of much lower density along Garner Road. Wetland communities within the project area are confined to drainage ditches along the road and crossings associated with the tributaries of Tiffany and Upper Twenty Mile creeks.

All of the watercourses within the study area have reaches that have been altered through a combination of agricultural and urban development, and are generally considered to have degraded habitat conditions for aquatic life.

1.1 Project Area

The ‘project area’ refers to the area of Hamilton Ontario, along Garner Road East to Highway 6, Rymal Road West to Upper James and Garth Street just north of Stone Church Road. The term ‘study area’ refers to the project area plus the surrounding area, approximately 1 km (shown in **Figure 1**). The study area is characterized by a mix of remnant wood lots, an overall urban gradient and residential/suburban land uses along Rymal Road and rural/recreational lands along Garner Road East.

2.0 FISH AND FISH HABITAT

2.1 Study Methods

The description of the existing aquatic conditions involved the collection and review of secondary source information and collection of data during the field investigation by SNC-Lavalin Environment (SLE) on December 22, 2011.

2.1.1 Background Data Collection

Background data on the natural environmental features within the study area were collected and reviewed from various published and non-published sources. Sources of information include:

- Hamilton Harbour and Watershed Fisheries Management Plan;
- Ontario Ministry of Natural Resources (MNR), Guelph District;
- Hamilton Conservation Authority (HCA);
- Niagara Peninsula Conservation Authority (NPCA);
- Natural Heritage Information Center (NHIC) website;
- Urban Hamilton Official Plan, Schedule B, Natural Heritage System;
- Canadian Wildlife Species at Risk (SARA); and
- Species at Risk in Ontario (SARO).

2.1.2 Field Surveys

To confirm background conditions and the sensitivity of fish and fish habitat reported by others, SLE conducted a field investigation on December 22, 2011 to fully characterize and assess habitat features present at the watercourse crossings in the study area for the Garner/Garth corridor. Field data collection methods included:

- ***Documented information*** on stream type, substrate, morphology, bank stability, in-stream cover, riparian cover vegetation, migratory obstructions and presence of any critical habitat (i.e., spawning); and
- ***Photographic Documentation*** of existing fish habitat conditions for the watercourses within the study area.

Fish community sampling and inventory was not completed as background data was deemed sufficient for the assessment of the fish community present at the watercourses in the study area. Information reported on fish species is derived primarily from historical fish collection records kindly provided by the Hamilton Region Conservation Authority and the *Hamilton Harbour and Watershed Fisheries Management Plan*[1]. The timing of the field investigations in December was considered appropriate to confirm and assess existing physical (e.g., flow regime, temperature) and biotic (e.g., aquatic vegetation) habitat conditions, and specific fish use of interest.

The fish habitat assessment was conducted utilizing the general methods and procedures outlined in the *MNR Ontario Stream Assessment Protocol*[2]. Information recorded included:

- Watercourse size, flow (permanent/intermittent) and thermal regime (coldwater/warmwater);

[1] Bowlby et al., 2009

[2] Stanfield (ed.), 2010

- Physical channel dimensions and habitat characteristics – width, depth (including bankfull and wetted widths and depths), substrate type, in-stream/overhead cover opportunities (e.g., woody debris, undercut banks, vegetation), bank stability/erosion, channel morphology, groundwater seepage/upwelling areas and riparian vegetation;
- Physical barriers to fish movement in the vicinity of the crossings;
- Identification of potential critical or specialized habitat areas or features (i.e., potential spawning or nursery areas); and
- Observations of habitat alterations/land use (i.e., channel modification, potential pollutant sources).

2.1.3 Aquatic Species at Risk

Designated Significant or Sensitive Aquatic Species

The designation of species of national significance is given by the *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC) which may then qualify for legal protection and recovery under the federal *Species at Risk Act* (SARA). Endangered, threatened or extirpated species on Schedule 1 of the SARA are afforded protection under the Act.

The designation of species of provincial significance is based on recommendations made by the *Committee on the Status of Species at Risk in Ontario* (COSSARO). Species classified as "at risk" (i.e., extirpated, endangered, threatened or special concern) by COSSARO are placed on the *Species at Risk List* in Ontario (SARO List). All species are afforded protection under the *Ontario Endangered Species Act* (ESA), with the exception of species of “special concern”.

From the review of Department of Fisheries and Oceans Canada (DFO) “Distribution of Fish Species at Risk” mapping for the study areas, there is one designated aquatic species at risk – Northern Brook Lamprey (*Ichthyomyzon fossor*), identified in the Twenty Mile Creek watershed outside of the study area. While the location of the Northern Brook Lamprey is outside of the study area, the upstream watercourses contribute indirectly to important fish habitat through baseflow and the allochthonous energy inputs to downstream reaches.

The COSEWIC assessed the Northern Brook Lamprey in 2007 and is currently listed on Schedule 1 of the federal *Species at Risk Act* (SARA) as a species of special concern[3].

Northern Brook Lamprey is also considered a provincially designated species at risk and the COSSARO assessed Northern Brook Lamprey as Special Concern.

[3] Government of Canada, 2011

2.2 Fish and Fish Habitat Conditions

2.2.1 Upper Ottawa Creek Subwatershed

Aquatic Habitat

Upper Ottawa Creek is a tributary of Red Hill Creek and the headwaters of Upper Ottawa Creek are located at the northeast corner of Garth Street and Rymal Road. These headwater tributaries are ephemeral and characterized as grassed agricultural swales that flow northeasterly out of the study area (location shown in **Figure 1**). Currently, some of the roadside drainage from parts of both Garth Street and Rymal Road flow into roadside ditches that ultimately flow to Upper Ottawa Creek however the new drainage design for the widening will eliminate overland flow to this subwatershed and it will be directed to the Upper Twenty Mile Creek subwatershed.

The Red Hill Creek watershed has experienced substantial anthropomorphic disturbance and a large proportion of the natural features once present within the watershed have long since been removed. The upper parts of the headwaters of Upper Ottawa Creek are located within an agricultural area but development in the area has already removed nearly half of the remaining agricultural fields and it is likely that some of these headwater watercourses may be buried beneath the development as other reaches have been piped underground just a short distance downstream of Garth Street.

Fish Community

Upper Ottawa Creek is classified as small riverine warmwater habitat[1]. No fish were observed in the watercourses during the SLE field visit in 2011 and fish use of the watercourses is likely limited by the lack of sufficient flow to maintain a baseflow. The headwater reaches located downstream of the study area are characterized by a warmwater fish community consisting of brook stickleback (*Culaea incontans*) and northern redbelly dace (*Chrosomus eos*)[1].

2.2.2 Upper Twenty Mile Creek Subwatershed

Aquatic Habitat

Upper Twenty Mile Creek is a subwatershed of Twenty Mile Creek watershed and is located within the study area on the south side of Rymal Road with one tributary (designated Tributary A) crossing Rymal Road flowing southerly parallel to Garth Street. This tributary of Twenty Mile Creek is classified as small riverine warmwater[1] and is intermittent in flow. It originates just north of the woodlot that borders Garth Street. There was some standing water observed in the stream channel at Rymal Road during the field investigations. The stream channel is characterized as an undefined channel choked with cattails (*Typha latifolia*) and common reed (*Phragmites* sp). Immediately downstream of Rymal Road the watercourse flows into a stormwater pond at St. Elizabeth Village (retirement community). The location of this watercourse is shown on **Figure 1**.

Legend

- Tributaries
- Roads
- Watercourse
- Study Area
- Water Body

N

0 0.1 0.2 0.4 0.6 0.8 1
Kilometers
NAD 1983 UTM Zone 17N

Hamilton

SNC·LAVALIN Environnement

Garner/Rymal and Garth EA
Watercourse crossings with the study area

Date: 10/08/12	File Number: 333123	Sub Code:0000
Figure Number: 1		Rev. 0

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South of the study area there are several tributaries of Upper Twenty Mile Creek that are conveyed in agricultural drainage channels/swales, roadside ditches, as well as some natural channels in varying states of preservation.

All the headwater reaches of Upper Twenty Mile Creek originate as agricultural drainage swales that provide marginal habitat, are intermittent in nature and only support fish habitat indirectly as seasonal contribution (e.g., food sources, baseflow) to downstream reaches. Some of the tributaries that are located just south of the study area appear to be piped underground through residential subdivisions. Upper Twenty Mile Creek is classified as a seasonal warmwater watercourse that provides a combination of important and marginal habitat[1]. Immediately downstream of Upper James Street (outside of the study area) the flow regime of these watercourses improves and they are classified as cool/coldwater containing critical habitat.

Fish Community

No fish were observed in the watercourse during the SLE field visit in 2011. The watercourse is classified as warmwater and indirectly supports (e.g. baseflow, food source contribution) a highly sensitive fishery and habitat located downstream a short distance. Downstream of the study area, Twenty Mile Creek has been classified as redside dace habitat and the intermittent reaches associated with the headwaters of Upper Twenty Mile Creek would indirectly support the downstream habitat.

Limitation to the use of Tributary A by fish is likely attributed to lack of sufficient flow to maintain adequate baseflow and also the diffuse characteristics of the watercourse. Additionally, it appears that the combination of the CSP culvert crossing Rymal Road to the stormwater pond is likely a barrier to fish movement, if adequate flow conditions existed. **Table 1** provides a summary of the physical habitat attributes and fish habitat sensitivity.

Fish sampling in Upper Twenty Mile Creek has not been conducted in proximity to the study area due to the intermittent nature of the headwater tributaries. The closest fish community sampling station in the Twenty Mile Creek watershed is located at Woodburn Road where nine species of fish were recorded including: black crappie (*Pomoxis nigromaculatus*), bluntnose minnow (*Pimephales notatus*), brown bullhead (*Ameiurus nebulosus*), tadpole madtom (*Noturus gyrinus*), largemouth bass (*Micropterus salmoides*), common white sucker (*Castostomus commersoni*), golden shiner (*Notemigonus crysoleucas*), northern pike (*Esox lucius*) and pumpkinseed (*Lepomis gibbosus*). Woodburn Road is located approximately 2 km downstream of the study area.

2.2.3 Spencer Creek Watershed

Within the Spencer Creek watershed there are two subwatersheds that fall within the study area: Tiffany Creek Subwatershed and Ancaster Creek Subwatershed. There are five crossings of Tiffany Creek and two crossings of Ancaster Creek located along Garner Road/Rymal Road.

2.2.3.1 Tiffany Creek Subwatershed

Aquatic Habitat

Tiffany Creek originates in a mixed agricultural and residential area near the Town of Ancaster. The creek flows in an easterly direction before turning north and crossing under Garner Road East where it flows into the Tiffany Creek Headwaters Environmentally Sensitive Area (ESA) and through riparian wetlands.

The area surrounding the headwaters of Tiffany Creek were developed between 1980 and 1999. These developments included highway and road expansion projects as well the development of stormwater management facilities.

There are five crossings of Tiffany Creek along Garner Road East and as this is the headwater area, each tributary is similar in character and classified, by the MNR, as small riverine warmwater. This stream is more variable in flow and temperature due to less groundwater discharge[1]. As a result, some sections of Tiffany Creek may cease to flow in dry periods in the summer months.

Tiffany Creek Tributary A is located just east of the transmission line corridor, is 1.2 m wide and 0.2 m deep with a substrate composed of mud, sand and small gravel. Cattails (*Typha latifolia*) line the stream banks as well as willow (*Salix* sp.), red-osier dogwood (*Cornus stolonifera*) and a mix of herbaceous vegetation. This tributary is permanent and provides direct fish habitat as fish were observed in the stream channel during the SLE field investigations.

Tiffany Creek Tributary B and C originate northwest of Garner Road and Glancaster Road and flow along the north side of Garner Road through a ditch. These watercourses combine with Tributary A and then flow north into the Tiffany Creek wetland. Tributary B originates in a meadow in a defined channel approximately 0.2 m wide and 0.05 m deep. The riparian zone is dominated by a mix of herbaceous vegetation including goldenrod, reed canary grass, teasel and burdock. Tributary C originates in a residential area and appears to function more like a drainage ditch as the watercourse is surrounded by manicured lawns and no natural riparian vegetation. Both of these watercourses are classified as intermittent and there was no standing water observed in the watercourses at the time of the field investigations. Due to the intermittent nature, there is no direct fish habitat use of these watercourses however they contribute indirectly to downstream habitats through allochthonous matter input and baseflow contribution in the spring and following storm events.

Tiffany Creek Tributary D originates just north of Garner Road East between Springbrook Avenue and Glancaster Road. This watercourse is conveyed through a small defined channel that was dry during the field investigations. This watercourse is ephemeral, provides no direct fish habitat and contributes indirectly to downstream fish habitats through seasonal input of baseflow and allochthonous matter inputs.

Tiffany Creek Tributary E originates north of Garner Road East between Smith Road and Springbrook Avenue. Just upstream of Garner Road the tributary has undergone some anthropomorphic alterations to accommodate development for Redeemer College. The tributary

flows through the college property into a stormwater pond that is located approximately 50 m upstream of Garner Road. The outlet of the stormwater pond is underground and the tributary is piped underground and daylights at Garner Road. The watercourse is classified as ephemeral however there was standing water observed in the channel at Garner Road at the time of the field investigations. It is likely that the standing water is a result of grade changes at the culvert, as reaches downstream of Garner Road were dry. The downstream reach is located in an agricultural field.

Fish Community

Tiffany Creek is classified as warmwater riverine and there is limited fish community information available, however sampling conducted in 1992 identified two species that are commonly found in warmwater systems: brook stickleback (*Culaea inconstans*) and fathead minnow (*Pimephales promelas*).

2.2.3.2 Ancaster Creek Subwatershed

Aquatic Habitat

Ancaster Creek originates as small grassed swales through agricultural lands south of Garner Road East and flows in a northerly direction across Garner Road to the Hamilton Golf and Country Club ESA where most of the valleylands have been developed as a golf course although there are a few remnant woodlots and some wetland pockets. Much of the Ancaster Creek valley in the vicinity of Garner Road is located in remnant agricultural lands that are slated for future development. There are two crossings of Ancaster Creek.

Ancaster Creek Tributary A is an intermittent watercourse that is located northwest of Southcote Road and Garner Road East. During the SLE field visit there was standing water observed in the stream channel with dense algal mats on the surface which suggests stagnant water and nutrient loading. Thick cattails dominate the riparian vegetation and some cattail growth extends into the stream channel. The small defined channel is approximately 0.2 m wide and 0.02 m deep.

Ancaster Creek Tributary B is a permanent coldwater watercourse that originates south of Garner Road and flows through the study area in a defined channel. The stream channel is approximately 0.3 m wide and 0.2 m deep with a substrate of sand, silt and small gravel. The riparian vegetation on the south side of Garner Road is kept trimmed and the grass is manicured to the water's edge, north of Garner Road there are thick cattails lining the stream banks with red-osier dogwood and willow.

Fish Community

Ancaster Creek is classified as small riverine coldwater and certain reaches of this stream form the most significant coldwater zones in the Hamilton Harbour watershed[1]. In the southernmost tributaries of Ancaster Creek historic brook trout communities have been replaced by rainbow trout (*Oncorhynkiss mykiss*) and it is unclear whether this change is a result of habitat alteration or just an overall change in the fish community. In recent years, there has been a decline in

young of the year rainbow trout that is consistent with spawning and nursery habitat deterioration resulting from urban development in the watershed[1].

Permanent reaches of Ancaster Creek have a fairly diverse fish community consisting of creek chub (*Semotilus atromaculatus*), brook stickleback, blacknose dace (*Rhinichthys atratulus*), rainbow trout, fathead minnow (*Pimephales promelas*), common shiner (*Luxilus cornutus*), common white sucker (*Catostomus commersoni*), Johnny darter (*Etheostoma nigrum*), rainbow darter (*Etheostoma caeruleum*) and fantail darter (*Etheostoma flabellare*).

Table 1: Description of fish and fish habitat of the watercourse crossings.

Watercourse	Flow Intermittent (I) / Permanent (P)	Channel Width and Depth	Substrate Type	Riparian Vegetation	Directly Supports a Fishery (Y/N)	Type of Fishery Supported	Sensitivity (H - High, M - Moderate, L - Low)
Upper Twenty Mile Creek	I	No defined channel – conveys roadside drainage	Sand and silt.	Cattails, common reed grass.	N	Warmwater	L
Tiffany Creek Tributary A	P	1.2 m wide and 0.2 m deep	Small gravel, sand and silt.	Cattails, red-osier dogwood, willow.	Y	Warmwater	M
Tiffany Creek Tributary B	I	0.2 m wide and 0.05 m deep	Sand and silt.	Burdock, teasel, milkweed, goldenrod.	N	Warmwater	L
Tiffany Creek Tributary C	I	0.2 m wide and 0.02 m deep	Sand and silt.	Manicured grass.	N	Warmwater	L
Tiffany Creek Tributary D	E	0.2 m wide and 0.02 m deep.	Sand and silt.	Willow, grasses, goldenrod.	N	Warmwater	L
Tiffany Creek Tributary E	E	No defined channel – sections are piped underground.	Sand and silt.	No vegetation, rip-rap lined.	N	Warmwater	L

Watercourse	Flow Intermittent (I) / Permanent (P)	Channel Width and Depth	Substrate Type	Riparian Vegetation	Directly Supports a Fishery (Y/N)	Type of Fishery Supported	Sensitivity (H - High, M - Moderate, L - Low)
Ancaster Creek Tributary A	I	0.2 m wide and 0.02 me deep	Sand and silt.	Cattails, goldenrod, willow, dogwood, reed canary grass, phragmites.	N	Coldwater	L
Ancaster Creek Tributary B	P	0.3 m wide and 0.2 m deep	Small gravel, sand and silt.	Cattails, goldenrod, willow, dogwood, reed canary grass.	Y	Coldwater	H

2.3 Summary of Fish Habitat Sensitivity and Constraints

As part of the aquatic habitat assessment for the Garner/Garth corridor fish and fish habitat sensitivity for the watercourses in the study area was assigned. This categorization of sensitivity encompassed both fish species and fish habitat, and their inter-relationships and dependencies. While an understanding of the component species and habitat requirements is important to assessing sensitivity, the interactions at the fish community and overall aquatic ecosystem level must be integrated in the analysis. The attributes used for assessing the sensitivity of fish and fish habitat included:

1. Species Sensitivity
2. Species' Dependence on Habitat
3. Rarity
4. Habitat Resiliency

The above attributes and process for determining fish habitat sensitivity are consistent with the approach documented in the *Guide to the Risk Management Framework for DFO Habitat Management Staff Practitioners*[4].

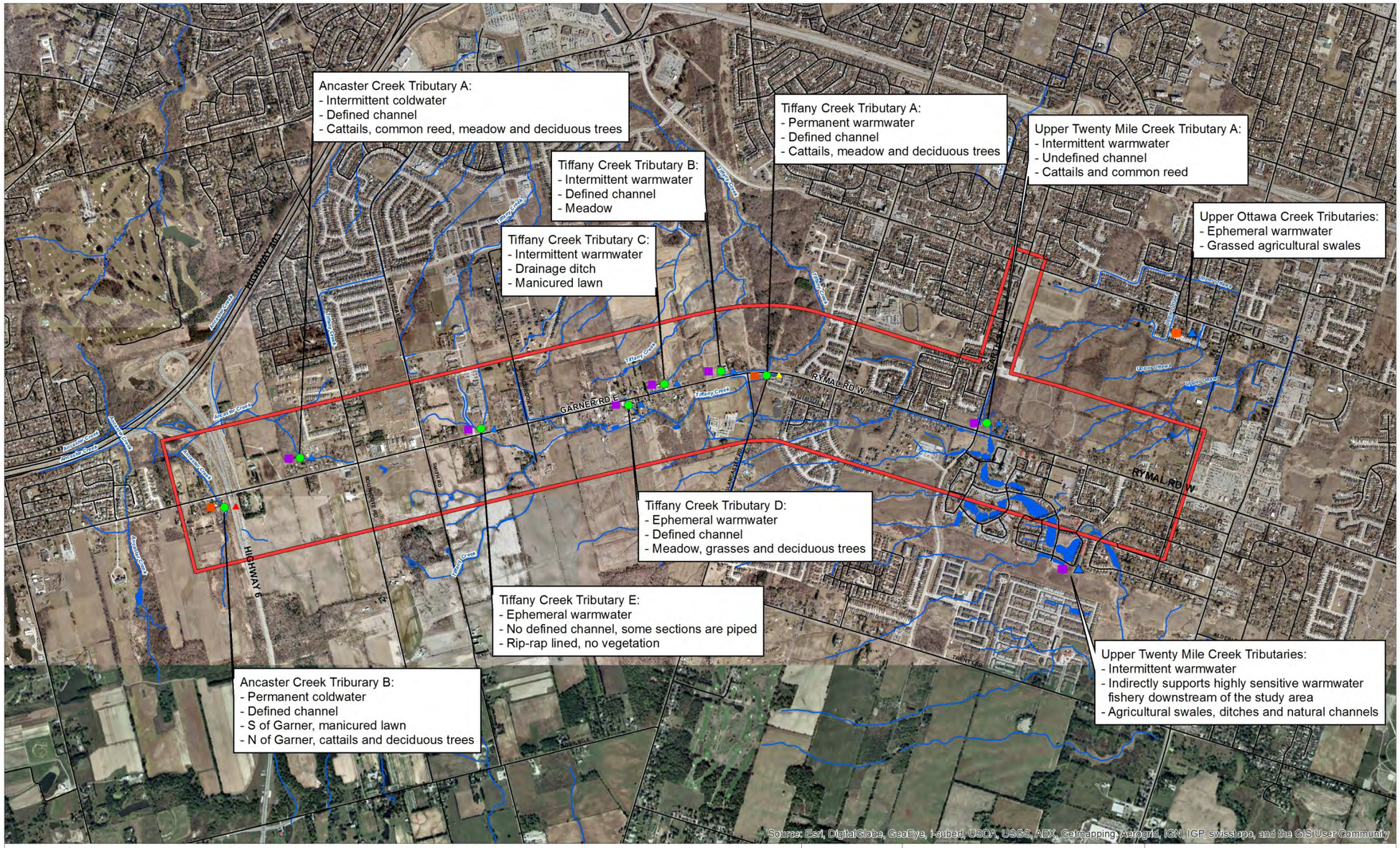
From the SLE aquatic habitat assessment and above approach for determining sensitivity, the tributaries within the Upper Ottawa Creek and Upper Twenty Mile Creek Subwatersheds do not support direct fish habitat and therefore are considered to have low sensitivity.

The permanent tributaries within the Tiffany Creek and Ancaster Creek Subwatershed in the study area provide direct fish habitat and these watercourses have been classified as moderate to high sensitivity. The ephemeral and intermittent tributaries provide indirect fish habitat through flows and allochthonous inputs to downstream reaches and these reaches are considered to have low sensitivity. Key factors in this determination include:

- The headwater watercourses contribute flows and allochthonous energy inputs to downstream reaches indirectly supporting a warmwater fish community;
- The habitat is considered to be common within the watershed;
- Species are not dependent on the habitat for any life stage (ie, migration, spawning);
- Tiffany Creek tributaries are classified warmwater and are able to tolerate or recover from changes in environmental conditions, such as flow and thermal regime.

The fish habitat sensitivity and constraints map (**Figure 2**) provides a summary of physical and biological attributes with respect to fish and fish habitat present at the watercourses in the study area. Based on the SLE review of background information and field investigations, the map shows information on sensitivity of fish habitat, flow and thermal regime. A photographic record of the watercourses is available in **Appendix A**.

[4] Fisheries and Oceans, 2010



Legend

- Tributaries
- Roads
- Watercourse
- Study Area
- Water Body

Habitat Sensitivity

- High
- Medium
- Low

Fish Use

- Direct
- Inirect

N

0 0.1 0.2 0.4 0.6 0.8 1
Kilometers
NAD 1983 UTM Zone 17N

Hamilton

SNC·LAVALIN Environnement

Garner/Rymal and Garth EA
Fish & Fish Habitat Sensitivity

Date: 10/08/2012	File Number: 333123	Sub Code:0000
Figure Number: 2		Rev. 0

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3.0 WILDLIFE RESOURCES

Wildlife resources were evaluated using background material and the incidental wildlife observations made during the SLE field visit on December 22, 2011. Background information on the natural environmental features and wildlife within the study area was gathered from:

- Natural Heritage Information Centre (NHIC) Biodiversity Explorer database
- Ontario Breeding Bird Atlas
- Ontario Herpetofaunal Atlas
- Ontario's Reptile and Amphibian Atlas
- Ontario Mammal Atlas

Species lists were compiled to provide information on wildlife species known from the local vicinity. All wildlife species known to occur within the vicinity of the study area were cross-referenced with updated listings of species identified as nationally significant or provincially significant.

3.1 Birds

Bird species observed during the SLE field visit on December 22, 2011 include: northern cardinal (*Cardinalis cardinalis*), black-capped chickadee (*Poecile atricapillus*), blue jay (*Cyanocitta cristata*), European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), song sparrow (*Melospiza melodia*) and mourning dove (*Zenaida macroura*).

A comprehensive bird species list from the Ontario Breeding Bird Atlas[5] (OBBA) can be found in **Table 2**. A total of 114 bird species are known from the one 10x10 km square (17NH88) that overlaps with the study area. Most of these species lack suitable breeding habitat within the study area. A review of the NHIC Biodiversity Explorer database[6] has also identified a historic record of a northern bobwhite (*Colinus virginianus*) from the vicinity for the study area. However, this provincially and federally endangered species was last observed in the area in 1904 and it is generally accepted that this species is no longer in the study area.

Background information from the OBBA indicates that nine significant bird species are recently known from the vicinity (within approximately 10 km) of the study area. These species, their habitat, and the likelihood of finding them in the study area are described in **Table 3** below. Based on aerial imagery, ecological land classification (ELC), and on-site observations, barn owl (*Tyto alba*), chimney swift (*Chaetura pelagica*), bobolink (*Dolichonyx oryzivorus*), eastern meadowlark (*Sturnella magna*), and barn swallow (*Hirundo rustica*) may have suitable habitat within the study area.

Chimney swifts and barn swallows are highly associated with man-made structures, and may nest in chimneys in urban areas and under bridges or ledges, respectively. The study area includes buildings in the suburban area that represent potential chimney swift and barn swallow nesting habitat. However, because the Garner/Rymal and Garth project is generally restricted to

[5] Cadman et al., 2009
[6] OMNR, 2010

existing transportation corridors in the suburban area, it will not likely impact any potential nesting structures, and they should not be impacted by the development.

Bobolink and eastern meadowlark prefer open meadow, grassland, and farmland habitat. Farmland habitat is found in the west portion of the study area. Also in the western portion of the study area, barn owl may inhabit the agricultural fields and scattered woodlots. However, because the road widening is generally limited to existing transportation corridors, it will not likely impact any potential barn owl, bobolink, or eastern meadowlark habitat.

There are 55 bird species that are considered to be Niagara Escarpment Priority Species. All planning authorities in the province must "have regard to" the guidelines and principles set forth in the *Provincial Policy Statement*[7] regarding the conservation of natural heritage features and values. In addition to these broad policy directives, the Niagara Escarpment Commission (NEC), by authority of the *Niagara Escarpment Planning and Development Act*, has developed its own set of rules with respect to development within Escarpment lands via "The Niagara Escarpment Plan". The Plan's purpose is to "provide for the maintenance of the Niagara Escarpment and land in its vicinity substantially as a continuous natural environment, and to ensure only such development occurs as is compatible with the natural environment".[8]

All species listed as Niagara Escarpment Priority Species have been ranked from 1 through 4. This is a relative ranking amongst all of the priority species and all are considered to have conservation priority. The birds specific to the study area and their ranking are listed in **Table 2**.

[7] OMMAH, 2005
[8] NEC, 1994

Table 2: Breeding birds potentially within the study corridor.

Family	Common Name	*Scientific Name*	SARA	SARO	Niagara Escarpment Priority Species	MNR Status (SRANK)
ARDEIDAE	HERONS/BITTERNS					
	Green Heron	*Butorides virscens*			4	S4B
CATHARTIDAE	VULTURES					
	Turkey Vulture	*Cathartes aura*			3	S5B
ANATIDAE	DUCKS/GEESE/SWANS					
	Canada Goose	*Branta canadensis*				S5
	Mute Swan	*Cygnus olor*				SNA
	Wood Duck	*Aix sponsa*			4	S5
	Mallard	*Anas platyrhynchos*				S5
ACCIPITRIDAE	HAWKS/EAGLES					
	Northern Harrier	*Circus cyaneus*	NAR	NAR		S4B
	Sharp-shined Hawk	*Accipiter striatus*		NAR	2	S5
	Cooper's Hawk	*Accipiter cooperii*	NAR	NAR	3	S4
	Broad-winged Hawk	*Buteo platypterus*			2	S5B
	Red-tailed Hawk	*Buteo jamaicensis*	NAR	NAR		S5
PHASIANIDAE	PHEASANT/GROUSE					
	Ring-necked Pheasant	*Phasianus colchicus*				SNA
	Ruffed Grouse	*Bonasa umbellus*			3	S4
RALLIDAE	RAILS					
	Virginia Rail	*Rallus limicola*			1	S5B
	Sora	*Porzana carolina*			1	S4B
CHARADRIIDAE	PLOVERS					
	Killdeer	*Charadrius vociferus*				S5B,S5N
SCOLOPACIDEA	SANDPIPERS					
	Spotted Sandpiper	*Actitis macularia*			3	S5
	Upland Sandpiper	*Bartramia longicauda*			2	S4B
	American Woodcock	*Scolopax minor*			4	S4B
COLUMBIDAE	PIGEONS/DOVES					
	Rock Dove	*Columba livia*				SNA

Family	Common Name	*Scientific Name*	SARA	SARO	Niagara Escarpment Priority Species	MNR Status (SRANK)
	Mourning Dove	*Zenaida macroura*				S5
CUCULIDAE	CUCKOOS					
	Black-billed Cuckoo	*Coccyzus erythropthalmus*			2	S5B
	Yellow-billed Cuckoo	*Coccyzus americanus*			3	S4B
TYTONIDAE	BARN OWLS					
	Barn Owl	*Tyto alba*	END	END	1	S1
STRIGIDAE	TYPICAL OWLS					
	Eastern Screech Owl	*Megascops asio*	NAR	NAR		S4
	Great Horned Owl	*Bubo virginianus*				S4
APODIDAE	SWIFTS					
	Chimney Swift	*Chaetura pelagica*	THR	THR		S4B,S4N
TROCHILIDAE	HUMMINGBIRDS					
	Ruby-throated Hummingbird	*Archilochus colubris*		NAR	2	S4B
ALCEDINIDAE	KINGFISHERS					
	Belted Kingfisher	*Ceryle alcyon*				S4B
PICIDAE	WOODPECKERS					
	Red-bellied Woodpecker	*Melanerpes carolinus*			3	S4
	Downy Woodpecker	*Picoides pubscens*				S5
	Hairy Woodpecker	*Picoides villosus*				S5
	Northern Flicker	*Colaptes auratus*				S4B
	Pileated Woodpecker	*Dryocopus pileatus*			2	S5
TYRANNIDAE	FLYCATCHERS					
	Eastern Wood-pewee	*Contopus virens*				S4B
	Alder Flycatcher	*Empidonax alnorum*			3	S5B
	Willow Flycatcher	*Empidonax traillii*				S5B
	Least Flycatcher	*Empidonax minimus*			3	S4B
	Eastern Phoebe	*Sayomis phoebe*			3	S5B
	Great crested Flycatcher	*Myriarchus crinitus*				S4B
	Eastern Kingbird	*Tyrannus tryrannus*			3	S4B

Family	Common Name	*Scientific Name*	SARA	SARO	Niagara Escarpment Priority Species	MNR Status (SRANK)
VIREONIDAE	VIREOS					
	Yellow-throated Vireo	*Vireo flavifrons*				S4B
	Warbling Vireo	*Vireo gilvus*				S5B
	Red-eyed Vireo	*Vireo olivaceus*				S5B
CORVIDAE	JAYS AND CROWS					
	Blue Jay	*Cyanocitta cristata*				S5
	American Crow	*Corvus brachyrhynchos*				S5B
ALAEDIDAE	LARKS					
	Horned Lark	*Eremophila alpestris*			3	S5B
HIRUNDINIDAE	SWALLOWS					
	Tree Swallow	*Tachycineta Bicolor*				S4B
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*			2	S4B
	Bank Swallow	*Riparia riparia*			2	S4B
	Barn Swallow	*Hirundo rustica*		THR	3	S4B
PARIDAE	CHICKADEES AND TITMICE					
	Black-capped Chickadee	*Parus atricapillus*				S5
	Tufted Titmouse	*Baeolophus bicolor*				S4
SITTIDAE	NUTHATCHES					
	Red-breasted Nuthatch	*Sitta canadensis*			3	S5
	White-breasted Nuthatch	*Sitta carolinensis*				S5
CERTHIIDAE	CREEPERS					
	Brown Creeper	*Certhia americana*			2	S5B
TROGLODYTIDAE	WRENS					
	Carolina Wren	*Thryothorus ludovicianus*				S4
	House Wren	*Troglodytes aedon*				S5B
	Winter Wren	*Troglodytes troglodytes*			3	S5B

Family	Common Name	*Scientific Name*	SARA	SARO	Niagara Escarpment Priority Species	MNR Status (SRANK)
	Sedge Wren	*Cistothorus platensis*	NAR	NAR		S4B
	Marsh Wren	*Cistothorus palustris*				S4B
SYLVIIDAE	GNATCATCHERS					
	Blue-gay Gnatcatcher	*Polioptila caerulea*				S4B
TURDIDAE	THRUSHES					
	Eastern Bluebird	*Sialia sialis*	NAR	NAR	1	S5B
	Veery	*Catharus fuscescens*			2	S4B
	Wood Thrush	*Hylocichla mustelina*				S4B
	American Robin	*Turdus migratorius*				S5B
MIMIDAE	MOCKINGBIRDS AND THRASHERS					
	Gray Catbird	*Dumetella carolinensis*			4	S4B
	Northern Mockingbird	*Mimus polyglottos*				S4
	Brown Thrasher	*Toxostoma rufum*				S4B
	European Starling	*Sturnus vulgaris*				SNA
BOMBYCILLIDAE	WAXWINGS					
	Cedar Waxwing	*Bombycilla cedrorum*				S5B
PARULIDAE	WOOD WARBLERS					
	Blue-winged Warbler	*Vermivora pinus*			1	S4B
	Golden-winged Warbler	*Vermivora chrysoptera*	THR	SC	1	S4B
	Yellow Warbler	*Dendroica petechia*				S5B
	Chestnut-sided Warbler	*Dendroica pensylvanica*			1	S5B
	Magnolia Warbler	*Dendroica magnolia*			1	S5B
	Black-throated blue Warbler	*Dendroica caerulescens*			2	S5B
	Black-throated green Warbler	*Dendroica virens*			1	S5B
	Pine Warbler	*Dendroica pinus*			3	S5B

Family	Common Name	*Scientific Name*	SARA	SARO	Niagara Escarpment Priority Species	MNR Status (SRANK)
	Black and White Warbler	*Mniotilta varia*			3	S5B
	American Redstart	*Setophaga ruticilla*			2	S5B
	Ovenbird	*Seiurus aurocapillus*			4	S4B
	Louisiana Waterthrush	*Seiurus motacilla*	SC	SC	1	S3B
	Mourning Warbler	*Oporomis philadelphia*			2	S4B
	Common Yellowthroat	*Geothlpis trichas*				S5B
	Hooded Warbler	*Wilsonia citrina*	THR	SC	1	S4B
	Yellow-breasted Chat	*Icteria virens*	SC	SC	1	S2B
THRAUPIDAE	TANAGERS					
	Scarlet Tanager	*Piranga olivacea*			2	S4B
EMBERIZIDAE	SPARROWS AND ALLIES					
	Eastern Towhee	*Pipilo erythrophthalmus*			2	S4B
	Chipping Sparrow	*Spizella Passerina*				S5B
	Clay-coloured Sparrow	*Spizella pallida*			1	S4B
	Field Sparrow	*Spizella pusilla*			3	S4B
	Vesper Sparrow	*Pooecetes gramineus*			3	S4B
	Savannah Sparrow	*Passerculus sandwichensis*			2	S4B
	Grasshopper Sparrow	*Ammodramus savannarum*			3	S4B
	Song Sparrow	*Melospiza melodia*				S5B
	Swamp Sparrow	*Melospiza georgina*				S5B
	White-throated Sparrow	*Zonotrichia albicollis*				S5B
CARDINALIDAE	CARDINALS AND ALLIES					
	Northern Cardinal	*Cardinalis cardinalis*				S5
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*				S4B

Family	Common Name	*Scientific Name*	SARA	SARO	Niagara Escarpment Priority Species	MNR Status (SRANK)
	Indigo Bunting	*Passerina cyanea*				S4B
ICTERIDAE	BLACKBIRDS AND ALLIES					
	Bobolink	*Dolichonyx oryzivorus*		THR	2	S4B
	Red-winged Blackbird	*Agelaius phoeniceus*				S4
	Eastern Meadowlark	*Sturnella magna*		THR	2	S4B
	Common grackle	*Quiscalus quiscula*				S5B
	Brown-headed Cowbird	*Molothrus ater*				S4B
	Orchard Oriole	*Icterus spurius*				S4B
	Baltimore Oriole	*Icterus galbula*				S4B
FRINGILLIDAE	FINCHES					
	House Finch	*Carpodacus mexicanus*				SNA
	American Goldfinch	*Carduelis tristis*				S5B
PASSERIDAE	OLD WORLD SPARROWS					
	House Sparrow	*Passer domesticus*				SNA

S1- Critically Imperiled, S2- Imperiled, S3- Vulnerable, S4- Apparently Secure, (N- Non-breeding, B- Breeding)
NAR- Not at Risk, THR- Threatened, SC- Special Concern, END- Endangered

Table 3: Significant bird species in the vicinity of study area.

Common Name	Scientific Name	S-Rank[A]	SARA[B] status	SARO[C] status	Preferred Habitat[D]	Habitat within study area?
Barn Owl	*Tyto alba*	S1	END	END	Open areas such as fields, agricultural lands with scattered woodlots, buildings and/or orchards; grasslands, sedge meadows, marshes; nests in hollow trees and live trees >46 cm dbh; also nests in barns, abandoned buildings.	Yes
Chimney Swift	*Chaetura pelagica*	S4B, S4N	THR	THR	Commonly found in urban areas near buildings; nests in hollow trees, crevices of rock cliffs, chimneys.	Yes
Golden-winged Warbler	*Vermivora chrysoptera*	S4B	THR	SC	Early successional habitat; shrubby, grassy abandoned fields with small deciduous trees bordered by low woodland and wooded swamps; alder bogs; deciduous, damp woods; shrubbery clearings in deciduous woods with saplings and grasses; brier-woodland edges; requires >10 ha of habitat.	No
Louisiana Waterthrush	*Seiurus motacilla*	S3B	SC	SC	Prefers wooded ravines with running streams; also woodlands swamps; large tracts of mature deciduous or mixed forests; canopy cover is essential; has strong affinity to nest sites; nests on ground.	No
Hooded Warbler	*Wilsonia citrina*	S3B	THR	SC	Favours mature, deciduous forest (Carolinian), particularly along stream bottoms, ravine edges and where saplings and shrubbery grow; nests above ground in small shrubs; feeds on or near ground.	No
Yellow-breasted Chat	*Icteria virens*	S2B	SC (ssp. *virens)*	SC	Thickets, tall tangles of shrubbery beside streams, ponds; overgrown bushy clearings with deciduous thickets; nests above ground in bush, vines etc.	No
Bobolink	*Dolichonyx oryzivorus*	S4B	NAR	THR	Large, open expansive grasslands with dense ground cover; hayfields, meadows or fallow fields; marshes; requires tracts of grassland	Yes

Common Name	Scientific Name	S-Rank[A]	SARA[B] status	SARO[C] status	Preferred Habitat[D]	Habitat within study area?
					>50 ha.	
Eastern Meadowlark	*Sturnella magna*	S4B	NAR	THR	Open, grassy meadows, farmland, pastures, hayfields or grasslands with elevated singing perches; cultivated land and weedy areas with trees; old orchards with adjacent, open grassy areas >10 ha in size.	Yes
Barn Swallow	*Hirundo rustica*	S4B	NAR	THR	Farmlands or rural areas; cliffs, caves, rock niches; buildings or other man-made structures for nesting; open country near body of water.	Yes

[A]OMNR 2010; [B]Government of Canada, 2011; [C]OMNR, 2009; [4]OMNR, 2000.
S1- Critically Imperiled, S2- Imperiled, S3- Vulnerable, S4- Apparently Secure, (N- Non-breeding, B- Breeding)
NAR- Not at Risk, THR- Threatened, SC- Special Concern, END- Endangered

3.2 Herpetofauna

Twenty-nine species of herpetofauna (reptiles and amphibians) are known to occur within the vicinity of the study area according to both the *Ontario Herpetofaunal Atlas*[9], and the *Ontario's Reptile and Amphibian Atlas*[10]. A complete list of herpetofauna known from the study area, their preferred habitat, and current status rankings is shown in **Table 4**. Based on compiled data from the two atlases, eight significant species are known to occur in the study area. **Table 5** presents a complete list of these significant species, their preferred habitat, and the likelihood of them inhabiting the study area. Based on aerial imagery, ELC, and on-site observations, it is assumed that snapping turtle (*Chelydra sepentina*), Blanding's turtle (*Emydoidea blandingii*), eastern milksnake (*Lampropeltis triangulum)*, and Jefferson/blue-spotted salamander polyploids (*Ambystoma jeffersonianum-laterale polyploids)* may have suitable habitat within the study area.

Milksnake and Jefferson/blue-spotted salamander may inhabit the agricultural lands and moist deciduous forest fragments, respectively, in the northern portion of the study area. The NHIC maintains a list of rare species "Element Occurrences" for the same 10 km x 10 km grids as the OBBA. Based on a review of rare species in the study area square (17NH88), milksnake have not been observed since 1989. Pure Jefferson salamanders were last observed in 2003, and Jefferson/blue-spotted polyploids in 2002.

Snapping and Blanding's turtle inhabit marshes, swamps, and bogs with soft muddy bottoms, which can be found in the west end of the study area. Blanding's turtle, listed as threatened, was last observed in the study area in 1921. A review of the NHIC Biodiversity Explorer database**Error! Bookmark not defined.** has also identified a historic record of timber attlesnake (*Crotalus horridus*) from the vicinity of the study area. However, this species has been extirpated and was last observed in the area in 1950. As such, it is accepted that timber rattlesnake no longer inhabits the study area.

Since Garner/Rymal and Garth Road development activities will generally remain within existing infrastructures footprint, the habitats listed above should not be impacted.

[9] Oldham and Weller, 2000
[10] Ontario Nature, 2011

Table 4: Herpteofauna potentially in the study area.

Species	Common Name	Scientific Name	SARA	SARO	MNR Status (SRANK)
Turtles					
	Spiny Softshell	*Apalone spinifera*	THR	THR	S3
	Snapping Turtle	*Chelydra serpentina*	SC	SC	S3
	Blanding's Turtle (*Great Lakes/St Lawrence population*)	*Emydoidea blandingii*	THR	THR	S3
	Eastern Musk Turtle	*Sternotherus odoratus*	THR	THR	S3
	Midland Painted Turtle	*Chrysemys picta marginate*			S5
	Northern Map Turtle	*Graptemys geographica*	SC	SC	S3
	Wood Turtle	*Clemmys insculpta*	THR	END	S2
Snakes					
	Dekay's Brownsnake	*Storeria dekayi*	NAR	NAR	S5
	Eastern Gartersnake	*Thamnophis sirtalis*			S5
	Milksnake	*Lampropeltis triangulum*	SC	SC	S3
	Northern Watersnake	*Nerodia sipedon sipedon*	NAR	NAR	S5
	Red-bellied Snake	*Storeria occipitomaculata*			S5
	Smooth Greensnake	*Opheodrys vernalis*			S4
Salamanders					
	Jefferson/Blue-spotted Salamander Polyploids	*Ambystoma jeffersonianum*			S2
	Jefferson Salamander	*Ambystoma jeffersonianum*	END	END	S2
	Blue-spotted Salamander	*Ambystoma laterale*			S4

	Spotted Salamander	*Ambystoma maculatum*			S4
	Eastern Red-backed Salamander	*Plethodon cinereus*			S5
	Eastern Newt	*Notophthalmus viridescens*			S5
	Four-toed Salamander	*Hemidactylium scutatum*	NAR	NAR	S4
Frogs					
	American Toad	*Anaxyrus americanus*			S5
	Spring Peeper	*Pseudacris crucifer*			S5
	Western Chorus Frog	*Pseudacris triseriata*	NAR	NAR	S4
	Gray Treefrog	*Hyla versicolor*			S5
	Wood Frog	*Lithobates sylvaticus*			S5
	Northern Leopard Frog	*Lithobates pipiens*	NAR	NAR	S5
	Green Frog	*Lithobates clamitans*			S5
	Pickerel Frog	*Lithobates palustris*	NAR	NAR	S4
	American Bullfrog	*Lithobates catesbeianus*			S4

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NAR- Not at Risk, THR- Threatened, SC- Special Concern, END- Endangered

Table 5: Significant reptile and amphibian species known in the vicinity of the study area.

Common Name	Scientific Name	S-Rank[A]	SARA status[B]	SARO status[C]	Preferred Habitat[D]	Habitat within study area?
Spiny Softshell	*Apalone spinifera*	S3	THR	THR	Large river systems, shallow lakes and ponds with muddy bottoms and aquatic vegetation; basks on sandbars, mud flats, grassy beaches, logs or rocks; eggs are laid near water on sandy beaches or gravel banks in areas with sun	No
Snapping Turtle	*Chelydra serpentina*	S5	SC	SC	Permanent, semi-permanent fresh water; marshes, swamps or bogs; rivers and streams with soft muddy banks or bottoms; often uses soft soil or clean dry sand on south-facing slopes for nest sites	Yes
Blanding's Turtle (*Great Lakes/St Lawrence population*)	*Emydoidea blandingii*	S3	THR	THR	Shallow water marshes, bogs, ponds or swamps, or coves in larger lakes with soft muddy bottoms and aquatic vegetation	Yes
Eastern Musk Turtle	*Sternotherus odoratus*	S3	THR	THR	Aquatic, except when laying eggs; shallow slow moving water of lakes, streams, marshes and ponds; hibernate in underwater mud, in banks or in muskrat lodges; eggs are laid in debris or under stumps or fallen logs at waters edge; often share nest sites; sometimes congregate at hibernation sites; not readily observed.	No
Northern Map Turtle	*Graptemys geographica*	S3	SC	SC	Large bodies of water with soft bottoms, and aquatic vegetation; basks on logs or rocks or on beaches and grassy edges, will bask in groups; uses soft soil or clean dry sand for nest sites; may nest at some distance from water; home range size is larger for females (about 70 ha) than males (about 30 ha) and includes hibernation, basking, nesting and feeding areas; aquatic corridors (e.g. stream) are required for movement; not readily observed	No
Wood Turtle	*Clemmys insculpta*	S2	THR	END	Slow-moving streams with sandy bottoms and woody edges; ponds, marshes, swamps; woodlands in floodplains; lives within 150m of stream shores; home range may be 5 to 25 ha, sometimes as much as 115 ha; riparian corridors important since this species is quite terrestrial	Yes
Eastern Milksnake	*Lampropeltis triangulum*	S3	SC	SC	Farmlands, meadows, hardwood or aspen stands; pine forest with brushy or woody cover; river bottoms or bog woods	Yes

Common Name	Scientific Name	S-Rank[A]	SARA status[B]	SARO status[C]	Preferred Habitat[D]	Habitat within study area?
Jefferson/Blue-spotted Salamander Polyploids	*Ambystoma jeffersonianum-laterale polyploids*	S2			Damp shady deciduous forest, swamps, moist pasture, lakeshores; temporary woodland pools for breeding	Yes

[A]OMNR, 2010; [B]Government of Canada, 2011; [C]OMNR, 2009; [D]OMNR, 2000.
S1- Critically Imperiled, S2- Imperiled, S3- Vulnerable, S4- Apparently Secure, (N- Non-breeding, B- Breeding)
NAR- Not at Risk, THR- Threatened, SC- Special Concern, END- Endangered

3.3 Mammals

Thirty mammal species are known from the vicinity of the study area based on information from the *Atlas of the Mammals of Ontario*[11], all of which are common species in Ontario. During the field visit, white-tailed deer (*Odocoileus virginianus*) tracks were noted. A complete list of mammals known from the study area, including their current status rankings, is show in **Table 6**. In addition, a review of the NHIC Biodiversity Explorer database indentified records of woodland vole (*Microtus pinetorum*) from the vicinity of the study area. This provincial and federal species of special concern prefers habitat of mature Carolinian deciduous forests, grasslands, meadows, and orchards with groundcover of duff or grass. Such meadow and orchard habitats are limited, but present, in the west portion of the study area. Given that the most recent local record of this species occurred in 1951, it is very unlikely that woodland vole inhabits the study area. Furthermore, Garner/Rymal and Garth widening activities will generally remain within existing infrastructures footprint, so potential woodland vole habitats should not be impacted.

Table 6: Mammal species known from the vicinity of the study area.

Species	Common Name	*Scientific Name*	SARA	SARO	MNR Status (SRANK)
Bats					
	Little Brown Bat	*Myotis lucifuga*	NAR	NAR	SNA
	Big Brown Bat	*Eptesicus fuscus*	NAR	NAR	S5
	Eastern Red Bat	*Lasiurus borealis*	NAR	NAR	S4
Carnivores					
	Coyote	*Canis latrans*	NAR	NAR	S5
	Red Fox	*Vulpes vulpes*	NAR	NAR	S5
	Raccoon	*Procyon lotor*	NAR	NAR	S5
	Long-tailed Weasel	*Mustela frenata*	NAR	NAR	S4
	Mink	*Mustela vison*	NAR	NAR	S4
	Striped Skunk	*Mephitis mephitis*	NAR	NAR	S5
Deer					
	White-tailed Deer	*Odocoileus virginianus*	NAR	NAR	S5
Opossums					
	Virginia Opossum	*Didelphis virginiana*	NAR	NAR	S4
Rabbits/Hares					
	Eastern Cottontail	*Sylvilagus floridanus*	NAR	NAR	S5
	European Hare	*Lepus europaeus*	NAR	NAR	SNA
Rodents					
	Eastern Chipmunk	*Tamias striatus*	NAR	NAR	S5
	Woodchuck	*Marmota monax*	NAR	NAR	S5
	Gray Squirrel	*Sciurus carolinensis*	NAR	NAR	S5

[11] Dobbyn, 1994

Species	Common Name	*Scientific Name*	SARA	SARO	MNR Status (SRANK)
	Red Squirrel	*Tamiasciurus hudsonicus*	NAR	NAR	S5
	Beaver	*Castor canadensis*	NAR	NAR	S5
	White-footed Mouse	*Peromyscus leucopus*	NAR	NAR	S5
	Deer Mouse	*Peromyscus maniculatus*	NAR	NAR	S5
	Meadow Vole	*Microtus pennsylvanicus*	NAR	NAR	S5
	Muskrat	*Ondatra zibethicus*	NAR	NAR	S5
	Meadow Jumping Mouse	*Zapus hudsonius*	NAR	NAR	S5
	Southern Flying Squirrel	*Glaucomys volans*	SC	NAR	S4
	Woodland Vole	*Microtus pinetorum*	SC	SC	S3?
Shrews/Moles					
	Masked Shrew	*Sorex cinereus*	NAR	NAR	S5
	Smokey Shrew	*Sorex fumeus*	NAR	NAR	S5
	Short-tailed Shrew	*Blarina brevicauda*	NAR	NAR	S5
	Star-nosed Mole	*Condylura cristata*	NAR	NAR	S5
	Hairy-tailed Mole	*Parascalops breweri*	NAR	NAR	S4

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3.4 Significance and Sensitivity of Natural Features

The majority of the study area consists of developed urban lands within the City of Hamilton, with some agricultural, recreational (i.e., golf courses) and natural areas in the southern portion.

A number of significant species are known from the vicinity of the study area, including 16 species of birds, 5 species of herpetofauna and 1 mammal species. Suitable habitat for a limited number of these significant species is present within the study area. In particular, seven bird species, including peregrine falcon, barn owl, bobolink, chimney swift, common nighthawk, and red-headed woodpecker, and two herpetofauna species, including eastern milksnake and Jefferson/blue-spotted salamander polyploids, all have the potential to inhabit the study area. However, none of these species are likely to be impacted by the proposed development based on the degree to which the widening of Garner/Garth will be located within the urbanized area of the City, or will otherwise be situated within existing road allowances.

4.0 TERRESTRIAL ECOSYSTEMS

4.1 Study Methods

4.1.1 Background Data Collection

Background information was reviewed in order to describe:

- Ecological landscape setting of the study area;
- General plant and faunal species/communities in potentially affected areas;
- Potential for rare or endangered species; and
- Information on other important ecological factors (e.g., potential critical habitats).

Background data were obtained from various published and non-published sources. Sources of information include:

- Guelph District Ontario Ministry of Natural Resources (OMNR);
- Hamilton Conservation Authority (HRCA);
- Niagara Peninsula Conservation Authority (NPCA);
- Natural Heritage Information Center (NHIC) website;
- City of Hamilton;
- Canadian Wildlife Species at Risk (SARA);
- Species at Risk in Ontario (SARO); and
- Ecological Land Classification for Southern Ontario.

4.1.2 Field Surveys

Field surveys were conducted with the goal of confirming the initial delineation and characterization of habitat types using aerial photography provided by the City of Hamilton, as well as the initiation of the vegetation survey/field investigations to confirm desktop analysis.

The field survey was conducted on March 7th 2012, using visual inspections from the road side at each significant or characteristic vegetative assemblage. Due to lack of access to lands outside the R.O.W, all vegetation assemblages identified using aerial photography were characterized to the Community Series level using the Ecological Land Classification (ELC) protocol[12]. Groomed areas or parklands where designated as Manicured Grass/Trees (MGT*).

Plant species were documented as they were encountered during the field surveys. A complete list of the vascular plant species found is presented in **Appendix B**. Nomenclature is based on the *Ontario Plant List*[13].

[12] Lee et al., 1998
[13] Newmaster et al., 1998

4.2 Provincially and Locally Identified Natural Heritage Features

Tiffany Creek ESA

The Tiffany Creek ESA # 46 is located immediately north of Rymal Road. It is located within the eastern headwaters of Tiffany Creek, and is one of the few remaining natural areas in a highly urbanized setting. Habitat composition found within the area is diverse, with cultural meadow dominating the northwestern portion, with pockets of thicket, pioneer aspen and elm woodlots, and cattail marsh found throughout. This is also found to the southwest. The remainder is a mosaic of remnant forests mainly dominated by red oak in the more mature units, with black walnut found in the lower valley slopes. Meadow marsh is prevalent in the bottom lands. A number of locally rare species are found in the area, all of which are considered secure or apparently secure by the MNR.

Tiffany Creek crosses Rymal Road near the intersection with Glancaster Road. Adjacent to the road are meadow marsh communities associated with the roadside ditch and Tiffany Creek crossing, as well as early successional cultural meadow and thickets where the natural vegetation was disturbed by the hydro and natural gas pipeline right of ways and service entrances.

4.3 Vegetation Communities

4.3.1 Overview

Regional

The study area is located within the Lake Erie Lowland Ecoregion. This is part of the Mixedwood Plain Ecozone which encompasses the lower Great Lakes basin and St. Lawrence River valley. The combination of gentle topography, fertile soils, warm growing season and abundant rainfall, have made the Mixedwood Plain Ecozone the most intensely used and populated area in Canada. Early scientists, such as Rowe (in his treatment of the Forest Regions of Canada, 1972), called this region the Deciduous Forest Region or Carolinian zone. Agriculture is the predominant land use occupying 65% of the ecoregion.

This ecoregion extends from Windsor to Toronto, including the Niagara Peninsula at the southern tip of Ontario. The dominant land cover is cultivated land with small, often isolated areas of mixed and deciduous forests. Urban development is the other significant land cover. Sugar maple, beech, white and red oak, shagbark hickory, black walnut, and butternut, among others, characterize climax vegetation. White elm, eastern cottonwood, balsam poplar, red and black ash, and silver maple characterize moist sites. Drier and warmer sites contain black maple, chestnut, and chinquapin oak. Tulip tree, sycamore, and bitternut hickory occur on moist slopes.

The ecoregion is underlain by carbonate-rich, Palaeozoic bedrock. Surficial deposits are dominated by a wide variety of deep glacial deposits. Southwest of the Niagara Escarpment, the land surface slopes gradually southwestward through low-relief, rolling topography. Bedrock outcrops are mainly limited to the area between Hamilton and Georgetown. Clayey Gleysolic and Gray Brown Luvisolic soils are dominant in the ecoregion.

The ecoregion has one of the warmest climates in Canada, marked by humid, warm to hot summers and mild, snowy winters. The mean annual temperature is approximately 8°C. It reaches as high as 9°C in the Windsor area. The mean summer temperature is 18°C and the mean winter temperature is –2.5°C. The mean annual precipitation ranges 750–900 mm. Precipitation is evenly distributed throughout the year.

Local

The project area is limited to the lands immediately adjacent, north and south of Garner/Rymal Rd, from west of Highway 6 to West 5th St, as well as the lands east and west of Garth Street from Rymal Road to Stone Church Road West. The majority of these areas are urbanized and most of the vegetated landscapes have been created as part of streetscaping, or landscaped property holdings which are subject to constant maintenance. Agriculture and rural residential development is more prevalent along Garner Road west of Glancaster Road. The natural areas remaining have been subject to significant anthropomorphic pressure, which has degraded the natural composition of the vegetative assemblies which remain. Cultural meadow or groomed open spaces dominate the project area, along with some small remnant woodlots, thickets and wetland pockets associated with roadside drainage, Tiffany Creek, Upper Twenty Mile Creek and their tributaries.

4.3.2 Vegetation Communities in the Project Area

Vegetation communities adjacent to Garner/Rymal Road and Garth Street affected by the proposed roadworks are principally restricted to roadside trees and vegetation associated with the frontage of homes and businesses, and do not qualify for assessment under the Ecological Land Classification (ELC) protocol. However, adjacent vegetation units have been described to ELC Community Series level in order to provide context for the project setting. A description of these can be found below, and mapping is provided in **Figure 3** following this section. Photo record of typical vegetation types can be found in **Appendix C**

<u>Manicured Grass/Trees (MGT)</u>

The majority of the habitat found within the study area, adjacent to the subject roads, is best described as Manicured Grass/Trees. This vegetation type is associated with the residential and commercial properties along Rymal Road and Garth Street, and the rural residential properties and businesses along Garner Road. Typical tree species observed in these areas include, Norway spruce (*Picea abies*), Austrian pine (*Pinus nigra*), Norway maple (*Acer platanoides*), Manitoba maple (*Acer negundo*), sugar maple (*Acer saccharum*), black locust (*Robinia pseudo-acacia*), black walnut (*Juglans nigra*), white ash (*Fraxinus americana*), and various ornamental elms (*Ulmus sp.*). For full details on roadside trees, refer to the tree inventory.

<u>Cultural Meadow (CUM)</u>

The second most common habitat type is Dry Moist Cultural Meadow, which is dominated by grasses, along with sun tolerant broad-leaf vegetation typical of old fields and disturbed areas. This vegetation type dominates the road right-of-way (R.O.W), and historic farm fields found in

various locations, including the hydro and natural gas R.O.W.'s located just east of Glancaster Road. Herbaceous vegetation in the cultural meadow areas consists of old field type vegetation, such as introduced forage grasses (e.g., smooth brome (*Bromus inermis*), timothy (*Phleum pretense*), reed canary grass (*Phalaris arundinacea*), red fescue (*Festuca rubra*) and Kentucky blue grass (*Poa pratensis*)). Broad-leaved ground cover includes common milkweed (*Asclepias syriaca*), common mullien (*Verbascum thapsus*), chickory (*Cicorinum intybus*), common burdock (*Arctium minus*), wild carrot (*Daucus carota*), rough fruited cinquefoil (*Potentilla recta*), common plantain (*Plantago major*), white sweet clover (*Melilotus alba*), crown vetch (*Coronilla varia*), common St. John's wort (Hypericum perforatum), common ragweed (*Ambrosia artemisiifolia*), yarrow (*Achillea millefolium*), bull thistle (*Cirsium vulgare*), bouncing bet (*Saponaria officianalis*), teasel (*Dipsacus fullonum*), as well as perennial asters (*Aster sp.*) and goldenrods (*Solidago sp.*).

There are also a number of hedgerow and naturalized/planted isolated and clustered trees and shrubs of various ages within these areas. Tree species are typically as those described under the manicured grass/trees section, while shrub species were similar to those described later under cultural thicket.

Deciduous Forest (FOD) – Garth Street Woodlot

One pocket of deciduous forest was observed within the study area, along the east side of Garth Street between Rymal Road and the West Highland Baptist Church property. This woodlot, a significant woodlot in the Urban Official Plan, contains a relatively mature community and is bounded on its western edge by a chain link fence, although many trees and shrubs grow between the fence and the road shoulder.

This woodlot is an upland forest community dominated by red oak (*Quercus rubra*) and black cherry (*Prunus serotina*). The canopy cover is quite dense (<60%) and other species noted within the woodlot included occasional white ash, basswood (*Tilia americana*), Hop hornbeam (*Ostrya virginiana*), and several scattered white pine (*Pinus strobus*).

The sub-canopy and understory vegetation is relatively sparse, though this increases near the edges of the woodlot. Sub-canopy species observed include sugar maple, and white ash saplings, as well as bitternut hickory (*Carya cordiformis*), and choke cherry (*Prunus. virginiana*). The understory consisted of tartarian honeysuckle, red-berried elderberry (*Sambucus racemosa*), red raspberry (*Rubus idaeus*), staghorn sumac, riverbank grape (*Vitis riparia*), and slender willow (*Salix petiolaris*). Herbaceous vegetation follows a similar pattern, with rough avens (*Geum laciniatum*), large leaved aster (*Aster macrophyllus*), common buttercup (*Ranunculus acris*), gill over the ground (*Glenchoma hederacea*), and celandine (*Chelidonium majus*) found scattered within the interior areas and vegetation similar to the cultural meadow areas observed along the roadside edges and disturbed areas observed towards the margins of the woodlot.

Cultural Woodlot (CUW)

A number of cultural woodlots and large individual tree specimens were observed to the west of Glancaster Road, where the land use becomes more rural residential. The majority of these within the study area are part of historic farmsteads or agricultural fields that have naturalized. Trees observed in these areas include sugar maple, Manitoba maple, red oak, balsam poplar (*Populus balsamifera*), black walnut, black locust, Scots pine (*Pinus sylvestris*), and white pine. These woodlots are quite small and the sub-canopy and understory can vary significantly depending the size of the unit and the amount of periodic disturbance occurring. Sub-canopy species include common buckthorn, hawthorn (*Crataegus sp.*) and tree species saplings, and the understory is a combination of tartarian honeysuckle, grey dogwood (*Cornus foemina ssp. racemosa*), red currant (*Ribes rubrum*), red raspberry, and Virginia creeper (*Parthenocissus quinquefolia*), with red osier dogwood observed in the wetter areas. Herbaceous vegetation was typically dominated by garlic mustard (*Alliaria petiolata*), bittersweet nightshade (*Solanum dulcamara*), and yellow avens (*Geum aleppicum*), with cultural meadow species found in edge and open areas.

Cultural Thicket (CUT)

A number of Cultural Thickets were also observed west of Glancaster Road, where the land use becomes more rural residential. These areas are typically naturalized farm fields or grazing areas in early successional stages. Cover varies within these areas, but most contain a mixture of dense cover interspersed with small open cultural meadow inclusions. Canopy vegetation observed consists of hawthorn, common buckthorn, tartarian honeysuckle, grey dogwood, red osier dogwood, staghorn sumac, choke cherry, and some scattered green ash. Ground cover was typical of the cultural meadow areas described above.

Meadow Marsh (MAM)

The only wetlands found within the study area are Meadow Marsh types located along the north and south sides of Garner Road/Rymal Road. At the Tiffany Creek and Upper Twenty Mile Creek tributary crossings, these are associated with the headwater tributaries. Other small patches exist as part of the roadside drainage ditches. Most of these areas are dominated by common cattail (*Typha latifolia*), or common reed grass (*Phragmites australis*). Shrub cover varies, with some dense inclusions and scattered individuals of red osier dogwood, grey dogwood, choke cherry, field rose, winterberry (*Ilex verticillata*), and tartarian honeysuckle. At the Tiffany Creek crossing near Glancaster Road, there were also a number of crack willow, as well as green ash (*Fraxinus pennsylvanica*) and balsam poplar. Herbs such as jewel-weed (*Impatiens sp.*) and spotted water hemlock (*Cicuta maculate*) were observed, as well as many of the common meadow species, due to their proximity to disturbed habitats in the utility R.O.W.'s as well as the road corridor.

Legend

- Option 1
- Natural Gas Pipeline
- Transmission Line
- Road
- Watercourse
- Study Area
- Un-evauated Wetland
- LSW
- PSW
- Deciduous Forest (FOD)
- ESA
- Cultural Woodlot (CUW)
- Cultural Meadow (CUM)
- Successional Cultural Woodlot/Thicket (CUW/CUT)
- Water Body

N

0 0.1 0.2 0.4 0.6 0.8 1
Kilometers

Hamilton

SNC·LAVALIN

Garner/Rymal - Garth Class EA
Natural Environment
Option 1

Date: November, 2013	File Number: 333126	Sub Code:0000
Figure Number: 3		Rev. 0

Path: Z:\333126Garner_RymalRd\MXD\NatEnv_Nov_2013.mxd

4.3.3 Vascular Plants

A complete species list of vascular plants observed and noted within the study area can be found in **Appendix B**. The list is organized by scientific family name, genus and species, and nomenclature is based on the Ontario plant list (Newmaster et al, 1998). Given the limited nature of access to the site, the species list generated as part of the field program is somewhat limited. A total of 108 vascular plant species were observed. Of these, 58 (54%) are listed as native species, and 50 (46%) are listed as invasive. Of the species observed, the majority are listed a S5 or SE5 by OMNR, with a few S4 or S4? (black walnut, rough avens, calico aster and Virginia creeper).

The majority of the species observed are typical of disturbed environments, or have been planted as part of landscaping initiatives, and as such provide no real indication of the true floristic quality of the sites. The disturbed and fragmented nature of the areas studied is apparent in the small size of the vegetative communities found and the even distribution of native and non-native species observed within the majority of these units.

It should be noted that the species list is not a complete list of the plants of the area. This is particularly applicable to short-term seasonal plants, since the area was not observed throughout the growing season. Nomenclature is primarily in accordance with the Ontario Plant List (Newmaster et al. 1998), and secondarily with NHIC (2010).

4.3.4 Plant Species at Risk

A review of all background information available from the NHIC Biodiversity Explorer database identified eighteen significant plant species known from the vicinity of the study area. The names of these significant species, and their given significance ranks are outlined below in Table 7.

Table 7: Significant vegetation species potentially occurring in the study area*.

Common Name	Scientific Name	S-Rank[A]	SARA status[B]	SARO status[C]
Fern-leaved Yellow False Foxglove	*Aureolaria pedicularia*	S2?		
Downy Yellow False Foxglove	*Aureolaria virginica*	S1		
White-tinged Sedge	*Carex albicans var. albicans*	S3		
Pignut Hickory	*Carya glabra*	S3		
American Chestnut	*Castanea dentata*	S2	END	END
Northern Hawthorn	*Crataegus dissona*	S3		
Forked Panic Grass	*Dichanthelium dichotomum*	S2		
Burning Bush	*Euonymus atropurpureus*	S3		

Panicled Hawkweed	*Hieracium paniculatum*	S2		
Butternut	*Juglans cinerea*	S3?	END	END
Scarlet Beebalm	*Monarda didyma*	S3		
Large Yellow Pond-lily	*Nuphar advena*	S3		
Soft-hairy False Gromwell	*Onosmodium molle ssp. hispidissimum*	S2		
Woodland Pinedrops	*Pterospora andromedea*	S2		
Sharp-leaved Goldenrod	*Solidago arguta*	S4		
Shiny Wedge Grass	*Sphenopholis nitida*	S1		
Clinton's Clubrush	*Trichophorum clintonii*	S2S3		
Perfoliate Bellwort	*Uvularia perfoliata*	S1		

[A]OMNR 2010; [B]Government of Canada, 2011; [C]OMNR 2009.
S1- Critically Imperiled, S2- Imperiled, S3- Vulnerable, S4- Apparently Secure, "?" following ranking - rank uncertain
NAR- Not at Risk, THR- Threatened, SC- Special Concern, END – Endangered
*Modified from Stantec, 2012

Field work conducted as part of the study identified only one SAR – butternut - in the project area. Butternut is listed as endangered by both COSEWIC and COSSARO due to Butternut canker, an infection with high rates of mortality. This species is intolerant of shade and grows best on rich, moist, well-drained loams, such as stream banks. In Ontario, butternut is typically found scattered individually or in small groups in deciduous woodlands, or in hedgerows. Four individual butternut trees were identified during the field study and are found along the south side of Rymal Road between Garth Street and West 5th Street. Subsequent genetic testing carried out by the City in October 2013 determined that these individuals are butternut/Japanese walnut (*Juglans ailantifolia*) hybrids and are not protected under provincial or federal legislation.

5.0 Recommended Mitigation

5.1 Fish and Fish Habitat

Work in and around water features containing fish and fish habitat have the potential to result in changes that prevent the physical, biological or chemical attributes of fish habitat from providing food, reproduction, cover and movement corridors, or any change in fish habitat that reduces its capacity to support one or more of life processes of fish. The proposed Garner/Rymal Road and Garth Road Widening may have the potential to adversely affect the aquatic environment and surface water quality. There are 4 subwatersheds located within the study area and there are nine (9) stream crossings combined along Garner Road and Garth Road. The works for the proposed road widening will involve in-water work within the watercourses that are located within the study area that will directly affect fish habitat, and may also include works near the watercourse such as earth excavation/grading, excess material storage, equipment maintenance activities and wastewater management that have the potential to indirectly impact fish habitat by altering/removing their physical habitat (i.e., channel bed, substrates, riparian vegetation, in-stream cover, etc.). Potential impacts include impairment of water quality, and direct fish kills or destruction of habitat due to spills (e.g., chemical or sediment) resulting in short term population decline.

Other potential effects to fish and fish habitat that are applicable to the proposed works include:

- Alteration/loss to riparian vegetation (potential loss of allochthonous inputs (food supply/sources) – leaf matter, terrestrial insects);
- Discharge of sediment to a watercourse from earth/spoil stockpiles, grading and excavation activities associated with road extension and associated culvert works resulting in the impairment of water quality and/or physical damage to habitat;
- Release of fuel, oil, grease contaminants from mobile equipment resulting in unacceptable contaminant concentrations in receiving watercourses;
- Displacement/stranding/mortality of fish during construction from use of mobile equipment (pumps, backhoe, etc;); and
- Change to sensitive life stages/process (i.e., spawning) if in-water works are not timed appropriately.

Recommended environmental design and construction mitigation measures to avoid and/or minimize potential impacts to the aquatic environment and surface water for consideration in future phases of the project include:

- Design and install native woody riparian vegetation and groundcover to pre-construction conditions or better.
- Design and implement erosion and sediment controls to prevent erosion of exposed soils and migration of sediment to the watercourse.
- Implement timing restrictions during construction for in-water work to protect sensitive life stages of fish, as identified by MNR. In-stream works in warmwater systems are permitted from July 1 to March 31 (Upper Ottawa Creek and Upper Twenty Mile Creek, Tiffany Creek). In-stream works in coldwater systems are permitted from July 1 to September 15 (Ancaster Creek).

- Isolate in-water work area ("in the dry") during construction through temporary flow passage system (e.g., by-pass pumping, cofferdam diversion channel) to maintain flow around the work zone at all times.
- Store, handle and dispose of all excess materials in a manner that prevents their entry to the watercourse.
- Operate, maintain and store (e.g., fuel, lubricates) all equipment and materials in a manner that prevents the entry of any deleterious substances to the watercourse.
- Design and implement erosion and sediment control measures such as straw bale flow checks, silt fence, and temporary rock flow checks to prevent erosion of exposed soils and migration of sediment to watercourses.
  - Stabilize and re-vegetate exposed soils immediately following construction.
  - Conduct work in a continuous fashion to minimize the duration of potential impacts and maintain the area of disturbance to a minimum.
- Design drainage and stormwater management systems to mimic overland drainage patterns and control runoff quality/quantity contribution to watercourse features.
- Store, handle and dispose of all excess materials by storing, handling and disposing of all materials generated during site preparation, construction and operations to prevent their entry into watercourses.
  - Place temporary stockpiles of material a minimum of 30 metres away from the watercourse and ensure material is stabilized to prevent sediment laden runoff from entry into watercourses.
  - Prepare a spill/emergency response plan for construction and operations.
- Manage dewatering and concrete effluent, where applicable, from excavations and structural works to prevent release of contaminated water to receiving watercourses.
  - Direct dewatering effluent to temporary settling basins, filter bags and energy discharge diffusers, as required.
  - Capture and transport concrete effluent off-site for disposal.
- Operate, maintain and store (e.g., fuel, lubricates) all equipment and materials (e.g., fuel, lubricants) in a manner that prevents the entry of any deleterious substances to watercourses.
- Equipment re-fuelling will take place no closer than 30 m from any watercourse to prevent water contamination due to accidental fuel spills.
- Prohibit/limit construction access to watercourse/watercourse banks.

Scale of Negative Effects and Net Residual Effects

Remaining residual effects after the application of mitigation measures were assessed in terms of the resulting Scale of Negative Effect (extent, duration, and intensity) in the context of the fish habitat being affected (i.e., the sensitivity of fish and fish habitat). The Department of Fisheries and Oceans (DFO) Risk Management Framework, which incorporates the above two factors (i.e., Scale of Negative Effect and Sensitivity of Fish/Fish Habitat), was used to characterize the level of risk (high or low) that any residual effects after the application of mitigation pose to fish/fish habitat, and thus the likelihood of a negative effect to fish habitat occurring as a result of the proposed works. Results from this assessment were then used to help determine whether the works will result in a low or high risk to fish habitat, as defined under the *Fisheries Act.*

The Hamilton Region Conservation Authority (HRCA), the local conservation authority has a Level 2 agreement in place with the DFO. In accordance with the agreement and DFO's Risk Management Framework, HRCA will complete an aquatic effects assessment to determine

potential impacts of the proposed work on fish and fish habitat during the Detail Design phase for the project. This process includes an assessment to determine the level of risk (high or low) that any residual effects after the application of mitigation pose to fish/fish habitat, and thus the likelihood of requiring a Fisheries Act Authorization for the proposed works.

From the preliminary assessment completed as part of this study it is expected the proposed work associated with the proposed road extension will be characterized as “Low Risk” by HRCA and, as such, will not require an Authorization under the *Fisheries Act*, providing the appropriate mitigation measures are applied. In conclusion from the assessment no significant residual effects to surface water resources are anticipated from the project with implementation of the identified mitigation.

Monitoring

An environmental monitoring plan to assess the mitigation measures for protection of aquatic and surface water resources will be prepared if needed in future phases of the project.

Monitoring during construction is anticipated to focus on:

- Routine inspections of temporary erosion and sediment control measures to ensure they are operating effectively to prevent any release of sediment- laden runoff to watercourses.
- Monitoring of treatment systems for any dewatering and/or concrete effluent to avoid any release of contaminated water to receiving watercourses.
- Compliance monitoring of best management practices related to refuelling and excess materials storage and handling.

5.2 Wildlife Resources

The impacts on wildlife, wildlife habitat resulting from this project are generally considered to be of minor significance; however, habitat loss will result along the preferred alignment. The following environmental protection measures designed to reduce or minimize vegetation removals/wildlife habitat will be considered on a site-specific basis during the Detail Design phase:

- Reduce grading requirements to the minimum extent possible;
- Work zones will be isolated using construction fencing, barrier fencing and silt fencing to avoid further encroachment on wildlife habitat;
- Prepare restoration, enhancement and streetscape plans to offset vegetation/habitat losses in order to achieve a net gain in vegetation/habitat area, attributes and functions;
- Prepare edge management plans for areas where encroachment on vegetation communities/habitat will occur;
- Engage in good housekeeping practices related to materials storage/stockpiling and equipment fuelling/ maintenance, during construction.

The Migratory Birds Convention Act (MBCA) prohibits the killing, capturing, injuring, taking or disturbing of migratory birds (including eggs) or the damaging, destroying, removing or disturbing of nests. To meet the requirements of the MBCA, no vegetation removals should occur during the nesting season. The critical nesting period is April 1 to July 15.This timing restriction will also protect the birds listed under the Fish and Wildlife Conservation Act.

To protect bird species the following measures are proposed:

- Implement timing constraints so that no vegetation or buildings deemed to be suitable for migratory bird/avian SAR habitat will be removed during the bird breeding season (April 1 to July 15);
- If construction is scheduled to occur during the aforementioned restricted period, conduct a nest search of vegetation or buildings deemed to be suitable for migratory bird habitat; and
- Conduct a general site visit prior to April 1 in the first year of construction, if required, to inspect the structures (buildings/bridges) scheduled for alteration or removal. If nesting is likely, the Contractor must install bird nesting preventative measures before April 1. The measures must remain in place until July 15. The Contractor will be responsible for installing and maintaining these measures during the bird breeding season.

The proponents of the project will comply with the requirements of the Migratory Birds Convention Act with regard to the nesting season, and as a result, the proposed widening will have no significant adverse effects on avian wildlife species/populations.

Monitoring

Monitoring of the migratory bird prevention measures will occur during the critical breeding/nesting period (April 1 – July 15) to ensure that the measures are effective in restricting nesting on structures scheduled for removal or alteration; thus, eliminating the potential for incidental take.

If any wildlife species, particularly nesting birds, are encountered during construction, a qualified biologist will be contacted immediately to identify the species encountered and ensure that the appropriate agencies are notified and arrangements are made with respect to the appropriate action to be taken to minimize impacts to the species.

5.3 Terrestrial Ecosystems

The majority of the vegetation communities within the study area are significantly degraded by historic residential/commercial development, or agricultural uses. Impacts to these communities from the implementation of Option 1 for the widening of Garner/Rymal Road and Garth Street will primarily be to roadside vegetation consisting of cultural meadow or thicket communities at the roadside, small meadow marsh communities associated with roadside ditches and watercourses, as well as manicured lawns and street trees. Principal areas of impacts to street trees will be along the existing boulevard and road edges on Rymal Road east of Glancaster Road and along the west side of Garth Street, as well as trees along the rural residential properties on Garner Road between Kitty Murray Lane and Glancaster Road. The only remnant

natural community impacted by the proposed widening is the locally significant deciduous forest patch along the east side of Garth Street, where it is anticipated approximately 0.26 hectares of this vegetation unit will be removed as a result of the proposed works.

The following Mitigation measure should be implemented to minimize the effects of construction of the new Garner/Rymal Rd and Garth Street alignments on those natural and/or semi-natural vegetative assemblies found within the project area.

- Minimize encroachment on, or avoid remnant woodlots and large healthy trees where possible. Individual specimens to be saved will be marked on the ground before construction takes place;
- Trees and areas to be preserved within, and adjacent to the R.O.W will be identified in a Tree Protection Plan protected with snow fence defining Tree Protection Zone(s);
- Designated staging, refueling areas.
- Siltation control in areas where sedimentation could potentially affect un-impacted vegetation.
- Stormwater management to maximize runoff water quality, and provide some peak flow controls which will benefit nearby natural features;
- The movement of construction machinery will be limited to within the boundaries of the R.O.W and operated in a manner that minimizes damage to adjacent vegetation;
- Approval will be obtained, and compensation/reimbursement will be provided, as required, for displacement of publicly owned roadside trees on public property, in compliance with City of Hamilton's Public Tree Removal Policy, the Forest Management Plan (Reforestation Policy) and By-Law 06-151 (Public Trees By-Law), as amended.
- Roots and branches, if damaged, will be treated using approved horticultural methods;
- Tree management as needed to remove any potentially hazardous trees along new wooded edges, and maintain forest health and balance;
- Trees felled will be dropped to fall within the R.O.W. to avoid damage to the remaining vegetation, where practicable;
- Retain dead standing trees where possible as long as there is no safety hazard;
- Wherever possible, construction activities will be restricted within the dripline of all trees not required for removal;
- No rare or endangered species have been identified within the study area. Specimens of rare or otherwise significant species, if observed, would be transplanted in nearby compatible habitat, where practical. The survival rate of any relocated rare and endangered species will also be monitored periodically.
- Inclusion of hard and soft landscaping in the corridor, including planting of additional street trees, where opportunities present themselves;
- Where practicable, use only native species for landscaping efforts along the R.O.W.;
- Provide dense edge plantings in areas of fresh forest edge exposure to protect from drying winds, sun exposure (desiccation and spread of invasive sun-tolerant plant species), and salt spray. These plantings may constitute an exception to the native species mandate, since non-native conifers may provide better screening/protection than native options.
- Return R.O.W. to pre-construction conditions, where possible.

- Provide environmental site inspection during key construction periods and at key locations to ensure environmental protection/re-vegetation measures are implemented and working and any required remedial action is undertaken.
- Check plantings of woody and herbaceous vegetation periodically for a period of one year to ensure an acceptable survival rate.

Monitoring

Environmental site inspections will be required during key construction periods and at key locations to ensure environmental protection/re-vegetation measures are implemented and working and any required remedial action is undertaken. If species at risk are identified within the influence zone of construction activities, MNR will be contacted to determine how specimens of such species should be treated.

Plantings of woody and herbaceous vegetation will be checked periodically for a period of one year to ensure an acceptable survival rate.

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Appendix A

Photographic Record of the Watercourses

Photo 1: Looking upstream at Tiffany Creek Tributary A.

Photo 2: Looking downstream at Tiffany Creek Tributary A.

Photo 3: Looking upstream at Tiffany Creek Tributary E. Stormwater pond is located between the culvert outlet and Redeemer College (visible in the background).

Photo 4: Downstream of Tiffany Creek Tributary E looking from above the culvert outlet at standing water and agricultural drainage swale.

Photo 5: Looking downstream at Ancaster Creek Tributary A.

Photo 6: Looking downstream at Ancaster Creek Tributary B (north side of Garner)

Photo 7: Looking upstream at Ancaster Creek Tributary A (south side of Garner)

Appendix B

Vascular Plants Found in the Study Area

Family	Scientific Name	Common Names	Global Rank	COSEWIC	COSSARO	S Rank	Introduced
ACERACEAE	*Acer japonica*	Japanese Maple	N/A			N/A	I
	Acer negundo	Manitoba Maple	G5			S5	
	Acer platanoides	Norway Maple	G?			SE5	I
	Acer saccharum ssp. saccharum	Sugar Maple	G5			S5	
	Acer saccharinum	Silver Maple	G5			S5	
	Acer X freemanii	Freeman's Maple	G?			S5	
ANACARDIACEAE	*Rhus radicans ssp. negundo*	Climbing Poison-ivy	G5			S5	
	Rhus typhina	Staghorn Sumac	G5			S5	
APIACEAE	*Daucus carota*	Wild Carrot	G?			SE5	I
ASCLEPIADACEAE	*Asclepias syriaca*	Common Milkweed	G5			S5	
ASTERACEAE	*Achillea millefolium ssp. millefolium*	Common Yarrow	G5			SE	I
	Ambrosia artemisiifolia	Common Ragweed	G5			S5	
	Antennaria neglecta	Field Pussytoes	G5			S5	
	Arctium minus ssp. minus	Common Burdock	G?			SE5	I
	Aster ericoides var. ericoides	Heath Aster	G5			S5	
	Aster lateriflorus var. hirsuticaulis	Calico Aster	G5			S4?	
	Aster macrophyllus	Large-leaved Aster	G5			S5	
	Aster novae-angliae	New England Aster	G5			S5	
	Aster sp	Aster Species					

Family	Scientific Name	Common Names	Global Rank	COSEWIC	COSSARO	S Rank	Introduced
ASTERACEAE cont…	*Bellis perennis*	English Daisy	G?			SE5	I
	Bidens cernua	Nodding Beggar-ticks	G5			S5	
	Cichorium intybus	Chicory	G?			SE5	I
	Cirsium vulgare	Bull Thistle	G5			SE5	I
	Crepis tectorum	Narrow-leaved Hawk's Beard	G?			SE5	I
	Erigeron annuus	Daisy Fleabane	G5			S5	
	Eupatorium maculatum ssp. maculatum	Spotted Joe-pye-weed	G5			S5	
	Euthamia graminifolia	Grass-leaved Goldenrod	G5			S5	
	Lactuca serriola	Prickly Lettuce	G?			SE5	I
	Solidago altissima var. altissima	Tall Goldenrod	G?			S5	
	Solidago rugosa ssp. rugosa	Rough Goldenrod	G5			S5	
	Taraxacum officinale	Common Dandelion	G5			SE5	I
	Tussilago farfara	Coltsfoot	G?			SE5	I
BALSAMINACEAE	*Impatiens capensis*	Spotted Touch-me-not	G5			S5	
BETULACEAE	*Betula papyrifera*	White Birch	G5			S5	
	Ostrya virginiana	Hop Hornbeam	G5			S5	
BRASSICACEAE	*Alliaria petiolata*	Garlic Mustard	G?			SE5	I
	Capsella bursa-pastoris	Shepherd's Purse	G?			SE5	I
	Lepidium densiflorum	Common Pepper-grass	G5			SE5	I
CAPRIFOLIACEAE	*Lonicera tatarica*	Tartarian Honeysuckle	G?			SE5	I

Family	Scientific Name	Common Names	Global Rank	COSEWIC	COSSARO	S Rank	Introduced
CAPRIFOLIACEAE cont…	*Sambucus racemosa ssp. pubens*	Red-berried Elderberry	G5			S5	
CARYOPHYLLACEAE	*Cerastium fontanum*	Common Mouse-ear Chickweed	G?			SE5	I
	Silene latifolia	Bladder Campion	G?			SE5	I
CHENOPODIACEAE	*Chenopodium album var. album*	Lamb's Quarters	G5			SE5	I
CLUSIACEAE	*Hypericum perforatum*	Common St. John's-wort	G?			SE5	I
CONVOLVULACEAE	*Convolvulus arvensis*	Field Bindweed	G?			SE5	I
	Convolvulus arvensis	Field Bindweed	G?			SE5	I
CORNACEAE	*Cornus foemina ssp. racemosa*	Grey Dogwood	G5			S5	
	Cornus stolonifera	Red-osier Dogwood	G5			S5	
CUPRESSACEAE	*Thuja occidentalis*	Eastern White Cedar	G5			S5	
	Juniperus communis	Ground Juniper	G5			S5	
CYPERACEAE	*Carex bebbii*	Bebb's Sedge	G5			S5	
	Carex hirta	Hammer Sedge	G?			SE2	I
DIPSACACEAE	*Dipsacus fullonum ssp. sylvestris*	Common Teasel	G?			SE5	I
EQUISETACEAE	*Equisetum arvense*	Field Horsetail	G5			S5	
FABACEAE	*Coronilla varia*	Trailing Crown-vetch	G?			SE5	I
	Lotus corniculatus	Bird's-foot Trefoil	G?				I
	Medicago lupulina	Black Medick	G?			SE5	I
	Melilotus alba	White Sweet-clover	G5			SE5	I
	Robinia pseudo-acacia	Black Locust	G5			SE5	I

Family	Scientific Name	Common Names	Global Rank	COSEWIC	COSSARO	S Rank	Introduced
FABACEAE cont…	*Trifolium hybridum ssp. elegans*	Alsike Clover	G?			SE5	I
	Trifolium pratense	Red Clover	G?			SE5	I
	Trifolium repens	White Clover	G?			SE5	I
	Quercus rubra	Red Oak	G5			S5	
GROSSULARIACEAE	*Ribes rubrum*	Garden Red Currant	G4G5			SE5	I
JUGLANDACEAE	*Carya ovata*	Shagbark Hickory	G5			S5	
	Juglans nigra	Black Walnut	G5			S4	
	Juglans cinerea	Butternut	G4	END	END	S3?	
OLEACEAE	*Fraxinus americana*	White Ash	G5			S5	
	Fraxinus pennsylvanica	Green Ash	G5			S5	
PAPAVERACEAE	*Chelidonium majus*	Celandine	G?			SE5	I
PINACEAE	*Picea abies*	Norway Spruce	G?			SE3	I
	Picea glauca	White Spruce	G5			S5	
	Pinus nigra	Austrian Pine	G?			SE2	I
	Pinus resinosa	Red Pine	G5			S5	
	Pinus strobus	Eastern White Pine	G5			S5	
	Pinus sylvestris	Scots Pine	GNR			SNA	
PLANTAGINACEAE	*Plantago major*	Common Plantain	G5			SE5	I
POACEAE	*Agrostis gigantea*	Redtop Grass	G4G5			SE5	I
	Bromus inermis ssp. inermis	Smooth Brome	G4G5			SE5	I

Family	Scientific Name	Common Names	Global Rank	COSEWIC	COSSARO	S Rank	Introduced
POACEAE cont…	*Echinochloa crusgalli*	Barnyard Grass	G?			SE5	I
	Festuca rubra	Red Fescue	G5			S5	
	Phalaris arundinacea	Reed Canary Grass	G5			S5	
	Phleum pratense	Timothy	G?			SE5	I
	Phragmites australis	Common Reed	G5			S5	
	Poa pratensis ssp. pratensis	Kentucky Blue Grass	G?			S5	
	Setaria viridis	Green Foxtail	G?			SE5	I
POLYGONACEAE	*Polygonum persicaria*	Lady's Thumb	G?			SE5	I
RANUNCULACEAE	*Ranunculus acris*	Tall Buttercup	G5			SE5	I
RHAMNACEAE	*Rhamnus cathartica*	Common Buckthorn	G?			SE5	I
ROSACEAE	*Crataegus sp*	Hawthorn Species					
	Geum aleppicum	Yellow Avens	G5			S5	
	Geum laciniatum	Rough Avens	G5			S4	
	Potentilla norvegica ssp. monspeliensis	Rough Cinquefoil	G5			S5	
	Prunus serotina	Black Cherry	G5			S5	
	Prunus virginiana ssp. virginiana	Choke Cherry	G5			S5	
	Rubus idaeus ssp. idaeus	Red Raspberry	G5			SE1	I
SALICACEAE	*Populus tremuloides*	Trembling Aspen	G5			S5	
	Salix alba	White Willow	G5			SE4	I
	Salix bebbiana	Bebb's Willow	G5			S5	

Family	Scientific Name	Common Names	Global Rank	COSEWIC	COSSARO	S Rank	Introduced
SALICACEAE cont…	*Salix fragilis*	Crack Willow	G?			SE5	I
	Salix petiolaris	Slender Willow	G5			S5	
	Salix sp	Willow Species					
SCROPHULARIACEAE	*Verbascum thapsus*	Common Mullein	G?			SE5	I
SOLANACEAE	*Solanum dulcamara*	Bittersweet Nightshade	G?			SE5	I
TYPHACEAE	*Typha latifolia*	Broad-leaved Cattail	G5			S5	
ULMACEAE	*Ulmus americana*	White Elm	G5?			S5	
VITACEAE	*Parthenocissus quinquefolia*	Virginia Creeper	G5			S4?	
	Vitis riparia	Riverbank Grape	G5			S5	

Appendix C

Photos of Typical Vegetation Found in the Study Area

Photo 1: Roadside manicured grass and trees (MGT) on Rymal Road

Photo 2: Deciduous Forest patch on east side of Garth Street. Small meadow marsh community present in drainage ditch.

Photo 3: Deciduous forest on Garth Street along fence line.

Photo 4: Meadow marsh community at Tiffany Creek crossing

Photo 5: Cultural meadow community at roadside near Tiffany Creek crossing. Cultural thicket inclusion visible on access road for hydro ROW.

Photo 6: Cultural meadow community in abandoned farmstead/agricultural land along Garner Road.

Photo 7: Early successional cultural woodlot community along Garner Road.

Appendix D

Tree Inventory

Stantec Consulting Ltd.
Suite 1 - 70 Southgate Drive
Guelph, ON N1G 4P5
Tel: (519) 836-6050
Fax: (519) 836-2493

February 22, 2012
Stantec File: 160960717
City of Hamilton PO #61644

City of Hamilton
Public Works Department
77 James Street North
Hamilton, Ontario
L8R 2K3

Attention: **Ms. Lorissa Skrypniak, Senior Project Manager, Environmental Planning**

Dear Ms. Skrypniak:

Reference: **Garner/Rymal Road & Garth Street Environmental Assessment**
Roster Assignment Under Category #21: Terrestrial and Avian Ecology
Tree Inventory and Species at Risk (SAR) Assessment (revised)

Further to our agreement with the City of Hamilton (the City), Stantec Consulting Ltd. (Stantec) has completed a Tree Inventory and Species at Risk (SAR) Assessment for the above-referenced project in the City of Hamilton. We are pleased to provide the results of the Tree Inventory and SAR Assessment along Garner/Rymal Road and Garth Street in the City of Hamilton (study area depicted on **Figure 1**, below).

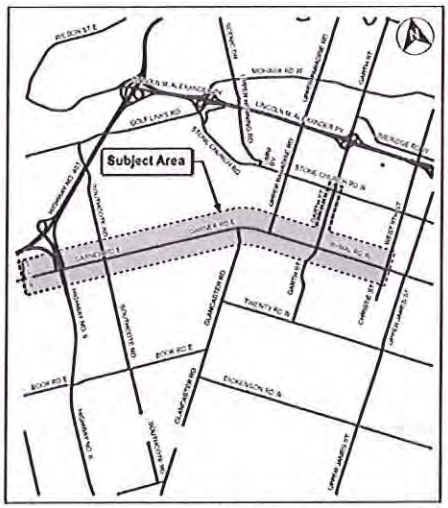

Figure 1. Study Area

The purpose of the Tree Inventory and SAR assessment was to document existing trees and shrubs within 10 m of the existing municipal road right-of-way (ROW) and identify constraints (i.e. SAR) for the proposed expansion of Garner/Rymal Road.

**Reference: Garner/Rymal Road & Garth Street Environmental Assessment
Roster Assignment Under Category #21: Terrestrial and Avian Ecology
Tree Inventory and Species at Risk (SAR) Assessment (revised)**

APPROACH

Further to Stantec's October 24, 2011 letter, field studies were conducted in accord with the work program described therein.

The tree assessment, using mapping provided to Stantec by the City, was conducted on November 15-16, 18, and 24-25, 2011. As noted in Stantec's work program, the timing of the survey and lack of access to private lands limited the study scope, such that it was not possible to assess common tree health indicators associated with foliage, and precise locations of specimens on private land were not collected. In addition, some horticultural tree species and varieties (i.e. non-native trees) were observed, which could not be identified with certainty, and some specimens growing closely together were assessed a group.

All trees and shrubs within 10 m of the existing municipal road right-of-way (ROW) were characterized as follows:

- species identification (where possible);
- diameter at breast height (DBH, at a height of 1.3 m) was using calipers (where possible) or estimated;
- location category (e.g, boulevard, beyond ditch, etc.),
- assumed tree ownership (City or private), and
- health details, as described below.

In the field, the following criteria were used to assess tree health:

- Evidence of insect damage;
- Disease and/or rotting;
- Bark and /or stem damage; and
- Canopy die-back.

These criteria were used to assign each specimen to one of the following categories;

- healthy (i.e. no major health defects visible; evidence of pruning, minor dieback or minor bark damage were acceptable);
- declining (i.e. moderate dieback, bark or stem damage; evidence of insect damage);
- unhealthy (i.e. major dieback, internal rot, diseases such as black knot or cankers); or
- dead (i.e. no live limbs or buds).

The Natural Heritage Information Centre (NHIC, Ministry of Natural Resources) was searched for records of vegetation Species At Risk (SAR) known to occur in the general vicinity of the study area prior to the field work.

The NHIC search results are summarized in **Table 1.** The study area (i.e. the existing ROW and 10 m on either side) was searched for these vegetation Species at Risk.

Table 1: Vegetation Species at Risk Potentially Occurring within the Study Area (NHIC search, November 2011)

Common Name	Scientific Name	S-Rank	COSEWIC Status	COSSARO Status	Last Observed	Extirpated?
American Chestnut	*Castanea dentata*	S2	END	END	1976-PRE	N
Burning Bush	*Euonymus atropurpureus*	S3			1894-06-25	N
Clinton's Clubrush	*Trichophorum clintonii*	S2S3			1954-05-24	N
Downy Yellow False Foxglove	*Aureolaria virginica*	S1			1957-07-26	Y
Fern-leaved Yellow False Foxglove	*Aureolaria pedicularia*	S2?			1888-09-19	N
Forked Panic Grass	*Dichanthelium dichotomum*	S2			1954-07-03	N
Large Yellow Pond-lily	*Nuphar advena*	S3			1952-07-27	N
Northern Hawthorn	*Crataegus dissona*	S3			1974-06-02	N
Panicled Hawkweed	*Hieracium paniculatum*	S2?			1956-08-08	N
Perfoliate Bellwort	*Uvularia perfoliata*	S1			1962-05-14	N
Pignut Hickory	*Carya glabra*	S3			1957-09-19	N
Scarlet Beebalm	*Monarda didyma*	S3			1950-07	N
Sharp-leaved Goldenrod	*Solidago arguta*	S4			1958-08-27	N
Shiny Wedge Grass	*Sphenopholis nitida*	S1			1957-06-17	N
Soft-hairy False Gromwell	*Onosmodium molle ssp. hispidissimum*	S2				N
White-tinged Sedge	*Carex albicans var. albicans*	S3			1980-05-17	N
Woodland Pinedrops	*Pterospora andromedea*	S2			1902-07-01	N

COSSARO: Committee on the Status of Species at Risk in Ontario
COSEWIC: Committee on the Status of Endangered Wildlife in Canada
S1: Critically Imperiled—Critically imperiled in the province (often 5 or fewer occurrences)
S2: Imperiled—Imperiled in the province, very few populations (often 20 or fewer),
S3: Vulnerable—Vulnerable in the province, relatively few populations (often 80 or fewer)
S4: Apparently Secure—Uncommon but not rare
S5: Secure—Common, widespread, and abundant in the province

When SAR were encountered a brief description of the general extent of suitable habitat as well as the general habitat requirements and sensitivities was noted. Where possible, on public land, GPS locations were taken for SAR, for specimens on private lands the coordinates were estimated as offsets from known locations.

RESULTS

The study area varied from agricultural and rural residential to suburban to commercial as the survey progressed from west to east.

A total of 2208 trees and shrubs were assessed during the tree inventory and are summarized in **Table 2** (attached hereto) and shown on the City of Hamilton Tree Preservation\Removal Plan Drawings (attached hereto; Garner/Rymal Road as Tiles T1-T6 with Garth Street as Tile T7). Seventy-four percent (74%) of trees were assessed as healthy, 18% as declining, 6% as unhealthy, and 2% as dead.

Butternut (*Juglans cinerea*) is a medium-sized tree that is listed as Endangered by both COSEWIC (Committee on the Status of Endangered Wildlife in Canada) and COSSARO (Committee on the Status of

Species at Risk in Ontario) due to the Butternut canker, an infection with high rates of mortality (COSEWIC 2003). This tree is intolerant of shade and grows best on rich, moist, well-drained loams, often associated with stream banks. In Ontario, butternut is typically found scattered individually or in small groups in deciduous woodlands, or in hedgerows (COSEWIC, 2003).

Four (4) Butternut trees were identified during the SAR survey. Locations are summarized in Table 3.

Table 3: Species at Risk present within the vicinity of Garner/Rymal Road and Garth Street , City of Hamilton, 2011

Tile #	Tree ID #	Common Name	Botanical Name	Diameter (cm)	Location	Ownership	UTM Easting	UTM Northing
T6	25	Butternut	*Juglans cinerea*	10	Private land	Private	588660	4784278
T6	26	Butternut	*Juglans cinerea*	8	Private land	Private	588660	4784278
T6	63	Butternut	*Juglans cinerea*	19.2	Sidewalk	City	588730	4784257
T6	149	Butternut	*Juglans cinerea*	25	Private land	Private	589449	4784040

Two joined butternuts (ID #25 and #26) were located outside the Study Area (approximately 20 m from the edge of the shoulder) on the south side of Rymal Road, in front of St. Elizabeth's Home Society (see the **City of Hamilton Tree Preservation\Removal Plan Drawings T1-T6** and **T7**, attached hereto). Habitat consisted of a tangle of Manitoba maples and other non-native species within a hedgerow.

A third butternut was found (ID #63) also on the south side of Rymal Road west of Bishop Ryan Way (see the **City of Hamilton Tree Preservation\Removal Plan Drawings T1-T6** and **T7**). This tree had moderate bark damage and was located on city property south of the sidewalk but north of the private fence, approximately 5 m from the road shoulder. Ground cover was maintained lawn.

A fourth and final butternut was identified on private property (ID #149) in the hedgerow at the property boundary between 123 and 117 Rymal Road. This tree is quite large (~25 cm DBH).

RECOMMENDATIONS

Prior to any construction work on site, the butternut trees should be assessed by a qualified Butternut Health Assessor. This assessment Should the health assessment determine the butternut trees are "retainable" a permit under the provincial *Endangered Species Act* (ESA) may be required to either remove the trees, or undertake works within 25 m of the trees. At the time of the health assessment, it is recommended MNR be consulted to ensure compliance under the ESA.

SUMMARY

A tree inventory is attached (**Table 2, City of Hamilton Tree Preservation\Removal Plan Drawings T1-T6** and **T7**) which outlines the trees and shrubs within 10 m of the ROW of Garner Road, Rymal Road, and Garth Street.

Butternut was the only Species at Risk encountered during the tree inventory. The locations are summarized in **Table 3** and shown on the **City of Hamilton Tree Preservation\Removal Plan Drawings T1-T6** and **T7**. Stantec recommends that a formal health assessment of the butternut trees be undertaken by a qualified Butternut Health Assessor and MNR be consulted prior to any construction taking place in the vicinity of the Butternut trees.

Reference: Garner/Rymal Road & Garth Street Environmental Assessment
Roster Assignment Under Category #21: Terrestrial and Avian Ecology
Tree Inventory and Species at Risk (SAR) Assessment (revised)

Thank you for the opportunity to provide this service to the City of Hamilton. We trust the foregoing information addresses the City's needs, however, should there be any questions, please do not hesitate to contact the undersigned.

Sincerely,

STANTEC CONSULTING LTD.

Melissa Straus, M.Sc.
Terrestrial Ecologist
Tel: (519) 836-6966 x303
Fax: (519) 836-2493
Melissa.Straus@stantec.com

David Charlton, M.Sc., P.Ag., LEED® AP
Senior Principal, Environmental Management
Tel: (519) 836-6966 x253
Fax: (519) 836-2493
David.Charlton@stantec.com

Att: **City of Hamilton Tree Preservation\Removal Plan Drawings T1-T6 and T7**; and **Table 2:** Tree Survey Results for Garner/Rymal Road and Garth Street.

c.c. Susan Jacob, City of Hamilton
Ian Upjohn, SNC Lavalin

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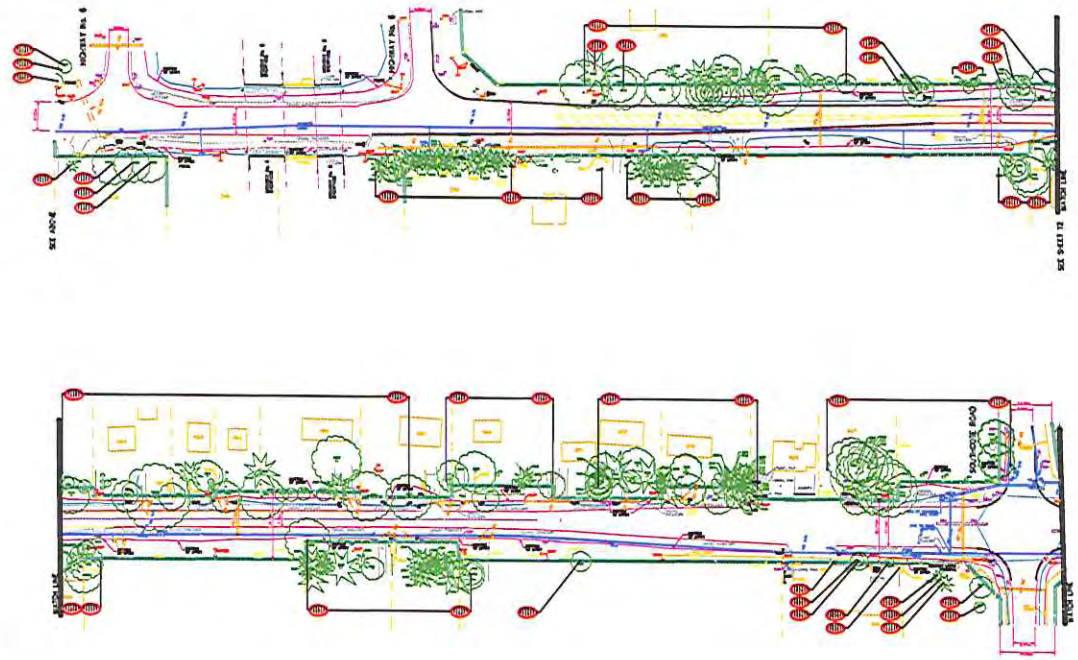
GARNER ROAD EAST

09-H-36 (T1)

GARNER ROAD EAST



CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-36
FILE No.

SHEET No.
T1 OF T6

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Unless scheduled for removal on this drawing, all trees to be protected by tree preservation

All contractors, engineers and architects working in the vicinity of municipally owned trees shall adhe

1) All existing trees to remain on site, or on adjacent properties, shall be tagged and fully prote fencing, to the satisfaction of the Manager of Forestry and Horticulture or his designee to prevent and traversed during construction. Areas within the protection fencing zone shall remain undisturbed a for the storage of building materials, structures or equipment. This tree protection zone shall be ob commencement of site clearance, demolition, or any type of construction.

2) Surplus soil, equipment, vehicles, tools, debris or materials shall not be placed over the root zo the Tree Protection Zone. No contaminants shall be dumped or flushed onto bare roots of trees

3) The Contractor shall, whenever possible, avoid cutting surface roots. If root cuts are necessary, quality, among smooth flush cuts. The roots shall be back-filled and watered before they have a ch

4) Where limbs or portions of trees must be removed to accommodate construction work, Forestry with accepted Arboricultural practices will remove them. Contractor shall take measures to prevent

5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry (or shapes during construction.

6) The Contractor shall, whenever possible, avoid disturbing original grades around trees to ensure

7) At no time shall the Contractor place, dump or stored any stone, brick, sand, concrete, and equipment which may impede the free passage of water, air or nutrients to the tree.

8) No cables or ropes of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain either cut or branch ribbed to it or survey markings or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be notified to inspect all trees th maintenance that remain in effect until the completion of construction, at which time authorization fo & Horticulture or his designate must be obtained for the removal of the Tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally own encountered during construction

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							

No.	REVISIONS	INITIAL	DATE

DRAWN BY: LC DATED: APRIL 16, 2009

Reviewed and Approved

Forestry & HorticulturBate

SCALES

0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

City OF HAMILTON
Public Works Department

GARNER ROAD EAST
Tree Preservation \ Removal Plan

From : Highway No. 6
To : West 5th Street

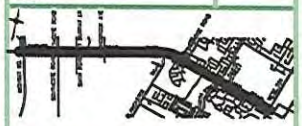
GARNER ROAD EAST

09-H-36 (T2)

GARNER ROAD EAST

CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-36
FILE No.

SHEET No. T2 OF T8



DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Unless scheduled for removal on this drawing, all trees to be protected by tree preservation

All contractors, engineers and architects working in the vicinity of municipally owned trees must adhere

1) All existing trees to remain on site, or on adjacent properties, shall be tagged and fully protect fencing to the satisfaction of the Manager of Forestry and Horticulture or his designate to prevent d and otherwise during construction. Areas within the protection fencing zone must remain undisturbed or for the storage of building materials, structures or equipment. This tree protection zone shall be com commencement of site clearance, demolition, or any type of construction.

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3) The Contractor shall, whenever possible, avoid cutting surface roots. If root cuts are necessary, quality, making smooth flush cuts. The roots shall be trimmed and cleaned before they have a chan

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5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry com weeks during construction.

6) The Contractor shall, whenever possible, avoid disturbing original grades around trees to prevent d

7) At no time shall the Contractor place, deposit or stockpile any stone, brick, sand, concrete, soil o equipment which may impede the free passage of water, air or nutrients to the tree.

8) No rubber or ropes of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain after construc or limbs attach to it of survey markings or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be notified to inspect all Tree Pro measures must remain in effect until the completion of construction, at which time authorization from & Horticulture or his designate must be obtained for the removal of the Tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally owned arboreal during construction

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							

No.	REVISIONS	INITIAL	DATE

DRAWN BY: LC DATE: APRIL 16, 2009

Reviewed and Approved

Forestry & HorticulturBole

SCALES 0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

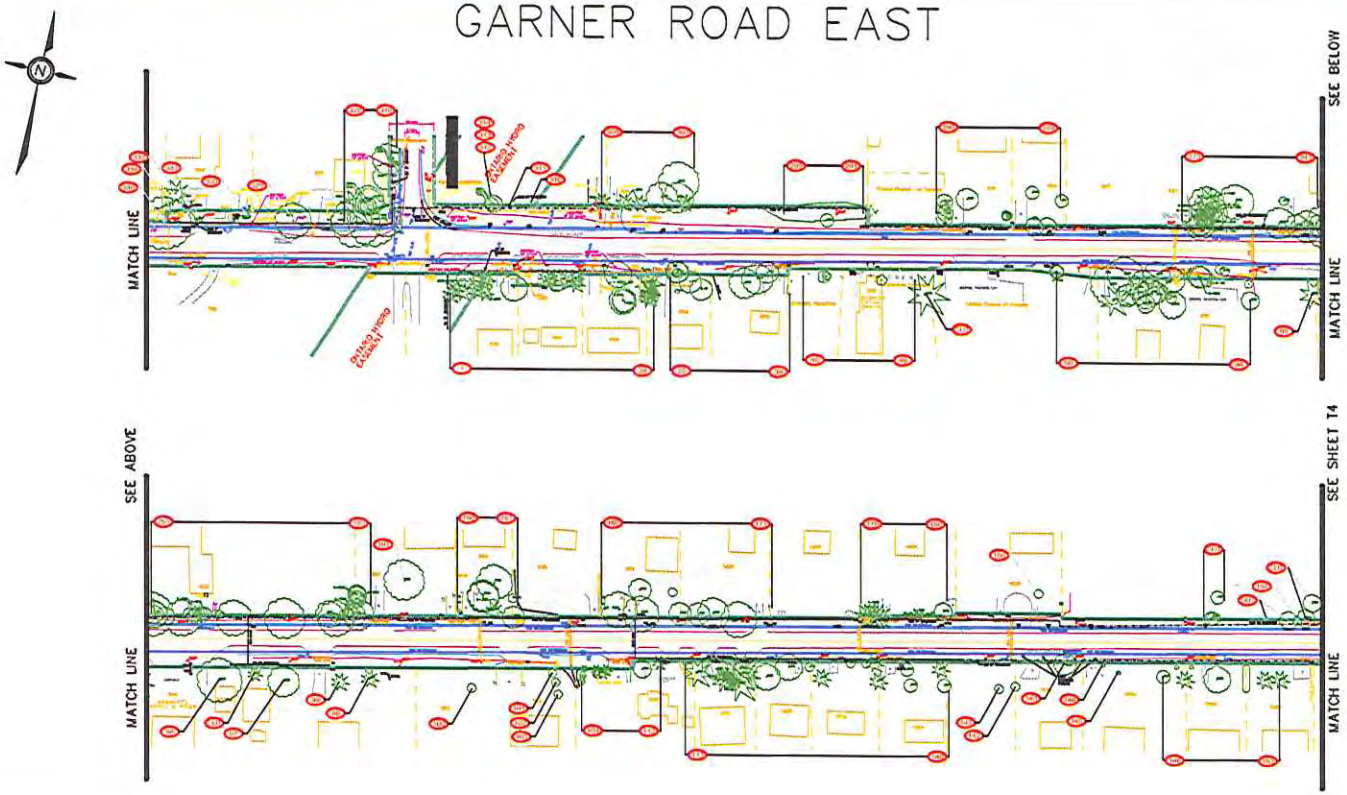
CITY OF HAMILTON
Public Works Department

GARNER ROAD EAST
Tree Preservation \ Removal Plan
From : Highway No. 6
To : West 5th Street

GARNER ROAD EAST

09-H-36 (T3)

GARNER ROAD EAST



CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-36
FILE No.

SHEET No. T3 OF T6

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Items scheduled for removal on this drawing, all trees to be protected by tree preservation

All contractors, engineers and architects working in the vicinity of municipally owned trees shall

1) All existing trees to remain on site, or on adjacent properties, shall be tagged and fully protected by the authorization of the Manager of Forestry and Horticulture or his designate to prevent damage during construction. Areas within the tree protection zone shall remain undisturbed and free of storage of building materials, structures or equipment. Only after prior authorization is obtained from the Manager of Forestry and Horticulture, or his designate, shall any excavation, trenching, or any type of construction.

2) Surplus soil, equipment, solution, tools, debris or materials shall not be placed near the tree and kept out of the Tree Protection Zone. No contaminants shall be dumped or flushed where feeder roots of trees

3) The Contractor shall, whenever possible, avoid cutting surface roots. If root cuts are necessary, they must be made smooth. Such cuts. The roots shall be sub-divided and material taken away from a tree.

4) Where limbs or portions of trees must be removed to accommodate construction work, Forestry and Horticulture practices will govern them. Contractor must take measures to prevent damage during construction.

5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry crew during construction.

6) The Contractor shall, whenever possible, avoid disturbing original grades around trees in areas of

7) At no time shall the Contractor place, deposit or stored any stone, brick, sand, concrete, soil, equipment, which may hinder the free passage of water, air or nutrients to the tree.

8) No cables or ropes of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain either scarred or fastened nailed to it or survey markings or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be notified to inspect all trees prior to commencement of construction, at which time authorization of which trees authorization from Forestry & Horticulture or his designate must be obtained for the removal of the Tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally owned trees are damaged during construction.

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							

No.	REVISIONS	INITIAL	DATE

DRAWN BY: LC & LM. DATE: APRIL 16, 2009

Reviewed and Approved

Forestry & HorticulturDate

SCALES 0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

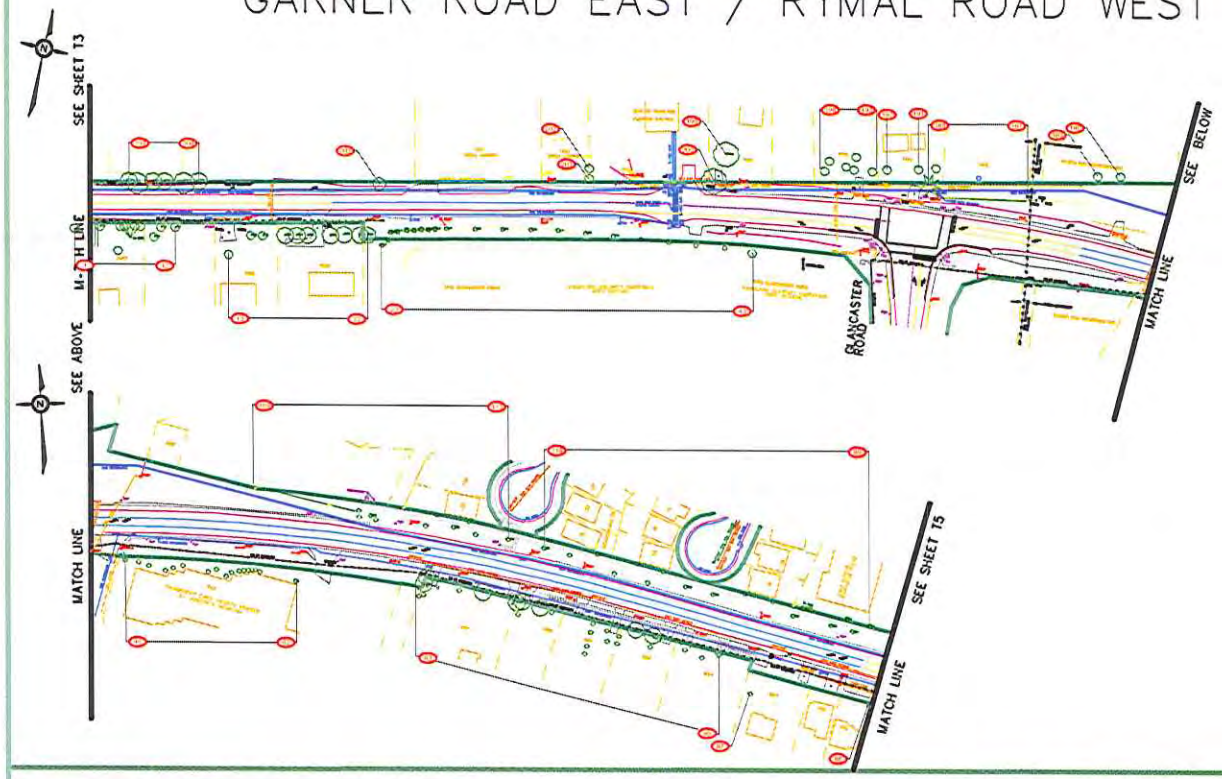
CITY OF HAMILTON
Public Works Department

GARNER ROAD EAST
Tree Preservation \ Removal Plan
From : Highway No. 6
To : West 5th Street

GARNER ROAD EAST/RYMAL ROAD WEST

09-H-36 (T4)

GARNER ROAD EAST / RYMAL ROAD WEST



CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-36
FILE No.

SHEET No. T4 OF T6

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Unless scheduled for removal on this drawing, all trees to be protected by tree preservation fen

All contractors, engineers and architects working in the vicinity of municipally owned trees shall adhere to

1) All building trees to remain on site, or on adjacent properties, shall be tagged and fully protected fencing, for the consideration of the Manager of Forestry and Horticulture at his discretion, for protection during construction. Areas within the protection fencing zone shall remain undisturbed and u for the storage of building materials, structures or equipment. No tree protection zone shall be compacted contaminated of site materials, operations, or any type of construction.

2) Surface soil, equipment, materials, tools, debris or materials shall not be placed over the root system Protection Zone. No materials shall be dumped or buried where trees exist or trees will

3) The Contractor shall, wherever possible, avoid cutting surface roots. If root cuts are necessary, these quality, cleaning smooth flush cuts. The roots shall be back-filled and watered before they have a chance

4) Where holes or portions of trees must be removed by unavoidable construction work, Forestry pers with complete Arboriculture practices on remote trees. Contractor must take measures to prevent injury to

5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry personnel charge during construction.

6) The Contractor shall, wherever possible, avoid disturbing original grades around trees in excess of

7) At no time shall the Contractor place, deposit or allowed any stone, brick, sand, concrete, oil or o machinery which may impede the free passage of water, air or nutrients to the tree.

8) No cables or cords of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain after construction or branches stated for it, or survey stakeings, or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be notified to inspect all Tree Protect measures that remain in effect until the completion of construction, at which time authorization from the of Horticulture or his designate must be obtained for the removal of all tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally owned tr encountered during construction

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
41							
42							
43							
44							
45							
46							

No.	REVISIONS	INITIAL	DATE

DRAWN BY: LM. DATE: MAY 7, 2009

Reviewed and Approved

Forestry & HorticulturBate

SCALES 0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

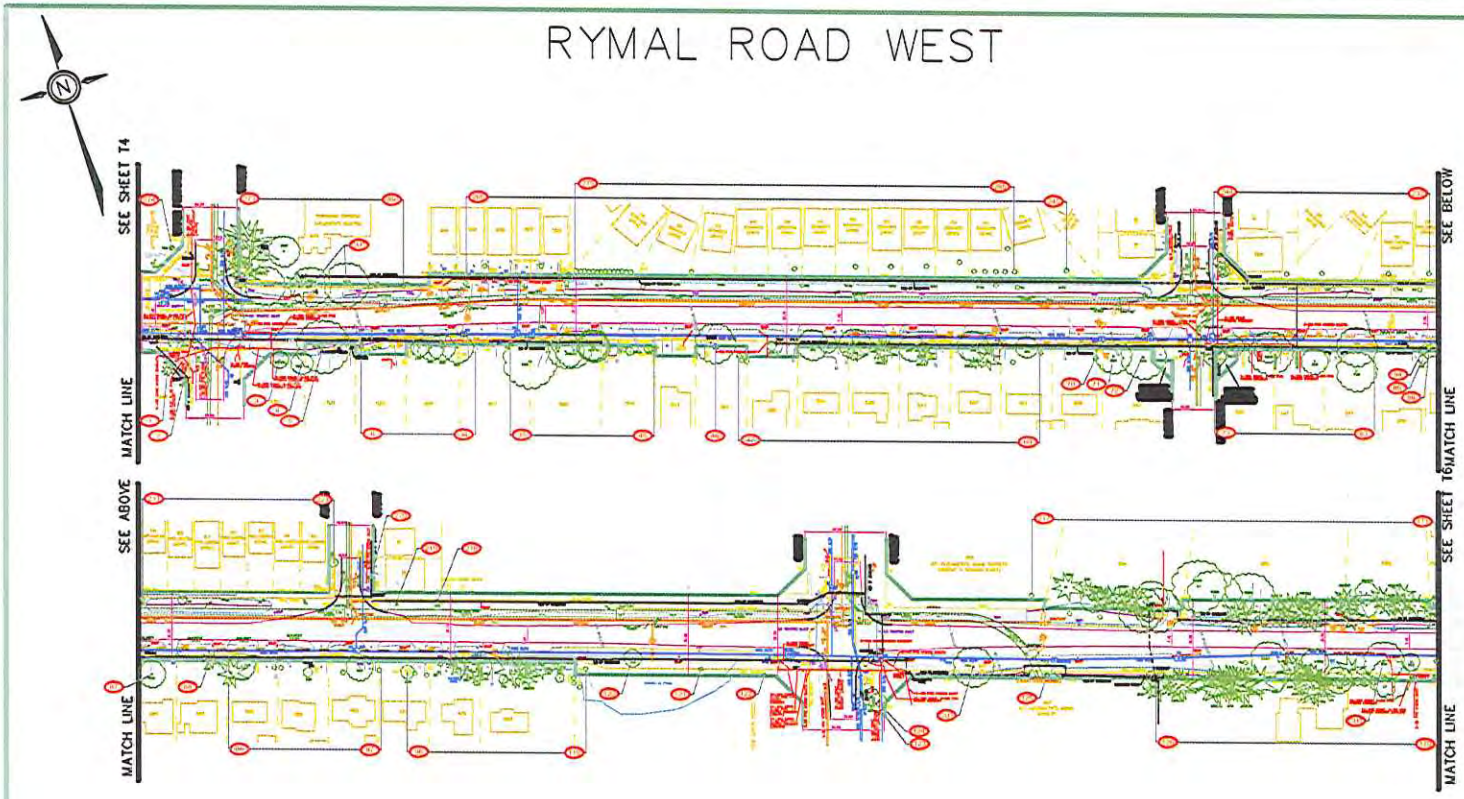
City OF HAMILTON
Public Works Department

GARNER ROAD EAST
RYMAL ROAD WEST
Tree Preservation \ Removal Plan
From : Highway No. 6
To : West 5th Street

RYMAL ROAD WEST

09-H-36 (T5)

RYMAL ROAD WEST



CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-36
FILE No.

SHEET No. T5 OF T6

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Unless scheduled for removal on this drawing, all trees to be protected by tree preservation

All contractors, engineers and architects working in the vicinity of municipally owned trees shall adhere

1) All existing trees to remain on site, or on adjacent properties, shall be tagged and fully protected
fencing. In the exclusion of the Manager of Forestry and Horticulture or his designee to prevent, or
root damage during construction. Areas within the protection fencing zone shall remain undisturbed a
for the storage of building materials, structures or equipment. The tree protection zone shall be kept
commencement of site clearance, demolition, or any type of construction.

2) Surplus soil, equipment, vehicles, tools, debris or materials shall not be placed over the root zone
the Tree Protection Zone. No compounds shall be dumped or flushed above feeder roots of trees o

3) The Contractor shall, wherever possible, avoid cutting surface roots. If root cuts are necessary, t
quickly, making smooth flush cuts. The roots shall be hand-dug and severed before they have a chan

4) Where limbs or portions of trees must be removed to accommodate construction work, Forestry
with accepted Arboricultural practices and ANSI standards. Contractor shall take standards in pruning and

5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry pers
stages during construction.

6) The Contractor shall, wherever possible, avoid disturbing original grades around trees in areas of

7) At no time shall the Contractor place, deposit or stored any stone, brick, sand, concrete, soil o
equipment which may impede the free passage of water, air or materials to the tree.

8) No cables or ropes of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain after construc
or branch stubs to a 4 or survey markings or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be entitled to inspect all Tree Pr
measures that remain in effect until the completion of construction, at which time authorization
a Forester or his designee must be obtained for the removal of the Tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally owned
damaged during construction.

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							

No.	REVISIONS	INITIAL	DATE

DRAWN BY: J.A.K. DATE: SEPTEMBER 1, 2009

Reviewed and Approved

Forestry & Horticulture Date

SCALES

0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

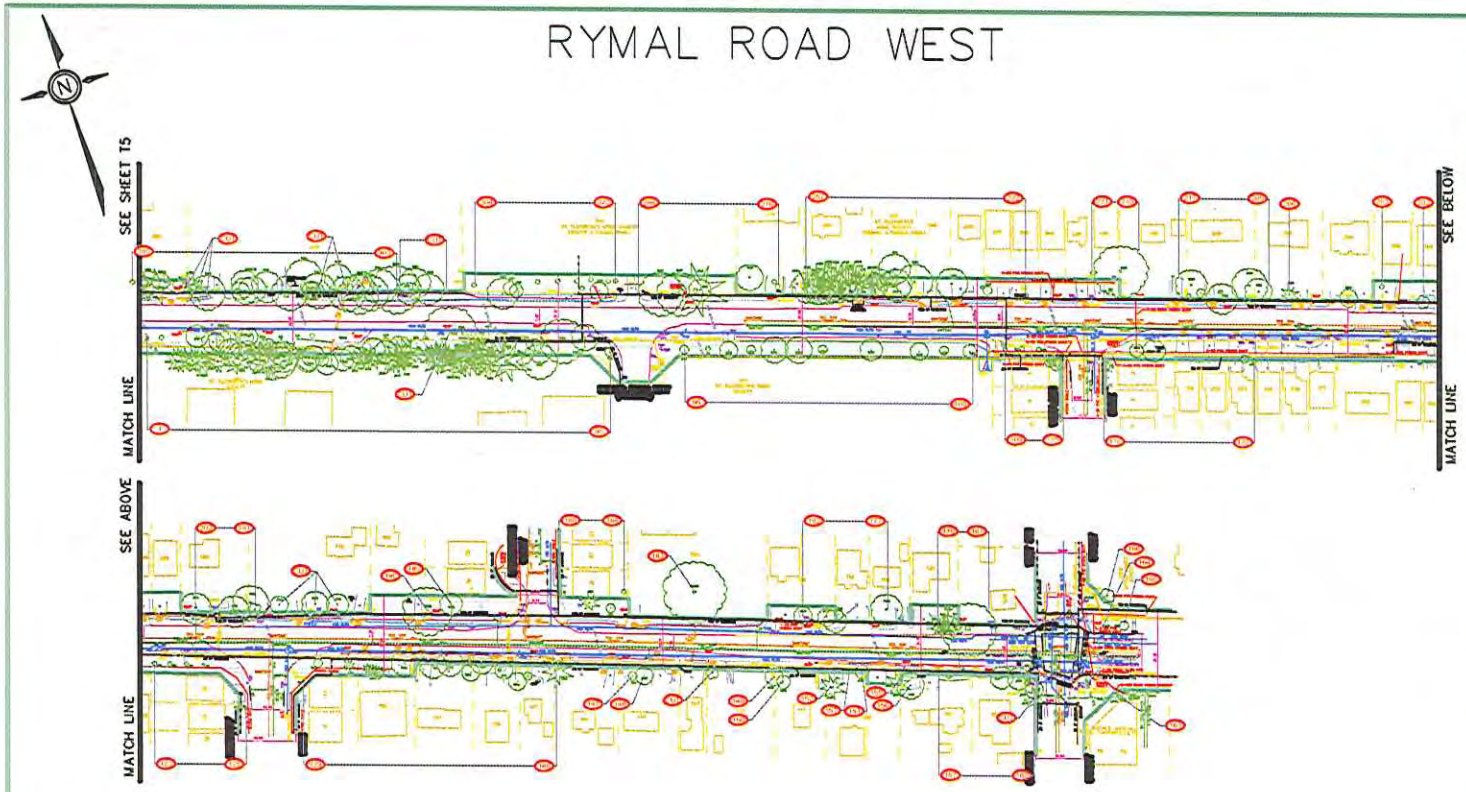
City OF HAMILTON
Public Works Department

RYMAL ROAD WEST
Tree Preservation \ Removal Plan
From : Highway No 6
To : West 5th Street

RYMAL ROAD WEST

09-H-36 (T6)

RYMAL ROAD WEST



CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-36
FILE No.

SHEET No. T6 OF T6

DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Unless scheduled for removal on this drawing, all trees to be protected by tree preservation

All contractors, engineers and architects working in the vicinity of municipally owned trees shall adhe

1) All existing trees to remain on site, or on adjacent properties, shall be tagged and fully protect fencing. In the discretion of the Manager of Forestry and Horticulture or his designate for protect and tree/shrub survey construction. Areas within the protection fencing or any small mature architectural for the storage of building materials, structures or equipment. This tree protection zone shall be mai or damage of any elements, destruction, or any type of construction.

2) Surplus soil, equipment, additions, tools, stacks or materials shall not be placed over the root zone the Tree Protection Zone. No contaminants shall be dumped or flushed where feeder roots of trees

3) The Contractor shall, wherever possible, avoid cutting surface roots. If root cuts are necessary, quality, sloping smooth flush cuts. The roots shall be kept moist and covered before they have a chi

4) Where limbs or portions of trees must be removed to accommodate construction work, Forestry with approved Arboricultural practices at remove them. Contractor must take measures to prevent

5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry pers during construction.

6) The Contractor shall, wherever possible, avoid disturbing original grades around trees in areas of

7) At no time shall the Contractor place, deposit or stored any stone, soil, sand, aggregate, and equipment which may harm the tree through of stress, air or nutrients to the tree.

8) No cables or ropes of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain after construction of fences cutted to 1 or survey markings or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be entitled to inspect all Tree Pr structures that remain in effect until the completion of construction, at which time authorization from & Horticulture or his designate must be obtained for the removal of the Tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally owned trees/shrubs during construction

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							

No.	REVISIONS	INITIAL	DATE

DRAWN BY: J.A.K. DATE: SEPTEMBER 1, 2009

Reviewed and Approved

Forestry & HorticulturBale

SCALES 0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

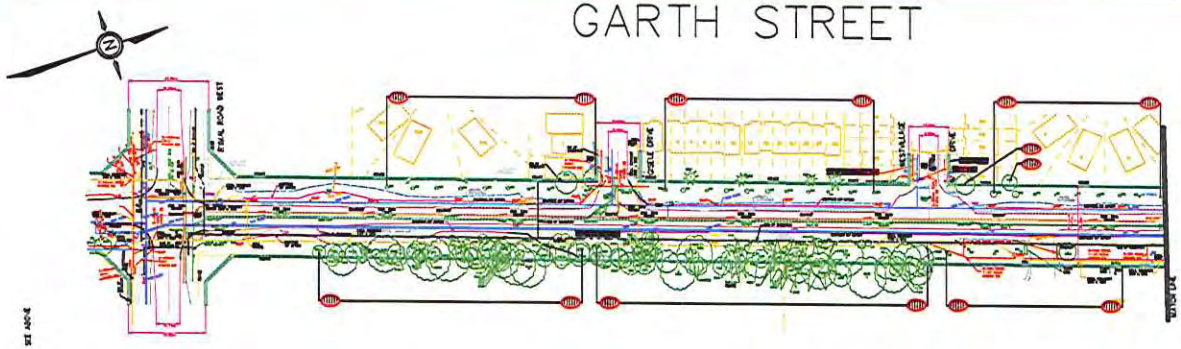
City OF HAMILTON
Public Works Department

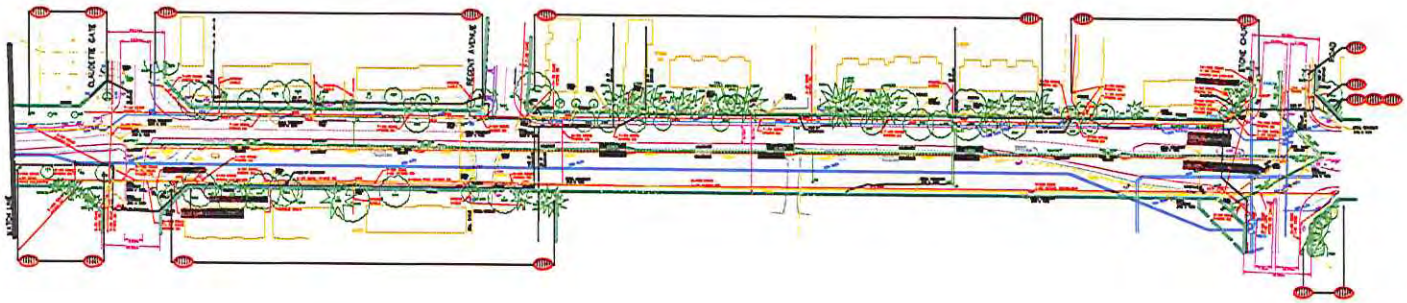
RYMAL ROAD WEST
Tree Preservation \ Removal Plan
From : Highway No 6
To : West 5th Street

GARTH STREET

09-H-43 (T1)

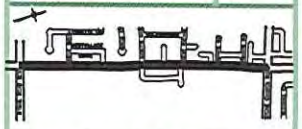
GARTH STREET





CONTRACT No. PW-08-00 (HSW)
DRAWING No. 09-H-43
FILE No.

SHEET No. T1 OF T1



DIMENSIONS SHOWN ON THIS PLAN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

LEGEND (Proposed Works)

- EXISTING DECIDUOUS TREE (TO REMAIN)
- EXISTING DECIDUOUS TREE (Remove)
- EXISTING CONIFEROUS TREE (TO REMAIN)
- EXISTING CONIFEROUS TREE (Remove)

GENERAL NOTES

(Unless scheduled for removal on this drawing, all trees to be protected by tree preservation

All contractors, engineers and architects working in the vicinity of municipally owned trees shall adhere

1) All existing trees to remain on site, or on adjacent properties, shall be tagged and fully protected during, to the satisfaction of the Manager of Forestry and Horticulture or his designee to protect it and hoarding during construction. Areas within the protection fencing zone shall remain undisturbed and for the storage of building materials, structures or equipment. Tree tree protection zone shall be along commencement of site clearance, demolition, or any type of construction.

2) Surplus soil, equipment, vehicles, tools, debris or materials shall not be placed over the root zone the Tree Protection Zone. No contaminants shall be dumped or flushed where feeder roots of trees

3) The Contractor shall, whenever possible, avoid cutting surface roots. If root cuts are necessary, t cutting, sharing smooth flush cuts. The roots shall be hand-dug and cutting before they have a chan

4) Where limbs or portions of trees must be removed to accommodate construction work, Forestry with accepted Arboricultural practices will remove them. Contractor shall take measures to prevent any

5) Where necessary, the trees will be given an overall pruning by the City of Hamilton Forestry pers damage during construction.

6) The Contractor shall, whenever possible, avoid disturbing original grades around trees to prevent of

7) At no time shall the Contractor place, deposit or stockpile any stone, brick, sand, aggregate, soil or equipment which may impede the free passage of water, air or nutrients to the tree.

8) No cables or ropes of any type shall be wrapped around or installed in trees.

9) At no time, under any circumstances, shall any part of the tree that is to remain after construc or branch extend to a or survey markings or paint applied to the tree.

10) The Manager of Forestry & Horticulture or his designate shall be notified to inspect all trees the protection that remain in effect until the completion of construction, at which time authorization from a Horticulturist or his designate must be obtained for the removal of the tree Protection Zone.

11) The Manager of Forestry & Horticulture must be notified immediately when any municipally owned unauthorized during construction

TREE PROTECTION ZONE SIGNAGE

(See Special Provisions for Tree Preservation Zone Signage)

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
1	Text	Text	Text	Text	behind walk	City	Text
2					in boulevard	City	
3					behind walk	City	
4					in boulevard	City	
5					behind curb	Private	
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
17	Text	Text	Text	Text	behind walk	City	Text
18					in boulevard	City	
19					behind walk	City	
20					in boulevard	City	
21					behind walk	Private	
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

TREE ID No.	COMMON NAME	BOTANICAL NAME	DIA. (cm)	CONDITION	LOCATION	OWNERSHIP	ACTION
33	Text	Text	Text	Text	behind walk	City	Text
34					in boulevard	City	
35					behind walk	City	
36					in boulevard	City	
37					behind walk	Private	
38							
39							
40							
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No.	REVISIONS	INITIAL	DATE

DRAWN BY: LC DATE: JULY 10, 2009

Reviewed and Approved

Forestry & Horticulture Date

SCALES 0 20m 40m

Project Manager (Design)

NAME

Manager of Design

Susan Jacob, P. Eng.

CITY OF HAMILTON
Public Works Department

GARTH STREET
Tree Preservation \ Removal Plan
From : Rymal Road West
To : Stone Church Road

Stantec

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
1	157	Deciduous ornamental tree		4	Healthy	Across Ditch	Private			
1	158	Deciduous ornamental tree		3-Feb	Healthy	Across Ditch	Private			
1	159	Norway spruce	*Picea abies*	13	Unhealthy	Private land	Private			
1	160	Blue Spruce	*Picea pungens*	30	Unhealthy	Private land	Private			
1	161	Norway spruce	*Picea abies*	35	Unhealthy	Private land	Private			
1	162	Black ash	*Fraxinus nigra*	35	Healthy	Private land	Private			
1	163	Ornamental shrub		1.5	Healthy	Private land	Private			
1	164	White ash	*Fraxinus americana*	9.3	Healthy	Cemetery	City?			
1	165	White ash	*Fraxinus americana*	46.1	Healthy	Cemetery	City?			
1	166	White ash	*Fraxinus americana*	29.4	Dead	Cemetery	City?			
1	167	White ash	*Fraxinus americana*	22.6	Healthy	Cemetery	City?			
1	168	White ash	*Fraxinus americana*	34.8	Unhealthy	Cemetery	City?			
1	169	White ash	*Fraxinus americana*	35.3	Healthy	Cemetery	City?			
1	170	White ash	*Fraxinus americana*	37.8	Healthy	Cemetery	City?			
1	171	Maple	*Acer sp.*	10.2	Healthy	Cemetery	City?			
1	172	Maple	*Acer sp.*	9.4	Healthy	Cemetery	City?			
1	173	Maple	*Acer sp.*	8.3	Healthy	Cemetery	City?			
1	174	Maple	*Acer sp.*	7.7	Healthy	Cemetery	City?			
1	175	Staghorn sumac	*Rhus typhina*	2.8	Healthy	Cemetery	City?	584626	4984150	x8 stems
1	176	Willow sp.	*Salix sp.*	41.2	Decline	Shoulder	City			
1	177	Willow sp.	*Salix sp.*	50.3	Decline	Shoulder	City			
1	178	Willow sp.	*Salix sp.*	30.3	Healthy	Shoulder	City			
1	179	Willow sp.	*Salix sp.*	49.7	Healthy	Shoulder	City			
1	180	Willow sp.	*Salix sp.*	45.8	Healthy	Shoulder	City			
1	181	Willow sp.	*Salix sp.*	60.3	Healthy	Ditch	City			
1	182	Willow sp.	*Salix sp.*	67.4	Decline	Ditch	City			
1	183	Crack willow	*Salix fragilis*	40	Healthy	Ditch	City			
1	184	Crack willow	*Salix fragilis*	50	Decline	Ditch	Private			
1	185	Crack willow	*Salix fragilis*	55	Decline	Ditch	Private			
1	186	Crack willow	*Salix fragilis*	30	Decline	Ditch	Private			
1	187	Crack willow	*Salix fragilis*	35	Healthy	Ditch	Private			
1	188	Crack willow	*Salix fragilis*	40	Healthy	Ditch	Private			
1	189	Crack willow	*Salix fragilis*	50	Healthy	Ditch	Private			
1	190	common buckthorn	*Rhamnus cathartica*	8.5	Healthy	Ditch	City			
1	191	common buckthorn	*Rhamnus cathartica*	7.5	Healthy	Ditch	City			
1	192	common buckthorn	*Rhamnus cathartica*	5.5	Healthy	Ditch	City			
1	193	common buckthorn	*Rhamnus cathartica*	9	Healthy	Ditch	City			
1	194	Manitoba maple	*Acer negundo*	18.5	Healthy	Ditch	City			
1	195	Manitoba maple	*Acer negundo*	17.2	Healthy	Ditch	City			
1	196	Manitoba maple	*Acer negundo*	12.5	Healthy	Ditch	City			
1	197	Manitoba maple	*Acer negundo*	8.8	Healthy	Ditch	City			
1	198	Manitoba maple	*Acer negundo*	7.6	Healthy	Ditch	City			
1	199	Manitoba maple	*Acer negundo*	6.5	Healthy	Ditch	City			
1	200	Manitoba maple	*Acer negundo*	6.2	Healthy	Ditch	City			
1	201	Manitoba maple	*Acer negundo*	5	Healthy	Ditch	City			
1	202	Manitoba maple	*Acer negundo*	5	Healthy	Ditch	City			
1	203	Manitoba maple	*Acer negundo*	15.7	Healthy	Ditch	City			
1	204	Manitoba maple	*Acer negundo*	5	Healthy	Ditch	City			
1	205	Manitoba maple	*Acer negundo*	25	Healthy	Ditch	Private			
1	206	Tartarian honeysuckle	*Lonicera tartarica*	<1	Healthy	Ditch	City			
1	207	Lilac	*Syringa vulgaris*	1.2	Healthy	Shoulder	City			
1	208	Lilac	*Syringa vulgaris*	1.2	Healthy	Shoulder	City			

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Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
1	313	Black walnut	*Juglans nigra*	4.5	Decline	Across Ditch	Private			
1	314	Sugar maple	*Acer saccharum ssp. saccharum*	3	Healthy	Across Ditch	Private	584263	4984110	
1	315	Black walnut	*Juglans nigra*	30	Healthy	Across Ditch	Private			
1	316	Black cherry	*Prunus serotina*	39.6	Unhealthy	Ditch	City			
1	317	Black walnut	*Juglans nigra*	10	Healthy	Across Ditch	Private			
1	318	Shagbark Hickory	*Carya ovata var. ovata*	43.7	Healthy	Across Ditch	City			
1	319	Juniper	*Juniperus sp.*	<1	Healthy	Development presentati	Private			x10 stems
1	320	Black walnut	*Juglans nigra*	20.3	Decline	Across Ditch	Private			
1	321	Black walnut	*Juglans nigra*	18.2	Healthy	Private land	Private			
1	322	Black walnut	*Juglans nigra*	26.3	Healthy	Private land	Private			
1	323	Black walnut	*Juglans nigra*	5	Healthy	Private land	Private			
1	324	Black walnut	*Juglans nigra*	12	Healthy	Private land	Private			
1	325	Black walnut	*Juglans nigra*	8	Healthy	Private land	Private			
1	326	Black walnut	*Juglans nigra*	<1-2-3	Healthy	Private land	Private	584157	4784092	
1	327	White Oak	*Quercus alba*	105	Healthy	Ditch	City			
1	328	Shagbark Hickory	*Carya ovata var. ovata*	44.2	Unhealthy	Ditch	City			
1	329	Sugar maple	*Acer saccharum ssp. saccharum*	25	Healthy	Edge of ditch	Private			
1	330	Sugar maple	*Acer saccharum ssp. saccharum*	20	Healthy	Private land	Private			
1	331	Scots pine	*Pinus sylvestris*	15	Unhealthy	Private land	Private			
1	332	Scots pine	*Pinus sylvestris*	12	Unhealthy	Private land	Private			
1	333	Scots pine	*Pinus sylvestris*	8	Dead	Private land	Private			
1	334	Scots pine	*Pinus sylvestris*	30	Healthy	Private land	Private			
1	335	Scots pine	*Pinus sylvestris*	10	Dead	Private land	Private			
1	336	Black walnut	*Juglans nigra*	30	Unhealthy	Private land	Private			
1	337	Shagbark Hickory	*Carya ovata var. ovata*	37.2	Healthy	Ditch	city			
1	338	Cardamine apple	*Malus x atrosanguinea*	33.7	Decline	Ditch	City			
1	339	Black cherry	*Prunus serotina*	27.4	Healthy	Ditch	City			
1	340	Norway maple	*Acer platanoides*	24.8	Healthy	Ditch	City			
1	341	Shagbark Hickory	*Carya ovata var. ovata*	53.8	Healthy	Ditch	City			
1	342	Shagbark Hickory	*Carya ovata var. ovata*	16.3	Decline	Ditch	City			
1	343	Shagbark Hickory	*Carya ovata var. ovata*	49.8	Healthy	Ditch	City			
1	344	Shagbark Hickory	*Carya ovata var. ovata*	22.9	Unhealthy	Ditch	City			
1	345	Shagbark Hickory	*Carya ovata var. ovata*	60.5	Healthy	Up slope from road	Private			
1	346	Norway spruce	*Picea abies*	50	Healthy	Up slope from road	Private			
1	347	Eastern white cedar	*Thuja occidentalis*	8	Unhealthy	Up slope from road	Private			
1	348	Norway maple	*Acer platanoides*	60	Healthy	Up slope from road	Private			
1	349	black cherry	*Prunus serotina*	110	Decline	Up slope from road	Private			
1	350	Willow sp.	*Salix sp.*	1	Decline	Beyond culvert	City?			
1	351	Green ash	*Fraxinus pennsylvanica*	5	Healthy	Beyond culvert	City?			
1	352	Black Walnut	*Juglans nigra*	20	Dead	Beyond culvert	City?			
1	352	Black Walnut	*Juglans nigra*	20	Dead	Beyond culvert	City?			
1	353	Scots pine	*Pinus sylvestris*	20	Unhealthy	Shoulder	Private			
2	1	Gray dogwood	*Cornus foemina ssp. racemosa*	2.0	Decline	Private land	Private	584776	4784201	x10 stems
2	2	Gray dogwood	*Cornus foemina ssp. racemosa*	2.0	Decline	Private land	Private	584819	4784210	x12 stems
2	3	Black locust	*Robinia psuedo-acacia*	3.3	Decline	Ditch	City	584819	4784210	
2	4	Black locust	*Robinia psuedo-acacia*	4.1	Decline	Ditch	City	584835	4784216	
2	5	Elm sp	*Ulmus sp.*	3.0	Healthy	Golf course	Private			
2	6	Elm sp	*Ulmus sp.*	4.0	Healthy	Golf course	Private			
2	7	Ornamental shrub		<1	Healthy	Golf course	Private			x12 stems
2	8	Eastern white cedar	*Thuja occidentalis*	3.0	Healthy	Golf course	Private			shrub
2	9	Gray dogwood	*Cornus foemina ssp. racemosa*	<1	Healthy	Private land	Private	585006	4784253	x6
2	10	Gray dogwood	*Cornus foemina ssp. racemosa*	0.8	Healthy	Ditch	City	585006	4784253	x2

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	11	Gray dogwood	*Cornus foemina ssp. racemosa*	0.6	Healthy	Ditch	City	585014	4784256	x3
2	12	Gray dogwood	*Cornus foemina ssp. racemosa*	<1	Healthy	Private land	Private	585014	4784256	x2
2	13	Red osier dogwood	*Cornus stolonifera*	0.8	Healthy	Ditch	City	585017	4784258	
2	14	Gray dogwood	*Cornus foemina ssp. racemosa*	1.0	Healthy	Ditch	City	585033	4784264	x25
2	15	American elm	*Ulmus americana*	1.6	Healthy	Ditch	City	585038	4784263	
2	16	Common buckthorn	*Rhamnus cathartica*	1.0	Decline	Ditch	City	585038	47884253	
2	17	Red osier dogwood	*Cornus stolonifera*	0.8	Decline	Ditch	City	585061	4784269	
2	18	Elm sp.	*Ulmus sp.*	2.9	Healthy	Ditch	City	585073	4784269	
2	19	Elm sp.	*Ulmus sp.*	8.0	Healthy	Private land	Private			
2	20	Elm sp.	*Ulmus sp.*	3.2	Healthy	Ditch	City	585079	4784274	
2	21	Common buckthorn	*Rhamnus cathartica*	1.0	Healthy	Ditch	City	585086	4784254	
2	22	Black walnut	*Juglans nigra*	5.0	Healthy	Private land	Private	585104	4784265	
2	23	Elm sp.	*Ulmus sp.*	4.0	Healthy	Private land	Private	585110	4784268	x2
2	24	Elm sp.	*Ulmus sp.*	2.0	Healthy	Private land	Private	585116	4784272	
2	25	Gray dogwood	*Cornus foemina ssp. racemosa*	1.0	Dead	Private land	Private	585105	4784279	
2	26	Gray dogwood	*Cornus foemina ssp. racemosa*	0.8	Decline	Ditch	City	585104	4784279	
2	27	Elm sp.	*Ulmus sp.*	3.1	Healthy	Ditch	City	585104	4784282	
2	28	Elm sp.	*Ulmus sp.*	3.8	Healthy	Ditch	City	585106	4784282	
2	29	Elm sp.	*Ulmus sp.*	1.1	Healthy	Ditch	City	585106	4784282	
2	30	Elm sp.	*Ulmus sp.*	3.5	Healthy	Ditch	City	585107	4784238	
2	31	Elm sp.	*Ulmus sp.*	4.2	Healthy	Ditch	City	585106	4784284	
2	32	Elm sp.	*Ulmus sp.*	2.1	Healthy	Ditch	City	585113	4784283	
2	33	Elm sp.	*Ulmus sp.*	7.1	Healthy	Ditch	City	585110	4784281	
2	34	Elm sp.	*Ulmus sp.*	4.0	Healthy	Private land	Private	585116	4784272	
2	35	Elm sp.	*Ulmus sp.*	2.0	Healthy	Private land	Private	585120	4784281	
2	36	Gray dogwood	*Cornus foemina ssp. racemosa*	0.8	Decline	Ditch	City	585120	4784281	
2	37	Black walnut	*Juglans nigra*	7.5	Healthy	Ditch	City	585127	4784286	
2	38	Red maple	*Acer rubrum*	2.0	Healthy	Ditch	City	585139	4784288	
2	39	Gray dogwood	*Cornus foemina ssp. racemosa*	1.4	Decline	Ditch	City	585139	4784289	
2	40	Elm sp.	*Ulmus sp.*	7.0	Healthy	Private land	Private	585145	4784291	
2	41	Elm sp.	*Ulmus sp.*	10.0	Healthy	Private land	Private			
2	42	Common buckthorn	*Rhamnus cathartica*	6.9	Healthy	Ditch	City			
2	43	Elm sp.	*Ulmus sp.*	9.3	Healthy	Private land	City?			
2	44	Elm sp.	*Ulmus sp.*	8.0	Healthy	Private land	Private			
2	45	Elm sp.	*Ulmus sp.*	10.0	Healthy	Private land	Private			
2	46	Elm sp.	*Ulmus sp.*	9.1	Healthy	Ditch	City			
2	47	Staghorn sumac	*Rhus typhina*	2.9	Decline	Ditch	City			
2	48	Black walnut	*Juglans nigra*	10.0	Healthy	Private land	Private			
2	49	Elm sp.	*Ulmus sp.*	25.0	Healthy	Private land	Private			
2	50	Elm sp.	*Ulmus sp.*	35.0	Healthy	Private land	Private			
2	51	Black locust	*Robinia psuedo-acacia*	20.0	Healthy	Private land	Private			
2	52	Black locust	*Robinia psuedo-acacia*	10.0	Healthy	Private land	Private			
2	53	Black locust	*Robinia psuedo-acacia*	15.0	Healthy	Private land	Private			
2	54	Black locust	*Robinia psuedo-acacia*	35.0	Healthy	Private land	Private			
2	55	Norway maple	*Acer platanoides*	15.0	Healthy	Private land	Private			
2	56	Norway maple	*Acer platanoides*	9.0	Healthy	Private land	Private			
2	57	Norway maple	*Acer platanoides*	15.0	Healthy	Private land	Private			
2	58	Black locust	*Robinia psuedo-acacia*	11.2	Healthy	Ditch	City			
2	59	Black locust	*Robinia psuedo-acacia*	4.0	Decline	Ditch	City			
2	60	Black locust	*Robinia psuedo-acacia*	3.9	Decline	Ditch	City			
2	61	Black locust	*Robinia psuedo-acacia*	5.7	Decline	Ditch	City			
2	62	Black locust	*Robinia psuedo-acacia*	10.0	Decline	Ditch	City			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	63	Black locust	*Robinia psuedo-acacia*	2.3	Decline	Ditch	City			
2	64	Black locust	*Robinia psuedo-acacia*	10.0	Decline	Ditch	City			
2	65	Black locust	*Robinia psuedo-acacia*	3.3	Decline	Ditch	City			
2	66	Black locust	*Robinia psuedo-acacia*	1.4	Decline	Ditch	City			
2	67	Norway maple	*Acer platanoides*	11.4	Decline	Ditch	City			
2	68	Black locust	*Robinia psuedo-acacia*	2.0	Dead	Ditch	City			
2	69	Black locust	*Robinia psuedo-acacia*	7.0	Decline	Ditch	City			
2	70	Black locust	*Robinia psuedo-acacia*	8.3	Decline	Ditch	City			
2	71	Norway maple	*Acer platanoides*	5.2	Decline	Ditch	City			
2	72	Black walnut	*Juglans nigra*	2.5	Decline	Ditch	City			
2	73	Norway maple	*Acer platanoides*	18.0	Healthy	Ditch	City			
2	74	Black locust	*Robinia psuedo-acacia*	18.0	Healthy	Ditch	City			
2	75	Norway maple	*Acer platanoides*	15.3	Healthy	Ditch	City			
2	76	Black locust	*Robinia psuedo-acacia*	19.2	Decline	Ditch	City			
2	77	Black locust	*Robinia psuedo-acacia*	1.4	Unhealthy	Ditch	City			
2	78	Black locust	*Robinia psuedo-acacia*	0.9	Decline	Ditch	City			
2	79	Norway maple	*Acer platanoides*	21.9	Healthy	Ditch	City			
2	80	Black locust	*Robinia psuedo-acacia*	27.1	Decline	Ditch	City			
2	81	Common buckthorn	*Rhamnus cathartica*	0.4	Healthy	Ditch	City			x2 stems
2	82	Black locust	*Robinia psuedo-acacia*	17.9	Decline	Ditch	City			
2	83	Black locust	*Robinia psuedo-acacia*	3.5	Healthy	Ditch	City			
2	84	Black locust	*Robinia psuedo-acacia*	26.7	Decline	Ditch	City			
2	85	Black locust	*Robinia psuedo-acacia*	3.0	Healthy	Ditch	City			
2	86	Black locust	*Robinia psuedo-acacia*	48.9	Healthy	Ditch	City			
2	87	Norway maple	*Acer platanoides*	30.0	Decline	Ditch	City			
2	88	Lilac	*Syringa vulgaris*	0.8	Decline	Ditch	City			
2	89	Lilac	*Syringa vulgaris*	4.4	Healthy	Ditch	City			
2	90	Norway maple	*Acer platanoides*	12.5	Healthy	Ditch	City			
2	91	Black locust	*Robinia psuedo-acacia*	61.5	Decline	Ditch	City			
2	92	Black locust	*Robinia psuedo-acacia*	68.3	Decline	Ditch	City			
2	93	Norway maple	*Acer platanoides*	6.0	Decline	Ditch	City			
2	94	Black locust	*Robinia psuedo-acacia*	6.0	Healthy	Private land	Private			
2	95	Norway maple	*Acer platanoides*	2.0	Healthy	Private land	Private			
2	96	Norway maple	*Acer platanoides*	8.0	Healthy	Private land	Private			
2	97	Norway maple	*Acer platanoides*	20.0	Healthy	Private land	Private			
2	98	Black walnut	*Juglans nigra*	30.0	Healthy	Private land	Private			
2	99	Black walnut	*Juglans nigra*	6.0	Healthy	Private land	Private			
2	100	Black locust	*Robinia psuedo-acacia*	20.0	Healthy	Private land	Private			
2	101	Norway maple	*Acer platanoides*	4.0	Healthy	Private land	Private			
2	102	Elm sp	*Ulmus sp.*	25.0	Healthy	Private land	Private			
2	103	Norway maple	*Acer platanoides*	20.0	Decline	Private land	Private			
2	104	Norway maple	*Acer platanoides*	8.0	Healthy	Private land	Private			x4 stems
2	105	Norway maple	*Acer platanoides*	10.0	Healthy	Private land	Private			
2	106	Black walnut	*Juglans nigra*	10.0	Decline	Private land	Private			x2 stems
2	107	Black walnut	*Juglans nigra*	10.0	Healthy	Private land	Private			
2	108	Black walnut	*Juglans nigra*	8.0	Decline	Private land	Private			
2	109	Black walnut	*Juglans nigra*	15.0	Decline	Private land	Private			
2	110	Black walnut	*Juglans nigra*	8.0	Decline	Private land	Private			
2	111	Black walnut	*Juglans nigra*	6.0	Decline	Private land	Private			x2 stems
2	112	Black walnut	*Juglans nigra*	4.0	Decline	Private land	Private			x2 stems
2	113	Black walnut	*Juglans nigra*	30.0	Decline	Private land	Private			
2	114	Black walnut	*Juglans nigra*	7.5	Healthy	Ditch	City	585196	4784306	

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	115	Norway maple	*Acer platanoides*	4.0	Decline	Ditch	City	585207	4784307	x3 stems
2	116	Black walnut	*Juglans nigra*	5.2	Healthy	Ditch	City	585209	4784310	
2	117	Black locust	*Robinia psuedo-acacia*	5.3	Healthy	Ditch	City	585209	4784310	
2	118	Black walnut	*Juglans nigra*	1.6	Healthy	Ditch	City	585213	4784304	
2	119	Norway maple	*Acer platanoides*	4.6	Healthy	Ditch	City	585213	4784304	
2	120	Norway maple	*Acer platanoides*	5.0	Healthy	Ditch	City	585218	4784305	
2	121	Black locust	*Robinia psuedo-acacia*	4.7	Healthy	Ditch	City	585211	4784308	
2	122	Black locust	*Robinia psuedo-acacia*	6.0	Healthy	Ditch	City	585214	4784306	
2	123	Black locust	*Robinia psuedo-acacia*	7.0	Decline	Ditch	City	585217	4784314	
2	124	Black locust	*Robinia psuedo-acacia*	3.9	Decline	Ditch	City	585213	4784312	
2	125	Black walnut	*Juglans nigra*	0.6	Decline	Ditch	City	585218	4784306	
2	126	Black locust	*Robinia psuedo-acacia*	5.1	Decline	Ditch	City	585222	4784311	x2 stems
2	127	Black locust	*Robinia psuedo-acacia*	6.7	Decline	Ditch	City	585220	4784314	
2	128	Black locust	*Robinia psuedo-acacia*	7.3	Decline	Ditch	City	585221	4784317	
2	129	Black locust	*Robinia psuedo-acacia*	4.0	Healthy	Ditch	City	585227	4784311	
2	130	Ribes sp	*Ribes sp.*	<1	Healthy	Ditch	City	585228	4784313	
2	131	Common buckthorn	*Rhamnus cathartica*	2.0	Healthy	Ditch	City	585230	4784315	
2	132	Willow sp	*Salix sp.*	15.0	Healthy	Private land	Private			
2	133	Blue spruce	*Picea pungens*	40.0	Healthy	Private land	Private			
2	134	Blue spruce	*Picea pungens*	35.0	Healthy	Private land	Private			
2	135	Horse chestnut	*Aesculus hippocastanum*	50.0	Healthy	Private land	Private			
2	136	Black locust	*Robinia psuedo-acacia*	50.0	Healthy	Private land	Private			
2	137	Norway maple	*Acer platanoides*	4.0	Healthy	Private land	Private			
2	138	Lilac	*Syringa vulgaris*	6.0	Decline	Private land	Private			
2	139	Lilac	*Syringa vulgaris*	5.0	Unhealthy	Private land	Private			
2	140	Black locust	*Robinia psuedo-acacia*	4.0	Unhealthy	Private land	Private			
2	141	Black locust	*Robinia psuedo-acacia*	50.0	Healthy	Private land	Private			
2	142	Norway maple	*Acer platanoides*	20.0	Healthy	Private land	Private			
2	143	Black locust	*Robinia psuedo-acacia*	50.0	Healthy	Private land	Private			
2	144	Norway maple	*Acer platanoides*	35.0	Healthy	Private land	Private			
2	145	Norway maple	*Acer platanoides*	45.0	Healthy	Private land	Private			
2	146	White spruce	*Picea glauca*	20.0	Unhealthy	Private land	Private			
2	147	White spruce	*Picea glauca*	15.0	Unhealthy	Private land	Private			
2	148	European larch	*Larix decidua*	15.0	Healthy	Private land	Private			
2	149	Black locust	*Robinia psuedo-acacia*	50.0	Healthy	Private land	Private			
2	150	Black locust	*Robinia psuedo-acacia*	50.0	Healthy	Private land	Private			
2	151	Norway maple	*Acer platanoides*	25.0	Healthy	Private land	Private			
2	152	Black locust	*Robinia psuedo-acacia*	60.0	Healthy	Private land	Private			
2	153	White spruce	*Picea glauca*	30.0	Healthy	Private land	Private			
2	154	Norway maple	*Acer platanoides*	40.0	Healthy	Private land	Private			
2	155	Black locust	*Robinia psuedo-acacia*	35.0	Decline	Private land	Private			
2	156	Norway spruce	*Picea abies*	20.0	Healthy	Private land	Private			
2	157	Blue spruce	*Picea pungens*	15.0	Healthy	Private land	Private			
2	158	Black locust	*Robinia psuedo-acacia*	25.0	Healthy	Private land	Private			
2	159	White spruce	*Picea glauca*	40.0	Healthy	Private land	Private			
2	160	Ash sp.	*Fraxinus sp.*	50.0	Healthy	Private land	Private			
2	161	Norway maple	*Acer platanoides*	15.0	Healthy	Private land	Private			
2	162	Ornamental shrub		1.0	Healthy	Private land	Private			
2	163	Red oak	*Quercus rubra*	1.0	Healthy	Private land	Private			
2	164	Norway maple	*Acer platanoides*	15.0	Healthy	Private land	Private			
2	165	Ornamental shrub		<1	Healthy	Private land	Private			x4 stems
2	166	Blue spruce	*Picea pungens*	20.0	Healthy	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	167	Blue spruce	*Picea pungens*	15.0	Healthy	Private land	Private			x3 stems
2	168	Silver maple	*Acer saccharinum*	40.0	Healthy	Private land	Private			
2	169	Silver maple	*Acer saccharinum*	50.0	Healthy	Private land	Private			
2	170	Silver maple	*Acer saccharinum*	80.0	Healthy	Private land	Private			
2	171	Elm sp	*Ulmus sp.*	10.0	Healthy	Private land	Private			
2	172	Norway maple	*Acer platanoides*	15.0	Healthy	Private land	Private			
2	173	Scots Pine	*Pinus sylvestris*	15.0	Dead	Private land	Private			
2	174	Elm sp.	*Ulmus sp.*	10.0	Healthy	Private land	Private			
2	175	Scots Pine	*Pinus sylvestris*	20.0	Dead	Private land	Private			
2	176	Scots Pine	*Pinus sylvestris*	15.0	Dead	Private land	Private			x7 stems
2	177	Scots Pine	*Pinus sylvestris*	15.0	Decline	Private land	Private			x5 stems
2	178	Norway maple	*Acer platanoides*	30.0	Healthy	Private land	Private			
2	179	Norway maple	*Acer platanoides*	20.0	Healthy	Private land	Private			
2	180	Norway maple	*Acer platanoides*	10.0	Healthy	Private land	Private			
2	190	Ash sp.	*Fraxinus sp.*	20.0	Healthy	Private land	Private			
2	191	Norway maple	*Acer platanoides*	40.0	Healthy	Private land	Private			
2	192	Gray dogwood	*Cornus foemina ssp. racemosa*	1.0	Healthy	Private land	Private			
2	193	Elm sp.	*Ulmus sp.*	5.0	Dead	Private land	Private			
2	194	Elm sp.	*Ulmus sp.*	14.7	Decline	Ditch	City			
2	195	Elm sp.	*Ulmus sp.*	13.7	Decline	Ditch	City			
2	196	Elm sp.	*Ulmus sp.*	4.5	Healthy	Ditch	City			
2	197	Ash sp.	*Fraxinus sp.*	4.0	Decline	Ditch	City			
2	198	Elm sp.	*Ulmus sp.*	1.3	Decline	Ditch	City			
2	199	Elm sp.	*Ulmus sp.*	18.0	Decline	Ditch	City			
2	200	Elm sp.	*Ulmus sp.*	12.3	Decline	Ditch	City			
2	201	Elm sp.	*Ulmus sp.*	4.1	Decline	Ditch	City			
2	202	Elm sp.	*Ulmus sp.*	2.6	Decline	Ditch	City			
2	203	Elm sp.	*Ulmus sp.*	17.3	Decline	Ditch	City			
2	204	Elm sp.	*Ulmus sp.*	7.6	Decline	Ditch	City			
2	205	Elm sp.	*Ulmus sp.*	13.6	Decline	Ditch	City			
2	206	Elm sp.	*Ulmus sp.*	7.8	Decline	Ditch	City			
2	207	Elm sp.	*Ulmus sp.*	1.4	Decline	Ditch	City			
2	208	High bush cranberry	*Viburnum trilobum*	3.7	Unhealthy	Ditch	City			
2	209	Elm sp.	*Ulmus sp.*	5.4	Decline	Ditch	City			
2	210	Elm sp.	*Ulmus sp.*	9.3	Decline	Ditch	City			
2	211	Elm sp.	*Ulmus sp.*	2.8	Decline	Ditch	City			
2	212	Elm sp.	*Ulmus sp.*	7.8	Healthy	Ditch	City			
2	213	Elm sp.	*Ulmus sp.*	10.7	Healthy	Ditch	City			
2	214	Elm sp.	*Ulmus sp.*	0.9	Healthy	Ditch	City			
2	215	Elm sp.	*Ulmus sp.*	8.4	Healthy	Ditch	City			
2	216	Elm sp.	*Ulmus sp.*	7.4	Healthy	Ditch	City			
2	217	Hawthorn sp.	*Craetegus sp.*	2.2	Healthy	Ditch	City			
2	218	Elm sp.	*Ulmus sp.*	2.7	Healthy	Ditch	City			
2	219	Elm sp.	*Ulmus sp.*	2.4	Healthy	Ditch	City			
2	220	Elm sp.	*Ulmus sp.*	2.5	Healthy	Ditch	City			
2	221	Elm sp.	*Ulmus sp.*	3.7	Healthy	Ditch	City			
2	222	Elm sp.	*Ulmus sp.*	1.5	Healthy	Ditch	City			
2	223	Elm sp.	*Ulmus sp.*	2.7	Healthy	Ditch	City			
2	224	Elm sp.	*Ulmus sp.*	0.7	Healthy	Ditch	City			
2	225	Elm sp.	*Ulmus sp.*	0.5	Healthy	Ditch	City			
2	226	Elm sp.	*Ulmus sp.*	7.3	Healthy	Ditch	City			
2	227	Gray dogwood	*Cornus foemina ssp. racemosa*	>1	Healthy	Ditch	City			x100 stems

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	228	Elm sp.	*Ulmus sp.*	4.9	Healthy	Ditch	City			
2	229	Elm sp.	*Ulmus sp.*	2.4	Healthy	Ditch	City			
2	230	Elm sp.	*Ulmus sp.*	0.9	Healthy	Ditch	City			
2	231	Scots Pine	*Pinus sylvestris*	20.4	Healthy	Ditch	City			
2	232	Hickory sp.	*Carya sp.*	2.2	Decline	Ditch	City			
2	233	Hickory sp.	*Carya sp.*	0.9	Decline	Ditch	City			
2	234	Elm sp.	*Ulmus sp.*	2.0	Healthy	Ditch	City			
2	235	Elm sp.	*Ulmus sp.*	0.8	Healthy	Ditch	City			
2	236	Elm sp.	*Ulmus sp.*	5.8	Healthy	Ditch	City			
2	237	Elm sp.	*Ulmus sp.*	6.0	Healthy	Ditch	City			
2	238	Elm sp.	*Ulmus sp.*	1.7	Healthy	Ditch	City			
2	239	Elm sp.	*Ulmus sp.*	5.1	Healthy	Ditch	City			
2	240	Elm sp.	*Ulmus sp.*	15.3	Healthy	Ditch	City			
2	241	Elm sp.	*Ulmus sp.*	1.1	Healthy	Ditch	City			
2	242	Elm sp.	*Ulmus sp.*	2.6	Healthy	Ditch	City			
2	243	Ash sp.	*Fraxinus sp.*	2.9	Decline	Ditch	City			
2	244	Common buckthorn	*Rhamnus cathartica*	1.1	Healthy	Ditch	City			
2	245	Elm sp.	*Ulmus sp.*	7.1	Unhealthy	Ditch	City			
2	246	Elm sp.	*Ulmus sp.*	3.9	Decline	Ditch	City			
2	247	Elm sp.	*Ulmus sp.*	2.5	Decline	Ditch	City			
2	248	Elm sp.	*Ulmus sp.*	2.5	Decline	Ditch	City			
2	249	Scots pine	*Pinus sylvestris*	3.6	Healthy	Ditch	City			
2	250	Elm sp.	*Ulmus sp.*	0.6	Healthy	Ditch	City			
2	251	Norway maple	*Acer platanoides*	8.8	Decline	Ditch	City			
2	252	Staghorn sumac	*Rhus typhina*	1 to 4	Healthy	Ditch	City			x50 stems
2	253	Black walnut	*Juglans nigra*	7.1	Decline	Ditch	City	585507	4784369	
2	254	Common buckthorn	*Rhamnus cathartica*	4.0	Unhealthy	Private land	Private			
2	255	Staghorn sumac	*Rhus typhina*	1 to 5	Healthy	Private land	Private			
2	256	Elm sp.	*Ulmus sp.*	10.0	Decline	Private land	Private			
2	257	Elm sp.	*Ulmus sp.*	8.0	Healthy	Private land	Private			
2	258	Elm sp.	*Ulmus sp.*	15.0	Decline	Private land	Private			
2	259	Elm sp.	*Ulmus sp.*	4.0	Decline	Private land	Private			
2	260	Elm sp.	*Ulmus sp.*	10.0	Decline	Private land	Private			
2	270	Sugar maple	*Acer saccharum ssp. Saccharum*	10.0	Decline	Private land	Private			x2 stems
2	271	Elm sp.	*Ulmus sp.*	4.0	Healthy	Private land	Private			x2 stems
2	272	Scots Pine	*Pinus sylvestris*	4.0	Healthy	Private land	Private			
2	273	Scots Pine	*Pinus sylvestris*	5.0	Healthy	Private land	Private			x4 stems
2	274	Scots Pine	*Pinus sylvestris*	4.0	Healthy	Private land	Private			
2	275	Scots Pine	*Pinus sylvestris*	10.0	Healthy	Private land	Private			x3 stems
2	276	Elm sp.	*Ulmus sp.*	8.0	Healthy	Private land	Private			
2	277	Elm sp.	*Ulmus sp.*	2.0	Healthy	Private land	Private			
2	278	Elm sp.	*Ulmus sp.*	2.0	Healthy	Private land	Private			x2 stems
2	279	Scots Pine	*Pinus sylvestris*	5.0	Healthy	Private land	Private			x2 stems
2	280	Scots Pine	*Pinus sylvestris*	2.0	Healthy	Private land	Private			
2	281	Freeman's maple	*Acer X Freemanii*	60.0	Healthy	Private land	Private			
2	282	White spruce	*Picea glauca*	40.0	Healthy	Private land	Private			
2	283	Lilac	*Syringa vulgaris*	8.0	Healthy	Private land	Private			
2	284	Lilac	*Syringa vulgaris*	2.0	Healthy	Private land	Private			
2	285	Blue spruce	*Picea pungens*	65.0	Healthy	Private land	Private			
2	286	Mountain ash	*Sorbus sp.*	20.0	Healthy	Private land	Private			
2	287	Norway maple	*Acer platanoides*	70.0	Decline	Private land	Private			
2	288	Rose sp.	*Rosa sp.*	1.0	Healthy	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	289	Elm sp.	*Ulmus sp.*	3.0	Healthy	Private land	Private			
2	290	Spirea sp.	*Spirea sp.*	<1	Healthy	Private land	Private			x4 stems
2	291	Dogwood sp.	*Cornus sp.*	2.0	Decline	Private land	Private			x3 stems
2	292	Ornamental shrub		5.0	Decline	Private land	Private			
2	293	Lilac	*Syringa vulgaris*	5.0	Unhealthy	Private land	Private			
2	294	Sugar maple	*Acer saccharum ssp. Saccharum*	15.0	Healthy	Private land	Private			
2	295	Magnolia	*Magnolia sp.*	15.0	Healthy	Private land	Private			
2	296	Red oak	*Quercus rubra*	115.0	Healthy	Parking lot	Private			
2	297	Shagbark hickory	*Carya ovata var. ovata*	30.0	Healthy	Parking lot	Private			
2	298	Norway maple	*Acer platanoides*	2.0	Decline	Parking lot	Private			
2	299	Honeysuckle sp.	*Lonicera sp.*	2.0	Decline	Parking lot	Private			
2	300	Norway maple	*Acer platanoides*	1.0	Healthy	Parking lot	Private			
2	301	Norway maple	*Acer platanoides*	3.0	Healthy	Parking lot	Private			
2	302	Common buckthorn	*Rhamnus cathartica*	1.0	Healthy	Parking lot	Private			
2	303	Common buckthorn	*Rhamnus cathartica*	1.0	Decline	Parking lot	Private			
2	304	Manitoba maple	*Acer negundo*	25.0	Decline	lawn/park	Private?			
2	305	Manitoba maple	*Acer negundo*	45.0	Healthy	lawn/park	Private?			
2	306	Lilac	*Syringa vulgaris*	1.0	Healthy	lawn/park	Private?			
2	307	Lilac	*Syringa vulgaris*	3.0	Healthy	lawn/park	Private?			
2	308	Maple sp.	*Acer sp.*	80.0	Decline	lawn/park	Private?			
2	309	Manitoba maple	*Acer negundo*	25.0	Healthy	lawn/park	Private?			
2	310	Manitoba maple	*Acer negundo*	20.0	Healthy	lawn/park	Private?			
2	311	Rose sp.	*Rosa sp.*	1.0	Healthy	lawn/park	Private?			
2	312	Red maple	*Acer rubrum*	35.0	Healthy	lawn/park	Private?			
2	313	Blue spruce	*Picea pungens*	n/a	Unhealthy	lawn/park	Private?			
2	314	Manitoba maple	*Acer negundo*	40.0	Decline	lawn/park	Private			
2	315	Manitoba maple	*Acer negundo*	50.0	Healthy	lawn/park	Private			
2	316	Norway maple	*Acer platanoides*	65.7	Healthy	Roadside	City			
2	317	Norway maple	*Acer platanoides*	57.9	Unhealthy	Roadside	City			
2	318	Maple cultivar	*Acer sp.*	5.0	Healthy	Private land	Private			
2	319	Ornamental shrub		<1	Healthy	Private land	Private			x10 stems
2	320	Ornamental cedar	*Thuja sp.*	2.0	Healthy	Private land	Private			x7 stems
2	321	Ornamental shrub		<1	Healthy	Private land	Private			x24 stems
2	322	Elm sp.	*Ulmus sp.*	5.0	Healthy	Private land	Private			
2	323	Ornamental shrub		<1	Healthy	Private land	Private			x8 stems
2	324	Maple cultivar	*Acer sp.*	5.0	Healthy	Private land	Private			
2	325	Ornamental cedar	*Thuja sp.*	2.0	Healthy	Private land	Private			x9 stems
2	326	Juniper	*Juniperus communis*	<1	Healthy	Private land	Private			x5 stems
2	327	Ornamental cedar	*Thuja sp.*	4.0	Healthy	Private land	Private			
2	328	Ornamental cedar	*Thuja sp.*	5.0	Healthy	Private land	Private			
2	329	white oak	*Quercus alba*	67.7	Healthy	Roadside	City			
2	330	Black locust	*Robinia psuedo-acacia*	70.0	Decline	Private land	Private			
2	331	Norway maple	*Acer platanoides*	10 to 15	Healthy	Private land	Private			x8 stems
2	332	Common buckthorn	*Rhamnus cathartica*	5.0	Healthy	Private land	Private			x2 stems
2	333	Black locust	*Robinia psuedo-acacia*	6.0	Healthy	Private land	Private			
2	334	Norway maple	*Acer platanoides*	3 to 8	Healthy	Private land	Private			x8 stems
2	335	Black locust	*Robinia psuedo-acacia*	30.0	Decline	Private land	Private			
2	336	red oak	*Quercus rubra*	50.0	Healthy	Private land	Private			
2	337	Black locust	*Robinia psuedo-acacia*	52.0	Decline	Roadside	City			
2	338	Red oak	*Quercus rubra*	45.7	Decline	Roadside	City			
2	339	Maple cultivar	*Acer sp.*	59.3	Unhealthy	Roadside	City			
2	340	Black locust	*Robinia psuedo-acacia*	61.6	Unhealthy	Roadside	City			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
2	341	Locust sp.	*Robinia sp.*	61.0	Decline	Roadside	City			
2	342	Black locust	*Robinia psuedo-acacia*	70.1	Decline	Roadside	City			
2	343	Norway maple	*Acer platanoides*	53.2	Unhealthy	Roadside	City			
2	344	Black locust	*Robinia psuedo-acacia*	63.6	Decline	Roadside	City			
2	345	Spruce sp	*Picea sp.*	15.0	Dead	Private land	Private			
2	346	Maple cultivar	*Acer sp.*	35.0	Healthy	Private land	Private			
2	347	Freeman's maple	*Acer X Freemanii*	100.0	Decline	Private land	Private			
2	348	Freeman's maple	*Acer X Freemanii*	100.0	Healthy	Private land	Private			
2	349	Locust sp.	*Robinia sp.*	45.0	Unhealthy	Private land	Private			
2	350	Norway spruce	*Picea abies*	80.0	Healthy	Private land	Private			
2	351	Ornamental deciduous tree		15.0	Healthy	Private land	Private			
2	352	Ornamental deciduous tree	*Taxus sp.*	20.0	Healthy	Private land	Private			
2	353	White oak	*Quercus alba*	150.0	Healthy	Private land	Private			
2	354	Eastern white cedar hedge	*Thuja occidentalis*	8 to 10	Healthy	Private land	Private			x25 stems
2	355	white oak	*Quercus alba*	150.0	Decline	Roadside	City			
2	356	Juniper shrub	*Juniperus communis*	1.0	Healthy	Parking lot	Private			
2	357	Mountain ash	*Sorbus sp.*	20.0	Healthy	Private land	Private			
2	358	Blue spruce	*Picea pungens*	45.0	Healthy	Private land	Private			
2	359	Norway maple	*Acer platanoides*	12.0	Decline	Private land	Private			
2	360	Norway maple	*Acer platanoides*	15.0	Decline	Private land	Private			
2	361	Norway maple	*Acer platanoides*	12.0	Unhealthy	Private land	Private			
2	362	Norway maple	*Acer platanoides*	4.0	Decline	Private land	Private			
2	363	Norway maple	*Acer platanoides*	40.0	Healthy	Private land	Private			
2	364	Common buckthorn	*Rhamnus cathartica*	4.0	Healthy	Private land	Private			
2	365	Lilac	*Syringa vulgaris*	3.0	Healthy	Private land	Private			
2	366	Honeysuckle sp.	*Lonicera sp.*	<1	Unhealthy	Private land	Private			
2	367	Norway maple	*Acer platanoides*	43.1	Decline	Boulevard	City			
2	368	Norway maple	*Acer platanoides*	44.3	Decline	Boulevard	City			
2	369	Norway maple	*Acer platanoides*	29.0	Decline	Boulevard	City			
2	370	Ornamental shrub		1.0	Healthy	Emergency service statio	City			x21 stems
2	371	Ornamental yew		<1	Healthy	Emergency service statio	City			
2	372	Ornamental deciduous tree		2.0	Healthy	Emergency service statio	City			x13 stems
2	373	Red oak	*Quercus rubra*	4.0	Healthy	Emergency service statio	City			x4 stems
2	374	Unknown	*n/a*	20.0	Healthy	Private land	private			
2	375	Norway maple	*Acer platanoides*	25.0	Decline	Private land	private			
2	376	Maple sp.	*Acer sp.*	40.0	Healthy	Private land	private			
2	377	Maple sp.	*Acer sp.*	50.0	Healthy	Private land	private			
2	378	Ornamental deciduous tree		3.0	Healthy	Private land	private			x9 stems
2	379	Freeman's maple	*Acer X Freemanii*	40.0	Healthy	Private land	private			
2	380	Norway maple	*Acer platanoides*	60.0	Healthy	Private land	private			
2	381	Ornamental shrub		<1	Healthy	Private land	private			
2	382	Ornamental shrub		<1	Healthy	Parking lot	private			
2	383	Black locust	*Robinia psuedo-acacia*	40.0	Healthy	Private land	private			
2	384	Black locust	*Robinia psuedo-acacia*	50.0	Healthy	Private land	private			
2	385	Manitoba maple	*Acer negundo*	25.0	Healthy	Private land	private			
2	386	Weeping willow	*Salix babylonica*	150.0	Decline	Private land	private			
3	1	Norway spruce	*Picea abies*	16	Healthy	Private land	Private			
3	2	Norway spruce	*Picea abies*	12	Healthy	Private land	Private			
3	3	Norway spruce	*Picea abies*	15	Healthy	Private land	Private			
3	4	Norway spruce	*Picea abies*	16	Healthy	Private land	Private			
3	5	Norway spruce	*Picea abies*	15	Healthy	Private land	Private			
3	6	Norway spruce	*Picea abies*	15	Unhealthy	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	7	Norway spruce	*Picea abies*	15	Healthy	Private land	Private			
3	8	Ornamental Juniper	*Juniperus communis*	<1	Healthy	Private land	Private			
3	9	Silver maple cultivar	*Acer saccharinum*	27	Healthy	Private land	Private			
3	10	Norway spruce	*Picea abies*	10	Healthy	Private land	Private			
3	11	Norway spruce	*Picea abies*	16	Healthy	Private land	Private			
3	12	Norway spruce	*Picea abies*	22	Unhealthy	Private land	Private			
3	13	Norway spruce	*Picea abies*	16	Healthy	Private land	Private			
3	14	Norway spruce	*Picea abies*	20	Decline	Private land	Private			
3	15	Norway spruce	*Picea abies*	20	Healthy	Private land	Private			
3	16	Norway maple	*Acer platanoides*	33	Healthy	Private land	Private			
3	17	Ornamental birch	*Betula sp.*	20	Healthy	Private land	Private			
3	18	Ornamental birch	*Betula sp.*	15	Healthy	Private land	Private			
3	19	Lilac	*Syringa vulgaris*	2 to 3	Healthy	Private land	Private			x3 stems
3	20	Ornamental barberry	*Berberris sp.*	<1	Healthy	Private land & ditch	Both			
3	21	Scots pine	*Pinus sylvestris*	25	Decline	Hedge row	Private			
3	22	Norway spruce	*Picea abies*	15	Healthy	Hedge row	Private			
3	23	Norway spruce	*Picea abies*	30	Healthy	Hedge row	Private			
3	24	Norway spruce	*Picea abies*	12	Healthy	Across ditch	Private			
3	25	Norway spruce	*Picea abies*	12	Healthy	Across ditch	Private			
3	26	Norway spruce	*Picea abies*	32	Healthy	Across ditch	Private			
3	27	Norway spruce	*Picea abies*	18	Healthy	Across ditch	Private			
3	28	Norway spruce	*Picea abies*	19	Healthy	Across ditch	Private			
3	29	Silver maple cultivar	*Acer saccharinum*	21.2	Healthy	Ditch	City			
3	30	Silver maple cultivar	*Acer saccharinum*	15.1	Healthy	Ditch	City			
3	31	Silver maple cultivar	*Acer saccharinum*	9.8	Healthy	Ditch	City			
3	32	Silver maple cultivar	*Acer saccharinum*	7.5	Healthy	Ditch	City			
3	33	Ornamental shrub		N/A	Healthy	Private land	Private			
3	34	Black locust	*Robinia psuedo-acacia*	13	Healthy	Private land	Private			
3	35	Black locust	*Robinia psuedo-acacia*	9	Healthy	Private land	Private			
3	36	Green ash	*Fraxinus pennsylvanica*	30	Healthy	Private land	Private			
3	37	Ornamental deciduous tree		35	Healthy	Private land	Private			
3	38	Sugar maple	*Acer saccharum ssp. Saccharum*	25	Healthy	Private land	Private			
3	39	Rose sp.	*Rosa sp.*	<1	Decline	Ditch	Private	585880	4784465	x8 stems
3	40	Horse chestnut	*Aesculus hippocastanum*	4.8	Decline	Private land	Private			
3	41	Ornamental deciduous tree		5	Healthy	Private land	Private			
3	42	Ornamental yew	*Taxus sp.*	4.5	Healthy	Private land	Private			x5 stems
3	43	Ornamental deciduous tree		2.3	Healthy	Private land	Private	5858883	4784469	
3	44	Horse chestnut	*Aesculus hippocastanum*	4.5	Healthy	Private land	Private	585889	4784470	
3	45	Ornamental shrub		N/A	Healthy	Private land	Private			
3	46	Juniper	*Juniperus communis*	3.8	Healthy	Church	Private	585396	4784466	
3	47	Ornamental yew	*Taxus sp.*	3.5	Healthy	Church	Private			
3	48	Horse chestnut	*Aesculus hippocastanum*	5.7	Healthy	Cemetary	Private	585922	4784472	
3	49	Horse chestnut	*Aesculus hippocastanum*	4.4	Healthy	Cemetary	Private	585930	4784476	
3	50	Black walnut	*Juglans nigra*	19.1	Healthy	Across ditch	City?			
3	51	Black walnut	*Juglans nigra*	17.3	Healthy	Across ditch	City?			
3	52	Black walnut	*Juglans nigra*	20.1	Healthy	Across ditch	City?			
3	53	Black walnut	*Juglans nigra*	N/A	Healthy	Across ditch	City?			x8 stems
3	55	sugar maple	*Acer saccharum ssp. Saccharum*	81.7	Unhealthy	Private land	Private			
3	56	Black locust	*Robinia psuedo-acacia*	38	Healthy	Across ditch	Private			
3	57	Norway spruce	*Picea abies*	35	Decline	Across ditch	Private			
3	58	Sugar maple	*Acer saccharum ssp. Saccharum*	7	Healthy	Private land	Private			
3	59	White ash	*Fraxinus americana*	30	Healthy	Private land	Private			

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Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	60	Black locust	*Robinia psuedo-acacia*	20	Healthy	Private land	Private			
3	61	Black locust	*Robinia psuedo-acacia*	40	Unhealthy	Private land	Private			
3	62	White ash	*Fraxinus americana*	23	Unhealthy	Private land	Private			
3	63	Black locust	*Robinia psuedo-acacia*	35	Healthy	Private land	Private			
3	64	White ash	*Fraxinus americana*	30	Healthy	Private land	Private			
3	65	Black locust	*Robinia psuedo-acacia*	40	Healthy	Private land	Private			
3	66	Black locust	*Robinia psuedo-acacia*	30	Healthy	Private land	Private			
3	67	Sugar maple	*Acer saccharum ssp. Saccharum*	20	Healthy	Private land	Private			
3	68	Black locust	*Robinia psuedo-acacia*	40	Healthy	Private land	Private			
3	69	Black locust	*Robinia psuedo-acacia*	45	Unhealthy	Private land	Private			
3	70	Black walnut	*Juglans nigra*	3	Decline	Private land	Private			
3	71	Locust sp.	*Robinia sp.*	5	Decline	Private land	Private			
3	72	Sugar maple	*Acer saccharum ssp. Saccharum*	11	Healthy	Private land	Private			
3	73	Black walnut	*Juglans nigra*	4	Healthy	Private land	Private			
3	74	Lilac	*Syringa vulgaris*	2.5	Healthy	Private land	Private			
3	75	Black locust	*Robinia psuedo-acacia*	40	Healthy	Private land	Private			
3	76	Black locust	*Robinia psuedo-acacia*	23.7	Healthy	Ditch	Private			
3	77	Black locust	*Robinia psuedo-acacia*	24	Healthy	Ditch	Private			
3	78	Sugar maple	*Acer saccharum ssp. Saccharum*	2	Healthy	Ditch	Private			
3	79	Sugar maple	*Acer saccharum ssp. Saccharum*	3	Healthy	Ditch	Private			
3	80	Sugar maple	*Acer saccharum ssp. Saccharum*	1	Healthy	Ditch	Private			
3	81	Sugar maple	*Acer saccharum ssp. Saccharum*	<1	Healthy	Ditch	Private			
3	82	Sugar maple	*Acer saccharum ssp. Saccharum*	<1	Healthy	Ditch	Private			
3	83	Sugar maple	*Acer saccharum ssp. Saccharum*	7	Decline	Ditch	Private			
3	84	Black walnut	*Juglans nigra*	4	Healthy	Ditch	Private			
3	85	Black walnut	*Juglans nigra*	4	Healthy	Across ditch	Private	586051	4784508	x3 stems
3	86	Black locust	*Robinia psuedo-acacia*	3	Healthy	Across ditch	Private			
3	87	Manitoba maple	*Acer platanoides*	4	Healthy	Across ditch	Private			x6 stems
3	88	Black locust	*Robinia psuedo-acacia*	3	Healthy	Across ditch	Private			
3	89	Black locust	*Robinia psuedo-acacia*	10	Healthy	Across ditch	Private			
3	90	Black locust	*Robinia psuedo-acacia*	8	Healthy	Across ditch	Private			
3	91	Black locust	*Robinia psuedo-acacia*	1	Healthy	Across ditch	Private			
3	92	Black locust	*Robinia psuedo-acacia*	<1	Healthy	Across ditch	Private			
3	93	Black locust	*Robinia psuedo-acacia*	3	Healthy	Across ditch	Private	586061	4781514	x2 stems
3	94	Manitoba maple	*Acer platanoides*	3 to 4	Healthy	Across ditch	Private			
3	95	Austrian pine	*Pinus nigra*	48.1	Decline	Across ditch	Private			
3	96	Norway maple	*Acer platanoides*	96.6	Unhealthy	private land	Private			
3	97	Norway maple	*Acer platanoides*	50	Unhealthy	private land	Private			
3	98	Norway spruce	*Picea abies*	30	Healthy	private land	Private			
3	99	Norway spruce	*Picea abies*	1	Decline	private land	Private	586184	4784546	
3	100	Red oak	*Quercus rubra*	35	Healthy	private land	Private	586249	4184554	
3	101	Ornamental deciduous tree		5	Healthy	private land	Private			
3	102	Ornamental deciduous tree		5	Healthy	private land	Private			
3	103	Ornamental deciduous tree		2	Healthy	private land	Private			
3	104	Ornamental deciduous tree		2	Healthy	private land	Private			
3	105	Ornamental deciduous tree		1	Healthy	private land	Private			
3	106	Ornamental deciduous tree		3	Healthy	private land	Private			
3	107	Norway spruce	*Picea abies*	10	Healthy	private land	Private			
3	108	Norway spruce	*Picea abies*	13	Healthy	private land	Private			
3	109	Norway spruce	*Picea abies*	10	Decline	private land	Private			
3	110	Ornamental shrub		<1 to 3	Decline	Across ditch	Private			x8 stems
3	111	Cardamine crab apple	*Malus x atrosanguinea*	26	Healthy	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	112	Blue spruce	*Picea pungens*	25	Healthy	Private land	Private			
3	113	Ornamental beech	*Fagus sp.*	18	Healthy	Private land	Private			
3	114	Austrian pine	*Pinus nigra*	35	Decline	Private land	Private			
3	115	Norway maple	*Acer platanoides*	30	Decline	Private land	Private			
3	116	Norway spruce	*Picea abies*	8	Healthy	Private land	Private			
3	117	Norway spruce	*Picea abies*	28	Decline	Private land	Private			
3	118	Norway spruce	*Picea abies*	17	Healthy	Private land	Private			
3	119	Norway spruce	*Picea abies*	10	Healthy	Private land	Private			
3	120	Norway spruce	*Picea abies*	15	Decline	Private land	Private			
3	121	Scots pine	*Pinus sylvestris*	35	Healthy	Private land	Private			
3	122	Scots pine	*Pinus sylvestris*	35	Healthy	Private land	Private			
3	123	Scots pine	*Pinus sylvestris*	28	Decline	Private land	Private			
3	124	Norway maple	*Acer platanoides*	32	Healthy	Private land	Private			
3	125	Norway maple	*Acer platanoides*	36	Decline	Private land	Private			
3	126	Norway maple	*Acer platanoides*	25	Decline	Private land	Private			
3	127	Norway maple	*Acer platanoides*	20	Healthy	Private land	Private	586396	4784590	
3	128	Austrian pine	*Pinus nigra*	40	Healthy	Private land	Private			
3	129	Austrian pine	*Pinus nigra*	40	Healthy	Private land	Private			
3	130	Austrian pine	*Pinus nigra*	40	Healthy	Private land	Private			
3	131	Cardamine crab apple	*Malus x atrosanguinea*	25	Decline	Ditch	Private			
3	132	Cardamine crab apple	*Malus x atrosanguinea*	23	Decline	Ditch	Private			
3	133	Austrian pine	*Pinus nigra*	23	Decline	Ditch	Private			
3	134	Austrian pine	*Pinus nigra*	40	Decline	Ditch	Private			
3	135	Austrian pine	*Pinus nigra*	25	Unhealthy	Private land	Private	586424	4784594	
3	136	Paper birch	*Betula papyrifera*	10	Healthy	Private land	Private			
3	137	Paper birch	*Betula papyrifera*	8 & 15	Decline	Private land	Private			x2 stems
3	138	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
3	139	Blue spruce	*Picea pungens*	28	Healthy	Private land	Private			
3	140	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
3	141	Ash sp.	*Fraxinus sp.*	11	Decline	Private land	Private	586479	4784609	
3	142	Ash sp.	*Fraxinus sp.*	20	Healthy	Private land	Private			
3	143	Shagbark hickory	*Carya ovata var. ovata*	57.3	Decline	Private land	Private			
3	144	Ornamental deciduous shrub		2	Decline	Private land	Private			
3	145	Ornamental deciduous shrub		N/A	Decline	Private land	Private			
3	146	Norway maple	*Acer platanoides*	18	Healthy	Private land	Private			
3	147	ornamental maple shrub	*Acer sp.*	2	Healthy	Private land	Private			
3	148	Eastern white cedar	*Thuja occidentalis*	8	Healthy	Private land	Private			
3	149	Lilac	*Syringa vulgaris*	2	Healthy	Private land	Private			
3	150	sugar maple	*Acer saccharum ssp. Saccharum*	80	Decline	Private land	Private			
3	151	ornamental shrub		<1	Healthy	Private land	Private			x18 stems
3	152	Ornamental yew	*Taxus sp.*	8	Healthy	Private land	Private			
3	153	Ornamental yew	*Taxus sp.*	5	Healthy	Private land	Private			
3	154	Common buckthorn	*Rhamnus cathartica*	<1	Healthy	Across ditch	City?	5866051	4789640	
3	155	Norway spruce	*Picea abies*	25	Unhealthy	Private land	Private			
3	156	Horse chestnut	*Aesculus hippocastanum*	85	Unhealthy	Private land	Private			
3	157	Blue spruce	*Picea pungens*	3	Healthy	Private land	Private			
3	158	Blue spruce	*Picea pungens*	2	Healthy	Private land	Private			
3	159	Blue spruce	*Picea pungens*	3	Healthy	Private land	Private			
3	160	Blue spruce	*Picea pungens*	2	Healthy	Private land	Private			
3	161	Blue spruce	*Picea pungens*	2	Healthy	Private land	Private			
3	162	Blue spruce	*Picea pungens*	2	Healthy	Private land	Private			
3	163	Norway spruce	*Picea abies*	44.7	Decline	Private land	Private			

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Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	164	Norway spruce	*Picea abies*	41.7	Decline	Private land	Private			
3	165	Norway spruce	*Picea abies*	38.8	Decline	Private land	Private	586421	4784613	
3	166	Norway spruce	*Picea abies*	8	Unhealthy	Private land	Private			
3	167	Staghorn sumac	*Rhus typhina*	4	Decline	Private land	Private			
3	168	ornamental shrub		4	Healthy	Private land	Private			x15 stems
3	169	Norway spruce	*Picea abies*	40	Decline	Private land	Private			
3	170	Norway spruce	*Picea abies*	40	Decline	Private land	Private			
3	171	Cedar Hedgerow	*Thuja occidentalis*	N/A	Decline	Private land	Private			x10 stems
3	172	Norway maple	*Acer platanoides*	54.9	Unhealthy	Private land	City			
3	173	Shagbark hickory	*Carya ovata var. ovata*	48	Healthy	Private land	Private			
3	174	Sycamore	*Platanus occidentalis*	45	Decline	Private land	Private			
3	175	Shagbark hickory	*Carya ovata var. ovata*	40	Unhealthy	Private land	Private			
3	176	Black cherry	*Prunus serotina*	60	Unhealthy	Private land	Private			
3	177	Shagbark hickory	*Carya ovata var. ovata*	50	Healthy	Private land	Private			
3	178	Black cherry	*Prunus serotina*	65	Healthy	Private land	Private			
3	179	ornamental shrub		<1	Healthy	Private land	Private			x3 stems
3	180	Blue spruce	*Picea pungens*	4	Healthy	Private land	Private			
3	181	Honey locust	*Gleditsia triacanthos*	8	Healthy	Ditch	City			x8 stems
3	182	Ornamental maple	*Acer sp.*	<1 to 1	Healthy	Across ditch	Private			x10 stems
3	183	Ornamental dogwood	*Cornus sp.*	<1	Healthy	Ditch	City	586251	4784576	
3	184	Norway maple	*Acer platanoides*	50	Decline	private land	Private			
3	185	Norway maple	*Acer platanoides*	55	Decline	private land	Private			
3	186	Poplar	*Populus sp.*	45	Decline	private land	Private			
3	187	Poplar	*Populus sp.*	40	Healthy	private land	Private			
3	188	Blue spruce	*Picea pungens*	35	Healthy	private land	Private			
3	189	Juniper hedge	*Juniperus communis*	N/A	Healthy	private land	Private			
3	190	Ornamental deciduous shrub		N/A	Healthy	private land	Private			
3	191	Black locust	*Robinia psuedo-acacia*	35	Healthy	private land	Private			
3	192	Tree of heaven	*Ailanthus altissima*	71.6	Decline	Outside fence	City			
3	193	Norway maple	*Acer platanoides*	19	Unhealthy	Outside fence	City			
3	194	Norway maple	*Acer platanoides*	10	Healthy	Outside fence	City			
3	195	Norway maple	*Acer platanoides*	3	Healthy	Private land	Private			
3	196	Norway maple	*Acer platanoides*	3	Healthy	Private land	Private			
3	197	Norway maple	*Acer platanoides*	4	Healthy	Private land	Private			
3	198	Norway maple	*Acer platanoides*	1	Dead	Private land	Private			
3	199	Black walnut	*Juglans nigra*	5	Decline	Private land	Private			
3	200	Norway maple	*Acer platanoides*	10	Healthy	Private land	Private			
3	201	Norway maple	*Acer platanoides*	18	Healthy	Private land	Private			
3	202	Norway maple	*Acer platanoides*	8	Healthy	Private land	Private			
3	203	Norway maple	*Acer platanoides*	20	Healthy	Private land	Private			
3	204	Norway maple	*Acer platanoides*	8	Healthy	Private land	Private			
3	205	Common buckthorn	*Rhamnus cathartica*	5	Healthy	Private land	Private			
3	206	Tree of heaven	*Ailanthus altissima*	2.2	Unhealthy	Across ditch	City			
3	207	Tartarian honeysuckle	*Lonicera tartarica*	1.3	Unhealthy	Across ditch	Private	586181	478536	
3	208	Tree of heaven	*Ailanthus altissima*	3 to 4	Unhealthy	Across ditch	City			x3 stems
3	209	Norway maple	*Acer platanoides*	74.1	Unhealthy	Across ditch	City			
3	210	Norway maple	*Acer platanoides*	6.7,6.6,2.5,<1(x3)	Decline	Across ditch	City			x7 stems
3	211	Norway maple	*Acer platanoides*	22.6	Healthy	Across ditch	City			
3	212	Norway maple	*Acer platanoides*	17.3	Healthy	Across ditch	City			
3	213	European high bush cranberry	*Viburnum opulus*	1	Healthy	Across ditch	Private			
3	214	Maple saplings	*Acer sp.*	<1	Healthy	Hedge row	City	586178	4784552	x5 stems
3	215	Norway maple	*Acer platanoides*	8.5	Healthy	Hedge row	Private			x2 stems

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	216	Norway maple	*Acer platanoides*	67.4	Healthy	Across ditch	City			
3	217	Common buckthorn	*Rhamnus cathartica*	2.3	Healthy	Across ditch	City			
3	218	Black walnut	*Juglans nigra*	1 to 1.5	Healthy	Across ditch	City	586148	4784530	
3	219	Black walnut	*Juglans nigra*	3.8	Decline	Across ditch	Private			
3	220	Norway maple	*Acer platanoides*	60.4	Decline	Across ditch	City			
3	221	Black walnut	*Juglans nigra*	11.1	Healthy	Across ditch	City	586124	4784541	
3	222	Manitoba maple	*Acer platanoides*	15	Decline	Across ditch	City			x10 stems
3	223	Black walnut	*Juglans nigra*	18.6	Healthy	Across ditch	City			
3	224	Black walnut	*Juglans nigra*	20.3	Decline	Across ditch	City			
3	225	Black walnut	*Juglans nigra*	15.5	Healthy	Across ditch	City			
3	226	Black walnut	*Juglans nigra*	8.3	Healthy	Across ditch	City			
3	227	Black walnut	*Juglans nigra*	23.3	Healthy	Fencerow	City			
3	228	Unknown		8.7	Dead	Fencerow	City			
3	229	Norway maple	*Acer platanoides*	61.1	Decline	Fencerow	City			
3	230	Norway maple	*Acer platanoides*	5.6	Healthy	Fencerow	City			
3	231	Black walnut	*Juglans nigra*	<1	Healthy	Fencerow	City	586105	4184534	
3	232	Black walnut	*Juglans nigra*	13.9	Healthy	Fencerow	City			
3	233	Black walnut	*Juglans nigra*	3.3	Healthy	Fencerow	City			
3	234	Black walnut	*Juglans nigra*	6.4	Dead	Fencerow	City			
3	235	Norway maple	*Acer platanoides*	<1	Healthy	Fencerow	City			
3	236	Norway maple	*Acer platanoides*	2.7	Healthy	Fencerow	City			
3	237	Norway maple	*Acer platanoides*	3.7	Decline	Fencerow	Private			
3	238	Norway maple	*Acer platanoides*	5.7	Healthy	Fencerow	Private			
3	239	Norway maple	*Acer platanoides*	17.1	Unhealthy	Fencerow	City			
3	240	Norway maple	*Acer platanoides*	8.8	Decline	Fencerow	City			
3	241	Norway maple	*Acer platanoides*	18.1	Unhealthy	Fencerow	Private			
3	242	Norway maple	*Acer platanoides*	66.8	Unhealthy	Fencerow	City			
3	243	Norway maple	*Acer platanoides*	<1	Decline	Fencerow	City			
3	244	Cherry sp	*Prunus sp.*	<1	Healthy	Fencerow	Private	586094	4784537	
3	245	Norway maple	*Acer platanoides*	9.8	Decline	Fencerow	City			
3	246	Norway maple	*Acer platanoides*	15.6	Healthy	Fencerow	Private			
3	247	Norway maple	*Acer platanoides*	12.6	Decline	Fencerow	City			
3	248	Norway maple	*Acer platanoides*	38	Decline	Fencerow	Private			
3	249	Norway maple	*Acer platanoides*	24.4	Decline	Fencerow	Private			
3	250	Black walnut	*Juglans nigra*	35	Healthy	Across ditch	Private			
3	251	Black walnut	*Juglans nigra*	8	Healthy	Private land	Private			
3	252	Norway maple	*Acer platanoides*	40	Unhealthy	Private land	Private			
3	253	Black locust	*Robinia psuedo-acacia*	0.8	Decline	Across ditch	Private			
3	254	Black locust	*Robinia psuedo-acacia*	<1	Healthy	Across ditch	Private			
3	255	Lilac	*Syringa vulgaris*	45	Healthy	Hedge row	Private			
3	256	White elm	*Ulmus americana*	30	Decline	Hedge row	Private			
3	257	Norway maple	*Acer platanoides*	3	Healthy	Hedge row	Private			
3	258	Norway maple	*Acer platanoides*	35	Healthy	Hedge row	Private			
3	259	Black locust	*Robinia psuedo-acacia*	4	Healthy	Hedge row	Private			
3	260	Norway spruce	*Picea abies*	40	Healthy	Hedge row	Private			
3	261	Norway spruce	*Picea abies*	43	Healthy	Hedge row	Private			
3	262	Black locust	*Robinia psuedo-acacia*	35	Healthy	Hedge row	Private			
3	263	Norway maple	*Acer platanoides*	30	Healthy	Hedge row	Private			
3	264	Black locust	*Robinia psuedo-acacia*	3	Healthy	Hedge row	Private			x4 stems
3	265	Black locust	*Robinia psuedo-acacia*	10	Healthy	Hedge row	Private			
3	266	Norway maple	*Acer platanoides*	35	Decline	Hedge row	Private			
3	267	Norway maple	*Acer platanoides*	5	Decline	Hedge row	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	268	Black locust	*Robinia psuedo-acacia*	9	Decline	Hedge row	Private			
3	269	Norway spruce	*Picea abies*	35	Decline	Hedge row	Private			
3	270	Norway maple	*Acer platanoides*	45	Healthy	Hedge row	Private			
3	271	Black walnut	*Juglans nigra*	6	Decline	Across ditch	Private			
3	272	Black walnut	*Juglans nigra*	3	Decline	Across ditch	Private			x5 stems
3	273	Lilac	*Syringa vulgaris*	<1	Healthy	Across ditch	Private			x30 stems
3	274	Cardamine crab apple	*Malus x atrosanguinea*	25.9	Decline	Ditch	Private			
3	275	Cardamine crab apple	*Malus x atrosanguinea*	21.8	Decline	Ditch	Private			
3	276	Ornamental deciduous shrub		1	Healthy	Private land	Private			
3	277	Cardamine crab apple	*Malus x atrosanguinea*	10	Healthy	Private land	Private			
3	278	Norway maple	*Acer platanoides*	15	Healthy	Private land	Private			
3	279	Norway maple	*Acer platanoides*	15	Healthy	Private land	Private			
3	280	Norway maple	*Acer platanoides*	5	Healthy	Private land	Private			
3	281	Norway maple	*Acer platanoides*	6	Healthy	Private land	Private			
3	282	Norway maple	*Acer platanoides*	8	Healthy	Private land	Private			
3	283	Norway maple	*Acer platanoides*	9	Healthy	Private land	Private			
3	284	Juniper shrub	*Juniperus communis*	2	Decline	Private land	Private			
3	285	Ornamental deciduous shrub		3	Healthy	Private land	Private			
3	286	Northern catalpa	*Catalpa speciosa*	40	Unhealthy	Across ditch	Private			
3	287	Norway maple	*Acer platanoides*	35	Healthy	Across ditch	Private			
3	288	Northern catalpa	*Catalpa speciosa*	5	Unhealthy	Across ditch	Private			
3	289	Norway maple	*Acer platanoides*	5	Unhealthy	Across ditch	Private			
3	290	Northern catalpa	*Catalpa speciosa*	20	Unhealthy	Across ditch	Private			
3	291	Black walnut	*Juglans nigra*	9.1	Healthy	Hedge row	City			
3	292	Black walnut	*Juglans nigra*	6.6	Healthy	Hedge row	City			
3	293	Black walnut	*Juglans nigra*	6.6	Decline	Hedge row	City			
3	294	Black walnut	*Juglans nigra*	6.7	Healthy	Hedge row	City			
3	295	Black walnut	*Juglans nigra*	6.5	Healthy	Hedge row	City			
3	296	Gray dogwood	*Foemina ssp. racemosa*	<1	Healthy	Hedge row	City			
3	297	Common buckthorn	*Rhamnus cathartica*	5	Healthy	Hedge row	City			
3	298	Black walnut	*Juglans nigra*	1.6,6.8,7.8,7.6,5, 5.3,8.9,9,10,6,9.3, 2,2,2,1,3	Healthy	Hedge row	City	585854	4784480	x16 stems
3	299	Black walnut	*Juglans nigra*	3	Healthy	Hedge row	City			
3	300	Black walnut	*Juglans nigra*	4,3,2	Healthy	Across ditch	Private			x3 stems
3	301	Eastern white cedar	*Thuja occidentalis*	1 to 2	Decline	Across ditch	Private			x15 stems
3	302	Norway spruce	*Picea abies*	28	Healthy	Across ditch	Private			
3	303	Maple	*Acer sp.*	80	Decline	private land	Private			
3	304	Maple	*Acer sp.*	80	Healthy	private land	Private			
3	305	Norway maple	*Acer platanoides*	60	Healthy	private land	Private			
3	306	Norway spruce	*Picea abies*	20	Healthy	Private land	Private			
3	307	Norway spruce	*Picea abies*	25	Healthy	Private land	Private			
3	308	Norway spruce	*Picea abies*	23	Healthy	Private land	Private			
3	309	Black walnut	*Juglans nigra*	5.5,5.3,5.6,5.2,3,3.2,2,2,2,1	Healthy	Shoulder	City			x10 stems
3	310	Red osier dogwood	*Cornus stolonifera*	<1	Healthy	Private land	Private			
3	311	Black locust	*Robinia psuedo-acacia*	2	Healthy	Ditch	Private			
3	312	Black locust	*Robinia psuedo-acacia*	30	Healthy	Ditch	City			
3	313	Black locust	*Robinia psuedo-acacia*	10	Healthy	Ditch	City			
3	314	Black locust	*Robinia psuedo-acacia*	5	Healthy	Ditch	City			
3	315	Norway maple	*Acer platanoides*	2,3.5	Healthy	Ditch	City			x2 stems

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
3	316	Weeping willow	*Salix babylonica*	35.4	Healthy	Across ditch	City			
3	317	Weeping willow	*Salix babylonica*	36.6	Healthy	Across ditch	City			
3	318	ornamental tree		62.6	Healthy	Across ditch	city			
3	319	Norway maple	*Acer platanoides*	4.1	Healthy	Across ditch	City			
3	320	Norway maple	*Acer platanoides*	94	Decline	Across ditch	City			
3	321	Norway maple	*Acer platanoides*	98.8	Decline	Across ditch	City			
3	322	Norway maple	*Acer platanoides*	42.3	Healthy	Across ditch	City			
3	323	Blue spruce	*Picea pungens*	40	Healthy	Across ditch	city			
3	324	Norway maple	*Acer platanoides*	8	Healthy	Private land	Private			
3	325	Norway maple	*Acer platanoides*	7	Healthy	Private land	Private			
3	326	Norway maple	*Acer platanoides*	12	Healthy	Private land	Private			
3	327	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
3	328	Norway maple	*Acer platanoides*	38	Healthy	Private land	Private			
3	329	Black locust	*Robinia psuedo-acacia*	91	Healthy	Ditch	City			
3	330	Ornamental deciduous shrub		N/A	Healthy	Private land	Private			x10 stems
3	331	ornamental coniferous shrubs		N/A	Healthy	Private land	Private			
3	332	Blue spruce	*Picea pungens*	40	Healthy	Private land	Private			
3	333	Red oak	*Quercus rubra*	180	Healthy	Ditch	City			
3	334	Deciduous ornamental shrub		<1	Healthy	Private land	Private			
4	1	Manitoba maple	*Acer platanoides*	105	Healthy	Private land	Private	586111	4784642	
4	2	Ornamental decidous hedge		<1	Unhealthy	Private land	City			x10 stems
4	3	Ornamental deciduous tree		10	Healthy	Across ditch	City			
4	4	Ornamental deciduous tree		8	Healthy	Across ditch	City			
4	5	Black walnut	*Juglans nigra*	12	Healthy	Across ditch	City			
4	6	Black walnut	*Juglans nigra*	10	Healthy	Across ditch	City			
4	7	Hickory	*Carya sp.*	3 to 5	Decline	Across ditch	City			x4 stems
4	8	Maple sp	*Acer sp.*	4	Unhealthy	Across ditch	City	586639	4784646	
4	9	Ornamental deciduous tree		40	Unhealthy	Private land	City			
4	10	Black walnut	*Juglans nigra*	8	Healthy	Private land	City			
4	11	Ornamental deciduous shrub		13	Healthy	Ditch	City			
4	12	Maple sp	*Acer sp.*	10	Healthy	Ditch	City			
4	13	Norway maple	*Acer platanoides*	65	Healthy	Private land	Private	586674	4784653	
4	14	Norway maple	*Acer platanoides*	20	Healthy	Private land	Private			
4	15	Norway maple	*Acer platanoides*	11	Decline	Private land	Private			
4	16	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	40	Healthy	Private land	Private			
4	17	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	35	Unhealthy	Private land	Private			
4	18	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	32	Decline	Private land	Private			
4	19	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	55	Decline	Private land	Private			
4	20	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	40	Healthy	Private land	Private			
4	21	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	35	Healthy	Private land	Private			
4	22	Sugar maple cultivar	*Acer saccharum ssp. Saccharum*	35	Healthy	Private land	Private			
4	23	Blue spruce	*Picea pungens*	13.4	Healthy	Park	City			
4	24	Blue spruce	*Picea pungens*	12.8	Healthy	Park	City			
4	25	Blue spruce	*Picea pungens*	9.6	Decline	Park	City			
4	26	Blue spruce	*Picea pungens*	9.6	Decline	Park	City			
4	27	Blue spruce	*Picea pungens*	5.5	Decline	Park	City			
4	28	Blue spruce	*Picea pungens*	6.6	Decline	Park	City			
4	29	Blue spruce	*Picea pungens*	2.5	Decline	Park	City			
4	30	Blue spruce	*Picea pungens*	2.6	Decline	Park	City			
4	31	Blue spruce	*Picea pungens*	7.7	Decline	Park	City			
4	32	Norway maple	*Acer platanoides*	5.8	Unhealthy	Park	City			
4	33	Norway maple	*Acer platanoides*	4.8	Healthy	Park	City			

Table 2: Tree Survey Results [illegible]

Tab #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Park	City			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
4	86	Ash sp.	*Fraxinus sp.*	18	Healthy	Private land	Private			
4	87	Norway spruce	*Picea abies*	30	Healthy	Private land	Private			
4	88	Eastern white cedar	*Thuja occidentalis*	20	Healthy	Private land	Private			
4	89	Ornamental deciduous shrub		<1	Healthy	Sidewalk	City			
4	90	Blue spruce	*Picea pungens*	9.1	Healthy	Sidewalk	City			
4	91	Ornamental Deciduous shrub		<1	Healthy	Sidewalk	City			
4	92	Ornamental deciduous tree		4.1	Decline	Boulevard	City			
4	93	Ornamental Deciduous shrub		<1	Healthy	Sidewalk	City			
4	94	Blue spruce	*Picea pungens*	10.3	Healthy	Sidewalk	City			
4	95	Ornamental deciduous shrub		<1	Healthy	Sidewalk	City			
4	96	American beech cultivar	*Fagus sp*	7.1	Healthy	Boulevard	City			
4	97	Ornamental deciduous shrub		<1	Healthy	Sidewalk	City			
4	98	Ornamental deciduous shrub		<1	Healthy	Sidewalk	City			
4	99	Eastern white cedar	*Thuja occidentalis*	6.6	Healthy	Sidewalk	City			
4	100	Eastern white cedar	*Thuja occidentalis*	5.4	Healthy	Sidewalk	City			
4	101	Eastern white cedar	*Thuja occidentalis*	7	Healthy	Sidewalk	City			
4	102	Blue spruce	*Picea pungens*	9.6	Healthy	Sidewalk	City			
4	103	Ornamental deciduous tree		5.6	Healthy	Boulevard	City			
4	104	Ornamental deciduous tree		5.1	Healthy	Boulevard	City			
4	105	Ornamental deciduous tree		4.5	Healthy	Boulevard	City			
4	106	Ornamental deciduous tree		4.8	Healthy	Boulevard	City			
4	107	Ornamental deciduous tree		4.7	Healthy	Boulevard	City			
4	108	Maple sp	*Acer sp.*	5.1	Decline	Sidewalk	City			
4	109	Maple sp	*Acer sp.*	9.6	Healthy	Sidewalk	City			
4	110	Maple sp	*Acer sp.*	8.8	Decline	Sidewalk	City			
4	111	Sycamore	*Platanus occidentalis*	4.4	Healthy	Boulevard	City			
4	112	Ornamental deciduous tree		4.8	Decline	Boulevard	City			
4	113	Ornamental		5.4	Healthy	Boulevard	City			
4	114	Ornamental		4.4	Healthy	Boulevard	City			
4	115	Ornamental		5.2	Healthy	Boulevard	City			
4	116	Sycamore	*Platanus occidentalis*	4.4	Healthy	Boulevard	City			
4	117	Ornamental		4.4	Decline	Boulevard	City			
4	118	Maiden-hair tree	*Ginkgo biloba*	3.3	Healthy	Sidewalk	City			
4	119	Horse chestnut	*Aesculus hippocastanum*	9.1	Healthy	Sidewalk	City			
4	120	Maple sp	*Acer sp.*	5.6	Healthy	Boulevard	City			
4	121	Ornamental shrub		2 to 4.3	Healthy	Boulevard	City			x12 stems
4	122	Ornamental shrub		2.2	Healthy	Boulevard	City			x10 stems
4	123	Black walnut	*Juglans nigra*	7.7	Healthy	Boulevard	City			
4	124	Ornamental shrub		1.5	Healthy	Ditch	City			
4	125	Black walnut	*Juglans nigra*	1.3, 1	Healthy	Ditch	City			
4	126	Hawthorn	*Craetegus sp.*	9.4	Healthy	Ditch	City			
4	127	Black walnut	*Juglans nigra*	8.7	Healthy	Ditch	City			
4	128	Black walnut	*Juglans nigra*	27.6	Healthy	Ditch	City			
4	129	Black walnut	*Juglans nigra*	12.4	Healthy	Ditch	City			
4	130	Black walnut	*Juglans nigra*	12.5	Healthy	Ditch	City			
4	131	Black walnut	*Juglans nigra*	9.6	Healthy	Ditch	City			
4	132	Black walnut	*Juglans nigra*	8.7	Healthy	Ditch	City			
4	133	Black walnut	*Juglans nigra*	4.5	Healthy	Ditch	City			
4	134	Black walnut	*Juglans nigra*	4.4	Healthy	Ditch	City			
4	135	Black walnut	*Juglans nigra*	6.8	Healthy	Ditch	City			
4	136	Black walnut	*Juglans nigra*	5.4	Healthy	Ditch	City			
4	137	Black walnut	*Juglans nigra*	9.3	Decline	Ditch	City			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
4	138	Elm sp.	*Ulmus sp.*	3.2	Dead	Ditch	City			
4	139	Willow sp.	*Salix sp.*	12.4	Unhealthy	Ditch	City			
4	140	Elm sp	*Ulmus sp.*	2.8	Decline	Ditch	City			
4	141	Elm sp	*Ulmus sp.*	4.7	Decline	Ditch	City			
4	142	European cranberry	*Viburnum opulus*	1	Decline	Ditch	City			
4	143	Elm sp.	*Ulmus sp.*	5.2	Decline	Ditch	City			
4	144	Elm sp.	*Ulmus sp.*	4.8	Dead	Ditch	City			
4	145	Elm sp.	*Ulmus sp.*	5.3	Decline	Ditch	City			
4	146	Elm sp.	*Ulmus sp.*	6.3	Decline	Ditch	City			
4	147	Elm sp.	*Ulmus sp.*	8.7	Dead	Ditch	City			
4	148	Elm sp.	*Ulmus sp.*	5.7	Dead	Ditch	City			
4	149	Elm sp.	*Ulmus sp.*	6.7	Dead	Ditch	City			
4	150	Elm sp.	*Ulmus sp.*	5.1	Healthy	Ditch	City			
4	151	Elm sp.	*Ulmus sp.*	3.8	Healthy	Ditch	City			
4	152	Elm sp.	*Ulmus sp.*	8.2	Dead	Ditch	City			
4	153	Elm sp.	*Ulmus sp.*	11.5	Dead	Ditch	City			
4	154	Elm sp.	*Ulmus sp.*	7.5	Dead	Ditch	City			
4	155	Elm sp.	*Ulmus sp.*	5.3	Dead	Ditch	City			
4	156	Elm sp.	*Ulmus sp.*	4.2	Dead	Ditch	City			
4	157	Elm sp.	*Ulmus sp.*	8.1	Decline	Ditch	City			
4	158	Elm sp.	*Ulmus sp.*	6.6	Decline	Ditch	City			
4	159	European cranberry	*Viburnum opulus*	4.8	Healthy	Ditch	City			
4	160	Gray dogwood	*Foemina ssp. racemosa*	<1	Healthy	Ditch	City			
4	161	Osage orange	*Maclura pomifera*	8	Healthy	Across ditch	City			
4	162	Osage orange	*Maclura pomifera*	7	Healthy	Across ditch	City			
4	163	Osage orange	*Maclura pomifera*	30	Healthy	Across ditch	City			
4	164	Osage orange	*Maclura pomifera*	6	Unhealthy	Across ditch	City			
4	165	Osage orange	*Maclura pomifera*	40	Healthy	Across ditch	City			
4	166	Osage orange	*Maclura pomifera*	11	Healthy	Across ditch	City			
4	167	Osage orange	*Maclura pomifera*	18	Healthy	Across ditch	City			
4	168	White Elm	*Ulmus americana*	8	Healthy	Across ditch	City			
4	169	White Elm	*Ulmus americana*	14	Healthy	Across ditch	City			
4	170	White Elm	*Ulmus americana*	11.2	Healthy	Across ditch	City			
4	171	White Elm	*Ulmus americana*	7.3	Dead	Across ditch	City			
4	172	White Elm	*Ulmus americana*	5.3	Dead	Across ditch	City			
4	173	White Elm	*Ulmus americana*	6.6	Dead	Across ditch	City			
4	174	White Elm	*Ulmus americana*	6.5	Healthy	Across ditch	City			
4	175	Various saplings		1 to 2	Healthy	Across ditch	Private/City			
4	176	Common buckthorn	*Rhamnus cathartica*	1	Healthy	Across ditch	City			
4	177	Various saplings		28	Decline	Across ditch	Hydro			
4	178	Various saplings		29.5	Healthy	Across ditch	Hydro			
4	179	Various saplings		35.5	Decline	Across ditch	Hydro			
4	180	Various saplings		11	Healthy	Across ditch	Hydro			
4	181	Various saplings		18	Decline	Across ditch	Hydro			
4	182	Various saplings		19.1	Decline	Across ditch	Hydro			
4	183	Various saplings		41.4	Unhealthy	Across ditch	Hydro			
4	184	Various saplings		50	Decline	Across ditch	Private			
4	185	Various saplings		35	Dead	Across ditch	Private			
4	186	Various saplings		30	Unhealthy	Across ditch	Private			
4	187	Austrian pine	*Pinus nigra*	35	Decline	Private land	Private			
4	188	Maple sp	*Acer sp.*	2	Healthy	Private land	Private			
4	189	Apple sp.	*Malus sp.*	2	Healthy	Boulevard	Hydro	587109	4784749	

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Tree ID	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM X Coordinate	UTM Y Coordinate	Comments
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Tag #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
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Tree #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
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Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
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Plot #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
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Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
7	20	Trembling aspen	*Populus tremuloides*	18.3	Healthy	Ditch	City			
7	21	Tartarian honeysuckle	*Lonicera tartarica*	2.5	Healthy	Ditch	City			
7	22	Trembling aspen	*Populus tremuloides*	2.1	Healthy	Ditch	City			
7	23	Trembling aspen	*Populus tremuloides*	2	Healthy	Ditch	City			
7	24	Trembling aspen	*Populus tremuloides*	4.7	Healthy	Ditch	City			
7	25	black walnut	*Juglans nigra*	2	Healthy	Ditch	City			
7	26	Trembling aspen	*Populus tremuloides*	1.3	Healthy	Ditch	City			
7	27	Trembling aspen	*Populus tremuloides*	3.5	Healthy	Ditch	City			x2 stems
7	28	Trembling aspen	*Populus tremuloides*	9.3,7.3	Healthy	Ditch	City			x2 stems
7	29	Trembling aspen	*Populus tremuloides*	9.1	Healthy	Ditch	City			
7	30	Trembling aspen	*Populus tremuloides*	4.7,3.7,7.1,4.1	Healthy	Ditch	City			x4 stems
7	31	Trembling aspen	*Populus tremuloides*	4.1	Healthy	Ditch	City			
7	32	White elm	*Ulmus americana*	4.1	Healthy	Ditch	City			
7	33	Trembling aspen	*Populus tremuloides*	5.3,17	Healthy	Ditch	City			x2 stems
7	34	Trembling aspen	*Populus tremuloides*	10	Decline	Ditch	City			
7	35	Dogwood sp	*cornus sp*	3	Healthy	Ditch	City			
7	36	Black walnut	*Juglans nigra*	21	Healthy	Ditch	City			
7	37	Ironwood	*Ostrya virginiana*	15,17,7,7	Healthy	Ditch	City			x4 stems
7	38	Trembling aspen	*Populus tremuloides*	4	Healthy	Ditch	City			x5 stems
7	39	Dogwood sp	*cornus sp*	<1	Healthy	Ditch	City			x5 stems
7	40	Red oak	*Quercus rubra*	53,47	Healthy	Ditch	City			x2 stems
7	41	Red oak	*Quercus rubra*	83	Healthy	Ditch	City			
7	42	Trembling aspen	*Populus tremuloides*	20	Healthy	Ditch	City			x2 stems
7	43	White elm	*Ulmus americana*	10	Healthy	Ditch	City			
7	44	Staghorn sumac	*Rhus typhina*	15,5	Healthy	Ditch	City			x7 stems
7	45	Black locust	*Robinia psuedo-acacia*	9,3,5	Healthy	Ditch	City			x3 stems
7	46	Staghorn sumac	*Rhus typhina*	16.5	Healthy	Ditch	City			x5 stems
7	47	Black locust	*Robinia psuedo-acacia*	13,7,5,3	Healthy	Ditch	City			x5 stems
7	48	Staghorn sumac	*Rhus typhina*	5	Healthy	Ditch	City			x10 stems
7	49	Trembling aspen	*Populus tremuloides*	7	Healthy	Ditch	City			x3 stems
7	50	Ironwood	*Ostrya virginiana*	18	Healthy	Ditch	City			
7	51	Ironwood	*Ostrya virginiana*	10	Healthy	Ditch	City			
7	52	Red maple	*Acer rubrum*	43,44	Healthy	Ditch	City			x2 stems
7	53	Ironwood	*Ostrya virginiana*	17	Healthy	Ditch	City			x5 stems
7	54	Staghorn sumac	*Rhus typhina*	5	Healthy	Ditch	City			x4 stems
7	55	Red oak	*Quercus rubra*	8.5	Healthy	Ditch	City			
7	56	Black walnut	*Juglans nigra*	37	Healthy	Ditch	City			
7	57	Dogwood sp	*cornus sp*	3	Healthy	Ditch	City			x40 stems
7	58	Raspberry	*Rubus sp*	<1	Healthy	Ditch	City			x50 stems
7	59	Black walnut	*Juglans nigra*	18	Healthy	Ditch	City			
7	60	Ironwood	*Ostrya virginiana*	7	Healthy	Ditch	City			
7	61	Black walnut	*Juglans nigra*	44	Healthy	Ditch	City			
7	62	Ironwood	*Ostrya virginiana*	6	Healthy	Ditch	City			
7	63	Dogwood sp	*cornus sp*	3	Healthy	Ditch	City			x20 stems
7	64	White ash	*Fraxinus americana*	23	Healthy	Ditch	City			
7	65	Black walnut	*Juglans nigra*	25	Healthy	Ditch	City			
7	66	Ironwood	*Ostrya virginiana*	23	Healthy	Ditch	City			
7	67	Ironwood	*Ostrya virginiana*	27	Healthy	Ditch	City			
7	68	White ash	*Fraxinus americana*	2	Healthy	Ditch	City			x4 stems
7	69	Black walnut	*Juglans nigra*	5	Healthy	Ditch	City			
7	70	Ironwood	*Ostrya virginiana*	28	Healthy	Ditch	City			
7	71	Ironwood	*Ostrya virginiana*	27	Healthy	Ditch	City			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
7	72	White ash	*Fraxinus americana*	2	Healthy	Ditch	City			x5 stems
7	73	Dogwood sp	*cornus sp*	1	Healthy	Ditch	City			x10 stems
7	74	Black cherry	*Prunus serotina*	25,21	Unhealthy,Dead	Ditch	City			x4 stems
7	75	Ash sp.	*Fraxinus sp*	31,4	Healthy	Ditch	City			x2 stems
7	76	Willow sp.	*Salix sp*	30	Healthy	Ditch	City			
7	77	Ash sp.	*Fraxinus sp*	25	Healthy	Forest edge	City			
7	78	Red oak	*Quercus rubra*	55	Healthy	Forest edge	City			
7	79	Ironwood	*Ostrya virginiana*	9	Healthy	Ditch	City			
7	80	Tartarian honeysuckle	*Lonicera tartarica*	<1	Healthy	Ditch	City			x20 stems
7	81	Black walnut	*Juglans nigra*	15, 14, 12, 7	Healthy	Ditch	City			x4 stems
7	82	Shagbark hickory	*Carya ovata var. ovata*	2	Healthy	Ditch	City			x4 stems
7	83	Shagbark hickory	*Carya ovata var. ovata*	21,7	Healthy	Ditch	City			x2 stems
7	84	Ironwood	*Ostrya virginiana*	18	Healthy	Ditch	City			
7	85	Red oak	*Quercus rubra*	3	Healthy	Ditch	City			x4 stems
7	86	Tartarian honeysuckle	*Lonicera tartarica*	3	Healthy	Ditch	City			x6 stems
7	87	Black walnut	*Juglans nigra*	3	Healthy	Ditch	City			
7	88	Red oak	*Quercus rubra*	2,60	Healthy	Ditch	City			2 stems, 1 stem
7	89	Shagbark hickory	*Carya ovata var. ovata*	<1	Healthy	Ditch	City			x2 stems
7	90	Dogwood sp	*cornus sp*	1	Healthy	Ditch	City			x50 stems
7	91	Staghorn sumac	*Rhus typhina*	3	Healthy	Ditch	City			x15 stems
7	92	White pine	*Pinus strobus*	55	Healthy	Ditch	City			
7	93	Black locust	*Robinia psuedo-acacia*	4,11,8	Healthy	Ditch	City			x3 stems
7	94	Ash sp.	*Fraxinus sp*	1	Healthy	Ditch	City			x16 stems
7	95	Red oak	*Quercus rubra*	30	Healthy	Ditch	City			
7	96	Ironwood	*Ostrya virginiana*	6	Healthy	Ditch	City			
7	97	White ash	*Fraxinus americana*	3	Healthy	Ditch	City			
7	98	White ash	*Fraxinus americana*	3	Healthy	Ditch	City			
7	99	White ash	*Fraxinus americana*	4	Healthy	Ditch	City			
7	100	White ash	*Fraxinus americana*	5	Healthy	Ditch	City			
7	101	White ash	*Fraxinus americana*	4	Healthy	Ditch	City			
7	102	Red oak	*Quercus rubra*	50	Healthy	Ditch	City			
7	103	White pine	*Pinus strobus*	52	Healthy	Ditch	City			
7	104	White pine	*Pinus strobus*	57	Healthy	Ditch	City			
7	105	Staghorn sumac	*Rhus typhina*	2	Healthy	Ditch	City			x5 stems
7	106	Ash sp.	*Fraxinus sp*	3	Healthy	Ditch	City			x20 stems
7	107	Shagbark hickory	*Carya ovata var. ovata*	4	Healthy	Ditch	City			
7	108	Red oak	*Quercus rubra*	3,5	Healthy	Ditch	City			x2 stems
7	109	Black locust	*Robinia psuedo-acacia*	5	Healthy	Ditch	City			x2 stems
7	110	Ash sp.	*Fraxinus sp*	4,2	Healthy	Ditch	City			x9 stems
7	111	Black locust	*Robinia psuedo-acacia*	17	Healthy	Ditch	City			
7	112	Manitoba maple	*Acer negundo*	5	Healthy	Ditch	City			
7	113	Ash sp.	*Fraxinus sp*	<1	Healthy	Ditch	City			x13 stems
7	114	White pine	*Pinus strobus*	51	Healthy	Ditch	City			
7	115	Ironwood	*Ostrya virginiana*	3	Healthy	Ditch	City			x5 stems
7	116	White ash	*Fraxinus americana*	<1,3	Healthy	Ditch	City			x20 stems
7	117	White ash	*Fraxinus americana*	53	Healthy	Ditch	City			
7	118	Black walnut	*Juglans nigra*	10,6	Healthy	Ditch	City			x2 stems
7	119	White ash	*Fraxinus americana*	<1,3	Healthy	Ditch	City			x10 stems
7	120	Black locust	*Robinia psuedo-acacia*	2	Healthy	Ditch	City			x3 stems
7	121	Black locust	*Robinia psuedo-acacia*	8	Healthy	Ditch	City			x3 stems
7	122	Dogwood sp	*cornus sp*	<1	Healthy	Ditch	City			x50 stems
7	123	Black walnut	*Juglans nigra*	15	Healthy	Ditch	City			

[illegible]

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
7	176	Apple sp	*Malus sp*	20	Healthy	Private land	Private			
7	177	Apple sp	*Malus sp*	15	Healthy	Boulevard	City			
7	178	Ash sp.	*Fraxinus sp*	10	Healthy	Private land	Private			
7	179	Juniper	*Juniperus communis*	N/A	Healthy	Private land	Private			x3 stems
7	180	Blue spruce	*Picea pungens*	40	Healthy	Private land	Private			
7	181	Norway maple	*Acer platanoides*	30	Healthy	Boulevard	City	588515	4784947	
7	182	Norway maple	*Acer platanoides*	34	Healthy	Boulevard	City	588514	4784935	
7	183	Norway maple	*Acer platanoides*	14	Healthy	Boulevard	City	588510	4784923	
7	184	Norway maple	*Acer platanoides*	31	Healthy	Boulevard	City	588505	4781913	
7	185	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
7	186	Norway maple	*Acer platanoides*	35	Healthy	Private land	Private			
7	187	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
7	188	Ornamental shrub		<1	Healthy	Private land	Private			
7	189	Norway maple	*Acer platanoides*	35	Healthy	Private land	Private			
7	190	Norway maple	*Acer platanoides*	35	Healthy	Private land	Private			
7	191	Dogwood sp	*cornus sp*	<1	Healthy	Private land	Private			x3 stems
7	192	Norway maple	*Acer platanoides*	50	Healthy	Private land	Private			
7	193	Ornamental maple		30	Healthy	Private land	Private			
7	194	Ornamental		20	Healthy	Boulevard	City			
7	195	Ornamental		10	Healthy	Private land	Private			
7	196	Linden tree	*Tilia cordata*	10	Healthy	Boulevard	City			
7	197	Ornamental		9	Healthy	Boulevard	City			
7	198	Ornamental		10	Healthy	Boulevard	City			
7	199	Ornamental		8	Healthy	Boulevard	City			
7	200	Ornamental		8	Healthy	Boulevard	City			
7	201	Ornamental		8	Decline	Boulevard	City			
7	202	Ornamental		4	Healthy	Boulevard	City			
7	203	Ornamental		6	Healthy	Boulevard	City			
7	204	Ornamental		6	Healthy	Boulevard	City			
7	205	Ornamental		5	Healthy	Boulevard	City			
7	206	Ornamental		5	Healthy	Boulevard	City			
7	207	Ornamental		<1	Healthy	Boulevard	City			
7	208	Ornamental		9	Healthy	Boulevard	City			
7	209	Red pine	*Pinus resinosa*	20	Healthy	Private land	Private			
7	210	Ornamental		8	Healthy	Boulevard	City			
7	211	Ornamental		8	Decline	Boulevard	City			
7	212	Red pine	*Pinus resinosa*	17	Healthy	Private land	Private			
7	213	Ornamental		7	Healthy	Boulevard	City			
7	214	Ornamental		6	Healthy	Boulevard	City			
7	215	Ornamental		7	Healthy	Boulevard	City			
7	216	Ornamental		7	Decline	Boulevard	City			
7	217	Red pine	*Pinus resinosa*	13	Healthy	Private land	Private			
7	218	Eastern white cedar	*Thuja occidentalis*	8	Healthy	Private land	Private	588429	4784671	x3 stems
7	219	Ornamental		7	Healthy	Boulevard	City			
7	220	Ornamental		5.5	Healthy	Boulevard	City			
7	221	Ornamental		3	Healthy	Boulevard	City			
7	222	Red pine	*Pinus resinosa*	15	Healthy	Private land	Private			
7	223	Red oak	*Quercus rubra*	25	Healthy	Private land	Private			
7	224	Cherry	*Prunus sp*	20	Healthy	Private land	Private			
7	225	Locust	*Robinia sp*	40	Healthy	Private land	Private			
7	226	Shagbark hickory	*Carya ovata var. ovata*	45	Healthy	Private land	Private			
7	227	Juniper	*Juniperus communis*	N/A	Healthy	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
7	228	Eastern white cedar	*Thuja occidentalis*	<1	Healthy	Private land	Private			
7	229	Norway maple	*Acer platanoides*	35	Healthy	Private land	Private			
7	230	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
7	231	Norway maple	*Acer platanoides*	30	Healthy	Private land	Private			
7	232	Norway maple	*Acer platanoides*	22	Healthy	Boulevard	City			
7	233	Apple sp	*Malus sp*	27	Healthy	Boulevard	City			
7	234	Austrian pine	*Pinus nigra*	35	Healthy	Private land	Private			
7	235	Austrian pine	*Pinus nigra*	40	Healthy	Private land	Private			
7	236	Austrian pine	*Pinus nigra*	35	Healthy	Private land	Private			
7	237	Austrian pine	*Pinus nigra*	35	Healthy	Private land	Private			
7	238	Austrian pine	*Pinus nigra*	35	Healthy	Private land	Private			
7	239	Norway maple	*Acer platanoides*	30	Healthy	Boulevard	City			
7	240	Norway maple	*Acer platanoides*	30	Healthy	Boulevard	City			
7	241	Blue spruce	*Picea pungens*	50	Healthy	Private land	Private			
7	242	Blue spruce	*Picea pungens*	40	Healthy	Private land	Private			
7	243	Blue spruce	*Picea pungens*	45	Healthy	Private land	Private			
7	244	Blue spruce	*Picea pungens*	40	Healthy	Private land	Private			
7	245	Ornamental shrub		<1	Healthy	Private land	Private			
7	246	Norway maple	*Acer platanoides*	25	Healthy	Boulevard	City			
7	247	Ornamental		30,20	Healthy	Private land	Private			x2 stems
7	248	Ornamental		10	Healthy	Private land	Private			x6 stems
7	249	Blue spruce	*Picea pungens*	30	Healthy	Private land	Private			
7	250	White spruce	*Picea glauca*	50	Healthy	Private land	Private			
7	251	Eastern white cedar	*Thuja occidentalis*	<1	Healthy	Private land	Private	588587	4785160	x6 stems
7	252	Red pine	*Pinus resinosa*	30	Healthy	Private land	Private			
7	253	Red pine	*Pinus resinosa*	40	Healthy	Private land	Private			
7	254	Red pine	*Pinus resinosa*	40	Healthy	Private land	Private			
7	255	Red pine	*Pinus resinosa*	45	Healthy	Private land	Private			
7	256	Red pine	*Pinus resinosa*	40	Healthy	Private land	Private			
7	257	Red pine	*Pinus resinosa*	40	Healthy	Private land	Private			
7	258	Norway maple	*Acer platanoides*	24	Healthy	Boulevard	City			
7	259	Ornamental		60	Healthy	Private land	Private			
7	260	Norway maple	*Acer platanoides*	43	Healthy	Boulevard	City			
7	261	Norway maple	*Acer platanoides*	33	Healthy	Boulevard	City			
7	262	Norway maple	*Acer platanoides*	45	Healthy	Boulevard	City			
7	263	Norway maple	*Acer platanoides*	45	Healthy	Boulevard	City			
7	264	Red pine	*Pinus resinosa*	40	Healthy	Private land	Private			
7	265	Red pine	*Pinus resinosa*	40	Healthy	Private land	Private			
7	266	Norway maple	*Acer platanoides*	22	Healthy	Boulevard	City			
7	267	Locust	*Robinia sp*	35	Decline	Boulevard	City			
7	268	Austrian pine	*Pinus nigra*	45	Healthy	Private land	Private			
7	269	Austrian pine	*Pinus nigra*	40	Healthy	Private land	Private			
7	270	Ornamental shrub		,1	Healthy	Private land	Private			
7	271	Norway spruce	*Picea abies*	25	Healthy	Private land	Private			
7	272	Norway spruce	*Picea abies*	25	Healthy	Private land	Private			
7	273	Locust	*Robinia sp*	24	Healthy	Boulevard	City			
7	274	Locust	*Robinia sp*	22	Healthy	Boulevard	City			
7	275	Maple sp.	*Acer sp*	35	Healthy	Private land	Private			
7	276	Ornamental		35	Healthy	Private land	Private			
7	277	Ornamental shrub		1	Healthy	Private land	Private	588621	4785292	x20
7	278	White spruce	*Picea glauca*	30	Healthy	Private land	Private			
7	279	Ornamental shrub		<1	Healthy	Private land	Private			

Table 2: Tree Survey Results for Garner/Rymal Road and Garth Street, City of Hamilton, 2011

Tile #	Tree ID No.	Common Name	Botanical Name	Diameter (cm)	Condition	Location	Ownership	UTM Easting	UTM Northing	Comments
7	280	Ornamental		5	Healthy	Boulevard	City			
7	281	Ornamental		7	Healthy	Boulevard	City			
7	282	Ornamental		6	Healthy	Boulevard	City			
7	283	Ornamental		20	Healthy	Private land	Private			
7	284	Norway spruce	*Picea abies*	35	Healthy	Private land	Private			
7	285	Norway spruce	*Picea abies*	30	Healthy	Private land	Private			
7	286	Ash sp.	*Fraxinus sp*	30	Healthy	Private land	Private			
7	287	Ornamental shrub		<1	Healthy	Private land	Private			x6 stems
7	288	Norway maple	*Acer platanoides*	35	Healthy	Private land	Private			
7	289	Norway maple	*Acer platanoides*	7	Healthy	Private land	Private			
7	290	Lombardy poplar	*Populus nigra*	35	Decline	Private land	Private			
7	291	Lombardy poplar	*Populus nigra*	30	Decline	Private land	Private			
7	292	Lombardy poplar	*Populus nigra*	30	Decline	Private land	Private			
7	293	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	294	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	295	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	296	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	297	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	298	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	299	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	300	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	301	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	302	Lombardy poplar	*Populus nigra*	20	Healthy	Private land	Private			
7	303	Maple sp.	*Acer sp.*	5.8	Healthy	Boulevard	City			
7	304	Common buckthorn	*Rhamnus cathartica*	<1	Healthy	Private land	Private			
7	305	Common buckthorn	*Rhamnus cathartica*	<2	Healthy	Private land	Private			
7	306	Common buckthorn	*Rhamnus cathartica*	<3	Healthy	Private land	Private			
7	307	Common buckthorn	*Rhamnus cathartica*	<4	Healthy	Private land	Private			
7	308	Common buckthorn	*Rhamnus cathartica*	<5	Healthy	Private land	Private			
7	309	Norway maple	*Acer platanoides*	30,25	Healthy	Private land	Private			x2 stems
7	310	Cardamine crab-apple	*Malus x atrosanguinea*	22.1	Healthy	Boulevard	City			
7	311	Ornamental shrub		N/A	Healthy	Private land	Private			x6 stems
7	312	English oak	*Quercus robur*	10	Healthy	Private land	Private			
7	313	English oak	*Quercus robur*	10	Healthy	Private land	Private			

* N/A indicates that the tree or shrub was less than 1.3 m in height, and thus did not have a DBH.

APPENDIX D.4
HYDROGEOLOGY REPORT

APPENDIX D.5
NOISE ASSESSMENT

- **Ambient Noise Survey Memo**
- **Noise Impact Assessment**

Ambient Noise Survey Memo

SNC• LAVALIN Inc.
400 Carlingview Drive
Toronto, Ontario
Canada M9W 6N9

Telephone: 416-679-6000
Fax: 416-231-5356

SLI No. 333126

April 9, 2010.

City of Hamilton
Environment and Sustainable Infrastructure Division
Public Works Department
77 James St. N., Suite 320
Hamilton, ON L8R 2K3

Attention: Christine Lee-Morrison, MCIP, RPP
Manager, Environmental Planning

Re: Ambient Noise Survey Memo
Garner Rd/Rymal Rd Municipal Class Environmental Assessment

The following memo provides a summary of our recent tour of the study area and noise monitoring results (Noise Survey) obtained in support of the Garner Road – Rymal Road Municipal Class Environmental Assessment (Project) currently undertaken by SNC-Lavalin Inc. (SLI) for the City of Hamilton (City; Client). The results will be included in the complete Noise Impact Study, to be prepared by SLI as part of the Project's report submission.

Ambient sound level measurements were taken at critical Outdoor Living Areas (OLAs) at residences along the Garner Road, Rymal Road, and Garth Street areas (study area) located in the City of Hamilton. The Noise Survey may support the characterization of the baseline noise levels at typical, worst case locations adjacent to the road traffic. These locations will be listed as Noise Sensitive Areas (NSAs), in accordance with the Ontario Ministry of Transportation Noise Guidelines.

The daytime and night time ambient sound levels were collected over several consecutive days. The values were found to be in the range of Leq(16h) 60 to 68 dBA during the day and Leq(8h) 50 to 62 dBA during the night. The following sections and figures detail the Noise Survey findings.

Site Description

The study area is located approximately 2 km south of the Highway 403 and the Lincoln Alexander Parkway interchange. In terms of environmental noise emissions, the study area is dominated by road traffic, based on SLI's observations at various times throughout the day and a limited number of traffic counts taken at Location 1. Very little industrial noise was observed in the immediate area. Both existing and future planned residences are located throughout the study area. The NSAs are generally in the direct line of sight with the main roads.

Monitoring Locations

Based on our review of the background information and a detailed tour of the study area, four locations (Figure 1) were selected at OLAs in order to characterize the noise emissions for NSAs near three main areas of interest (i.e., center, east end, west end, and north end of the study area), as follows:

- Location 1: northeast corner of Garner Rd. E. and Garth St.;
- Location 2: northeast corner of Garth St. and Stone Church Rd. W.;
- Location 3: 95 Rymal Rd. W. (just southwest of Rymal Rd. and West 5th St.); and,
- Location 4: 581 Garner Rd. E. (just northwest of Garner Rd. and Southcote Rd. intersection).

Figure 1: Noise Monitor Locations within the Study Area

The selection of the monitoring location is based on a position that best captures the typical worst-case noise emissions at the NSA due to the existing road traffic, while achieving a reasonably secure installation in terms of avoiding equipment damage or theft.

Figure 2: Noise Monitor at Location 1 - installed along fence line facing intersection

Figure 3: Noise Monitor at Location 2 – installed at backyard of Glenhill Crescent residence

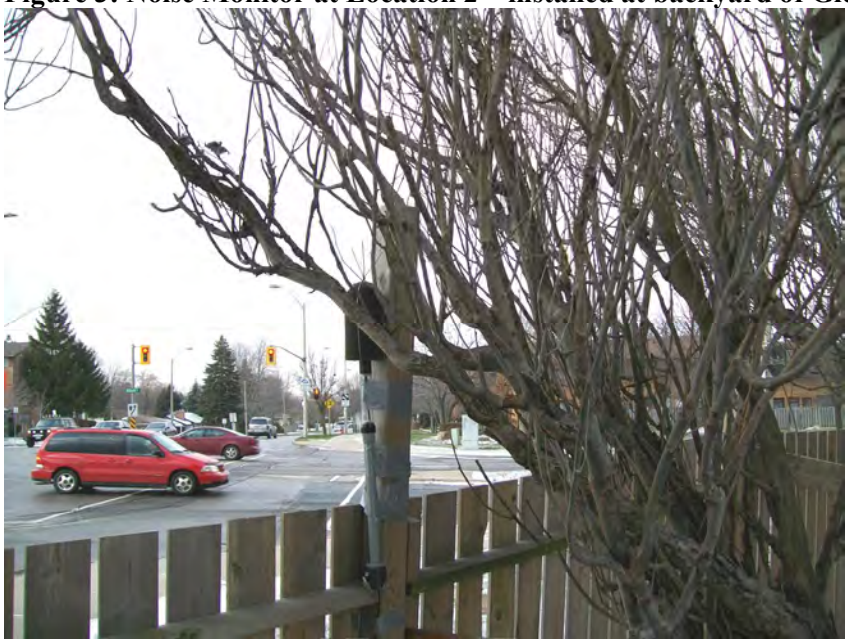

Figure 4: Noise Monitor Location 3 – installed at front yard facing Rymal Rd. W.

Figure 5: Noise Monitor Location 4 – installed at front yard facing Garner Rd. E.

Instrumentation

The following key instruments were used to complete the background noise survey:

- *Larson Davis* – Model 820 Integrating Sound Level Meters (Type 1)
- *Larson Davis* – Precision Microphone Calibrator - Model CAL200
- Supporting field equipment, including tripods and environmental protection (cases, screens, etc.).

Procedures

Long term, unattended noise monitoring was conducted using sound level meters equipment with the appropriate environmental protection. The monitoring was conducted during the month of December, 2009. The continuous sampling periods were over 6 days at Locations 1 and 2, and over 3 days at Locations 3 and 4.

The sound level measurements (dB) were based on the Ministry of Environment procedures, as outlined in the NPC-102 guideline, entitled: "Instrumentation" and the NPC-103 guideline, entitled: "Procedures". The instrument manufacturer's recommendations and industry best practices were considered in order to meet the site specific conditions. The sound level meters were calibrated prior to use, and checked upon completion of the noise monitoring task.

The weather conditions encountered during certain hourly periods were not favourable for outdoor measurements. In particular, high winds were present during the initial monitoring schedule at Locations 1 and 2. Hourly sound level data collected during periods with adverse weather conditions have been excluded in the results presented below.

Results

The measured existing background levels were found to be in the range of 60 to 68 dBA during the daytime period and 50 to 62 dBA during the night time period.

The hourly sound levels are summarized in Figures 6 to 9. The graphs include the equivalent (Leq) and maximum (Lmax) measurements in dBA. The figures also highlight the Leq data collected during periods with acceptable weather conditions (noted as "qualified data").

Figure 6: Noise Monitor Measurements at Location 1

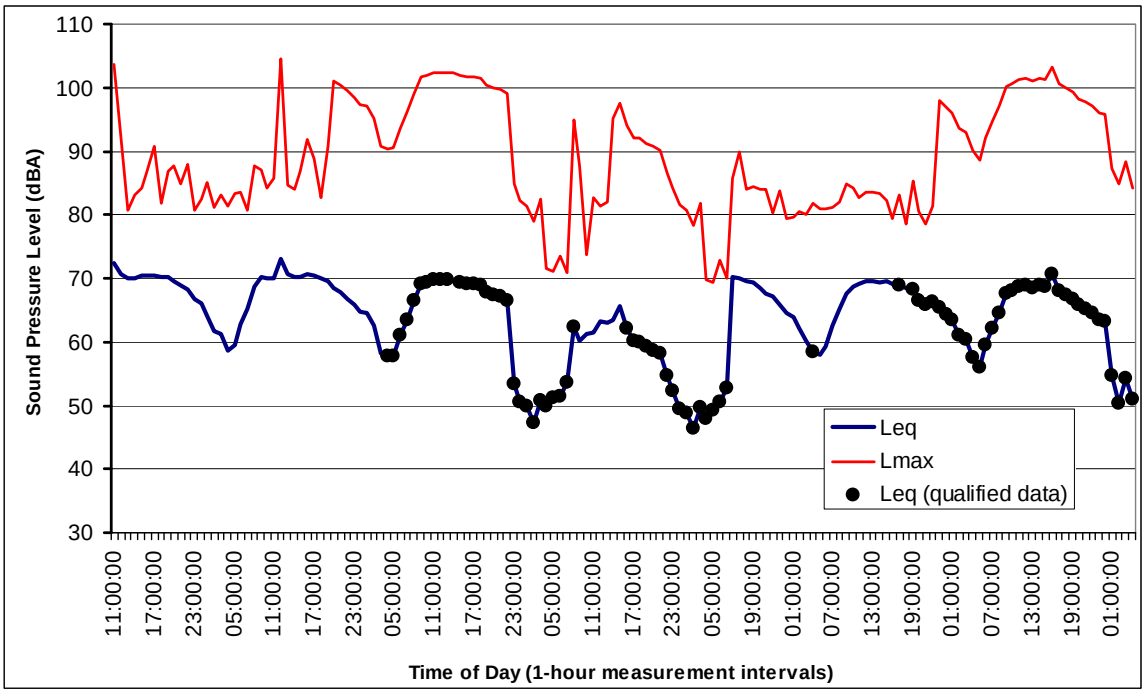

Figure 7: Noise Monitor Measurements at Location 2

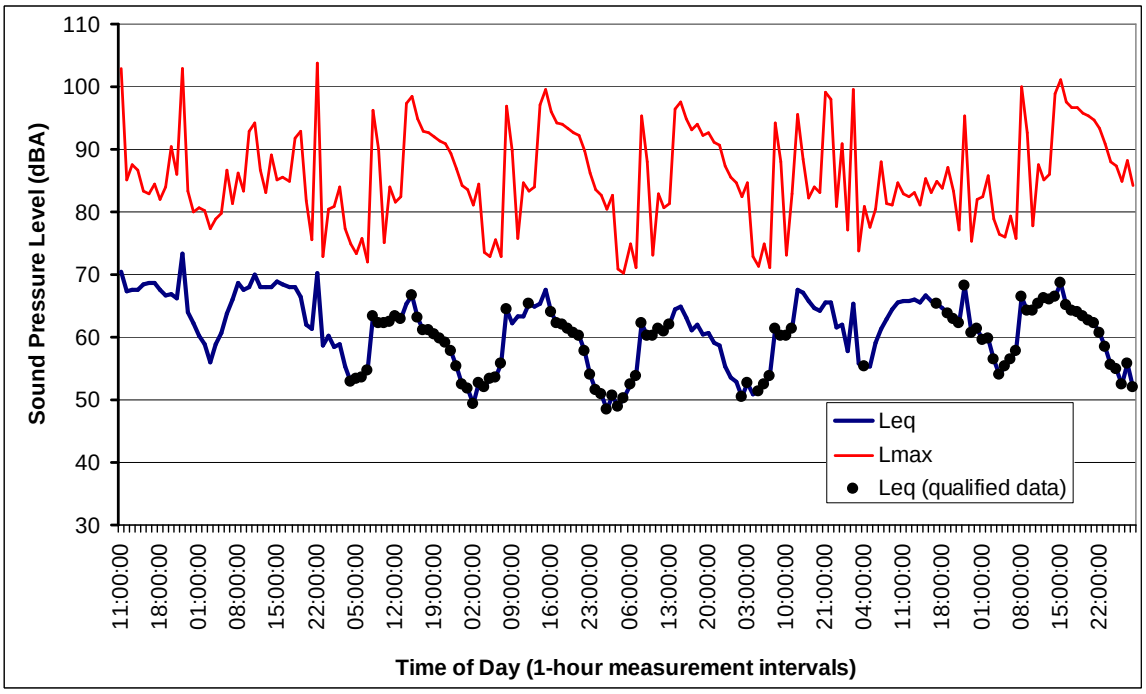

Figure 8: Noise Monitor Measurements at Location 3

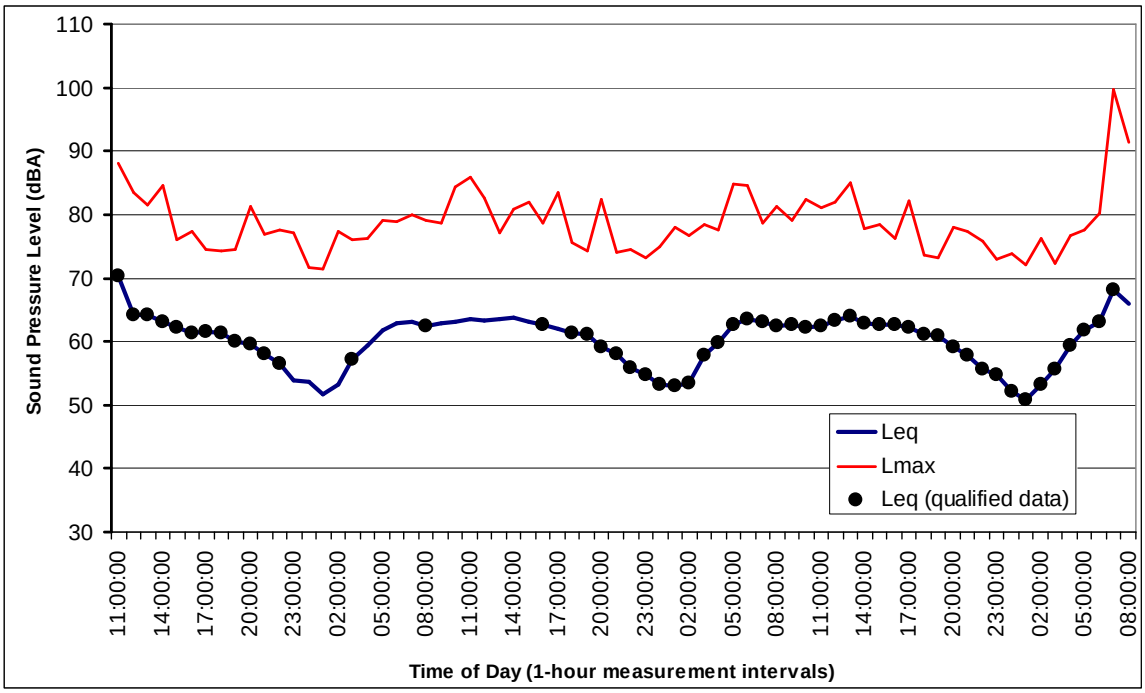

Figure 9: Noise Monitor Measurements at Location 4

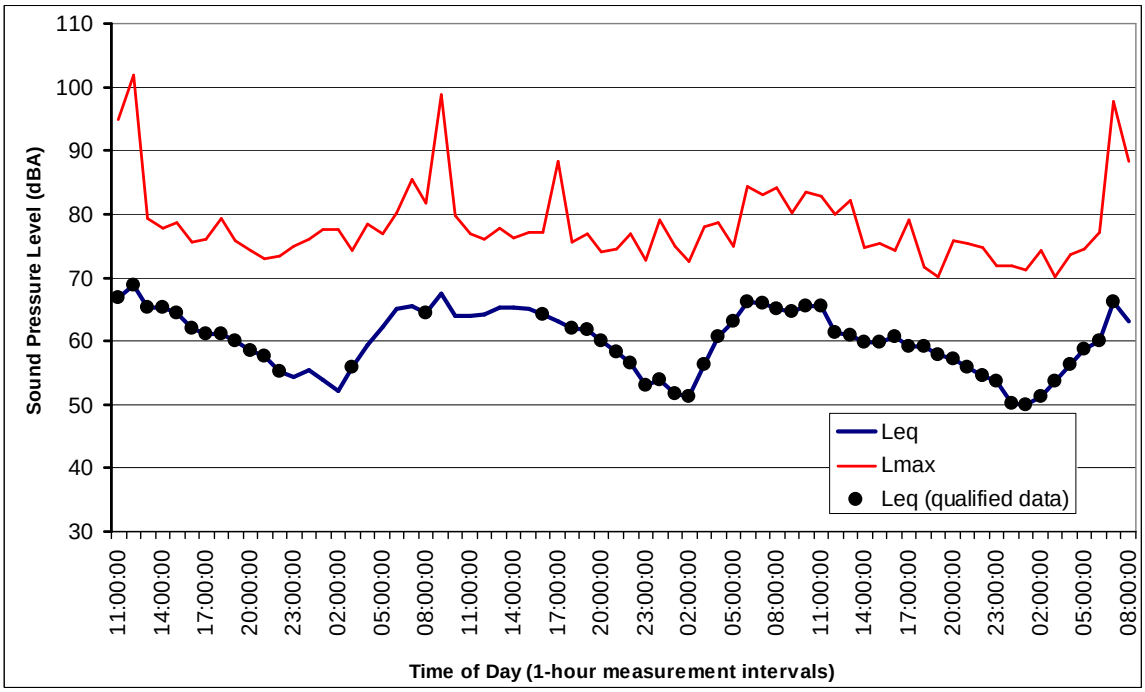

Table 1 provides a summary of the background noise levels during the daytime and night time intervals. The complete measurement data and relevant environmental conditions are presented in Attachments 1 to 4.

Table 1: Background Noise Level Summary (dBA)

Monitoring Location	Date	Leq (16h) Day	Leq (8h) Night
Location 1	Dec. 10, 2009	n/a*	
	Dec. 11, 2009	n/a	n/a
	Dec. 12, 2009	68	59
	Dec. 13, 2009	60	51
	Dec. 14, 2009		50
	Dec. 18, 2009	n/a	n/a
	Dec. 19, 2009	67	59
	Dec. 20, 2009	68	62
	Dec. 21, 2009		59
Location 2	Dec. 10, 2009	n/a*	
	Dec. 11, 2009	n/a	n/a
	Dec. 12, 2009	62	53
	Dec. 13, 2009	62	53
	Dec. 14, 2009	61	51
	Dec. 15, 2009	60	52
	Dec. 18, 2009	n/a	
	Dec. 19, 2009	65	55
	Dec. 20, 2009	65	59
	Dec. 21, 2009		55
Location 3	Dec. 15, 2009	62	57
	Dec. 16, 2009	61	59
	Dec. 17, 2009	62	58
	Dec. 18, 2009	68	n/a
Location 4	Dec. 15, 2009	62	57
	Dec. 16, 2009	61	59
	Dec. 17, 2009	62	58
	Dec. 18, 2009	68	n/a

* Note: "n/a" indicates that no qualified data is available due to unacceptable weather conditions

The results presented above will be included in the complete Noise Impact Study report to be prepared in support of the Municipal Class Environmental Assessment (EA) for the Project.

Closure

This document contains the expression of the professional opinion of SNC-Lavalin Inc. ("SLI") as to the matters set out herein, using its professional judgment and reasonable care. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SLI has followed methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care. However, no warranty should be implied as to the accuracy of estimates. SLI disclaims any liability to the Client and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

We trust that the noise monitoring survey tasks and results presented in this memo provide an acceptable summary of the existing conditions within the study area. These results will be included in the EA in order to support the evaluation of the baseline conditions due to road traffic noise.

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SNC-Lavalin Inc.

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Member of the SNC•LAVALIN Group

Noise Impact Assessment

DRAFT

NOISE IMPACT ASSESSMENT
PROPOSED GARNER/GARTH/RYMAL ROAD EXPANSION
CITY OF HAMILTON

FOR

SNC-LAVALIN INC.

PREPARED BY

_____

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NOVEMBER 27, 2013

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1.0 INTRODUCTION

The City of Hamilton is proposing to expand Garner Road between Highway 6 and Glancaster Rad, Rymal Road between Glancaster Road and West 5th Street, and Garth Street between Stone Church Road and Rymal Road. As part of the review process, SNC-Lavalin Inc. requested that J.E. COULTER ASSOCIATES LIMITED consider the shortlisted alternatives of the proposed alignment and the technically-preferred alignment for noise impacts. Please see Figure 1 in Appendix A for a Key Plan of the area.

This noise impact assessment has been prepared to support the Environmental Assessment of the proposed road expansions.

2.0 NOISE IMPACT CRITERIA

The noise impacts of the proposed alternatives are evaluated using the Ministry of Transportation's "Environmental Guide for Noise" (the protocol). This protocol compares the future daytime (0700h-2300h) equivalent sound levels (16hr L_{eq}) under the various scenarios at a point 10 years after the hypothetical completion of the project. The comparison is between the sound levels that would be present with the project in place (the "with project" scenario) and the sound levels that would be present assuming the project did not proceed (the "no project" scenario). If the difference between these two scenarios is 5 dB or greater, the economic, technical, and administrative feasibility of noise control needs to be investigated. Generally, increases in transportation noise can be characterized based on the following scale:

- <3 dB sound level increase: No impact as the sound level change would be hardly noticeable to a majority of individuals, especially if it occurs gradually over time.

- 3-4 dB sound level increase: Presents a noticeable, but not notable impact on the receptors. The increase in sound level would be noticeable to most individuals, but does not warrant noise mitigation measures.

- 5-9 dB sound level increase: Presents a significant change in the sound level and a notable impact on the receptors. The feasibility of noise mitigation measures should be explored to reduce the impact.

- 10+ dB sound level increase: Presents a serious change in the sound level and a significant impact on the receptors. Efforts for noise mitigation measures are normally extended to more extreme possibilities.

Sound levels are calculated based on the Ministry of the Environment's *ORNAMENT* prediction procedure for roadway noise and using the *STAMSON 5.04* computer program.

3.0 IDENTIFICATION OF SENSITIVE RECEPTORS

Based on the alternatives presented, a total of seven (7) sensitive receptors (alternatively known as noise sensitive areas) has been identified. The point of evaluation is typically an outdoor living area (OLA). For a developed area (Class 1 or Class 2), the OLA is typically a point 1.5m high and 3m from the rear façade of a house or a balcony more than 4m deep of an

apartment. For a rural area (Class 3), the OLA is less clearly defined and can usually be a point within 30m of the dwelling on all sides. In areas with large outdoor living areas, the protocol only requires that an outdoor area of approximately 55m^2 or 600 ft.^{2} be considered. In areas with receptors that do not have OLAs exposed directly to roadway noise, the impact assessment considers the nearest façade of the building. Figures 2 to 8 in Appendix A show the locations of the points of reception (PORs).

The characteristics of the seven PORs are summarized in Table 1, below.

Table 1: Point of Reception Descriptions

Point of Reception	Roadway	Receptor Description
1	Garner Road	Low-rise house, front façade
2	Garner Road	Low-rise house, front façade
3	Rymal Road	Low-rise house, OLA
4	Rymal Road	Low-rise house, front façade
5	Rymal Road	Low-rise house, OLA
6	Garth Street	Low-rise townhouse, OLA
7	Garth Street	Low-rise house, OLA

4.0 EVALUATION OF ALTERNATIVES

A total of three options were considered as part of the assessment. Generally, these three options differed only in the width of the roadway. The centrelines of the roadways under all three options were very similar. The traffic volumes between the options were identical.

The sound levels at a given point of reception will vary with the distance to the centreline of the roadway and the traffic volumes on the roadway, all other factors being equal. If the centreline of the roadway and the traffic volumes do not change noticeably, then the sound levels also will not differ.

Hence, the difference in sound levels between the various options was negligible and did not play a role in the selection of the preferred alternative.

5.0 EVALUATION OF TECHNICALLY-PREFERRED ALTERNATIVE

The Technically-Preferred Alternative is Option 1. The traffic volumes for this option, which are the same for all of the other options, were determined based on peak-hour traffic volumes prepared by SNC-Lavalin Inc. A typical peak hour factor of 10 was used to scale up the peak hour volumes into the average annual daily traffic (AADT) volumes needed for the noise impact assessment. This peak hour factor implies that during the peak periods, the total traffic on the road represents 10% of the daily traffic. The truck percentages vary somewhat across the entire route. The typical truck percentage is approximately 6%, based on a review of all the turning movement counts provided by the City. This truck percentage data available do not differentiate between heavy and medium trucks. Based on observations, the heavy truck component is relatively minimal and so a ratio of 2:1 has been assumed for medium to heavy trucks. The speed limit is 60 km/h on Garner Road and Rymal Road and 50 km/h on Garth Street. These speed limits will not change as a result of the widening of either roadway. It is further assumed that 90% of the daily traffic occurs during the daytime period (0700h-2300h).

As per the protocol, the sound levels with the project and the sound levels without the project must be evaluated at a point 10 years after the completion of the project. For this project, a horizon year of 2031 has been used. Copies of the relevant figures from the traffic study are attached in Appendix B.

The traffic volumes at the various PORs are summarized in Table 2, below.

Table 2: Traffic Volumes

POR	Roadway	No Project AADT	With Project AADT	Medium Truck %	Heavy Truck %	Speed Limit (km/h)
1	Garner	15,750	26,600	4	2	60
2	Garner	11,120	19,200	4	2	60
3	Rymal	14,800	20,200	4	2	60
4	Rymal	14,750	19,600	4	2	60
5	Rymal	15,200	19,350	4	2	60
6	Garth	11,950	19,500	4	2	50
7	Garth	10,950	17,000	4	2	50

Table 3, below, summarizes the sound level increases that can be expected as a result of the TPA, Option 1.

Table 3: TPA Sound Levels and Impacts Summary

POR	No Project Sound Level (dB 16-hr L_{eq})	With Project Sound Level (dB 16-hr L_{eq})	Impact (dB)
1	62	65	3
2	62	64	2
3	62	64	2
4	58	59	1
5	64	65	1
6	58	63	5
7	59	60	1

For the most part, the widening of Garner, Garth, and Rymal does not generate significant (5 dB) impacts. This is to be expected since the centreline of these roadways, except Garth Street, does not shift noticeably as a result of the widening. In the absence of a shift in the centreline or other major roadway changes, traffic volumes would need to increase by a factor of 3 before a 5 dB impact occurs. In most cases, the traffic volumes only double as a result of a widening from 2 to 4 lanes, resulting in a 3 dB impact.

The exception to the above is the receptors located on the east side of Garth Street. On Garth, a widening along the centreline is not possible. As a result, the centreline shifts approximately 8m farther east and closer to the receptors. Coupled with the increase in traffic volumes, shifting the centreline of the roadway farther east results in a 5 dB impact at the group of receptors represented by POR 6. As a result of this impact, noise control measures need to be investigated for their economic, technical, and administrative feasibility.

6.0 EVALUATION OF NOISE CONTROL MEASURES

As discussed in the previous section, the townhouse blocks represented by POR 6 will experience a 5 dB increase in sound levels as a result of the widening of Garth Street. A total of 4 of the townhouse blocks will be affected. The most practical method to deal with noise from transportation sources is the construction of a noise barrier to protect the OLAs of the affected townhouse blocks. The townhouse blocks affected are shown in Figure 9 in Appendix A.

As detailed topographical data (receptor elevations, roadway elevations, etc.) are unavailable, only preliminary recommendations can be made at this time. The topography around POR 6, however, is fairly flat and the final design should not change significantly from that discussed below.

In order to obtain a 5 dB reduction in the sound levels, a 2.0m high acoustic barrier built along the property line will be sufficient for most of the townhouse blocks.

At Block 1, the barrier will need to start at the access roadway and continue north along the property line. It will need to extend past the northern property line by approximately 20m to achieve a 5 dB reduction at the OLA of Block 1.

At Blocks 3 and 4, a 2.0m high barrier would be sufficient to achieve a 5 dB reduction in sound levels at all the units of these blocks.

Achieving a 5 dB reduction at Block 2 using a 2.0m high barrier is not possible for the units at the northern limit of that Block. The opening in the barrier needed to permit access into and out of the townhouse complex results in only a 4 dB reduction in the sound levels. It is also not possible to return the barrier along the side yards of these dwellings, as it is not City owned property. It is possible to achieve a 5 dB reduction by increasing the height of the barrier to 2.4m while continuing to maintain an opening for traffic to pass into and out of the complex. This will however require increasing the height of the barriers for units in the townhouse blocks that do not themselves need the height to achieve a 5 dB reduction. Nevertheless, there will be a greater benefit in the form of an increased reduction in sound levels for these dwellings at the cost of a taller barrier. Further, the length of barrier required for the northern portion of Block 1 and the southern portion of Block 4 could be reduced by approximately 10m with the use of a higher barrier.

If obtaining a 5 dB reduction at all affected units of the townhouse complex is critical, it is recommended that a 2.4m high barrier be constructed along the property lines as shown in Figure 10 in Appendix A. However, if a 4 dB reduction at the northerly most units of Block 2 can be tolerated, a 2.0m high barrier should be constructed along the property lines, as shown in Figure 11 in Appendix A.

Table 4, below, summarizes the sound levels at the OLAs of POR 6 based on a 2.0m high acoustic barrier and a 2.4m high acoustic barrier.

Table 4: POR 6 Barrier Recommendations

Block	2.0m HIGH BARRIER		2.4m HIGH BARRIER	
	Sound Level (dB 16h L_{eq})	Length (m)	Sound Level (dB 16h L_{eq})	Length (m)
1	58	50	58	40
2 (north)	59	60	58	60
2 (south)	57		55	
3	57	34	55	34
4	58	55	58	45

As per MOE standards, barriers should be solid, without any gaps, and maintain a minimum surface density of approximately 20 kg/m2. The above barrier calculations are conservative and based on simple topography data. More detailed calculations considering receptor elevation, barrier base elevation, and noise source elevation should be completed once such information becomes available.

7.0 CONSTRUCTION NOISE REVIEW

The MOE and other agencies and municipalities in Ontario do not place receiver based restrictions on construction noise. Instead, all construction equipment used should adhere to the source-based guidelines as published by MOE in its publication *NPC-115* “Construction Equipment.”

The City of Hamilton’s noise by-law (no. 11-285) restricts construction activity from 7 p.m. one day to 7 a.m. the next day. If construction activity is expected to occur outside of these prescribed periods, a bylaw exemption will be required.

Blasting is not expected to be required for the construction of this roadway and so particularly high vibration levels are not expected during construction.

8.0 SUMMARY AND CONCLUSIONS

Overall, as the widening of Garner Road and Rymal Road do not generate significant noise impacts at any of the PORs located along the roadways. The widening of Garth Street does generate a 5 dB increase in noise at receptors located along its eastern side, due to the offset in the centreline proposed as a result of the widening.

Noise control measures in the form of acoustic barriers have been recommended for POR 6, which represents a group of townhouses on the east side of Garth Street. Please refer to Section 6.0 for more details.

APPENDIX A: FIGURES

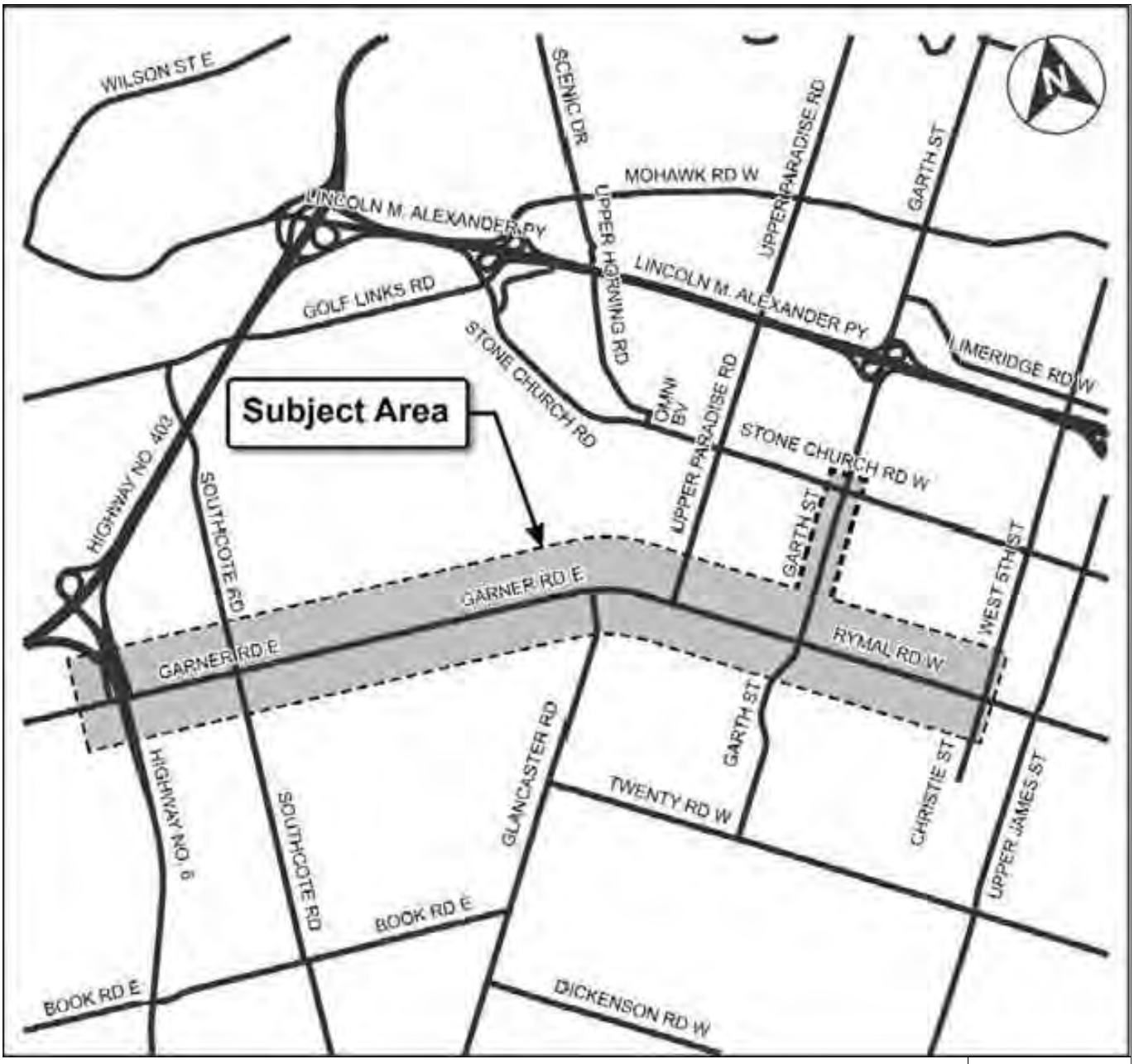


FIGURE 1
KEY PLAN

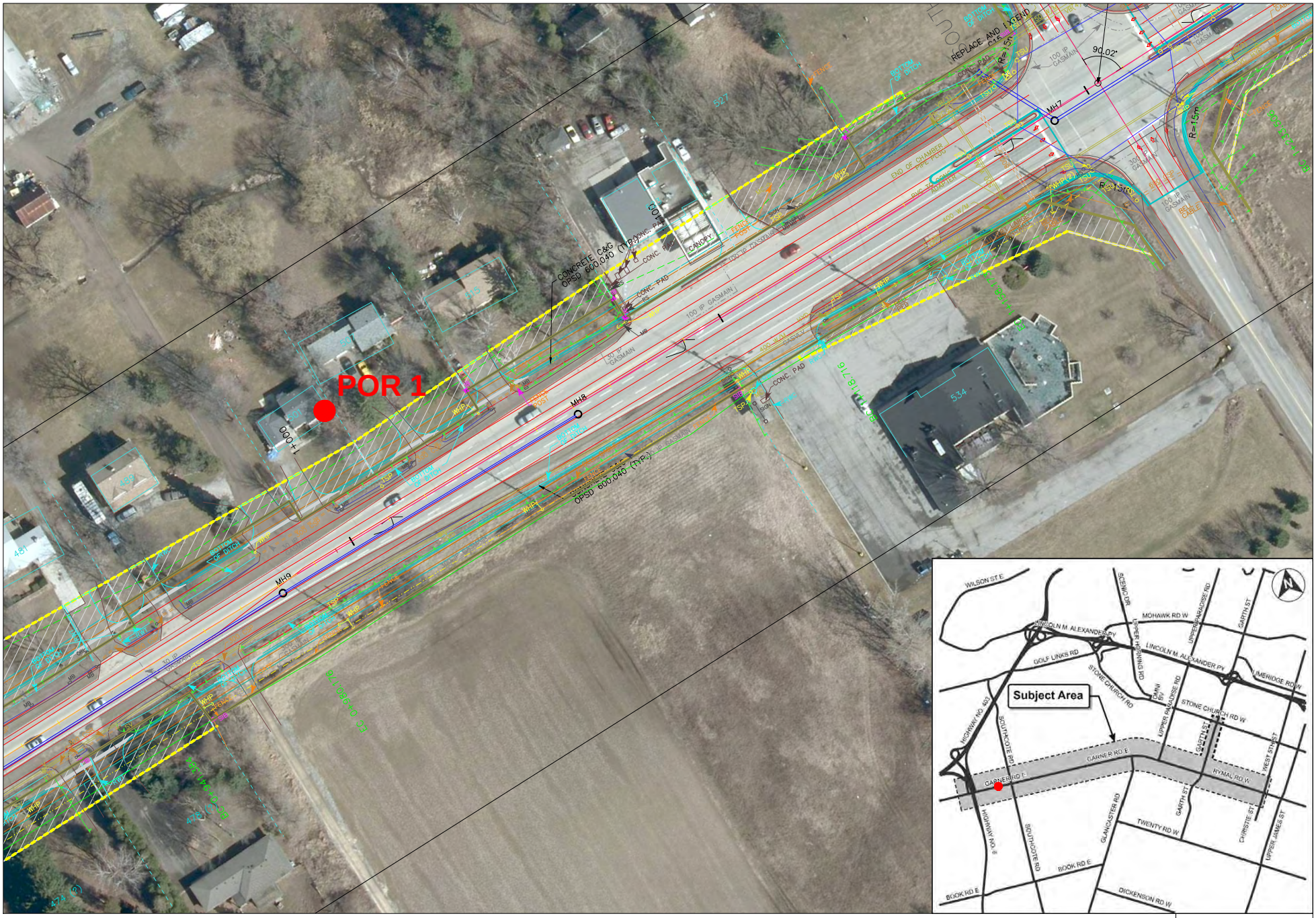


FIGURE 2
POR 1

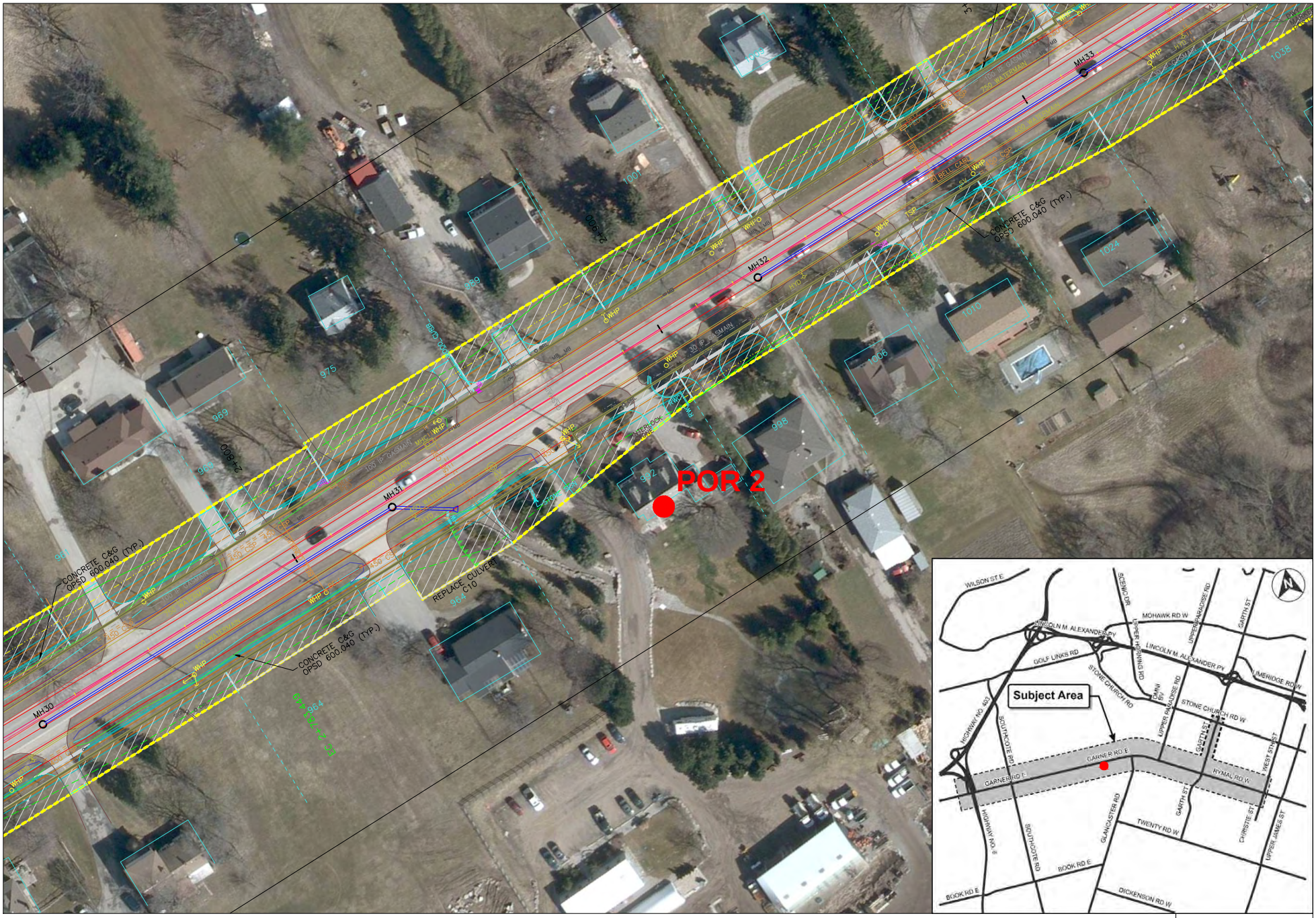


FIGURE 3
POR 2

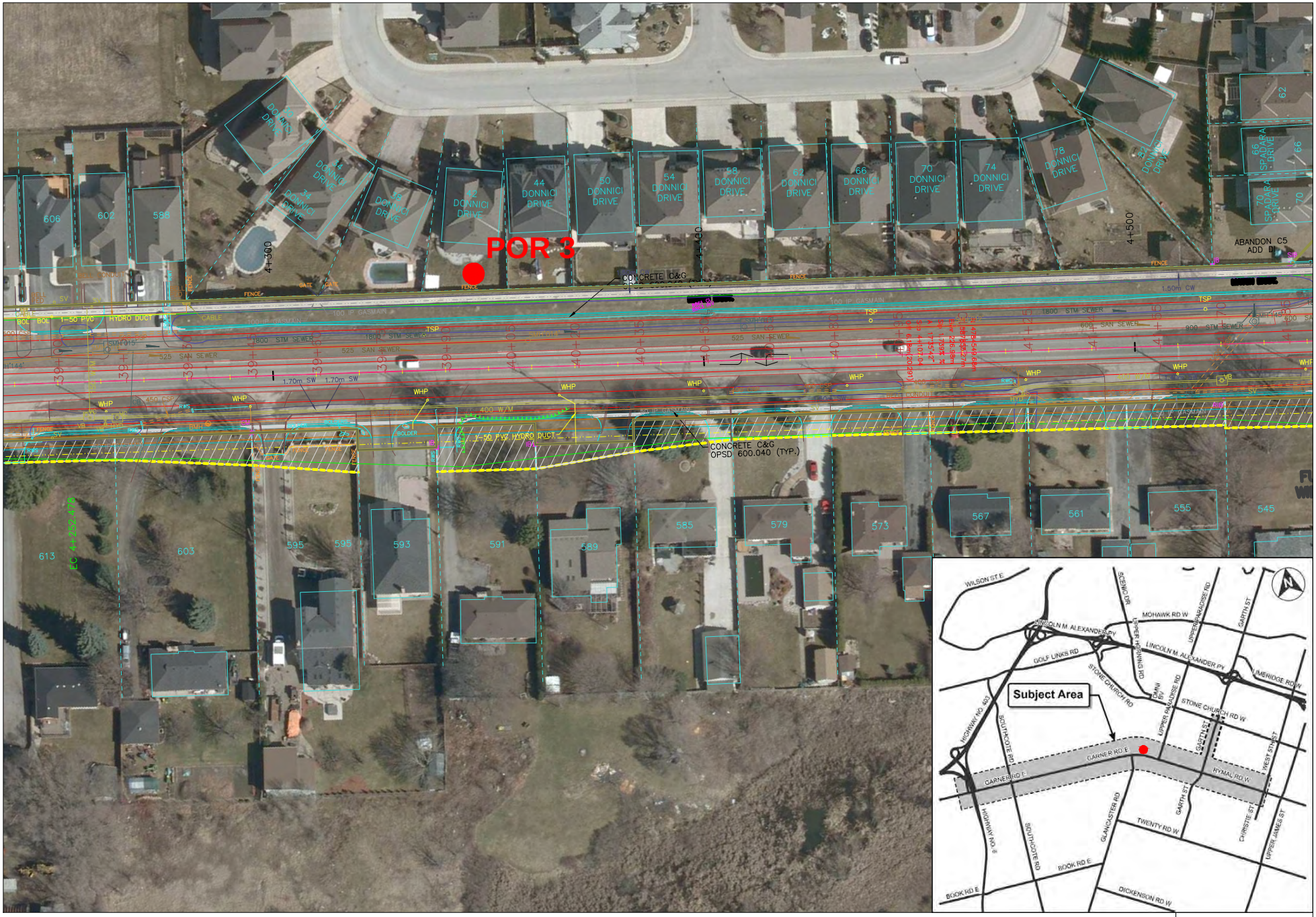


FIGURE 4
POR 3

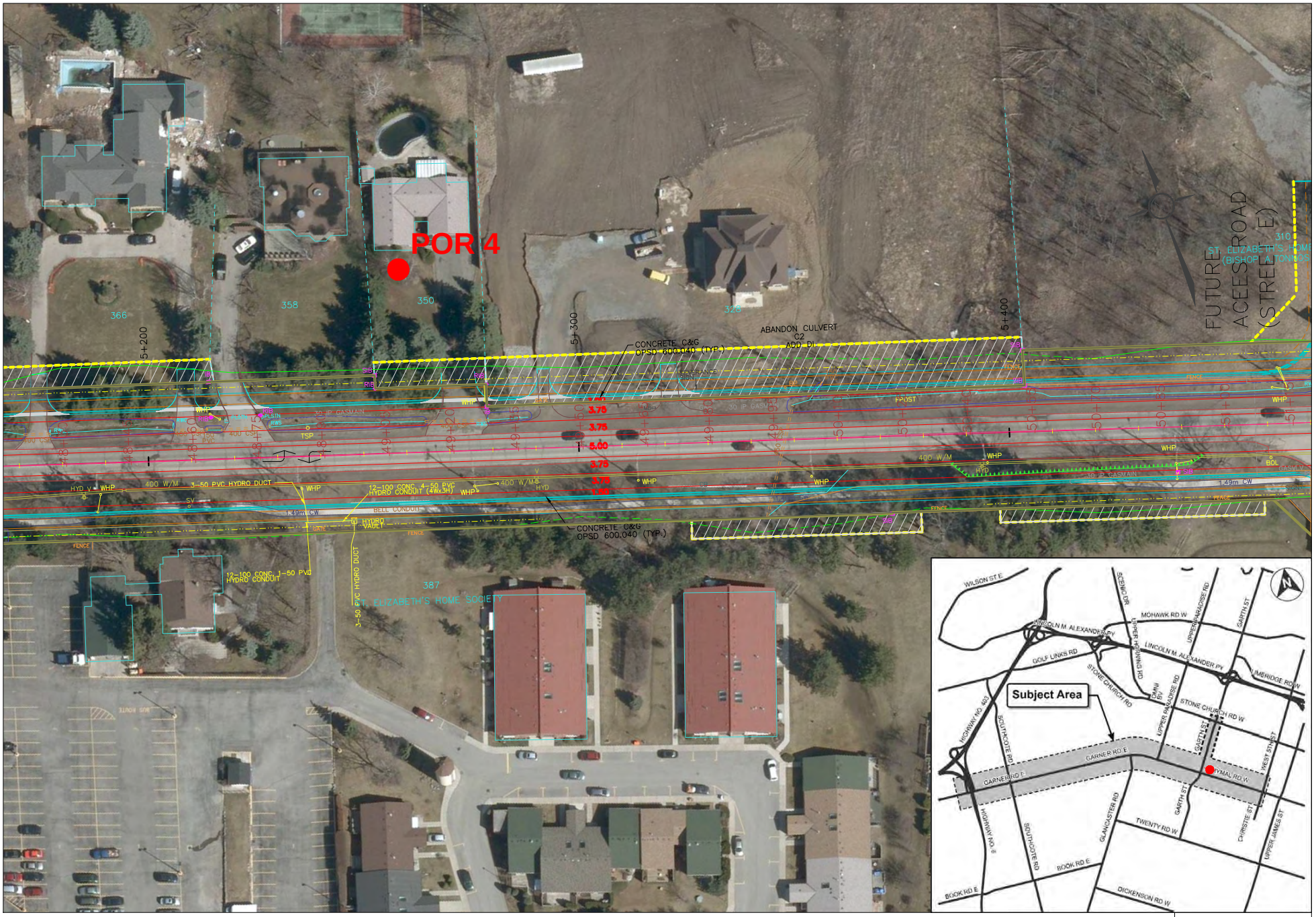


FIGURE 5
POR 4

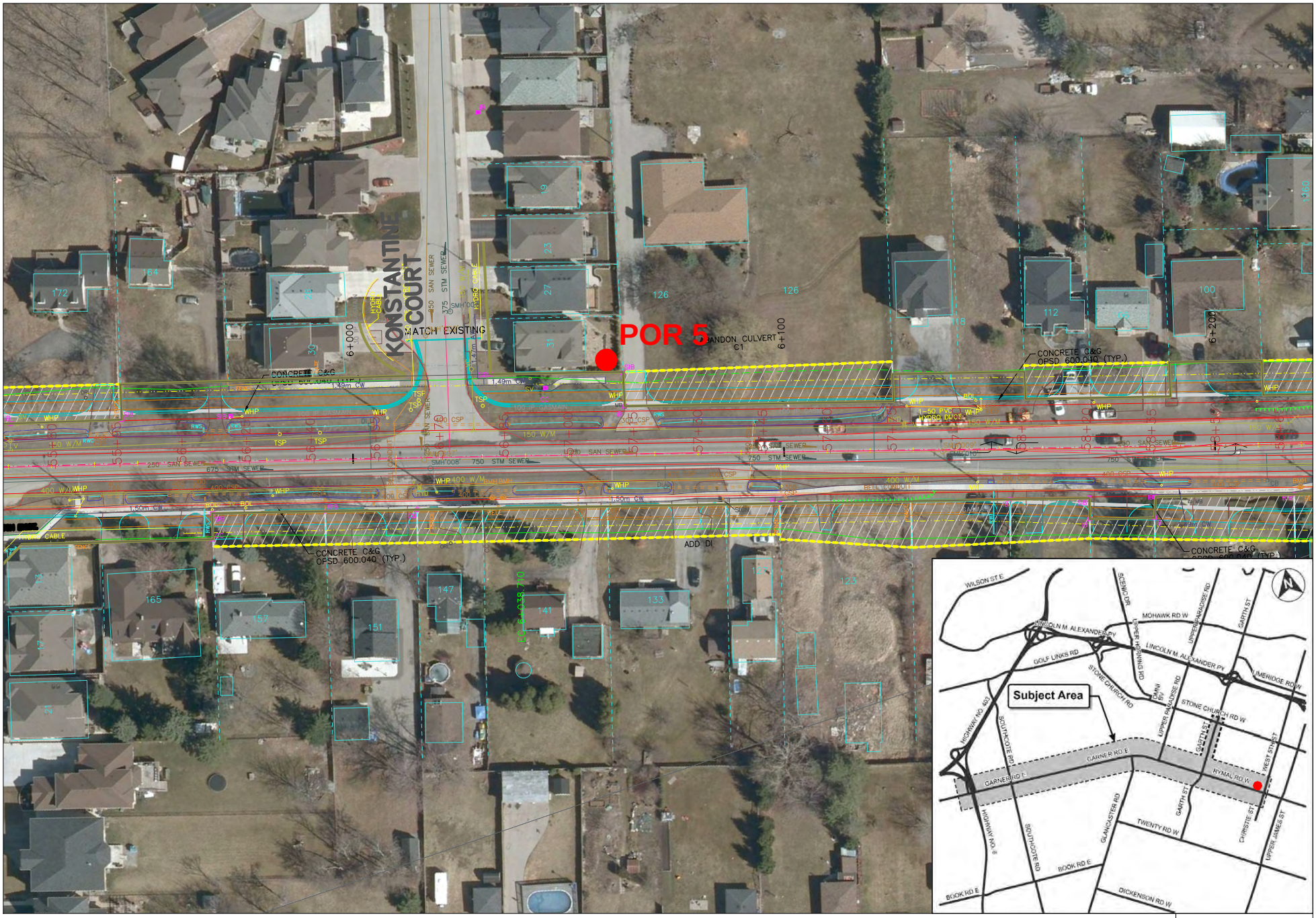


FIGURE 6
POR 5

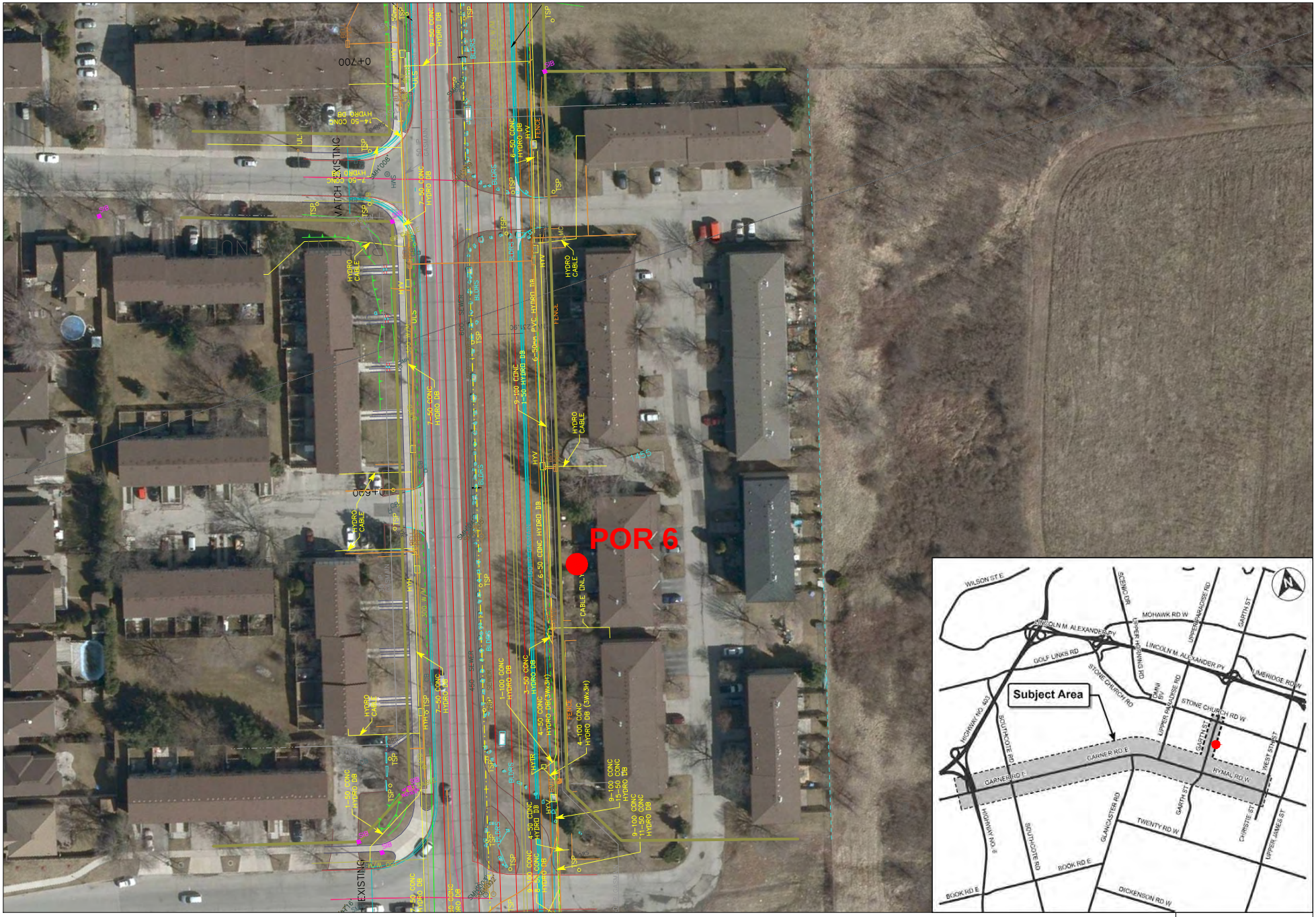


FIGURE 7
POR 6

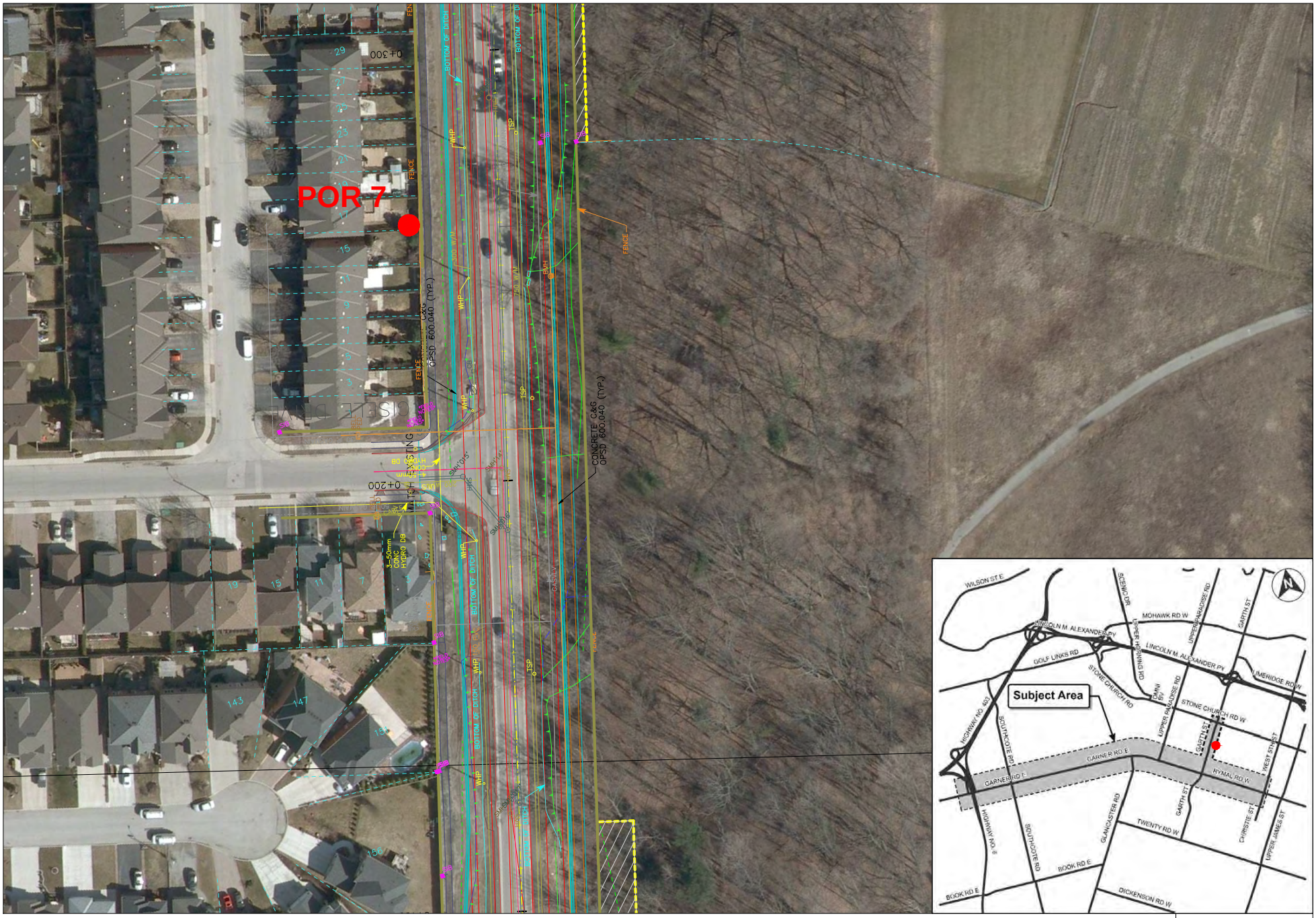


FIGURE 8
POR 7

FIGURE 9
POR 6 TOWNHOUSE BLOCKS

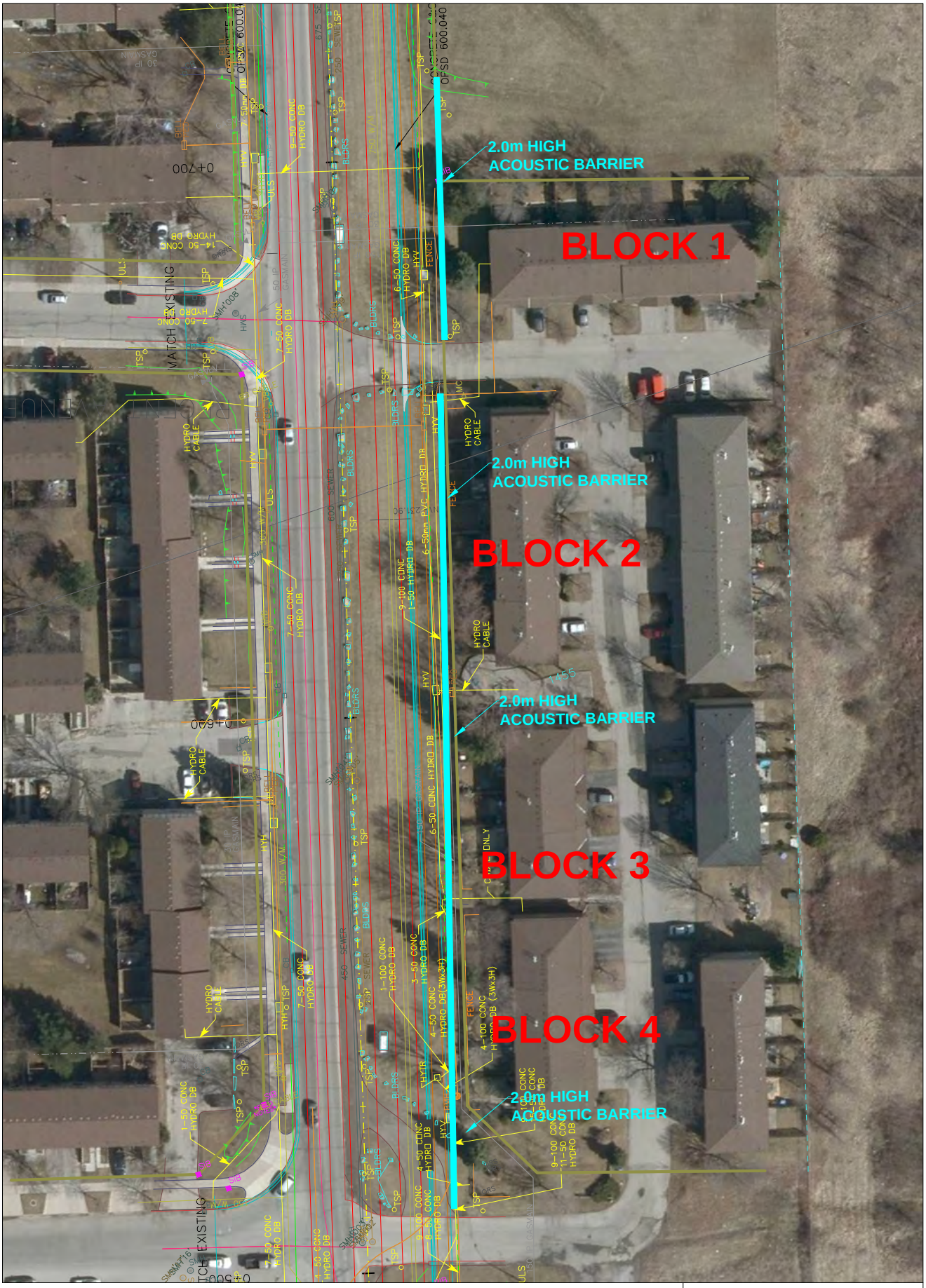


FIGURE 10
POR 6 BARRIER
2.0m HIGH OPTION

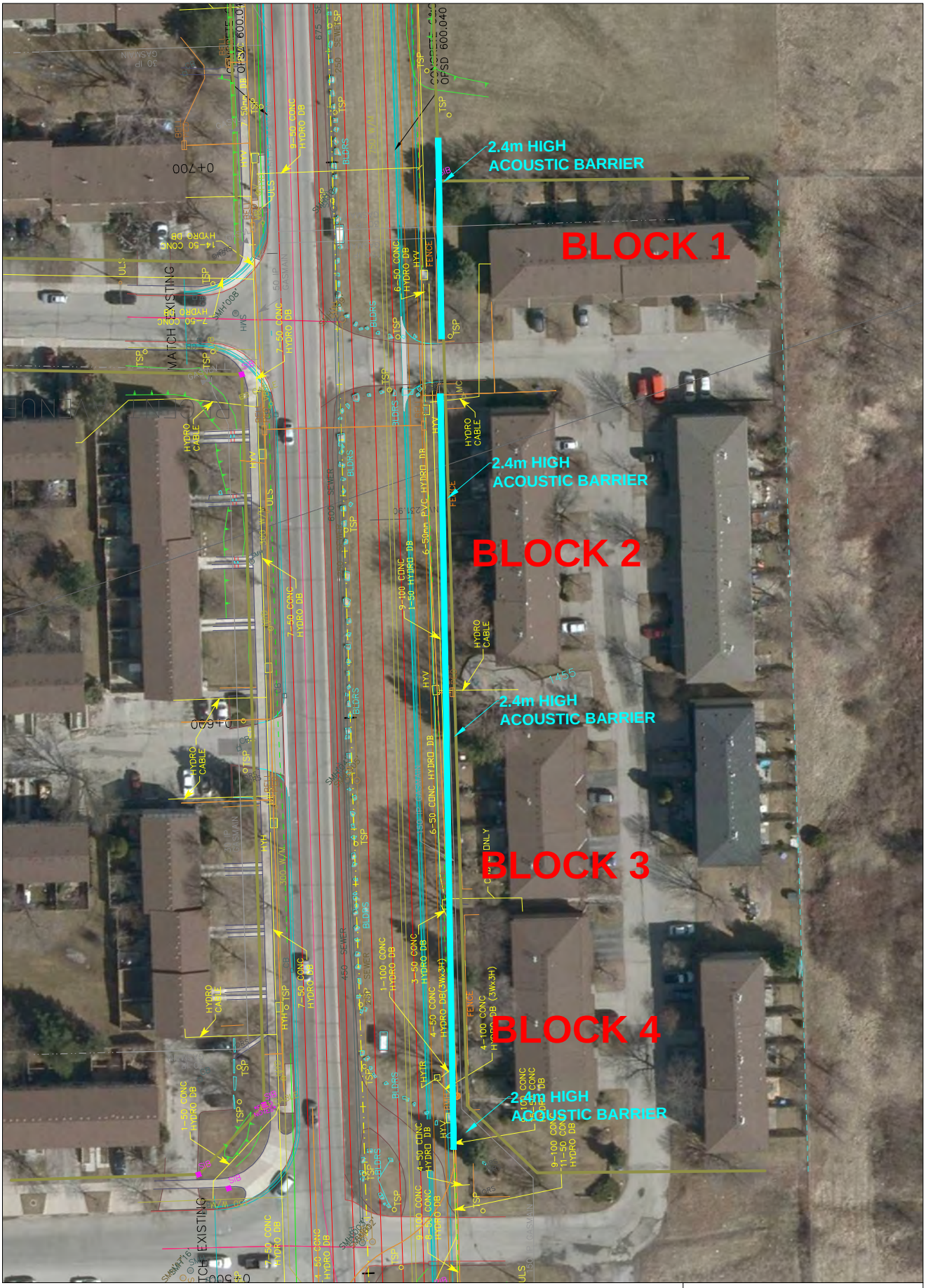
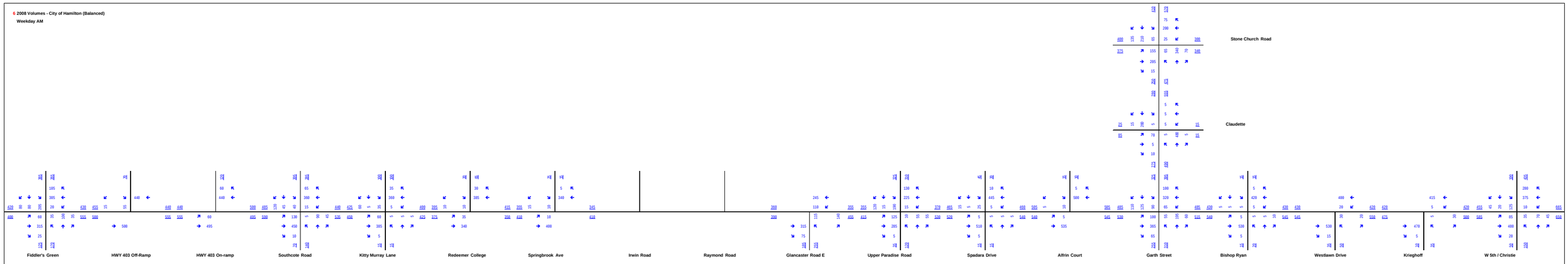


FIGURE 11
POR 6 BARRIER
2.4m HIGH OPTION

APPENDIX B: SAMPLE CALCULATIONS AND TRAFFIC DATA



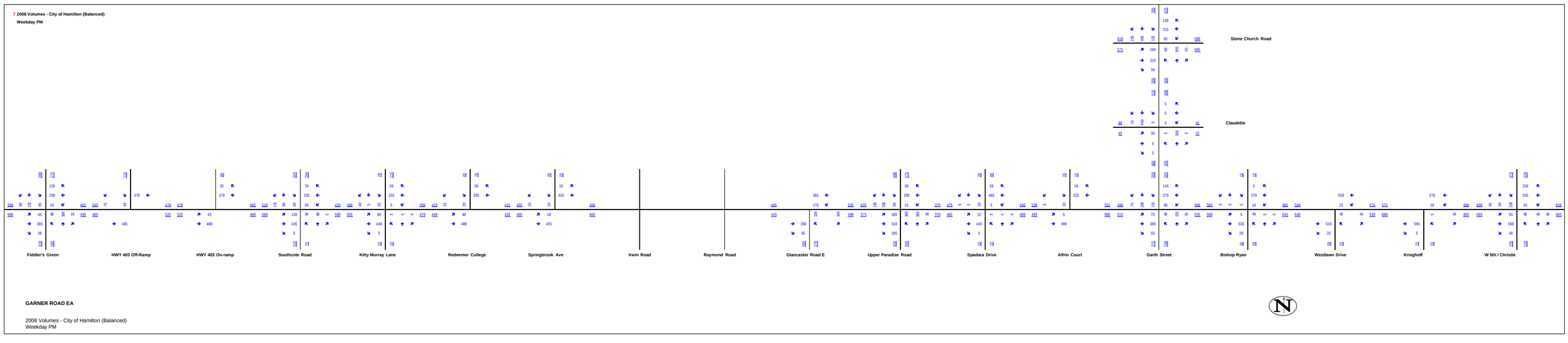
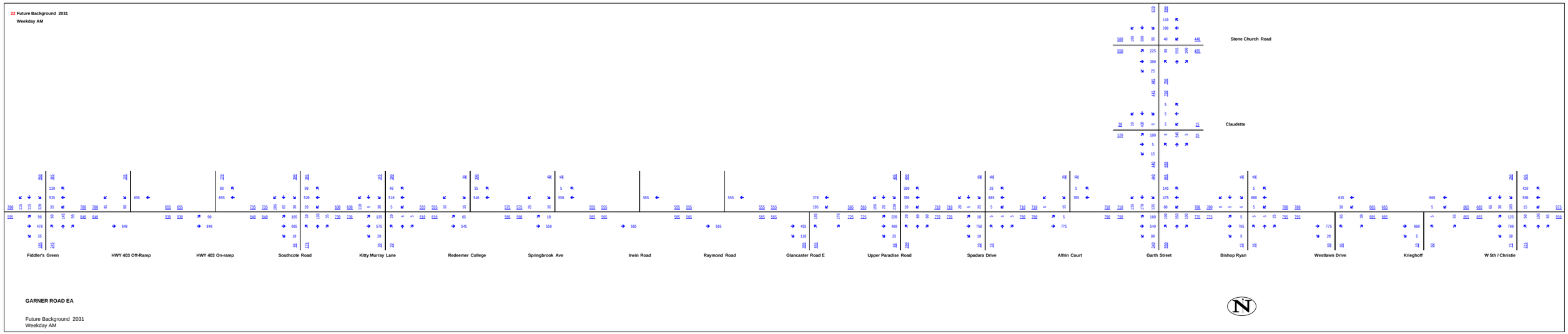


Figure 1 - Existing Traffic Volumes (2008)



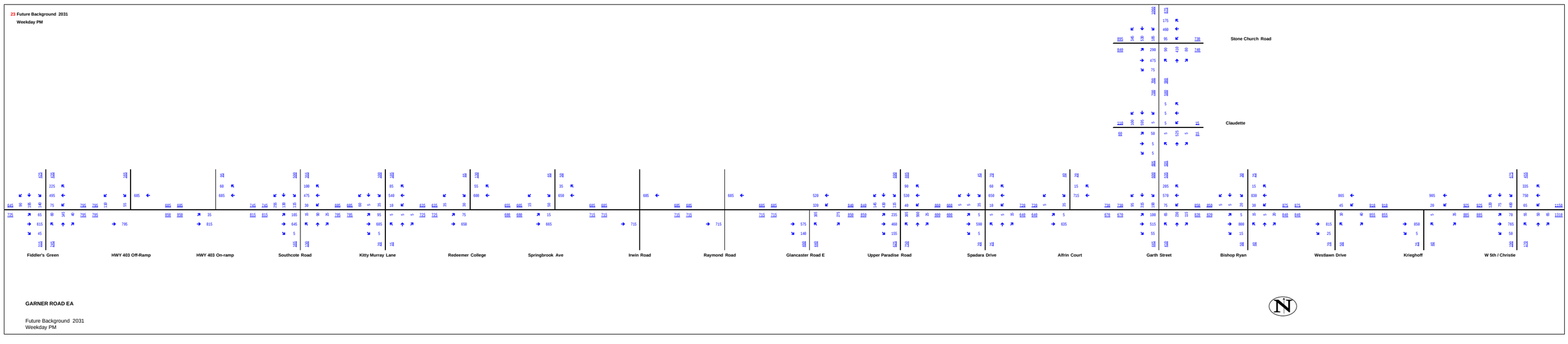
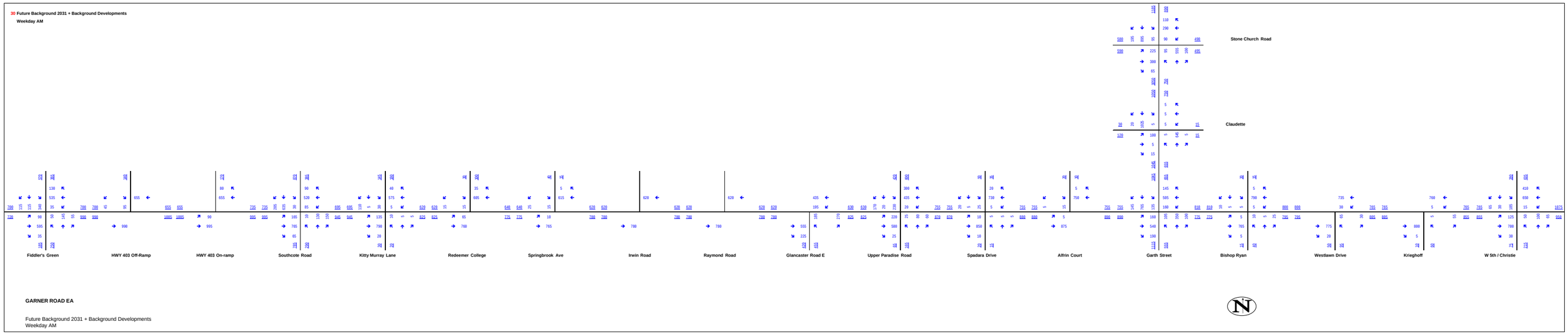


Figure 2 - 2031 Future Background Traffic Volumes (Corridor Growth Only)



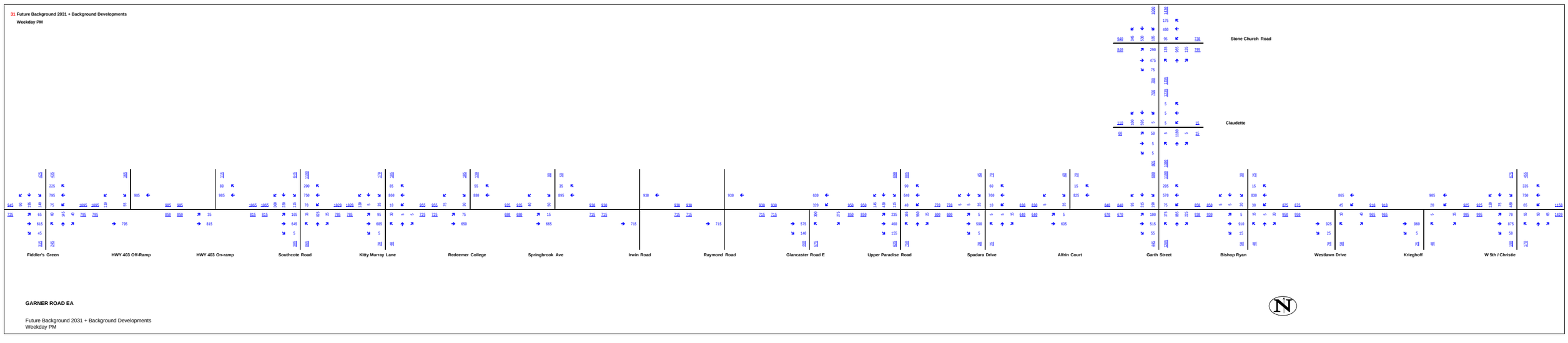
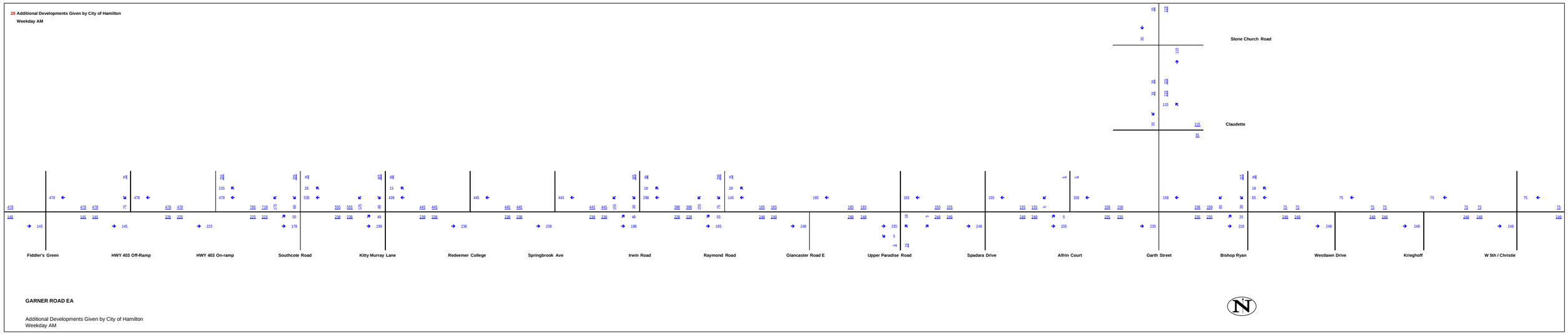


Figure 3 - 2031 Future Background (Balanced to AEGD Volumes)



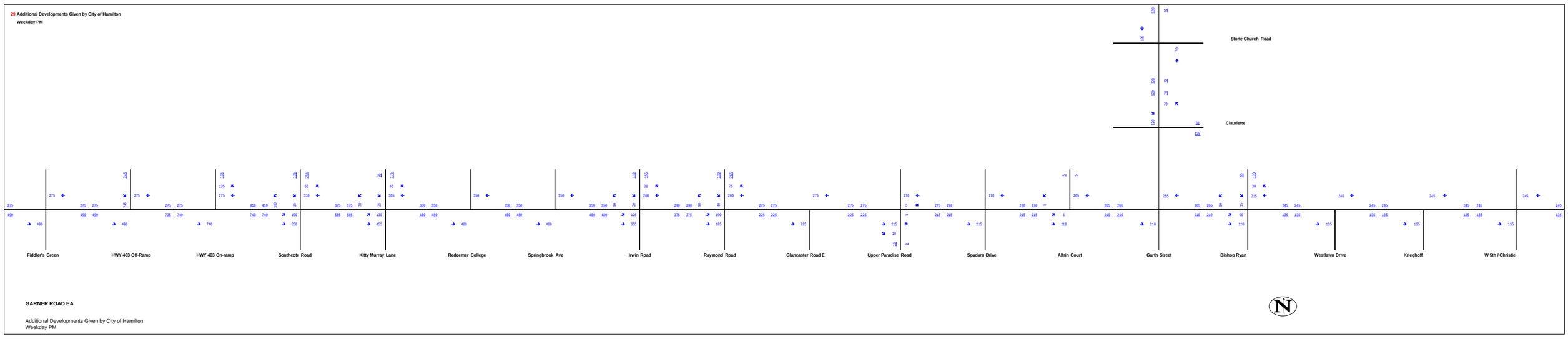
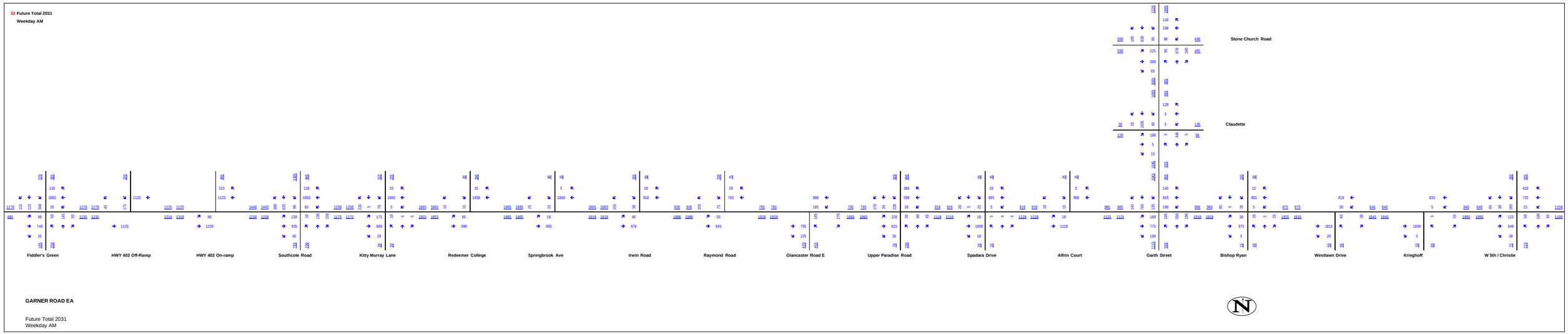


Figure 4 - Site Traffic Volumes - Background Developments (North of Garner Road)



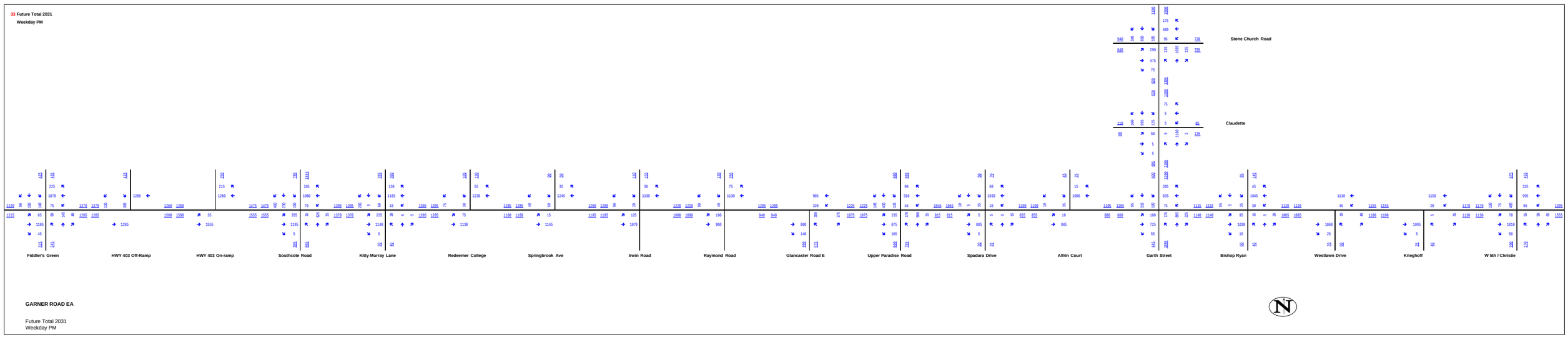


Figure 5 - Future Total Traffic Volumes (2031)

APPENDIX C: GUIDELINES

APPENDIX D: REFERENCES

1. Ministry of the Environment's *STAMSON* Computer Programme (*Version 5.04*).

2. Ministry of Transportation of Ontario, Provincial and Environmental Planning Office "Environmental Guide for Noise," October 2006.

3. Model Municipal Noise Control By-Law, Final Report, Publication *NPC-101* Technical Definitions, Ministry of the Environment, August 1978.

4. Model Municipal Noise Control By-Law, Final Report, Publication *NPC-102* Instrumentation, Ministry of the Environment, August 1978.

5. Model Municipal Noise Control By-Law, Final Report, Publication *NPC-103* Procedures, Ministry of the Environment, August 1978.

6. Model Municipal Noise Control By-Law, Final Report, Publication *NPC-104* Sound Level Adjustments, August 1978.

7. Ministry of the Environment, Sound Levels Due to Road Traffic, Publication *NPC-206*, October 1995.

8. Model Municipal Noise Control By-Law, Final Report, Publication NPC-115, Construction Equipment, August 1978

9. City of Hamilton, Noise Control By-law., Bylaw No. 11-285, November 2011

10. SNC-Lavalin Inc., Garner Road East/Rymal Road West and Garth Street Traffic Study Report, May 16, 2011

APPENDIX D.6

CULTURAL HERITAGE ASSESSMENT REPORT

Cultural Heritage Assessment Report:
Built Heritage Resources and Cultural Heritage Landscapes

Garner /Rymal Road and Garth Street Widening
Environmental Assessment
City of Hamilton, Ontario

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ASI File 10EA-188

September 2010
(October 2010, February 2012, March 2012)

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Cultural Heritage Assessment Report:
Built Heritage Resources and Cultural Heritage Landscapes

Garner /Rymal Road and Garth Street Widening
Environmental Assessment
City of Hamilton, Ontario

EXECUTIVE SUMMARY

Archaeological Services Inc. (ASI) was contracted by the City of Hamilton. The project, at time of writing, extends east from the new Highway Six interchange to West 5th Street along the Garner/Rymal Road corridor . Garth Street, between Rymal Road and Stone Church Road was a later addition to the projects The overall project will consider existing and future transportation issues, surface water drainage requirements, property needs and traffic management options for the Garner/ Rymal Road and Garth Street study area. Three options for this road widening and improvements have been proposed .

The Garner /Rymal Road and Garth Street road widening may have a variety of impacts upon built heritage resources and cultural heritage landscapes. Impacts can include: direct impacts that result in the loss of resources through demolition or alteration, or the displacement of resources through relocation; and indirect impacts that result in the disruption of resources by introducing physical, visual, audible or atmospheric elements that are not in keeping with the resources and/or their setting. Three options have been provided for this undertaking; in general, whilst similar, there are distinct elements to each of the plans. Based on the results of background data collection and a field review, the following recommendations have been developed:

1. At time of writing there were three widening options under consideration: Option 1, Option 2 and Option 2A. Each of these options is broadly similar although, as noted elsewhere, each has unique components that may impact the identified heritage resources in somewhat different ways. Looking to the most serious of the assessed impacts—'removal' of the resource—Option 1 overall presents the most impacts with the most direct impacts, potentially requiring that up to five of the identified resources would be altered or disturbed through removal. Likewise, although Option 2 presents similar numbers (four) of removals there are some alterations to work plans that mean impacts through encroachment of the frontages or with respect to proximity to the resource will be lessened. Option 2A potentially requires one fewer removal (CHL 7) and presents encroachment impacts that are further reduced. In sum, Option 2A (followed by Option 2) provides a work plan that presents the fewest impacts to the identified heritage resources.

2. Road widening plans should be reviewed to best avoid identified cultural heritage resources—notably those four identified cultural heritage resource which may be subject to removal—should be reviewed carefully in order to ensure that there are not equally viable options which would avoid the resource. Of particular note is CHL 7 an historic farm complex where an historic barn may be subject to removal. Ideally, the route of the planned work would be shifted to the south side of the right-of-way, where the impact to an identified cultural heritage resource would be on the scale of encroachment on the frontage and, thus, much reduced. Likewise, the planned activities associated with CHL 4 should be similarly reviewed in order to determine that the path of the planned work could not be removed to the south side of the right of way.

3. For those properties where threats are through encroachment; all work undertaken should be planned to avoid impacts through noise and/or vibrations, especially when in close proximity to the resource(s). Where possible, mature plantings (particularly those marking property lines or other boundary lines) should be avoided as much as possible In instances where the work is carried out in close proximity to a resource protective measures—including but not limited to fencing--should be undertaken .

4. In all instances where cultural heritage resources have been identified road improvement activities should be planned to avoid impacts to t those resources. Where any identified, above ground, cultural heritage resources are to be affected by direct or indirect impacts, further research should be undertaken to identify the specific heritage significance of the affected cultural heritage resource and/or appropriate mitigation measures should be adopted once the final work plan has been chosen from these three alternatives . This may include completing a heritage impact assessment or documentation report, or employing suitable measures such as landscaping, buffering or other forms of mitigation, where appropriate. In this regard, provincial guidelines should be consulted for advice and further heritage assessment work should be undertaken as necessary.

ARCHAEOLOGICAL SERVICES INC.
ENVIRONMENTAL ASSESSMENT DIVISION

PROJECT PERSONNEL

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1.0 INTRODUCTION

Archaeological Services Inc. (ASI) was contracted by the City of Hamilton. At time of writing, the project extends from west of the new Highway Six interchange to West 5th Street along the Garner/Rymal Road corridor. The overall project will consider existing and future transportation issues, surface water drainage requirements, property needs and traffic management options for the Garner/ Rymal Road and Garth Street study area. Three options for this road widening and improvements have been proposed .

The purpose of this report is to present a built heritage and cultural landscape inventory of cultural heritage resources in the study area, identify general impacts to identified cultural heritage resources, and propose appropriate mitigation measures. This research was conducted under the project direction of Rebecca A. Sciarra, Cultural Heritage Specialist.

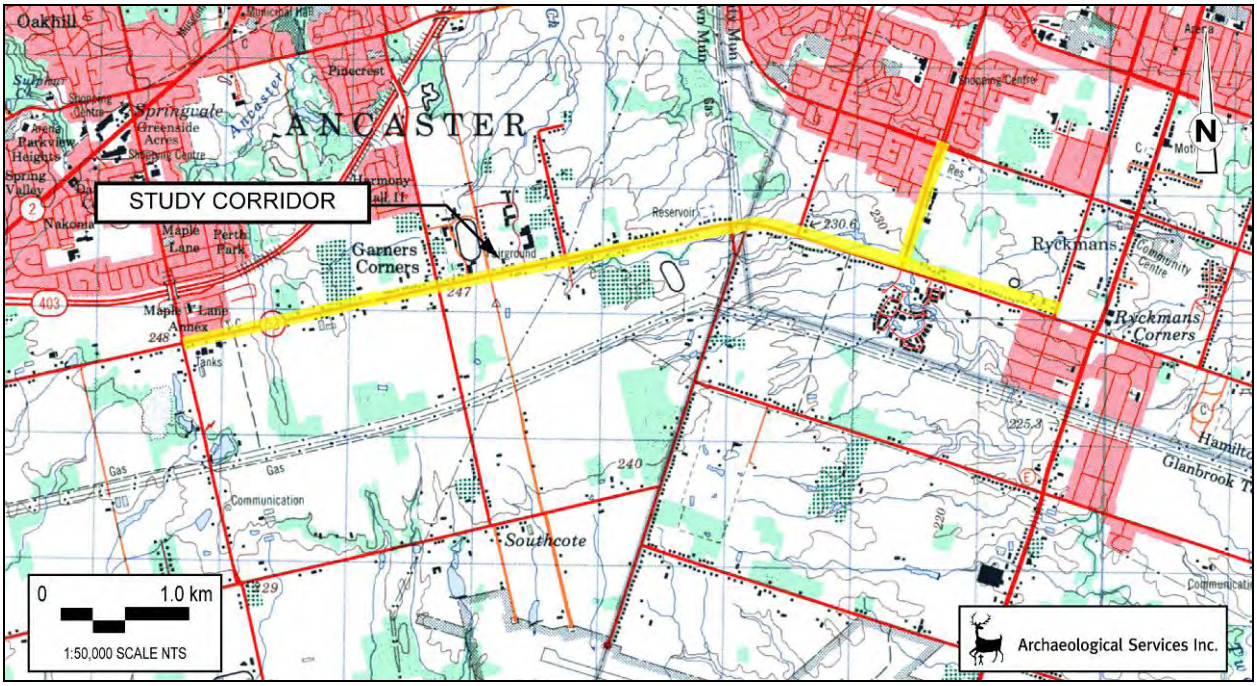

Figure 1: Location of the study area, City of Hamilton.

Base map: NTS Sheet 30 M/04 (Hamilton-Grimsby)

2.0 BUILT HERITAGE RESOURCE AND CULTURAL HERITAGE LANDSCAPE ASSESSMENT CONTEXT

2.1 Approach and Methodology

This cultural heritage assessment considers cultural heritage resources in the context of improvements to specified areas, pursuant to the *Environmental Assessment Act*. This assessment addresses above ground cultural heritage resources over 40 years old. Use of a 40 year old threshold is a guiding principle when conducting a preliminary identification of cultural heritage resources (Ministry of Transportation 2006; Ministry of Transportation 2007; Ontario Realty Corporation 2007). While identification of a resource that is 40 years old or older does not confer outright heritage significance, this threshold provides a means to collect information about resources that may retain heritage value. Similarly, if a resource is slightly younger than 40 years old, this does not preclude the resource from retaining heritage value.

Road improvements have the potential to affect cultural heritage resources in a variety of ways. Impacts can include: direct impacts that result in the loss of resources through demolition, or the displacement of resources through relocation; and indirect impacts that result in the disruption of resources by introducing physical, visual, audible or atmospheric elements that are not in keeping with the resources and/or their setting. Potential impacts on identified cultural heritage resources were identified based on the proximity of a resource to the proposed undertaking.

For the purposes of this assessment, the term cultural heritage resources was used to describe both cultural landscapes and built heritage features. A cultural landscape is perceived as a collection of individual built heritage features and other related features that together form, for example, farm complexes, roadscapes and nucleated settlements. Built heritage features are typically individual buildings or structures that may be associated with a variety of human activities, such as historical settlement and patterns of architectural development.

The analysis throughout the study process addresses cultural heritage resources under various pieces of legislation and their supporting guidelines. Under the *Environmental Assessment Act* (1990) environment is defined in Subsection 1(c) to include:

- cultural conditions that influence the life of man or a community, and;
- any building, structure, machine, or other device or thing made by man.

The Ministry of Tourism and Culture is charged under Section 2 of the *Ontario Heritage Act* with the responsibility to determine policies, priorities and programs for the conservation, protection and preservation of the heritage of Ontario and has published two guidelines to assist in assessing cultural heritage resources as part of an environmental assessment: *Guideline for Preparing the Cultural Heritage Resource Component of Environmental Assessments* (1992), and *Guidelines on the Man-Made Heritage Component of Environmental Assessments* (1981). Accordingly, both guidelines have been utilized in this assessment process.

The Guidelines on the Man-Made Heritage Component of Environmental Assessments (Section 1.0) states the following:

> When speaking of man-made heritage we are concerned with the works of man and the effects of his activities in the environment rather than with movable human artefacts or those environments that are natural and completely undisturbed by man.

In addition, environment may be interpreted to include the combination and interrelationships of human artefacts with all other aspects of the physical environment, as well as with the social, economic and cultural conditions that influence the life of the people and communities in Ontario. The *Guidelines on the Man-Made Heritage Component of Environmental Assessments* distinguish between two basic ways of visually experiencing this heritage in the environment, namely as cultural landscapes and as cultural features.

Within this document, cultural landscapes are defined as the following (Section 1.0):

> The use and physical appearance of the land as we see it now is a result of man's activities over time in modifying pristine landscapes for his own purposes. A cultural landscape is perceived as a collection of individual man-made features into a whole. Urban cultural landscapes are sometimes given special names such as townscapes or streetscapes that describe various scales of perception from the general scene to the

> particular view. Cultural landscapes in the countryside are viewed in or adjacent to natural undisturbed landscapes, or waterscapes, and include such landuses as agriculture, mining, forestry, recreation, and transportation. Like urban cultural landscapes, they too may be perceived at various scales: as a large area of homogeneous character; or as an intermediate sized area of homogeneous character or a collection of settings such as a group of farms; or as a discrete example of specific landscape character such as a single farm, or an individual village or hamlet.

A cultural feature is defined as the following (Section 1.0):

> …an individual part of a cultural landscape that may be focused upon as part of a broader scene, or viewed independently. The term refers to any man-made or modified object in or on the land or underwater, such as buildings of various types, street furniture, engineering works, plantings and landscaping, archaeological sites, or a collection of such objects seen as a group because of close physical or social relationships.

Additionally, the *Planning Act* (1990) and related *Provincial Policy Statement* (*PPS*) make a number of provisions relating to heritage conservation. One of the general purposes of the *Planning Act* is to integrate matters of provincial interest in provincial and municipal planning decisions. In order to inform all those involved in planning activities of the scope of these matters of provincial interest, Section 2 of the *Planning Act* provides an extensive listing. These matters of provincial interest shall be regarded when certain authorities, including the council of a municipality, carry out their responsibilities under the *Act*. One of these provincial interests is directly concerned with:

> 2.0 …protecting cultural heritage and archaeological resources for their economic, environmental, and social benefits.

Part 4.5 of the *PPS* states that:

> Comprehensive, integrated and long-term planning is best achieved through municipal official plans. Municipal official plans shall identify provincial interests and set out appropriate land use designations and policies. Municipal official plans should also coordinate cross-boundary matters to complement the actions of other planning authorities and promote mutually beneficial solutions.
>
> Municipal official plans shall provide clear, reasonable and attainable policies to protect provincial interests and direct development to suitable areas.
>
> In order to protect provincial interests, planning authorities shall keep their official plans up-to-date with this Provincial Policy Statement. The policies of this Provincial Policy Statement continue to apply after adoption and approval of a municipal official plan.

Those policies of particular relevance for the conservation of heritage features are contained in Section 2-Wise Use and Management of Resources, wherein Subsection 2.6 - Cultural Heritage and Archaeological Resources, makes the following provisions:

> 2.6.1 Significant built heritage resources and cultural heritage landscapes shall be conserved.

A number of definitions that have specific meanings for use in a policy context accompany the policy statement. These definitions include built heritage resources and cultural heritage landscapes.

Built heritage resources mean one or more buildings, structures, monuments, installations or remains associated with architectural, cultural, social, political, economic, or military history, and identified as being important to a community.

*Cultural heritage landscape*s mean a defined geographical area of heritage significance that has been modified by human activities. Such an area is valued by a community, and is of significance to the understanding of the history of a people or place. Examples include farmscapes, historic settlements, parks, gardens, battlefields, mainstreets and neighbourhoods, cemeteries, trailways, and industrial complexes of cultural heritage value (*PPS* 2005).

In addition, significance is also more generally defined. It is assigned a specific meaning according to the subject matter or policy context, such as wetlands or ecologically important areas. With regard to cultural heritage and archaeology resources, resources of significance are those that are valued for the important contribution they make to our understanding of the history of a place, an event, or a people (*PPS* 2005).

Criteria for determining significance for the resources are recommended by the Province, but municipal approaches that achieve or exceed the same objective may also be used. While some significant resources may already be identified and inventoried by official sources, the significance of others can only be determined after evaluation (*PPS* 2005).

Accordingly, the foregoing guidelines and relevant policy statement were used to guide the scope and methodology of the cultural heritage assessment.

2.2 Data Collection

In the course of the cultural heritage assessment, all potentially affected cultural heritage resources within the study area are subject to inventory. Short form names are usually applied to each resource type, (e.g. barn, residence). Generally, when conducting a preliminary identification of cultural heritage resources, three stages of research and data collection are undertaken to appropriately establish the potential for and existence of cultural heritage resources in a particular geographic area.

Background historic research, which includes consultation of primary and secondary source research and historic mapping, is undertaken to identify early settlement patterns and broad agents or themes of change in a study area. This stage in the data collection process enables the researcher to determine the presence of sensitive heritage areas that correspond to nineteenth and twentieth century settlement and development patterns. To augment data collected during this stage of the research process, federal, provincial, and municipal databases and/or agencies are consulted to obtain information about specific properties that have been previously identified and/or designated as retaining cultural heritage value. Typically, resources identified during these stages of the research process are reflective of particular architectural styles, associated with an important person, place, or event, and contribute to the contextual facets of a particular place, neighbourhood, or intersection.

A field review is then undertaken to confirm the location and condition of previously identified cultural heritage resources. The field review is also utilized to identify cultural heritage resources that have not been previously identified on federal, provincial, or municipal databases.

Several investigative criteria are utilized during the field review to appropriately identify new cultural heritage resources. These investigative criteria are derived from provincial guidelines, definitions, and past experience. A built structure or landscape is identified as a cultural heritage resource that should be considered during the course of the environmental assessment. A resource will be considered if it is 40 years or older[1], and if the resource satisfies at least one of the following three categories:

Design/Physical Value:

- It is a rare, unique, representative or early example of a style, type, expression, material or construction method
- It displays a high degree of craftsmanship or artistic merit
- It demonstrates a high degree of technical or scientific achievement
- The site and/or structure retains original stylistic features and has not been irreversibly altered so as to destroy its integrity

Historical/Associative Value:

- It has a direct association with a theme, event, belief, person, activity, organization, or institution that is significant to: the City of Hamilton; the Province of Ontario; Canada; or the world heritage list
- It yields, or had the potential to yield, information that contributes to an understanding of: the City of Hamilton; the Province of Ontario, Canada; or the world heritage list
- It demonstrates or reflects the work or ideas of an architect, artist builder, designer, or theorist who is significant to: the City of Hamilton, the Province of Ontario; Canada; or the world heritage list

Contextual Value:

- It is important in defining, maintaining, or supporting the character of an area
- It is physically, functionally, visually, or historically linked to its surroundings
- It is a landmark
- It illustrates a significant phase in the development of the community or a major change or turning point in the community's history
- The landscape contains a structure other than a building (fencing, culvert, public art, statue, etc.) that is associated with the history or daily life of that area or region
- There is evidence of previous historic and/or existing agricultural practices (e.g. terracing, deforestation, complex water canalization, apple orchards, vineyards, etc.)

If a resource meets one or more of the categories, it will be identified as a cultural heritage resource and is subject to further research where appropriate and when feasible. Typically, further historical research and consultation is required to determine the specific significance of the identified cultural heritage resource.

When identifying cultural heritage landscapes, the following categories are typically utilized for the purposes of the classification during the field review:

[1] Use of a 40 year old threshold is a guiding principle when conducting a preliminary identification of cultural heritage resources (Ministry of Transportation 2006; Ministry of Transportation 2007; Ontario Realty Corporation 2007). While identification of a resource that is 40 years old or older does not confer outright heritage significance, this threshold provides a means to collect information about resources that may retain heritage value. Similarly, if a resource is slightly younger than 40 years old, this does not preclude the resource from retaining heritage value.

Farm complexes:	comprise two or more buildings, one of which must be a farmhouse or barn, and may include a tree-lined drive, tree windbreaks, fences, domestic gardens and small orchards.
Roadscapes:	generally two-lanes in width with absence of shoulders or narrow shoulders only, ditches, tree lines, bridges, culverts and other associated features.
Waterscapes:	waterway features that contribute to the overall character of the cultural heritage landscape, usually in relation to their influence on historic development and settlement patterns.
Railscapes:	active or inactive railway lines or railway rights of way and associated features.
Historical settlements:	groupings of two or more structures with a commonly applied name.
Streetscapes:	generally consists of a paved road found in a more urban setting, and may include a series of houses that would have been built in the same time period.
Historical agricultural Landscapes:	generally comprises a historically rooted settlement and farming pattern that reflects a recognizable arrangement of fields within a lot and may have associated agricultural outbuildings, structures, and vegetative elements such as tree rows;
Cemeteries:	land used for the burial of human remains.

Results of data collection are contained in Section 3.0; while Sections 4.0 and 5.0 contain conclusions and recommend mitigation measures with respect to the undertaking.

3.0 BUILT HERITAGE RESOURCE AND CULTURAL HERITAGE LANDSCAPE ASSESSMENT

3.1 Introduction

This section provides a brief summary of historic research and a description of identified above ground cultural heritage resources that may be affected by the proposed Garner/ Rymal Road and Garth Street corridor. A review of available primary and secondary source material was undertaken to produce a contextual overview of the study area, including a general description of Euro-Canadian settlement and land-use. Historically, the study area is located in the Townships of Ancaster, Barton and Glanford. This area is now part of the City of Hamilton, Ontario.

3.2 Township Survey and Settlement

3.2.1 City of Hamilton

This section provides a brief summary of historic research for the study area. A review of available primary and secondary source material was undertaken to produce a contextual overview of the study area, including a general description of Euro-Canadian settlement and land-use.

Although the study area falls within the present-day limits of the City of Hamilton, historically it was associated with the Townships of Ancaster, Barton and Glanford and, thus, the early settlement and development of these townships is important in understanding the cultural heritage resources

The land within Ancaster Township was acquired by the British from the Mississaugas in 1784. The first township survey was undertaken in 1793, and the first legal settlers occupied their land holdings two years later. The township is said to have been named after a town in Lincolnshire, England. Ancaster was initially settled by disbanded soldiers, mainly Butler's Rangers, and other Loyalists following the end of the American Revolutionary War. In 1805, Boulton noted that this township contained both excellent and indifferent soils. By the 1840s, the township was noted for its fine farms (Boulton 1805:79; Smith 1846:6; Armstrong 1985:141; Rayburn 1997:11).

The land within Barton Township was acquired by the British from the Mississaugas in 1784. The first township survey was undertaken in 1791, and the first legal settlers occupied their land holdings the same year. The township is said to have been named after Barton upon Humber in Lincolnshire, England. Barton was initially settled by disbanded soldiers, mainly Butler's Rangers, and other Loyalists following the end of the American Revolutionary War. By the 1840s, the township was noted for its good farms and soil (Smith 1846:8; Burkholder 1956; Armstrong 1985:141; Rayburn 1997:24).

The land within Glanford Township was acquired by the British from the Mississaugas in 1784. The first township survey was undertaken in 1794, and the first legal settlers occupied their land holdings in the same year. The township is said to have been named after a town called Glanford Brigg in Lincolnshire, England. Glanford was initially settled by disbanded soldiers, mainly Butler's Rangers, and other Loyalists following the end of the American Revolutionary War. In 1805, Boulton noted that Glanford contained good soil, and only required time to render it a valuable township. By the 1840s, the township was noted for its good farms and "a mixed population" (Boulton 1805:79; Smith 1846:63; Armstrong 1985:143; Rayburn 1997:134).

3.2.2 Nineteenth Century Historic Map Review

This section provides a brief summary of historic research and a description of identified above ground cultural heritage resources that may be affected by the proposed improvements along the Garner/ Rymal Road and the Garth Street corridor. A review of available primary and secondary source material was undertaken to produce a contextual overview of the study area, including a general description of Euro-Canadian settlement and land-use.

Historically, the study area was located on Lots 46 to 51, between the road allowance for Concession III and IV, in the former Township of Ancaster, Lots 16 to 21, Concession VIII, in the former Township of Barton, and Lots 1 to 4, Concession I, in the former Township of Glanford (Figures 2 to 4). Garner Road/Rymal Road and Garth Street are all historically surveyed thoroughfares. The available data gathered from the historic atlas is summarized in Table 1. It should be noted, however, that not all features of interest were mapped systematically in the Ontario series of historical atlases, given that they were financed by subscription, and subscribers were given preference with regard to the level of detail provided on the maps. Moreover, not every feature of interest would have been within the scope of the atlases.

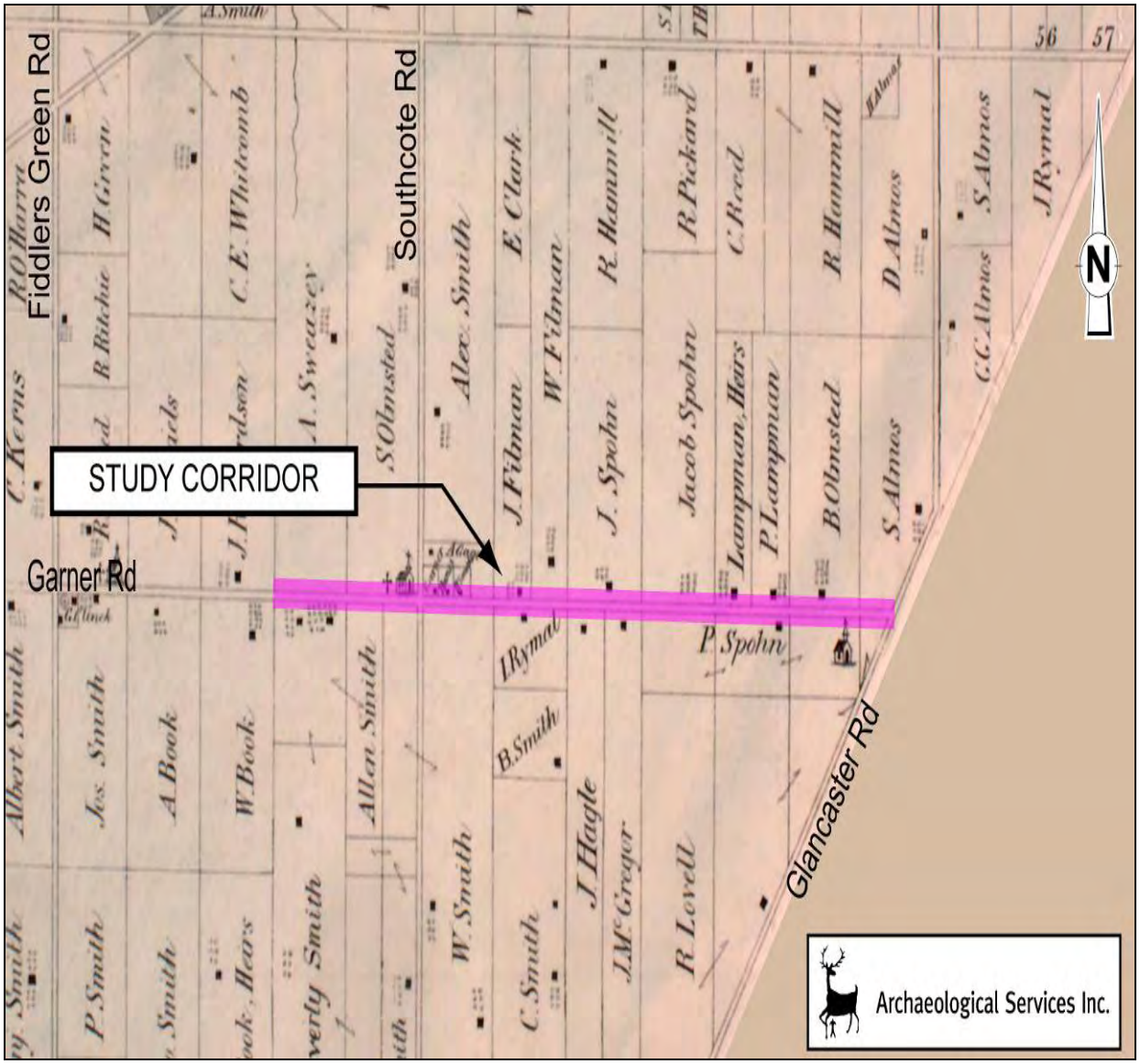

Figure 2: A portion of the study area overlaid on the map of the Township of Ancaster.
Base Map: 1875 *Illustrated Historical Atlas of the County of Wentworth*

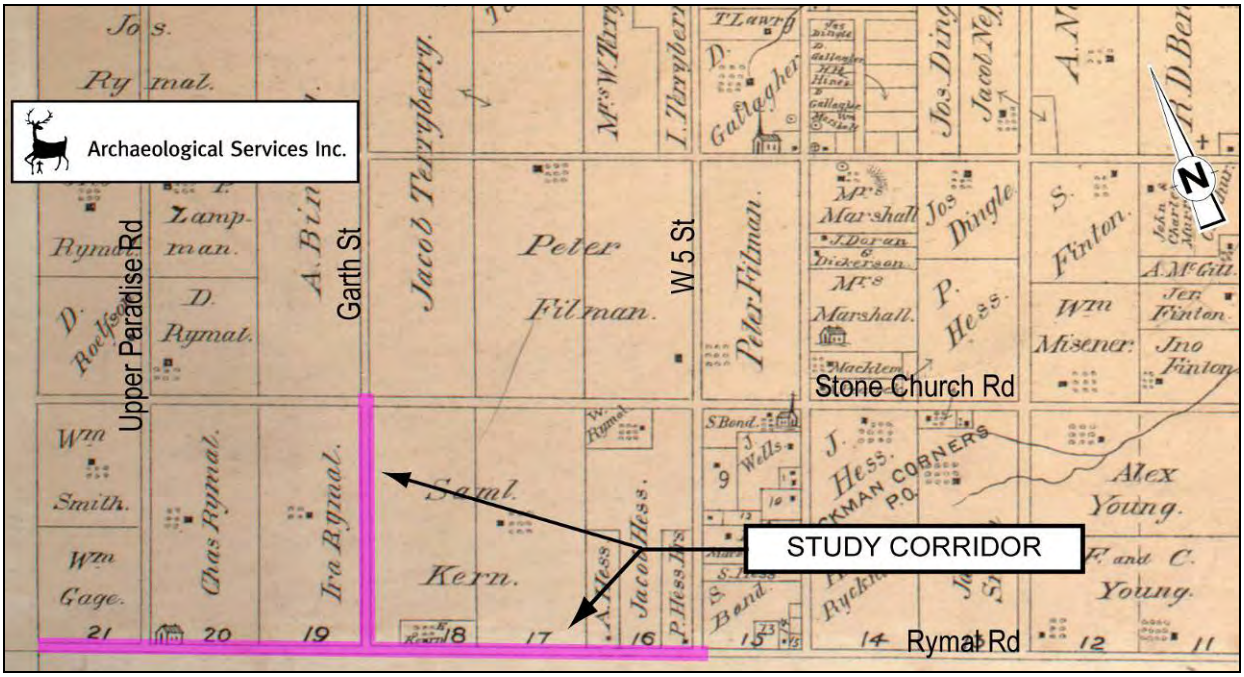

Figure 3: A portion of the study area overlaid on the map of the Township of Barton.
Base Map: 1875 *Illustrated Historical Atlas of the County of Wentworth*

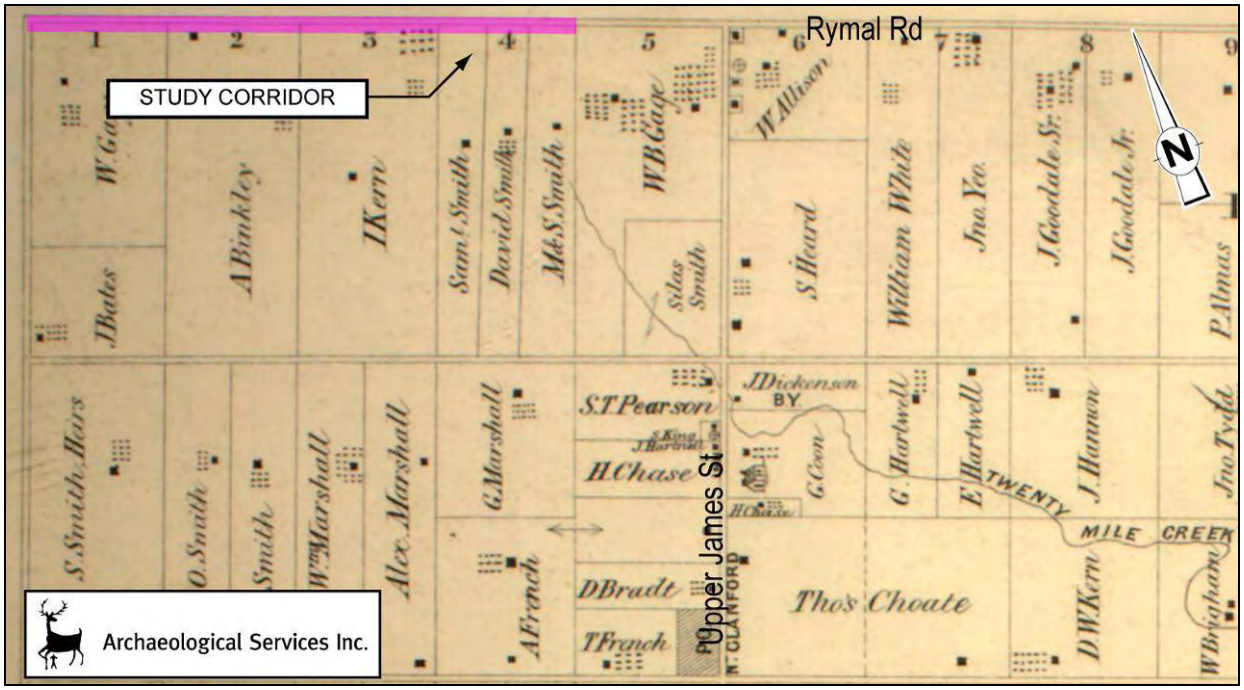

Figure 4: A portion of the study area overlaid on the map of the Township of Glanford.
Base Map: 1875 *Illustrated Historical Atlas of the County of Wentworth*

Table 1: Historical Property Owners Illustrated within or adjacent to the study area

Lot	Conc.	Property Owner	Historic Feature
Township of Ancaster			
46	III	A. Sweazey	
47		S. Olmstead	Church, cemetery
48		Garner Hanes H. Smith A. Gage	Homestead Homestead Homestead
49		J. Filman W. Filman	Homestead, orchard
50		J. Spohn	Homestead, orchard
51		Jacob Spohn	Orchard
52		Lampman Estate P. Lampman	Homestead, orchard Homestead, orchard
53		B. Olmsted	Homestead, orchard
54		S. Almos	
46	IV	Alan Smith	2 homesteads, 2 orchards
47		Alan Smith William S. Smith	
48		William S. Smith	
49		I Rymal	Homestead
50		J. Hagle J. McGregor	Homestead Homestead
51		P. Spohn	
52		P. Spohn	
53		P. Spohn	Church
Township of Barton			
16	VIII	P. Hess Jacob Hess A. Hess	Homestead Homestead
17		Samuel Kern	
18		Isaiah Kern Samuel Kern	Orchard
19		Ira Rymal	
20		Charles Rymal	School House
21		William Gage	
Township of Glanford			
1	I	W. Gage	
2		Aley Binkley	Homestead
3		I. Kern	Orchard
4		Samuel Smith David Smith M & S Smith	

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3.3 Existing Conditions

In order to make a preliminary identification of existing built heritage resources and cultural heritage landscapes within the study area, a number of municipal resources were consulted. The City of Hamilton Register of Property of Cultural and Historical Interest and the City of Hamilton Heritage Inventories, which includes both designated and non-designated properties, were consulted.

A review of the inventories of designated properties revealed that there are no properties which are designated under Part IV or Part V of the Ontario Heritage Act within the vicinity of and in the study area. A review of the City of Hamilton Heritage Register revealed that are also no non-designated properties of heritage interest in the vicinity of the study area within the City limits.

A field review was undertaken by Lindsay Popert and Mary-Cate Garden, ASI in September 2010 to document the existing conditions of the study area. The field review revealed that Garner Road East/ Rymal Road West is a busy east-west thoroughfare. Garner Road East and Rymal Road West join at Glancaster Road which runs south from this intersection. Garth Street, which intersects with Rymal Road, is a busy north-south thoroughfare with new subdivisions on both sides. The streetscape of Garth Street is wholly modern and is characterised by late twentieth century/early twenty-first century residences and subdivisions. The present-day appearance of the Garner Road/Rymal Road area ranges from late nineteenth and early twentieth-century residences and farmsteads to recent residential subdivisions and commercial enterprises (including malls). The western section, closest to the Highway Six interchange is much more rural and includes some working farms and barns with smaller early to mid-twentieth century small scale residences in between. Towards the east, particularly east of the intersection of Glancaster where Rymal Road and Garner Road meet, the area becomes more densely settled with a number of modern subdivisions (some currently under construction) and malls in the section nearest West 5th Street.

A total of nine cultural heritage landscapes and sixteen built heritage resources were identified within the study area. Table 2 provides a list of identified cultural heritage resources, which includes a photograph and brief description of the resource. Section 6.0 provides location mapping of identified cultural heritage resources.

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-1 Residence	378 Garner Road E	This 2½ storey brick, gabled nineteenth century residence sits on a slight rise above the road. Roofed in asphalt with a single dormer, the upper half storey and dormer are clad with synthetic siding. There is a single internal chimney at the gable end. The house has two ground-floor porches; both have poured concrete steps and gable roofs. The foundation is stone. The windows are modern. Front elevation window openings on the ground floor are half-round arches. A small frame outbuilding is also located on this property. Mature plantings are largely confined to the rear and sides of the property. This structure is set back from the road.	Identified during field review	
BHR-2 Residence	443 Garner Road E	This dwelling consists of a small scale, single storey house. Dating to the early twentieth-century residence is the most westerly of a number of similar structures located along Garner Road East. Clad with synthetic siding , the structure has a small extension located on the east side. The gable roof is steeply pitched and has a single forward-facing dormer. A small frame garage with gable roof is located at the end of the driveway. The house sits on a small rise on an otherwise level property. Mature plantings are found along the drive at the road. (c.f., BHR 3 & 4). The house is set back from Garner Road East.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-3 Residence	453 Garner Road East	Similar to the above property this residence consists of a 1½ storey house and single storey extension set back from the road. Both have gable roofs. The house is clad in synthetic siding and all the windows have been replaced. There is a single internal chimney located at the rear. The foundation is not visible. There is a small rear yard but no outbuildings were identified on this property. This house is close to the road with mature plantings limited to the rear of the property. (c.f. BHR 2 & 4)	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-4 Residence	459 Garner Road East	This single storey dwelling is part of a line of similar structures (c.f., BHR 2 & 3). Although each of these properties were classified as built heritage resources due to the amount of infill between the individual properties they were precluded from inclusion as a cultural heritage landscape. These built heritage resources were most in evidence between in the stretch of road between 443 Garner Road East and 509 Garner Road East. These built heritage resource are typical of the early twentieth century character of Garner Road East. A single storey building with gabled roof and clad in synthetic siding, the house sits on a rusticated concrete block foundation. A single story extension is found at the rear. All of the windows on this structure are modern. A mature deciduous tree sits at the junction of the driveway and the road, whilst mature conifers are found along the western edge of the property.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-5 Residence	581 Garner Road East	This structure sits amid a commercial enterprise known as Bud's Pool and Spa; it no longer appears to be a residence. The structure has been remodelled considerably but likely dates to the nineteenth century. Consisting of a 1½ storey building with a gabled roof and dormer, this residence has a large two storey rear extension. The house has been recently modified and has modern windows—including ground-floor bay windows—a synthetic siding and a concrete stoop with a wooden porch. A modern outbuilding sits at the rear. This property is located adjacent to the road.	Identified during field review	
BHR-6 Residence	681 Garner Road E	This early twentieth-century property includes a 1½ storey house and detached garage. The house is gabled roof with a large projecting gable/ bay on the front elevation. A single external (bottom is partially enclosed) chimney stack is located on the front. All windows are modern and the house itself is clad in synthetic siding. The detached garage has a gambrel roof and is wood-clad. The doors on the garage are new but the building is older (contemporaneous with house?). A mature apple tree and other mature plantings are located in close proximity to the road	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-7 Residence	716 Garner Road E	This large-scale, mid-nineteenth century residence sits above and set back from the road; it appears that Garner Road has been cut through and now sits at a lower level than this property. A 2 storey Italianate buff-coloured brick house, it consists of a hipped roof with flat central area and stacked bay windows also with hipped roofs. The main roof has large overhanging eaves with decorative fascia with brackets. The ground floor porch appears to be original with hipped roof and gingerbread trim. Doors and windows all appear to be original including sidelights and fanlights on main door and the 'suicide door' on the second floor. The property includes mature plantings directly in front of the house and along the east side of the property and driveway.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-8 Residence	792 Garner Road E	This dwelling consists of a small, single storey stucco structure and a small single storey gabled garage. The dwelling most likely dates to the early part of the twentieth century. The hipped roof is clad in asphalt shingles and features a shed dormer. There is a single external brick chimney stack. The house sits on a rusticated concrete block foundation. The front porch is comprised of poured concrete steps and rusticated concrete blocks. All visible windows are modern as is the front door; however, the door frame/ configuration may be older. There are a number of mature plantings located back from the road near the house.	Identified during field review	
BHR-9 Residence	819 Garner Road E	This property consists of a 2 storey, brick house with a gambrel roof. Located on a corner lot, the house is aligned with the gable end facing onto Garner Road. The house features an asphalt shingled roof with a shed dormer on the gable end. A two storey extension/ projecting bay is located at the rear of the west elevation. A newer single storey frame addition with a shed roof has been added to this extension. The overhanging eaves of the main roof form the roof of the front porch. The main door and all visible windows appear to be modern. This structure and some mature conifers sit adjacent to Garner Road	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-10 Residence	1009 Garner Road E	This small-scale 1½ storey, early twentieth century structure is located behind a screen of mature conifers and set back from the road. The dwelling is clad with synthetic siding and features a gabled roof with asphalt shingles and an eyebrow dormer. The house sits on a rusticated concrete block foundation and features a projecting bay on the front elevation. Windows on the front elevation appear to be older but may not be original to the house. Mature plantings line the driveway	Identified during field review	
BHR-11 Residence	975Garner Road E	Similar to a number of twentieth century properties located to the east (c.f. BHR 2-4), this 1½ storey brick structure presents a gabled roof with gabled dormer and projecting porch/bay. The front elevation features stone window sills and decorative stonework around the door. The house sits on a rusticated concrete block foundation. An external brick chimney stack is located on the east elevation. A small gable roofed garage sits adjacent to the dwelling. The house is set back from the road with a few mature conifers at the front and side of property.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-12 Residence	1021 Garner Road E	This property consists of a 1½ storey, stone house and single storey addition with a detached garage and frame outbuilding with a hip roof. The garage is modern and clad in board and batten. Both the house and the garage are set back from the road. Constructed of fieldstone with darker cut-stone quoins, the house retains many original features including all visible windows, porch and door and fanlight/sidelight configuration. The glass in these lights and in the main door both appear to be modern. The east elevation features 9/6 sash windows with decorative brick flat arches. The roof of the porch appears to be original with a dentilled cornice and pediment. The house features a gable roof, clad with asphalt shingles. Two mature, deciduous trees are located in the front of the property: one adjacent to the house and, a second, located on the road.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-13 Residence	1157 Garner Road E	A small-scale 1½ storey house, this gabled house sits back from the road on a slight rise. It appears that this structure may be older—dating to the very late nineteenth or early twentieth century— but modern elements including new windows and a modern porch suggest that it has undergone remodelling. There is a single external brick chimney stack on the east elevation. A large gabled barn sits to the rear of the house; however, it is unclear whether this structure is associated with the house.	Identified during field review	
BHR-14 Residence	723 Rymal Road W	A regency-style structure, this brick dwelling sits in the midst of a parking lot on a small rise. Concrete steps lead from the parking lot to front door. The property retains most of its original features including 6/6 sash windows on the front elevation, fanlight and sidelights. The front door has been replaced and a modern security door has been cut into the rear elevation. Windows on the front elevation are capped with a jack arch and the door with a segmental arch. This property may be part of the c. 1854 'Sanitorium Road' complex which was located on this site.	City of Hamilton Inventories (vol 2 and 3)	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-15 Public Building	634 Rymal Road West	Located at the corner of Rymal Road and Upper Paradise Road, the 'School Union' structure sits on a rise above the road. This rise of land, with a line of mature, established trees along Rymal Road appears to be early or original topography. In particular, the arrangement of trees, topography and mature trees suggests that this is a remnant landscape with evidence of original circulation routes. Constructed of red brick, this building has multiple projecting porches/bays. This Arts and Crafts style structure features decorative brickwork on the upper half of the front elevation. Two wooden porches are located at each of the two front doors with an external chimney stack sitting between them. Above these doors is a date stone inscribed "UNION/No 3/ABG 1927". A modern, one storey flat roofed extension has been built out from the east elevation. The bell tower and bell are both extant.	City of Hamilton Inventories (vol 2)	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
BHR-16 Residence	1268 West 5th Street	Located at the corner of West 5th St and Rymal Road West, this house faces onto Rymal Road although it is slightly misaligned with the grid. A 1½ storey structure dating to the nineteenth century, this gothic-style dwelling has been modified. This steep gabled roof features a single gabled dormer. The house is stuccoed with stone quoins and decorative stone work around windows on the front elevation. There are no established trees on this site; plantings are limited to modern shrubs and ornamental conifers.	Identified during field review	
CHL-1 Farm Complex	389 Garner Road E	This property comprises a 2½ storey brick house with gabled roof, at least two large barns, concrete silo, a drive shed, a small frame outbuilding and an intact farm yard landscape. The large house features a gable dormer and front porch with shed roof. All the barns possess gabled roofs and the large barn sits on a field stone foundation. The property is heavily planted with mature deciduous trees and the driveway is lined with mature conifers.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-2 Farm Complex	474 Garner Road East	This property consists of a nineteenth century brick house, large barn and a small frame outbuilding. The house and outbuilding are set well back from the road and are screened from view by mature mixed plantings including an apple tree located at the front of the property. This 2 storey, brick structure has a gabled roof with a forward facing gable. The house and front porch sit on a rusticated concrete block foundation. The dwelling possesses a large brick porch built onto a rusticated brick with an horseshoe arch opening.	Identified during field review	
CHL-3 Cemetery	Southcote Road at Garner Road East	Located at the corner of Garner Road E and Southcote Road, this property is set back from both roads. The property is bordered by brush on two sides and separated from Southcote Road by a ditch. Known as 'Garner's Corners Cemetery' this cemetery is still in use with new stones at front (east) and older stones located at the back. A sign dates the cemetery to 1842 while the City of Hamilton's heritage inventories note that the deed to property was held from 1831.	City of Hamilton Heritage Inventories (vol. 6)	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-4 Farm Complex	701 Garner Road E	This property features a two storey, gable roofed house; a small detached garage; a remnant agricultural landscape and the remains of a demolished barn. The house and the garage are both clad with synthetic siding. The dwelling is aligned with the gable end towards Garner Road. The roof presents a forward and rear facing gable dormers. There is a single internal chimney located at the rear gable end. All visible windows are modern. Two mature apple trees line the road and a large mature conifer is sited adjacent to the house	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-5 Church and Cemetery	880 Garner Road E	This property comprises the Bowman United (Methodist) Church, attached cemetery and parking lot. The 1881 church sits adjacent to the road and is accessible via a set of concrete steps. The cemetery sits level with the church suggesting that the current road has been cut through. The church is a brick structure with gabled roof and gothic arched windows. A small brick porch with gabled roof is attached to the front elevation. At the rear, is a one storey extension clad with synthetic siding. A date stone located above the porch is inscribed "M.C .of C. /Bowman Church/ 1881". The front gable end has decorative brick work beneath the eaves. Surrounding the church on three sides is a medium-sized cemetery which dates to 1803 and has a sign denoting it as a "United Empire Loyalist Burial Site". The cemetery is unfenced with plantings along the south limits, a wood fence on the west and a modern wrought iron fence between it and the parking lot. The cemetery is separated from the road by a cement sidewalk and railing. The cemetery appears to be open with newer stones located near the front and older stones dating to the early nineteenth century are located to the south/ rear of the cemetery.	City of Hamilton Heritage Inventories (vol. 6)	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-6 Farm Complex	910 Garner Road E	This complex consists of a 2 story house, a barn and a small one storey outbuilding/ garage The house and property are partially screened from view by mature plantings which sit along the road. The dwelling, which dates to the nineteenth century, is clad with synthetic siding and features a gable roof clad with metal .The front porch is similarly roofed. All visible windows are modern as is the front door and the glass in the sidelights. The barn, located to the rear of the property is metal clad. Mature deciduous plantings sit along the road.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-7 Farm Complex	927 Garner Road E	Consisting of a large scale house set well back from the road, the property also includes: at least three large barns located along Garner Road and outbuildings. The dwelling is a 2 storey, nineteenth century, brick structure with a steeply pitched, hipped roof with large overhanging eaves. The roof is clad in asphalt shingles and features a forward facing dormer. The house is screened from view by densely planted mature deciduous trees. These barns are located adjacent to Garner Road. The largest barn is banked and sits on a fieldstone foundation. The smaller barns appear to be sitting on a sill or pad—neither of which is visible. The barns are painted red and possess gable roofs. The barnyard is fenced along the road with a modern post and wire fence.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-8 Industrial/ Commercial Complex	944 Garner Road E	Bennett's Apple and Cider is a complex of a cider mill, small barn, house and farm market shop. A small parking lot lies between the shop, the mill and the barn. The market shop consists of a gable roofed barn with shed roof additions on both the front and rear elevations. The dwelling consists of an Edwardian-style two storey brick house and presents a hipped roof and two external chimney stacks—both stacks are unusually tall. There is forward-facing shed dormer and a projecting bay on the west side of the house. Both the windows and the door appear to be original. The front elevation possesses a brick porch and the rear elevation has an enclosed single story extension/closed in porch with a flat roof. Located to the rear of the shop and the house are two more buildings: a small barn and a cider mill. The barn, which is the smaller of the two buildings, has a gambrel roof and two large doors on the front elevation. The cider mills is a larger but otherwise a very similar, structure to the barn.	Identified during field review	

Table 2: Identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Feature & Feature Type	Location	Description/Comment	Recognition and Reference(s)	Photo
CHL-9 Farm Complex	1038 Garner Road East	This property consists of a 2 storey, brick house dating to the nineteenth century and a collection of small outbuildings and barns. The barns, some of which are in poor condition, are difficult to see from the road. The house is well set back from the road with mature deciduous plantings along the road and on the front lawn. This gable roofed structure has large projecting shed dormers on the front and rear elevations. A ground floor porch runs the length of the building. There is gingerbread trim on the porch; both the porch and the trim may be original to the house construction. The ground floor windows appear to be modern; however, dormer windows present with 6/6 panes and may be older.	Identified during field review	

3.4 Impact Assessment

The field review confirmed that the study area runs through landscapes which should be viewed as sensitive heritage areas and, as such, appropriate mitigation measures for the undertaking will need to be considered. Garner and Rymal Roads are historic thoroughfares and, in areas immediately west of the western terminus of the study corridor, the road has retained many of its nineteenth and early twentieth-century characteristics. The study corridor as a whole represents a landscape which has evolved from rural, agricultural properties to periurban settlements. The identified cultural heritage resources range from the mid-nineteenth century through to the mid-twentieth century. Even in the latter instances, many

of the early lots have retained their early boundaries. The widening of the road will require property adjacent to both the north and south of the current right-of-way.

Three alternatives have been proposed for this road widening project. Each of the three alternatives is similar (c.f. Appendix B) although distinct meaning that there are unique impacts that may occur. Each of the identified cultural heritage resources was applied, initially, against the three alternatives in order to identify direct or indirect impacts. These are collected in tabular form (c.f. Appendix A). These are initial evaluations undertaken to assess and compare impacts across each of the alternatives.

Where any identified, above ground, cultural heritage resources to be affected by direct or indirect impacts, appropriate mitigation measures should be developed. This may include completing a heritage impact assessment or documentation report, or employing suitable measures such as landscaping, buffering or other forms of mitigation, where appropriate. In this regard, provincial guidelines should be consulted for advice and further heritage assessment work should be undertaken as necessary.

To assess the potential impacts of the undertaking, identified cultural heritage resources were considered against a range of possible impacts as outlined in the Ministry of Tourism and Culture document entitled *Screening for Impacts to Built Heritage and Cultural Heritage Landscapes* (September 2010), which include:

- Destruction of any, or part of any, significant heritage attribute or feature (III.1).
- Alteration which means a change in any manner and includes restoration, renovation, repair or disturbance (III.2).
- Shadows created that alter the appearance of a heritage attribute or change the visibility of a natural feature of plantings, such as a garden (III.3).
- Isolation of a heritage attribute from it surrounding environment, context, or a significant relationship (III.4).
- Direct or indirect obstruction of significant views or vistas from, within, or to a built and natural feature (III.5).
- A change in land use such as rezoning a battlefield from open space to residential use, allowing new development or site alteration to fill in the formerly open spaces (III.6).
- Soil Disturbance such as a change in grade, or an alteration of the drainage pattern or excavation (III.7)

Twenty-five cultural heritage resources were identified within the study area; each of these was evaluated against the above criteria and the following provides a summary of impact screening results:

- Twenty of these identified cultural heritage resources are subject to impacts which were identified as:
    - i. ‘ENCROACHMENT (FRONTAGE). This includes properties where there will be limited encroachment (i.e. encroachment across the property frontage and/or across previously altered frontages) and where legibility of the landscape would be retained;
    - ii. ENCROACHMENT (PROXIMITY) Properties assessed under this category include encroachment which will occur near the identified cultural heritage resource(s) and which will alter, destroy or sever the landscape associated with the resource;
    - iii. REMOVAL: In this category, properties and/or identified cultural heritage resource(s) will be altered, disturbed or demolished.

3.4.1 Encroachment (Frontage)

A total of twelve identified cultural heritage resources are subject to encroachment (frontage). Within this category there are ten resources: BHR 2, BH7, BHR 8, BHR 10, BHR 11, BHR 13, CHL 2, CHL 6, CHL 9 where each of the three options (1, 2 and 2A) was assessed to have equal/ similar impacts on the identified cultural heritage resources. As the work being undertaken will be at grade, vistas (III.5) will not be obstructed nor are shadows expected to alter or change visibility of a natural feature, although in many cases the lines of mature plantings along the frontage of the property will be impacted. Each of these is potentially subject to impacts through changes in soil disturbance (III. 7) which may occur as part of the road widening work.

Two of the identified cultural heritage resources which are subject to encroachment (frontage) present different impacts across the three options:

- BHR 12. Option 1 presents the potential for the most impact to the resource. Each of the three options presented impacts in terms of encroachment across the frontage of the subject property. However, both Option 2 and 2A present a slightly different plan of work which means that there will be even less impact to the cultural heritage resource under these two options. Apart from the changes in soil and/or grade noted above (III.7) impacts are expected to be limited to the frontage of the property.

- CHL 1. In this instance, the first option, Option 1, was assessed to present the potential for the most impact to the resource and property. None of the three options poses impacts to the resource; however, Option 2 and 2A present little or no threat to the plantings through removal (III.7)

3.4.2 Encroachment (Proximity)

A total of six resources (BHR 2, BHR 3, BHR 4, BHR 6, BHR 9 and BHR 15) were assessed as subject to impacts due to the proximity of the identified cultural heritage resources to the proposed work. These identified resources include BHR 2 and BHR 6 which were subject to similar/equal impacts across all three of the options. In this instance the most likely impacts to these resources would occur within the area between the right-of-way and the identified resource; in these cases, the major concerns would arise from impacts to the plantings (III.3), isolation of the resource (III.4) and alterations of soil and/ or grade (III.7). As the work to be undertaken is largely at ground level it is not anticipated that obstructions of views or shadows would impact the resource.

The remaining four resources—BHR 3, BHR 4 BHR 9 and BHR 15 —present slightly different impacts across each of the three options. These are outlined below:

- BHR 3. Option 2 presents the most potential for impact to the resource. Both the overall legibility of the landscape and the mature plantings are potentially subject to impacts although Options 1 and 2a provide somewhat less potential for impacts to the resource. All three of the options are in proximity to the resource with the above two options being slightly further away than the proposed plan in Option 2. Option 2presents impacts to both the plantings (III.3) and a change in grade or ground surface (III.7). As with the above six resources (BHR 2, BHR 3, BHR 4, BHR 6 BHR 9 and BHR 15), isolation of

the resource could occur (III.4) when work is undertaken in proximity to an identified cultural heritage resource.

- BHR 4. Option 2A presents the least potential for impact; whereas both Options 1 and 2 present impacts due to the proximity of the work to the resource. Option 2A is reduced in scale and was assessed as presenting impacts of encroachment across the frontage. All options present impacts to the plantings and natural features (III.3) and may affect the grade or ground surface (III.7); however, only the first two options (i.e.,1 and 2) hold any potential for isolation of the resource from its surroundings (III.4).

- BHR 9. For this resource, Option 1 presents the most potential for impact. This cultural heritage resource is subject to three different types of potential impacts for each of the three options. These impacts range from (at the low end) encroachment across the frontage (Option 2A) to encroachment with close proximity to the resource (Option 2) to possible removal of the resource (the most serious level of the assessed impacts) in Option 1. Both Options 2 and 2A could present no or little impacts to the plantings. Some reduction in the legibility of the landscape could occur with both of these options via the encroachment; most of these would relate to criteria III.7. The more serious impacts which could occur in Option 1 include the destruction of all or part of the heritage resource (III1) and/or alteration of the resource and/or property (III.2) and, in addition to those noted above, potentially could result in a change of land use (III.6)

- BHR 15. Option 2A presents the potential for most impact to the resource. Option 1 presents little or no impacts to the cultural heritage resource. Option 2 presents some threat as this work plan takes place in closer proximity (than Option 1) to the resource while Option 2A is anticipated to impact the cultural heritage resource as it is undertaken in close proximity to the resource. Options 1 2 is expected to alter the legibility of the landscape particularly with respect to the alteration of the early grade and ground surface (III.7) and what appears to be an early circulation route (including stair location). Each of the options threatens to further impact the legibility of the landscape (through the removal of plantings (III.3) and further isolation of the resource (III.4).

3.4.3 Removal

Five of the identified cultural heritage resources (BHR 5, BHR 8, BHR 16, CHL 4 and CHL 7) were assessed against the three options with impacts that would necessitate removal of the heritage asset. For three of these resources, BHR 5, BHR 8 and BHR 16, the impacts are the same across all three of the options and each would require removal of the heritage resource. For these three resources there is not a preferred option.

- CHL 4. There are no clearly preferred options for this heritage resource. Like the above resources (BHR 5, BHR 8 and BHR 16) this heritage resource is subject to impacts through removal. It should be noted that Option 2A presents a work plan for CHL 4 that requires a smaller work area than Options 1 and 2. Nonetheless, Option 2A would also require removal of the resource.

- CHL 7. Option 2A presents a slightly altered plan (than Options 1 and 2) that appears to abut rather than intersect with the resource. The other two options (1 and 2) both require removal of the resource and reduction in the legibility of the landscape

4.0 CONCLUSIONS

The results of historical research confirmed that the study area features historically surveyed thoroughfares, residences and farm complexes that date back to the nineteenth century. The field review confirmed that the study area retains elements associated with early residential development, dating predominantly to the late nineteenth century and early twentieth century. In the western section, farm complexes give a strong sense of the rural landscapes that predominated in this area in the late nineteenth and early twentieth century. The early twentieth-century character of this area may be seen in two sets of early to mid twentieth-century houses (one each on Garner and Rymal Roads) that lend clue to the earlier streetscape. A total of twenty-five cultural heritage resources were identified within the study area.

- A total of sixteen built heritage resources and nine cultural heritage landscapes were identified in the study area;
- Four properties (CHL 3, CHL 5, BHR14 and BHR 15) were previously identified by the municipality);
- There is are no cultural heritage resources in the study area that are designated under the *Ontario Heritage Act*;
- The identified cultural heritage resources consist of seven farm complexes (CHL 1, CHL 2, CHL 4, CHL6-7 and CHL 9); two cemeteries (CHL 3), one with attached church (CHL 5); one commercial/industrial complex (CHL 8); fifteen residences (BHR 1-14 and BHR 16) and one public building (CHL 15); and
- Identified cultural heritage resources are historically, architecturally, and contextually associated with nineteenth century and early to mid-twentieth century land use patterns and urban development.

5.0 RECOMMENDATIONS

The Garner /Rymal Road and Garth Street road widening may have a variety of impacts upon built heritage resources and cultural heritage landscapes. Impacts can include: direct impacts that result in the loss of resources through demolition or alteration, or the displacement of resources through relocation; and indirect impacts that result in the disruption of resources by introducing physical, visual, audible or atmospheric elements that are not in keeping with the resources and/or their setting. Three options have been provided for this undertaking; in general, whilst similar, there are distinct elements to each of the plans. Based on the results of background data collection, a field review, and impact assessment of three project alternatives, the following recommendations have been developed:

1. At time of writing there were three preferred options under consideration for the proposed road improvements: Option 1, Option 2 and Option 2A. Each of these options is broadly similar although, as noted elsewhere, each has unique components that may impact identified heritage resources in somewhat different ways. Looking to the most serious of the assessed impacts—'removal' of the resource—Option 1 overall presents the most impacts with the most direct impacts, potentially requiring that up to five of the identified cultural heritage resources would be altered or disturbed through removal. Likewise, although Option 2 presents similar numbers

(five) of removals there are some adjustments to the proposed work plan that mean impacts through encroachment of frontages or with respect to proximity to the resource will be lessened. Option 2A potentially requires one fewer removal (CHL 7) and, generally, presents encroachment impacts that are further reduced. In sum, Option 2A (followed by Option 2) provides a work plan that presents the fewest impacts to identified cultural heritage resources.

2. Road widening plans should be reviewed to avoid identified cultural heritage resources—notably those five identified cultural heritage resource which may be subject to removal—should be reviewed carefully in order to ensure that there are not equally viable options which would avoid these resources. Of particular note is CHL 7 an historic farm complex where an historic barn may be subject to removal. Ideally, the route of the planned work could be shifted to the south side of the right-of-way, where the impact to an identified cultural heritage resource would be on the scale of encroachment on the frontage and, thus, much reduced. Likewise, the planned activities associated with CHL 4 should be similarly reviewed to consider if the planned work could be realigned to the south side of the road, which would result in no impacts to cultural heritage resources in this location.

3. For those properties where threats are through encroachment; all work undertaken should be planned to avoid impacts through noise and/or vibrations, especially when in close proximity to the resource(s). Where possible, mature plantings (particularly those marking property lines or other boundary lines) should be avoided as much as possible. In instances where the work is carried out in close proximity to a resource appropriate mitigation strategies measures—including but not limited protective measures, such as fencing --should be developed.

4. In all instances where cultural heritage resources have been identified road improvement activities should be planned to avoid impacts to those resources. Where any identified, above ground, cultural heritage resources are to be affected by direct or indirect impacts, further research should be undertaken to identify the specific heritage significance of the affected cultural heritage resource and/or appropriate mitigation measures should be adopted once the final work plan has been chosen from these three alternatives . This may include completing a heritage impact assessment or documentation report, or employing suitable measures such as landscaping, buffering or other forms of mitigation, where appropriate. In this regard, provincial guidelines should be consulted for advice and further heritage assessment work should be undertaken as necessary.

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2005 *Ontario Heritage Act*

Ministry of Environment, Ontario
2006 *Environmental Assessment Act*

Ministry of Municipal Affairs and Housing, Ontario
2005 *Ontario Planning Act*
2005 *Provincial Policy Statement*

Ministry of Transportation
2002 *Environmental Reference for Highway Design*
2006 *Cultural Heritage – Built Heritage and Cultural Heritage Landscapes: Technical Requirements for Environmental Impact Study and Environmental Protection/Mitigation.*
2007 *Environmental Guide for Built Heritage and Cultural Heritage Landscapes*

Rayburn, Alan.
1997 *Place Names of Ontario*. Toronto: University of Toronto Press.

Smith, William H.
1846 *Smith's Canadian Gazetteer*. Toronto:

7.0 CULTURAL HERITAGE RESOURCE MAPPING

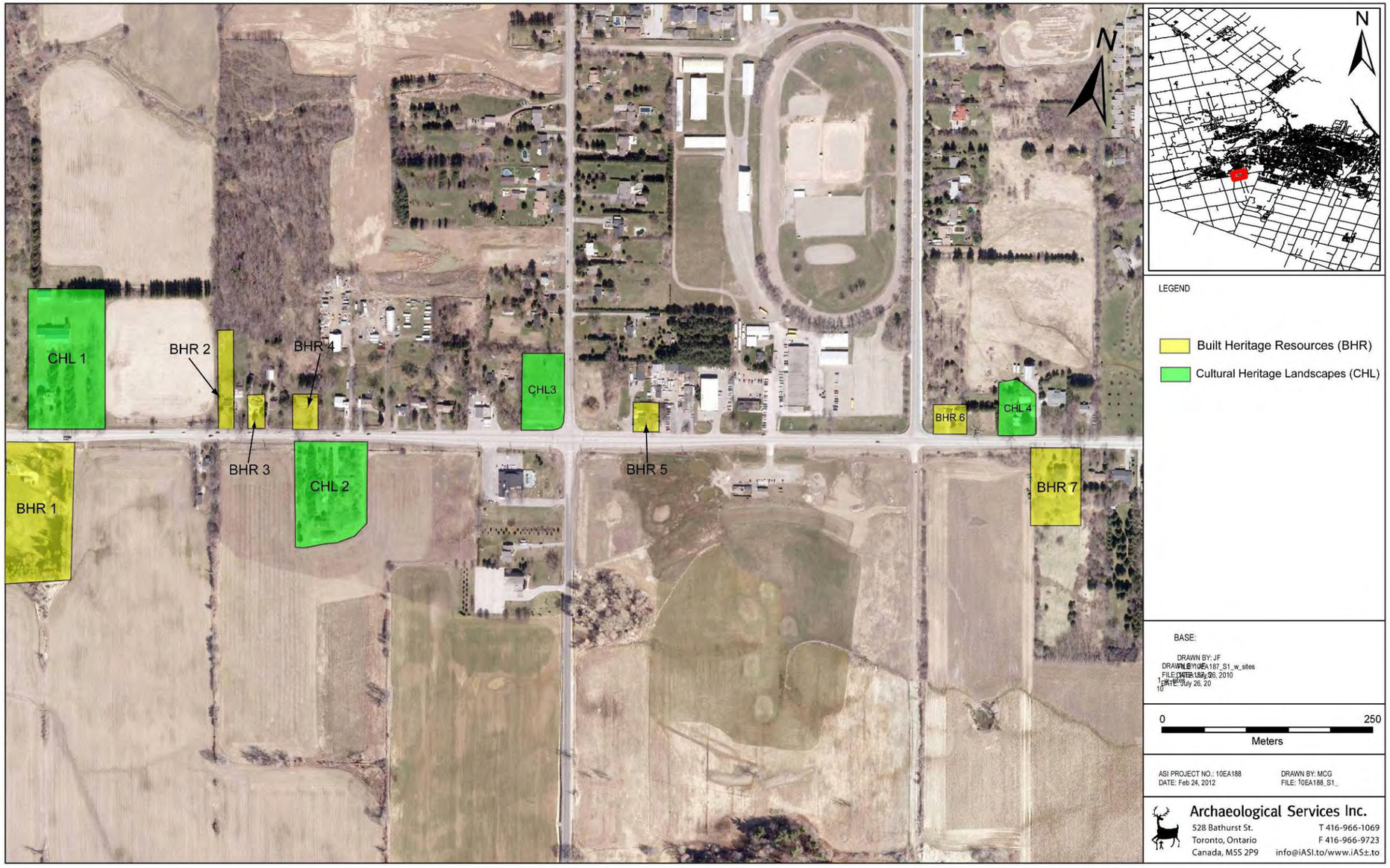


Figure 5: Location of Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

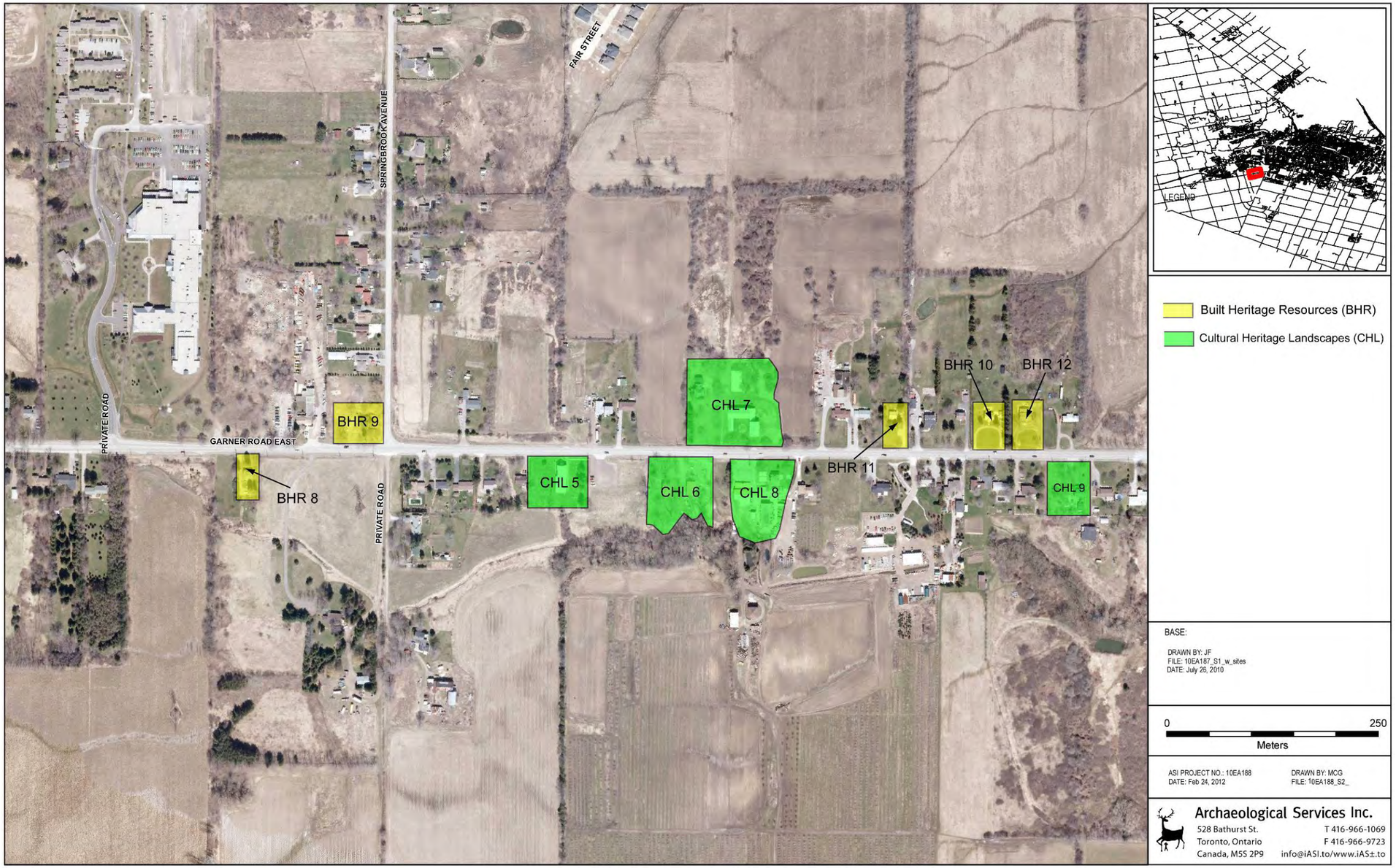


Figure 6: Location of Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Figure 7: Location of Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Figure 8: No identified Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

Figure 9: No Built Heritage Resources (BHR) or Cultural Heritage Landscapes were Located within this Section of Study Area

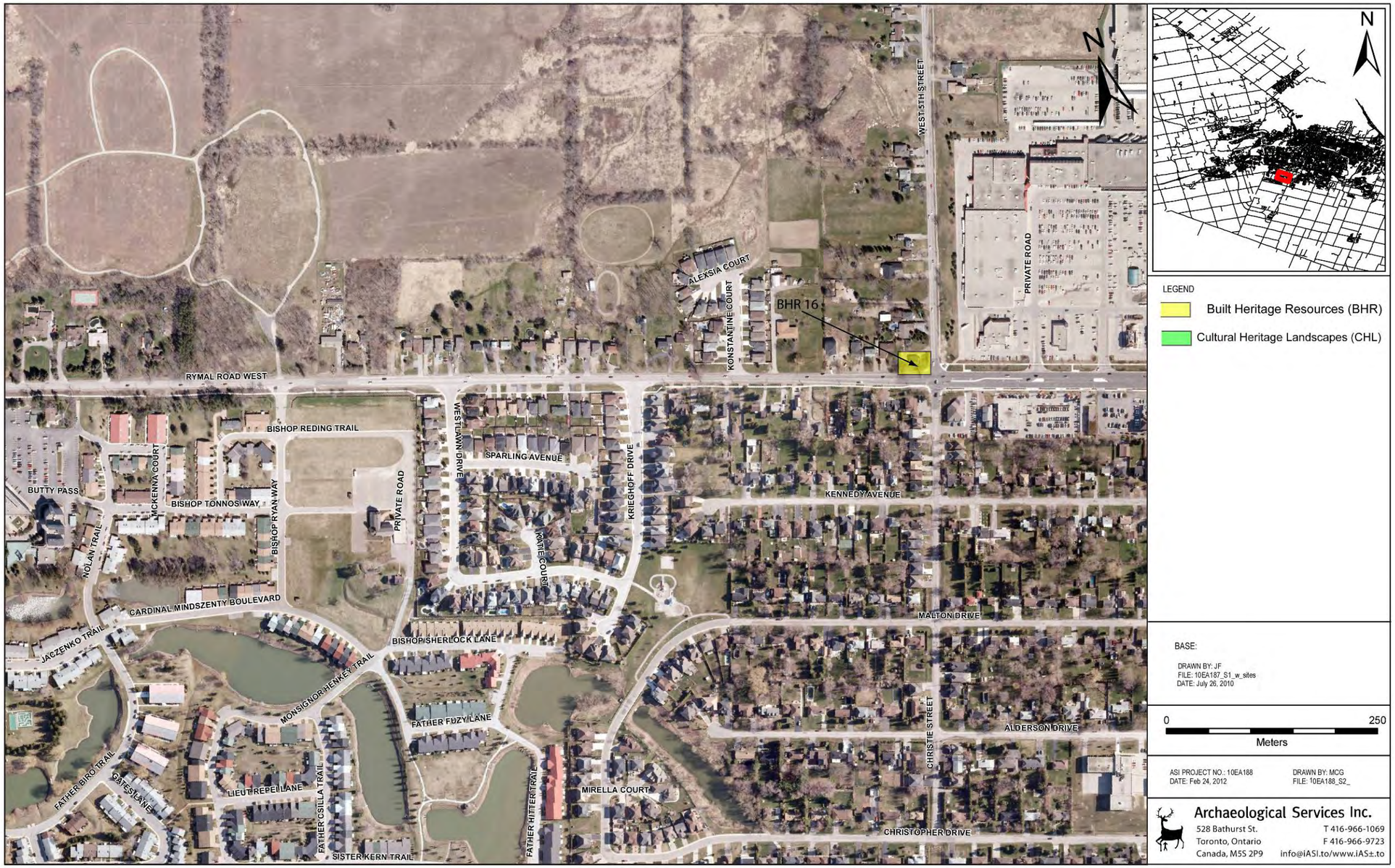


Figure 10: Location of Built Heritage Resources (BHR) and Cultural Heritage Landscapes (CHL) in the Study Area

APPENDIX A: ASSESSED IMPACTS TO IDENTIFIED CULTURAL HERITAGE RESOURCES BY OPTION

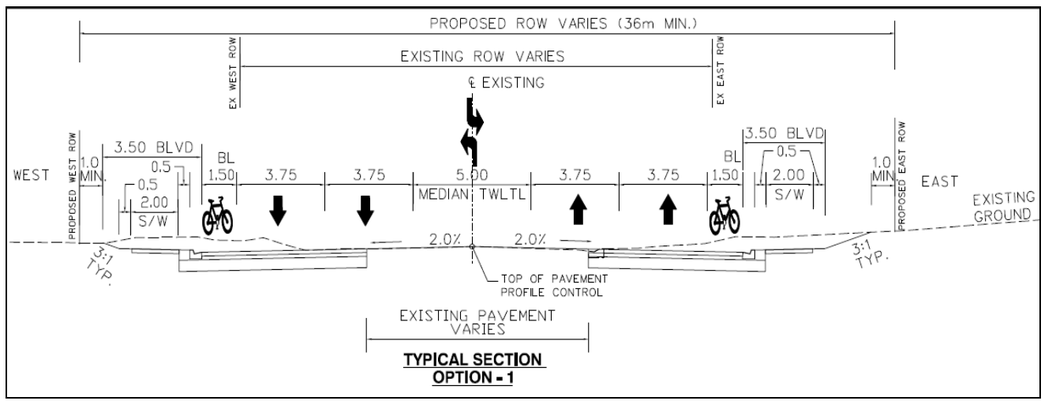
RESOURCE	ADDRESS	POTENTIAL IMPACTS		
		OPTION 1	OPTION 2	OPTION 2A
BHR 1 Residence	378 Garner Road East	ENCROACHMENT (FRONTAGE) No impacts to resource Possible impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1
BHR 2 Residence	443 Garner Road East	ENCROACHMENT (PROXIMITY TO RESOURCE) Impacts to plantings along frontage Some reduction in legibility of landscape	ENCROACHMENT (PROXIMITY TO RESOURCE) c.f. Option 1	ENCROACHMENT (PROXIMITY TO RESOURCE) c.f. Option 1
BHR 3 Residence	453 Garner Road East	ENCROACHMENT (PROXIMITY TO RESOURCE) No impacts to resource Possible impact to plantings Some reduction in legibility of landscape	ENCROACHMENT (PROXIMITY TO RESOURCE) more notable than Option 1 Plantings impacted Legibility of landscape threatened	ENCROACHMENT (PROXIMITY TO RESOURCE) c.f. Option 1
BHR 4 Residence	459 Garner Road East	ENCROACHMENT (PROXIMITY TO RESOURCE) Impact to plantings along frontage Some reduction in legibility of landscape	ENCROACHMENT (PROXIMITY TO RESOURCE) c.f. Option 1	ENCROACHMENT (FRONTAGE) Impact to plantings along frontage Some reduction in legibility of landscape
BHR 5 Residence	581 Garner Road East	REMOVAL Direct impact to resource through disruption/ demolition No impact to landscape (isolated from surroundings)	REMOVAL c.f. Option 1	REMOVAL c.f. Option 1
BHR 6 Residence	681 Garner Road East	ENCROACHMENT (PROXIMITY TO RESOURCE) No impact to resource Impact to plantings Notable reduction in legibility of landscape	ENCROACHMENT (PROXIMITY TO RESOURCE) c.f. Option 1	ENCROACHMENT (PROXIMITY TO RESOURCE) c.f. Option 1
BHR 7 Residence	716 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1
BHR 8 Residence	792 Garner Road East	REMOVAL Direct impact through disruption/demolition Impact to plantings Notable reduction of legibility of the landscape	REMOVAL c.f. Option 1	REMOVAL c.f. Option 1
BHR 9 Residence	819 Garner Road East	ENCROACHMENT, POSSIBLY REMOVAL Possible direct impact to resource through disruption/demolition Impact to plantings Notable reduction of legibility of landscape	ENCROACHMENT (PROXIMITY TO RESOURCE) No impact to resource Limited impact to plantings Reduction in legibility of landscape	ENCROACHMENT (FRONTAGE) No impact to resource Little/no impact to plantings Some reduction of legibility of landscape
BHR 10 Residence	1009 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1

BHR 11 Residence	975 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1
BHR 12 Residence	1021 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) Reduced impact to resource than Option 1 Some impact to plantings Good legibility of landscape retained	ENCROACHMENT TO FRONTAGE c.f. Option 2
BHR 13 Residence	1157 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource No impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1
BHR 14 Residence	723 Rymal Road West	NO IMPACT Resource located in parking lot no associated landscape	NO IMPACT c.f. Option 1	NO IMPACT c.f. Option 1
BHR 15 Public Building	634 Rymal Road West	ENCROACHMENT (PROXIMITY) No impact to resource Impact to plantings Notable reduction in legibility of landscape (esp. across frontage and early circulation route)	ENCROACHMENT (PROXIMITY) Greater proximity to resource than Option 1 Impact to plantings Notable reduction in legibility of landscape (esp. across frontage and early circulation route)	ENCROACHMENT (PROXIMITY TO RESOURCE) Most encroachment, closest proximity to resource Impact to plantings Notable reduction in legibility of landscape (esp. across frontage and early circulation route)
BHR 16 Residence	1268 West 5th Street	REMOVAL Direct impact to resource through disruption/demolition No impact to plantings (no established/mature plantings) Reduction of remaining legibility of landscape (prev. altered)	REMOVAL c.f. Option 1	REMOVAL c.f. Option 1
CHL 1 Farm Complex	389 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE)--REDUCED No impact to resource Some impact to plantings Good legibility of landscape retained	ENCROACHMENT (FRONTAGE)—MUCH REDUCED No impact to resource Limited impact to planting (across small section of frontage) Good legibility of landscape retained
CHL 2 Farm Complex	474 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings (including old apple tree) Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1
CHL 3 Cemetery	Southcote Road at Garner Road East	NO IMPACT Work diverted to south side of right-of-way to avoid resource	NO IMPACT c.f. Option 1	NO IMPACT c.f. Option 1
CHL 4 Farm Complex	701 Garner Road East	REMOVAL Direct to impact through disruption/demolition Impact to plantings Notable reduction of legibility of landscape	REMOVAL c.f Option 1	REMOVAL Slightly reduced encroachment (than Option 1) but resource impacted Impact to plantings Notable reduction of legibility of landscape
CHL 5 Church & Cemetery	880 Garner Road East	NO IMPACT Work diverted to north side of right-of-way to avoid resource	NO IMPACT c.f. Option 1	NO IMPACT c.f. Option 1
CHL 6 Farm Complex	910 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings (limited to small area on east) Good legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1, area of work extends further west	ENCROACHMENT (FRONTAGE) c.f. Option 1, area of work extends further west
CHL 7 Farm Complex	927 Garner Road East	REMOVAL Historic barn(s) directly impacted, residence is not impacted Impact to plantings Notable reduction of legibility of landscape	REMOVAL Slightly reduced area of work than Option 1 but barns still directly impacted Impact to plantings Notable reduction of legibility of landscape	ENCROACHMENT (PROXIMITY TO RESOURCE) No impact to resource, although work area abuts barns Impact to plantings Notable reduction of legibility of landscape

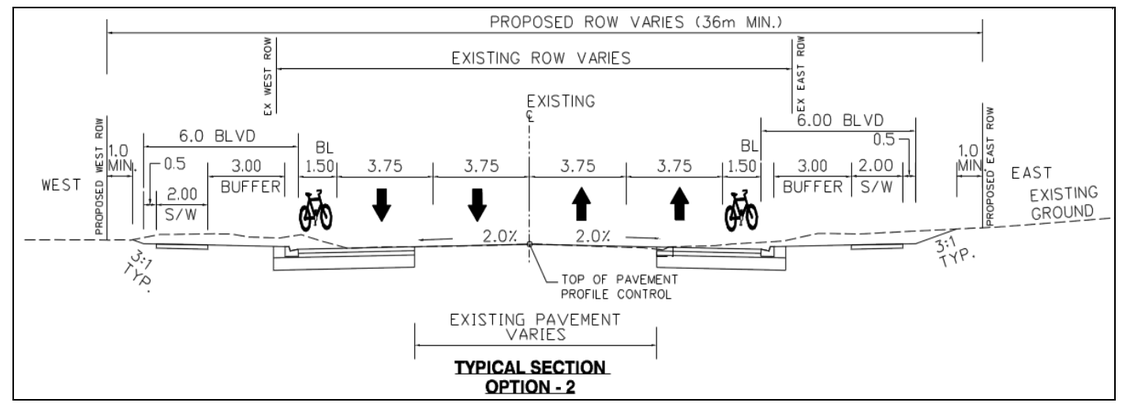
CHL 8 Industrial/Commercial Complex	944 Garner Road East	NO IMPACT Work limited to north of right-of-way, picks up to east of residence May be limited impact to plantings No impact to legibility of landscape	NO IMPACT Work limited to east and west extremes of property	NO IMPACT Work limited to east and west extremes of property
CHL 9 Farm Complex	1038 Garner Road East	ENCROACHMENT (FRONTAGE) No impact to resource Some impact to plantings (limited to small area on east) Fair legibility of landscape retained	ENCROACHMENT (FRONTAGE) c.f. Option 1	ENCROACHMENT (FRONTAGE) c.f. Option 1

APPENDIX B: CLIENT MAPS DEPICTING OPTIONS AND WORK PLANS

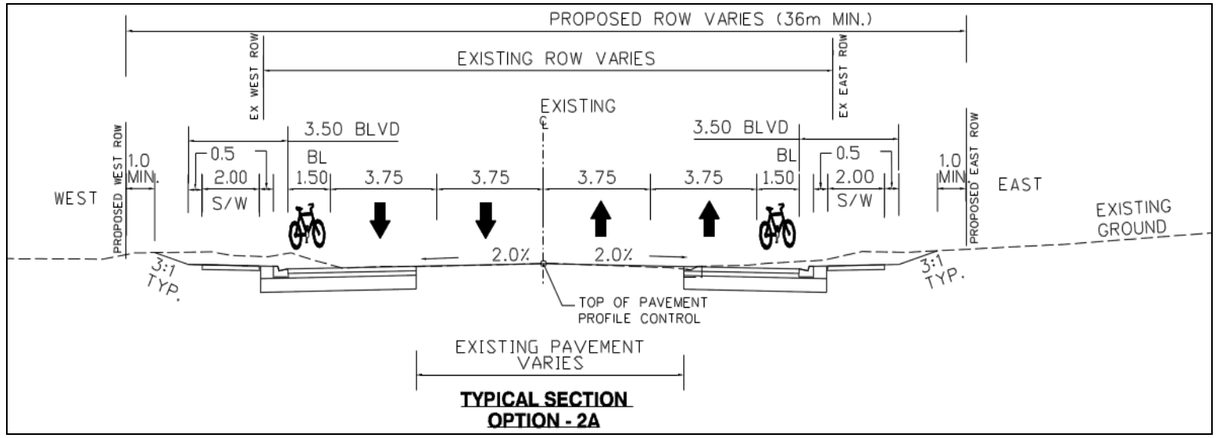
Appendix-B1 Typical Cross Sections of Proposed Work



ALTERNATIVE 1 - 5.0m Continuous Median, 3.5m Blvd



ALTERNATIVE 2 - No Continuous Median, 6m Blvd.



Alternative 2A- No Continuous Median, 3.5m Blvd.

Source: SNC Lavalin Environment

Appendix B2: Plan Drawings of Proposed Work

Appendix B2: Plan Drawings of Proposed Work

Design Option 1

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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FILE: 10EA188_bh__opt1_s1

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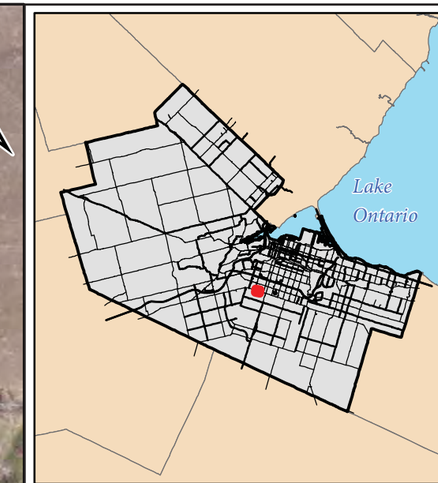
10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 1)



Design Option 1

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- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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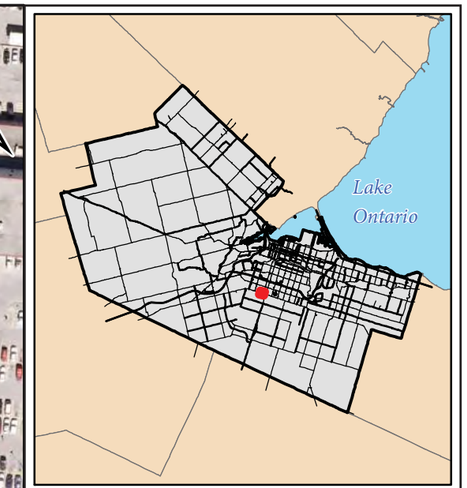
10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 10)



Design Option 1

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- Sidewalk
- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 11)

Design Option 1

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 2)

Design Option 1

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 3)

Design Option 1

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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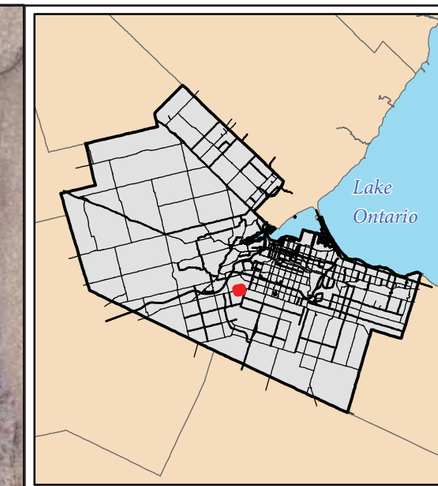
10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 4)



Design Option 1

- Grading Limit
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- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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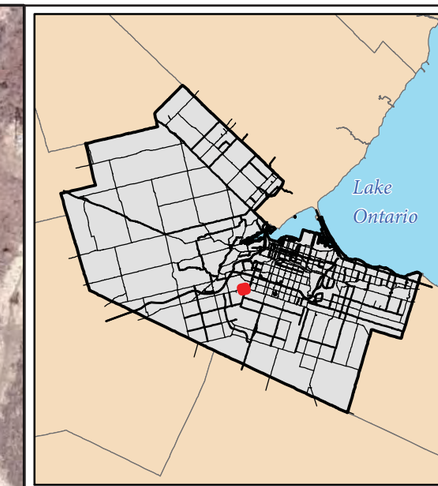
10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 5)



Design Option 1

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- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 6)

Design Option 1

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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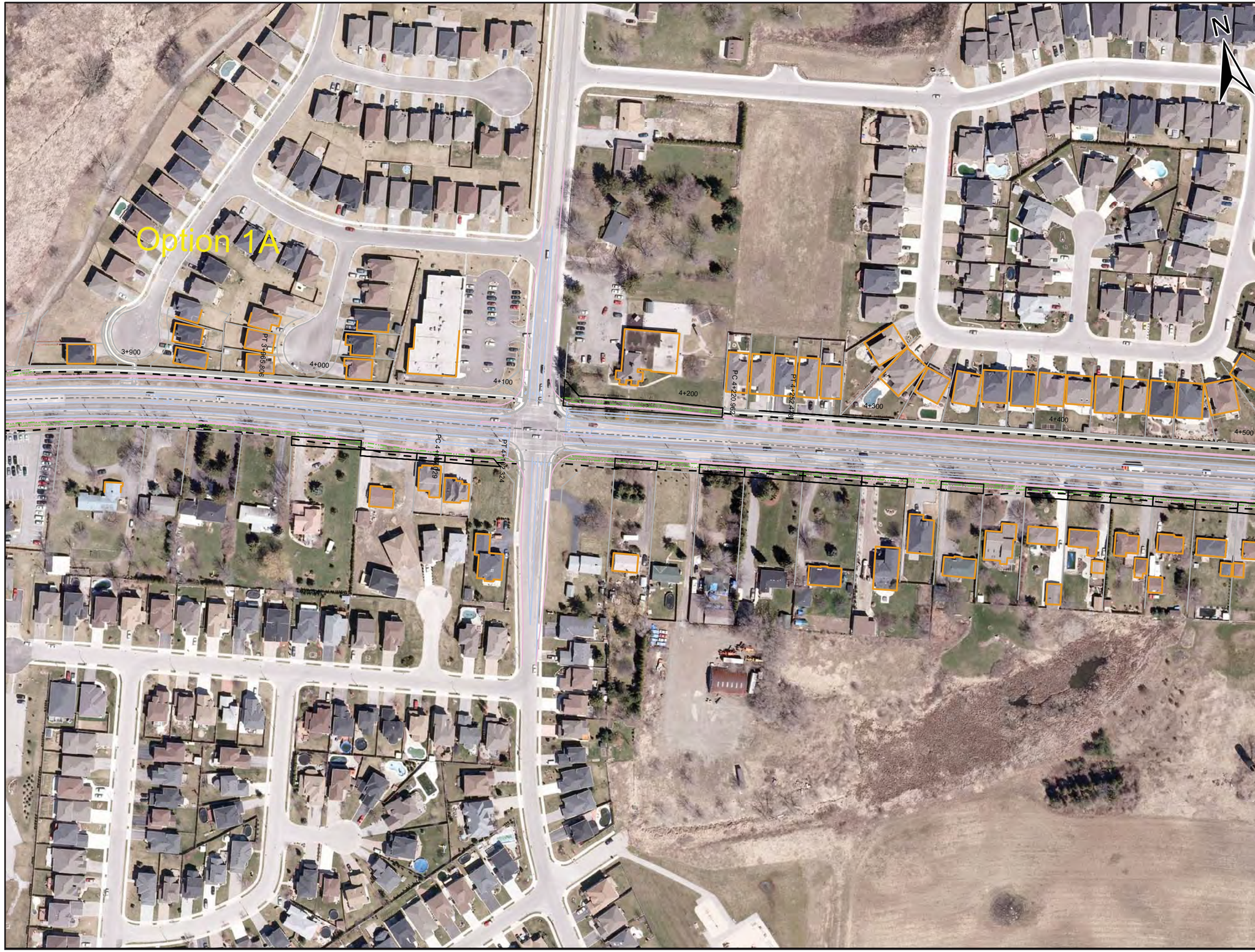
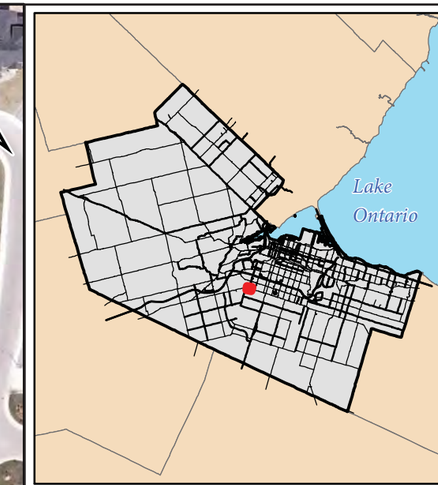
10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 7)





Design Option 1

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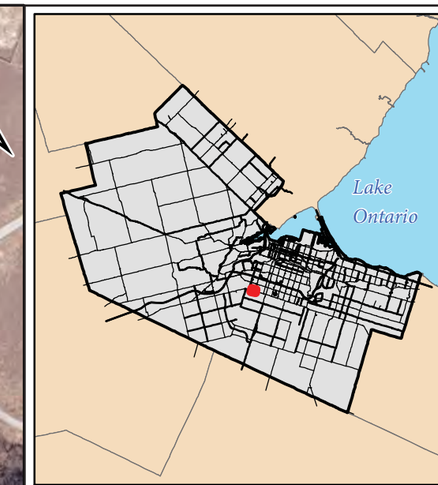
10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 8)



Design Option 1

- Grading Limit
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- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 1 - Field Map (Sheet 9)

Design Option 2

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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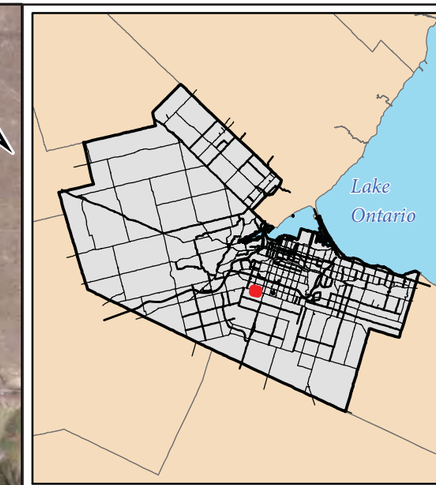
10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 1)



Design Option 2

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- Sidewalk
- Traffic Markings

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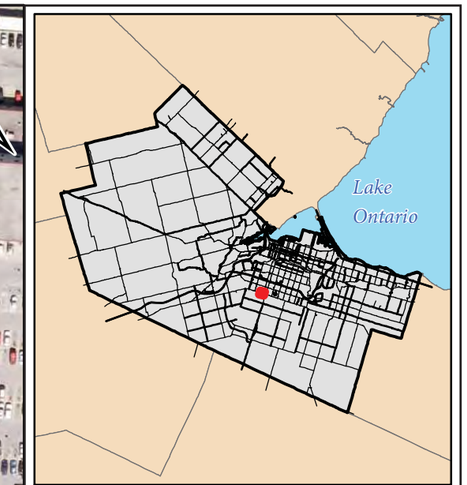
10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 10)



Design Option 2

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- Sidewalk
- Traffic Markings

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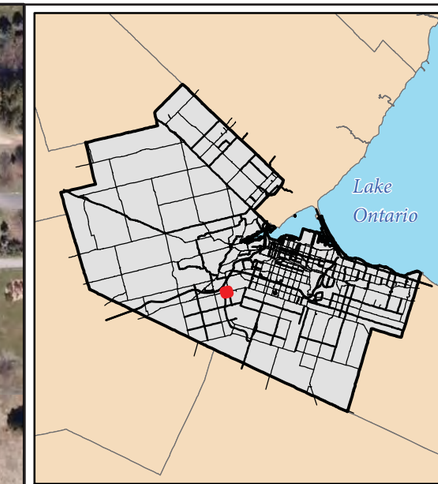
10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 11)



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- Sidewalk
- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 2)

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- Property Line (Road Allowance)
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10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 3)

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- Property Line (Road Allowance)
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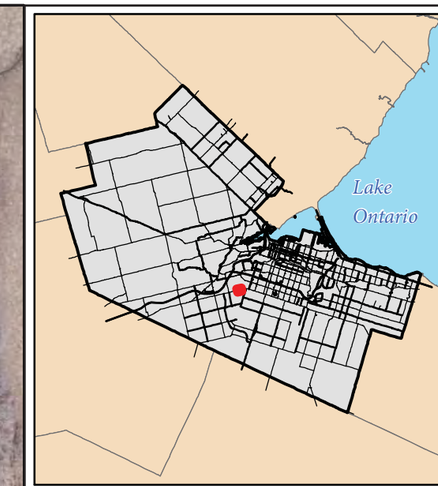

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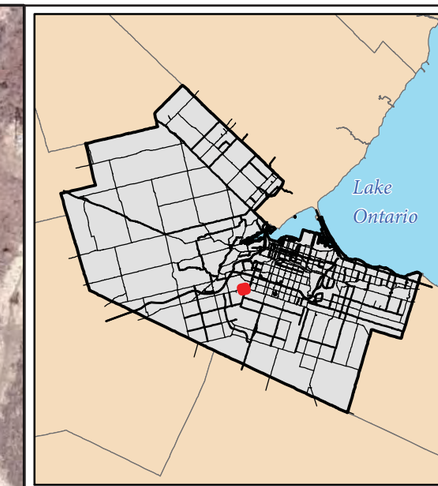

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- Traffic Markings

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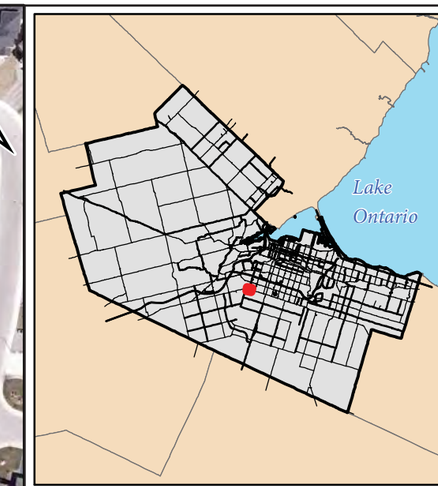
10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 7)



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- Traffic Markings

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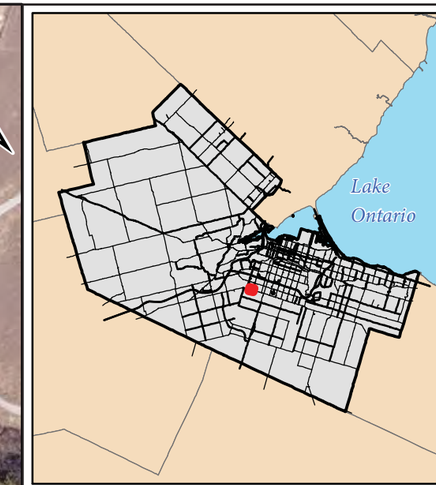
10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 8)



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- Roads And Curbs And Text
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- Traffic Markings

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10EA-188 Garner-Rymal-Garth Road: Option 2 - Field Map (Sheet 9)

Design Option 2A

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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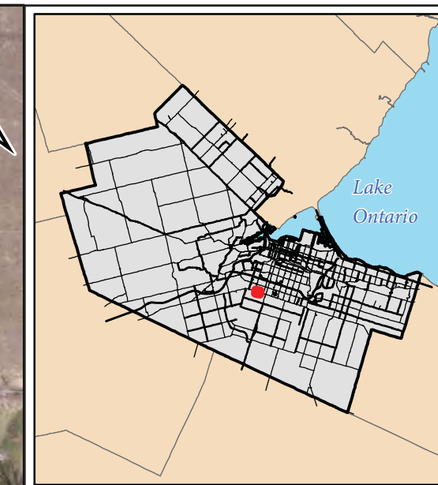

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- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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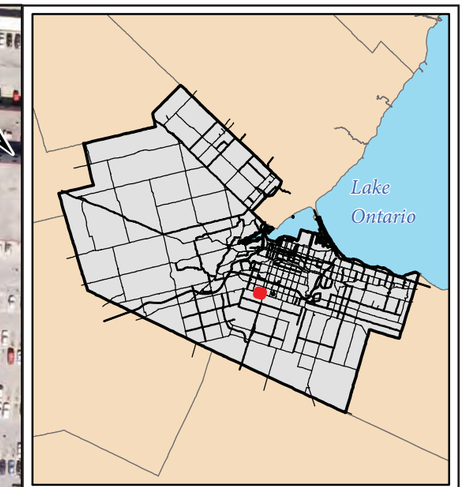
10EA-188 Garner-Rymal-Garth Road: Option 2A - Field Map (Sheet 10)



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- Grading Limit
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- Property Line (Road Allowance)
- Roads And Curbs And Text
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- Traffic Markings

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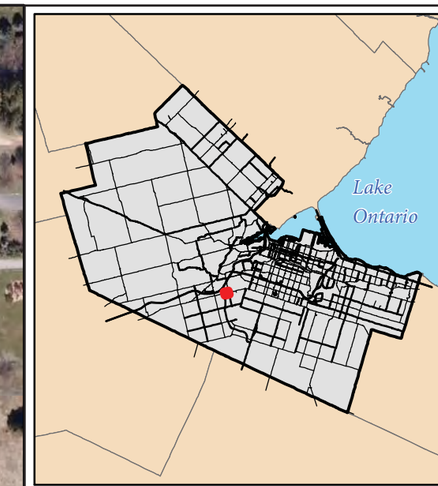
10EA-188 Garner-Rymal-Garth Road: Option 2A - Field Map (Sheet 11)



Design Option 2A

- Grading Limit
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- Property Line (Road Allowance)
- Roads And Curbs And Text
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BASE: Bing Maps Aerial
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10EA-188 Garner-Rymal-Garth Road: Option 2A - Field Map (Sheet 2)

Design Option 2A

- Grading Limit
- NEW-CL
- Property Line (Road Allowance)
- Roads And Curbs And Text
- Sidewalk
- Traffic Markings

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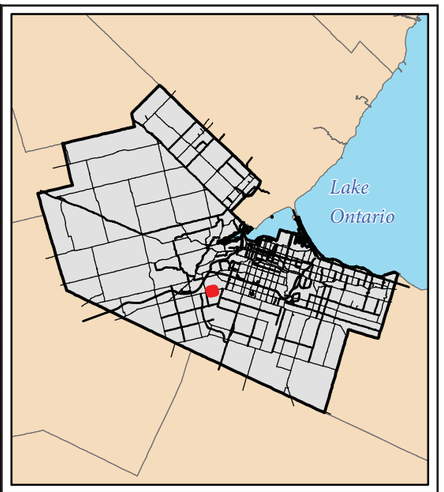

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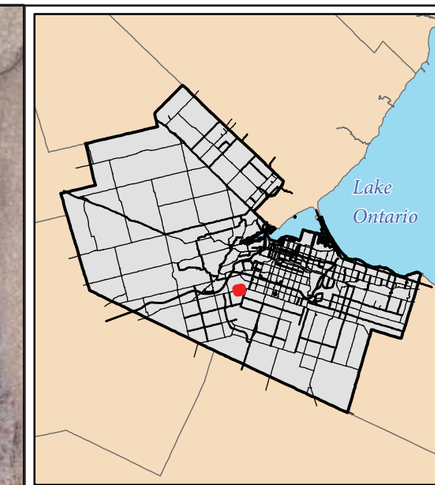
10EA-188 Garner-Rymal-Garth Road: Option 2A - Field Map (Sheet 4)



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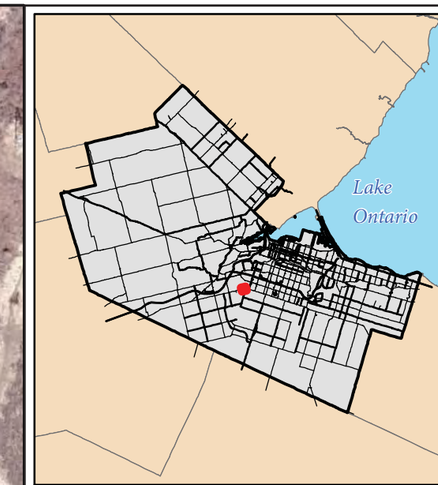

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10EA-188 Garner-Rymal-Garth Road: Option 2A - Field Map (Sheet 6)

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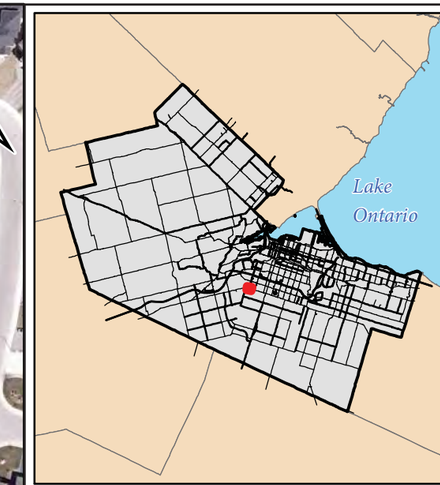

Design Option 2A

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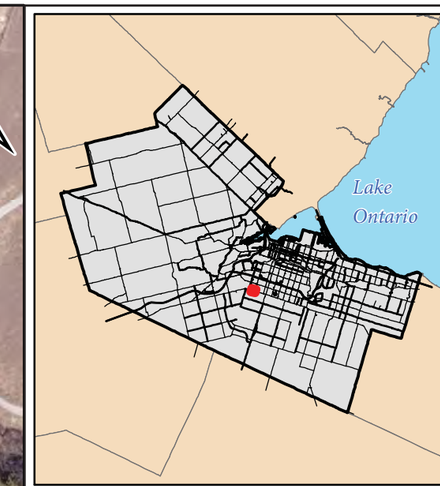
10EA-188 Garner-Rymal-Garth Road: Option 2A - Field Map (Sheet 8)



Design Option 2A

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APPENDIX D.7

STAGE 1 ARCHAEOLOGICAL ASSESSMENT

Stage 1 Archaeological Assessment
(Background Research and Property Inspection)

Garner Road/Rymal Road and Garth Street Widening
Class Environmental Assessment,
City of Hamilton, Ontario

Prepared for:

City of Hamilton
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Hamilton ON L8R 2K3
Tel: 905-546-2424
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Archaeological Licence P057 (Robert Pihl)
MTC PIF P057-644-2010
ASI File 10EA-187

August 2010

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Stage 1 Archaeological Assessment
(Background Research and Property Inspection)

Garner Road/Rymal Road and Garth Street Widening Class Environmental Assessment, City of Hamilton, Ontario

EXECUTIVE SUMMARY

Archaeological Services Inc. (ASI) was contracted by the City of Hamilton, to conduct a Stage 1 Archaeological Assessment (background research and property inspection) as part of the Garner Road/Rymal Road and Garth Street Widening Class Environmental Assessment. The study corridor extends along Garner Road/Rymal Road from the new Highway 6 interchange to West 5th Street. The study corridor also includes the stretch of Garth Street, from Rymal Road to Stonechurch Road.

The Stage 1 Archaeological Assessment determined that 72 archaeological sites have been registered within 500 m of the study corridor, two of which are located immediately adjacent to the study corridor. A review of the geography and local nineteenth century land use of the study corridor suggested that it has potential for the identification of Aboriginal and Euro-Canadian archaeological sites.

Based on the results of the property inspection, it was determined that the Garner Road, Rymal Road, and Garth Street right-of-ways (ROW) have been subject to extensive and deep land alterations. However, minimal disturbances have occurred beyond the disturbed ROW.

In light of these results, ASI makes the following recommendation:

1. The existing Garner Road, Rymal Road, and Garth Street ROWs do not retain archaeological site potential due to previous ground disturbances. Additional archaeological assessment is therefore not required along this portion of the study corridor;

2. If construction extends beyond the disturbed ROWs, a Stage 2 Archaeological Assessment (property assessment) is recommended on any lands along the study corridor where there is potential for archaeological sites, in accordance with the *Draft Standards and Guidelines for Consultant Archaeologists*; and

3. Prior to any land-disturbing activities adjacent to Garner's Corners Cemetery or Bowman Cemetery, a Cemetery Investigation should be conducted. This work will be done in accordance with the *Draft Standards and Guidelines for Consultant Archaeologists*, in order to confirm the presence or absence of unmarked graves within the ROW. This work will involve the removal of the topsoil with a Gradall followed by the shovel shining of the exposed surfaces and subsequent inspection for grave shafts.

ARCHAEOLOGICAL SERVICES INC.
ENVIRONMENTAL ASSESSMENT DIVISION

PROJECT PERSONNEL

Senior Project Manager:	Robert Pihl, MA, CAHP [MTC license P057] *Partner and Senior Archaeologist* *Manager, Environmental Assessment Division*
Project Director (licensee):	Robert Pihl
Project Manager/Archaeologist:	Caitlin Lacy, Hon. BA [MTC license R303] *Staff Archaeologist*
Project Coordinator:	Sarah Jagelewski, Hon. BA *Research Archaeologist*
Field Director:	Peter Carruthers, MA CAHP [MTC license P163] *Senior Associate*
Report Writer and Graphics:	Caitlin Lacy
Graphics:	Jonas Fernandez, MSc [MTC licence R281] *GIS Technician*
Report Reviewer:	Lisa Merritt, MSc [MTC license P094] *Senior Archaeologist, Assistant Manager,* *Environmental Assessment Division*

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1.0 INTRODUCTION

Archaeological Services Inc. (ASI) was contracted by the City of Hamilton, to conduct a Stage 1 Archaeological Assessment (background research and property inspection) as part of the Garner Road/Rymal Road and Garth Street Widening Class Environmental Assessment (Figure 1). The study corridor extends along Garner Road/Rymal Road from the new Highway 6 interchange to West 5th Street. The study corridor also includes the stretch of Garth Street, from Rymal Road to Stonechurch Road.

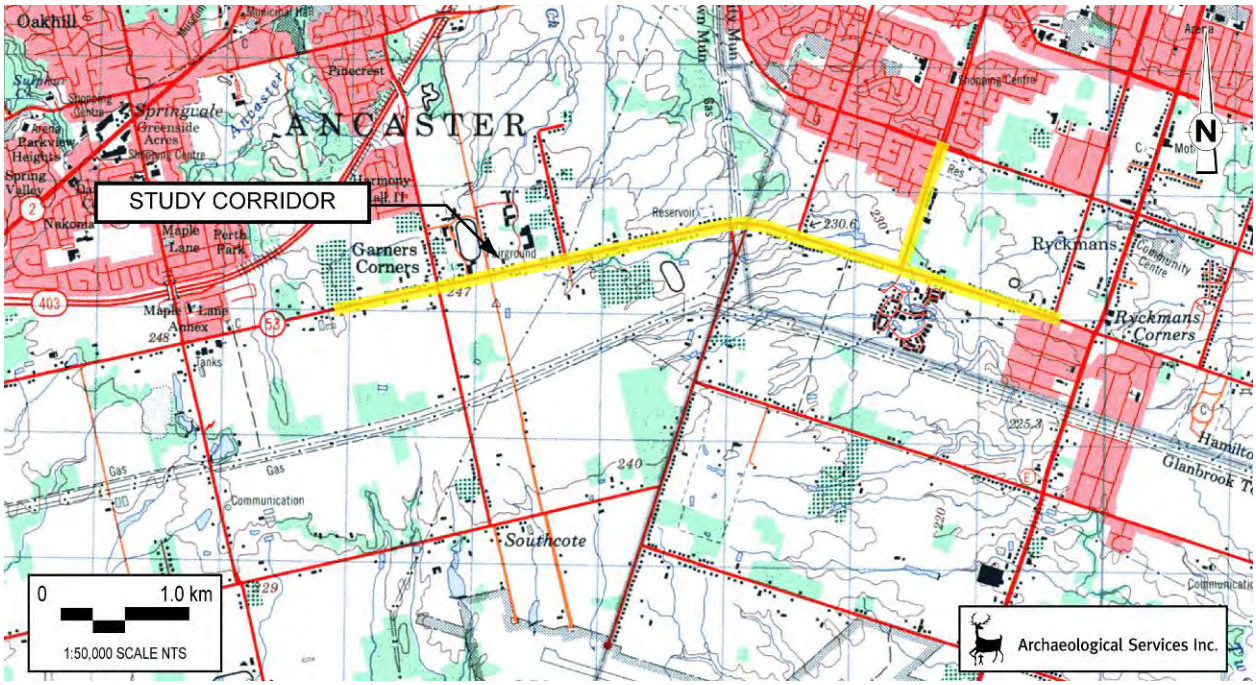

Figure 1: Location of the study corridor.

NTS Sheet 30 M/04 (Hamilton-Grimsby)

Authorization to carry out the activities necessary for the completion of the Stage 1 assessment was granted to ASI by City of Hamilton on May 27, 2010.

The objectives of this report are:

- To provide information about the geography, history, previous archaeological fieldwork and current land condition of the study corridor;
- To evaluate in detail the archaeological potential of the study corridor which can be used, if necessary, to support recommendations for a Stage 2 Archaeological Assessment for all or parts of the study corridor; and
- To recommend appropriate strategies for a Stage 2 Archaeological Assessment, if necessary.

2.0 BACKGROUND RESEARCH

The Stage 1 Archaeological Assessment of the study corridor was conducted in accordance with the *Ontario Heritage Act* (2005) and the *Draft Standards and Guidelines for Consultant Archaeologists* (MCL 2009). A Stage 1 archaeological assessment involves a background study to provide detailed documentary research on the archaeological and land use history and present conditions of the study corridor. Specifically, the background study provides information about previous archaeological fieldwork within and around the study corridor, its geography and history, and current land conditions.

2.1 Previous Archaeological Research

In order for an inventory of archaeological resources to be compiled for the study corridor, three sources of information were consulted: the site record forms for registered sites housed at the Ministry of Tourism and Culture (MTC) [1]; published and unpublished documentary sources; and the files of ASI.

In Ontario, information concerning archaeological sites is stored in the Ontario Archaeological Sites Database (OASD) maintained by the MTC. This database contains archaeological sites registered within the Borden system. Under the Borden system, Canada has been divided into grid blocks based on latitude and longitude. A Borden block is approximately 13 km east to west, and approximately 18.5 km north to south. Each Borden block is referenced by a four-letter designator, and sites within a block are numbered sequentially as they are found. The study corridor is located in Borden block *AhGx*.

According to the OASD (email communication, Robert von Bitter, MTC Data Coordinator, June 28, 2010), 72 archaeological sites have been registered within 500 m of the study corridor (Table 1). Two of these sites are located immediately adjacent to the study corridor.

Table 1: List of registered sites within 1 km of Farewell Creek Bridge.

Borden #	Site Name	Cultural Affiliation	Site Type	Researcher
AhGx-29	Kamermans	Aboriginal – Archaic	Campsite	W. Fox 1983
AhGx-254	Abby Hill 1	Aboriginal	Campsite	MPP 1988
AhGx-255	Abby Hill 2	Aboriginal	Campsite	MPP 1988
AhGx-256	Binkl, Gage, Elliott Farm 1	Euro-Canadian	Homestead	R. Michael 1988
AhGx-267	Carpenter 4	Aboriginal	Undetermined	R. Michael 1988
AhGx-270	Jacob Smith	Euro-Canadian	Shed	ASI 1990
AhGx-309		Aboriginal – Archaic	Undetermined	ASI 1992
AhGx-312		Aboriginal	Undetermined	ASI 1992
AhGx-316		Aboriginal	Undetermined	ASI 1992
AhGx-318		Aboriginal	Undetermined	ASI 1992
AhGx-319		Aboriginal	Undetermined	ASI 1992
AhGx-322	Harvest	Aboriginal	Undetermined	MTO 1992
AhGx-333	**Mitsu**	**Aboriginal**	**Undetermined**	**MTO 1992**
AhGx-334	Spy	Aboriginal	Undetermined	MTO 1992
AhGx-335	Golden	Aboriginal	Undetermined	MTO 1992
AhGx-336	Crab	Aboriginal	Undetermined	MTO 1992

[1] In January 2010, the Government of the Province of Ontario re-organized several of its ministries, and the new Ministry of Tourism and Culture was formed from the former Ministry of Culture and the Ministry of Tourism.

Borden #	Site Name	Cultural Affiliation	Site Type	Researcher
AhGx-337	Snow	Aboriginal	Undetermined	MTO 1992
AhGx-338	MacIntosh	Aboriginal	Undetermined	MTO 1992
AhGx-339	Cider	Aboriginal	Undetermined	MTO 1992
AhGx-340	Courtland	Aboriginal	Undetermined	MTO 1992
AhGx-341	Winter	Aboriginal	Undetermined	MTO 1993
AhGx-342	Spartan	Aboriginal	Undetermined	MTO 1993
AhGx-343	Core	Aboriginal	Undetermined	MTO 1993
AhGx-344	Core	Aboriginal	Undetermined	MTO 1993
AhGx-345	Red	Aboriginal	Undetermined	MTO 1993
AhGx-346	Blossom	Aboriginal - Woodland	Undetermined	MTO 1993
AhGx-347	Butter	Aboriginal	Undetermined	MTO 1993
AhGx-348	Northern	Aboriginal	Undetermined	MTO 1993
AhGx-349	Anchor	Aboriginal	Undetermined	MTO 1993
AhGx-350	Line	Aboriginal	Undetermined	MTO 1993
AhGx-351	Rosea lot IV	Aboriginal – multi component	Undetermined	MTO 1993, ASI 2006, FAC 2007
AhGx-352	Rosea lot III	Aboriginal – Archaic	Undetermined	MTO 1993, ASI 2006
AhGx-356	Arthur	Aboriginal	Campsite	MTO 1993, NDA 2000
AhGx-364	Bad Apple	Aboriginal	Undetermined	MTO 1997
AhGx-374	Rusty Nail	Aboriginal	Campsite	MTO 1995, ASI 2006
AhGx-375	Dragon's Breath	Euro-Canadian, Aboriginal – Archaic	Undetermined, Campsite	MTO 1995, ASI 2006, FAC 2007
AhGx-376	Blistering Butte	Aboriginal – Archaic	Campsite	MTO 1995, ASI 2006
AhGx-377	Last Spike	Aboriginal – Woodland	Campsite	MTO 1995, ASI 2006
AhGx-378	Satellite	Aboriginal	Campsite	MTO 1995, ASI 2006
AhGx-382	Bitter	Aboriginal	Campsite	MTO 1995
AhGx-385		Aboriginal – Archaic	Isolated Find	MTO 1995
AhGx-386		Aboriginal – Archaic	Isolated Find	MTO 2002
AhGx-387		Aboriginal – Archaic	Isolated Find	MTO 2002
AhGx-388		Aboriginal – Paleo-Indian	Undetermined	MTO 1995
AhGx-389		Aboriginal – Woodland	Isolated Find	MTO 1995
AhGx-391		Aboriginal – Woodland	Isolated Find	MTO 1995
AhGx-44	Smith 3	Aboriginal	Campsite	C. Dodd 1986
AhGx-48	Smith 1	Aboriginal	Campsite	C. Dodd 1986
AhGx-49	Smith 2	Aboriginal	Campsite	C. Dodd 1985
AhGx-403	John Faber	Aboriginal	Campsite	A. Howey 1997, 2002
AhGx-497	Paradise Gardens I	Aboriginal	Lithic Scatter	R. Sutton 2003
AhGx-498	Paradise Gardens II	Aboriginal – Archaic	Isolated Find	R. Sutton 2003
AhGx-499	Paradise Gardens III	Aboriginal	Campsite	R. Sutton 2003
AhGx-52	Carpenter 1	Aboriginal	Campsite	C. Dodd 1985

Borden #	Site Name	Cultural Affiliation	Site Type	Researcher
AhGx-53	Carpenter 2	Aboriginal	Campsite	C. Dodd 1985
AhGx-54	Carpenter 3	Aboriginal	Undetermined	C. Dodd 1985
AhGx-500	Paradise Gardens IV	Aboriginal	Campsite	R. Sutton 2003
AhGx-538		Aboriginal	Isolated Find	ASI 2004
AhGx-540		**Aboriginal**	**Isolated Find**	**ASI 2004**
AhGx-541		Aboriginal	Isolated Find	ASI 2004
AhGx-545		Aboriginal	Isolated Find	ASI 2004
AhGx-546		Aboriginal	Isolated Find	ASI 2004
AhGx-557		Aboriginal – Archaic	Isolated Find	NDA 2004
AhGx-62	Freeland	Aboriginal	Isolated Find	M. Ambrose 1985, 1986, MHCI 1997
AhGx-619		Aboriginal	Isolated Find	ASI 2006
AhGx-620		Aboriginal	Isolated Find	ASI 2006
AhGx-621		Aboriginal	Isolated Find	ASI 2006
AhGx-622		Aboriginal	Isolated Find	ASI 2006
AhGx-623		Aboriginal	Lithic Scatter	ASI 2006
AhGx-624		Euro-Canadian	Homestead	ASI 2006
AhGx-643	Gage	Euro-Canadian	Homestead	ASI 2007
AhGx-646	Kitty Murray	Aboriginal	Lithic Scatter	NDA 2007

*sites in bold are located immediately adjacent to the study corridor

The Mitsu site (AhGx-333) was discovered during the Ministry of Transportation's (MTO) Stage 2 assessment for the new Highway 6 alignment (MTO 1992). The site was encountered on elevated ground at the southeastern corner of a mature apple orchard, on the north side of Garner Road East. The site is 40 m by 20 m, and consists of six widely spaced positive test pits. The distribution of positive test pits straddled the eastern edge of the proposed right-of-way, but further work confirmed that the main site area way beyond the proposed construction limits (MTO 1993). No further work was recommended for this site. However, if the proposed undertaking extends beyond the disturbed Garner Road ROW, further work should be carried out to determined if the site will be impacted.

AhGx-540 was discovered during ASI's Stage 2 assessment of the Paletta Lands Subdivision (ASI 2004). The site is located at the edge of an agricultural field, immediately adjacent to Garner Road. A single groundstone celt of unknown Aboriginal affiliation was recovered. Do to the isolated nature of the site, no further work was recommended. The site was cleared of further archaeological concern.

2.2 Geography

The study corridor is situated on the northeastern edge of the Haldimand Clay Plain physiographic region, south of the Niagara Escarpment (Chapman and Putnam 1984). This is among the largest of the 53 defined physiographic regions of southern Ontario, comprising approximately 3,500 km^2 (MacDonald 1980:3). The topography in this particular area is flat to very gently rolling (Chapman and Putnam 1984:156).

Potable water is the single most important resource necessary for any extended human occupation or settlement. Since water sources have remained relatively stable in south central Ontario since the Pleistocene era, proximity to water can be regarded as a useful index for the evaluation of archaeological

site potential. Indeed, distance from water has been one of the most commonly used variables for predictive modeling of site location.

The *Draft Standards and Guidelines* stipulates that primary water sources (lakes, rivers, streams, creeks, etc.), secondary water sources (intermittent streams and creeks, springs, marshes, swamps, etc.), ancient water sources (glacial lake shorelines indicated by the presence of raised sand or gravel beach ridges, relic river or stream channels indicated by clear dip or swale in the topography, shorelines of drained lakes or marshes, cobble beaches, etc.), as well as accessible or inaccessible shorelines (high bluffs, swamp or marsh fields by the edge of a lake, sandbars stretching into marsh, etc.) are characteristics that indicate archaeological potential (MCL 2009:5). Ancaster Creek and Twenty Mile Creek bisect the study corridor.

Other geographic characteristics that can indicate archaeological potential include: elevated topography (eskers, drumlins, large knolls, plateaux), pockets of well-drained sandy soil, especially near areas of heavy soil or rocky ground, distinctive land formations that might have been special or spiritual places, such as waterfalls, rock outcrops, caverns, mounds, and promontories and their bases. There may be physical indicators of their use, such as burials, structures, offerings, rock paintings or carvings. Resource areas, including: food or medicinal plants (migratory routes, spawning areas, prairie) and scarce raw materials (quartz, copper, ochre, or outcrops of chert) are also considered characteristics that indicate archaeological potential (MCL 2009:5-6). The present study corridor does not exhibit any of these characteristics.

Therefore, due to the proximity of Ancaster Creek and Twenty Mile Creek, it may be concluded that there is potential for the recovery of Aboriginal cultural material along the study corridor.

2.3 Land-Use History

2.3.1 Township Survey and Settlement

This section provides a brief summary of historic research for the study corridor. A review of available primary and secondary source material was undertaken to produce a contextual overview of the study corridor, including a general description of Euro-Canadian settlement and land-use.

The land within Ancaster Township was acquired by the British from the Mississaugas in 1784. The first township survey was undertaken in 1793, and the first legal settlers occupied their land holdings two years later. The township is said to have been named after a town in Lincolnshire, England. Ancaster was initially settled by disbanded soldiers, mainly Butler's Rangers, and other Loyalists following the end of the American Revolutionary War. In 1805, Boulton noted that this township contained both excellent and indifferent soils. By the 1840s, the township was noted for its fine farms (Boulton 1805:79; Smith 1846:6; Armstrong 1985:141; Rayburn 1997:11).

The land within Barton Township was acquired by the British from the Mississaugas in 1784. The first township survey was undertaken in 1791, and the first legal settlers occupied their land holdings the same year. The township is said to have been named after Barton upon Humber in Lincolnshire, England. Barton was also initially settled by disbanded soldiers, mainly Butler's Rangers, and other Loyalists following the end of the American Revolutionary War. By the 1840s, the township was noted for its good farms and soil (Smith 1846:8; Burkholder 1956; Armstrong 1985:141; Rayburn 1997:24).

The land within Glanford Township was acquired by the British from the Mississaugas in 1784. The first township survey was undertaken in 1794, and the first legal settlers occupied their land holdings in the same year. The township is said to have been named after a town called Glanford Brigg in Lincolnshire, England. Like Ancaster and Barton Townships, Glanford was initially settled by disbanded soldiers, mainly Butler's Rangers, and other Loyalists following the end of the American Revolutionary War. In 1805, Boulton noted that Glanford contained good soil, and only required time to render it a valuable township. By the 1840s, the township was noted for its good farms and "a mixed population" (Boulton 1805:79; Smith 1846:63; Armstrong 1985:143; Rayburn 1997:134).

2.3.2 Historic Map Review

The 1875 *Illustrated Historical Atlas of the County of Wentworth* was reviewed to determine the potential for the presence of historical archaeological remains along the study corridor during the nineteenth century.

Historically, the study corridor was located on Lots 46 to 51, between the road allowance for Concession III and IV, in the former Township of Ancaster, Lots 16 to 21, Concession VIII, in the former Township of Barton, and Lots 1 to 4, Concession I, in the former Township of Glanford (Figures 2 to 4). Garner Road/Rymal Road and Garth Street are all historically surveyed thoroughfares. The available data gathered from the historic atlas is summarized in Table 2. It should be noted, however, that not all features of interest were mapped systematically in the Ontario series of historical atlases, given that they were financed by subscription, and subscribers were given preference with regard to the level of detail provided on the maps. Moreover, not every feature of interest would have been within the scope of the atlases.

Historic cemeteries require particular attention during an archaeological assessment if impact is anticipated in the vicinity. Preliminary research has indicated that the Garner's Corners Cemetery, located on Lots 47-48, Concession III and the Bowman Cemetery, located on Lots 50-51, Concession IV are situated adjacent to the study corridor.

For the Euro-Canadian period, the majority of early nineteenth century farmsteads (i.e., those which are arguably the most potentially significant resources and whose locations are rarely recorded on nineteenth century maps) are likely to be captured by the basic proximity to the water model outlined in Section 2.2, since these occupations were subject to similar environmental constraints. An added factor, however, is the development of the network of concession roads and railroads through the course of the nineteenth century. These transportation routes frequently influenced the siting of farmsteads and businesses. Accordingly, undisturbed lands within 100 m of an early settlement road, such as Garner Road, Rymal Road, and Garth Street, are also considered to have potential for the presence of Euro-Canadian archaeological sites.

Figure 2: A portion of the study corridor overlaid on the map of the Township of Ancaster.
Base Map: 1875 *Illustrated Historical Atlas of the County of Wentworth*

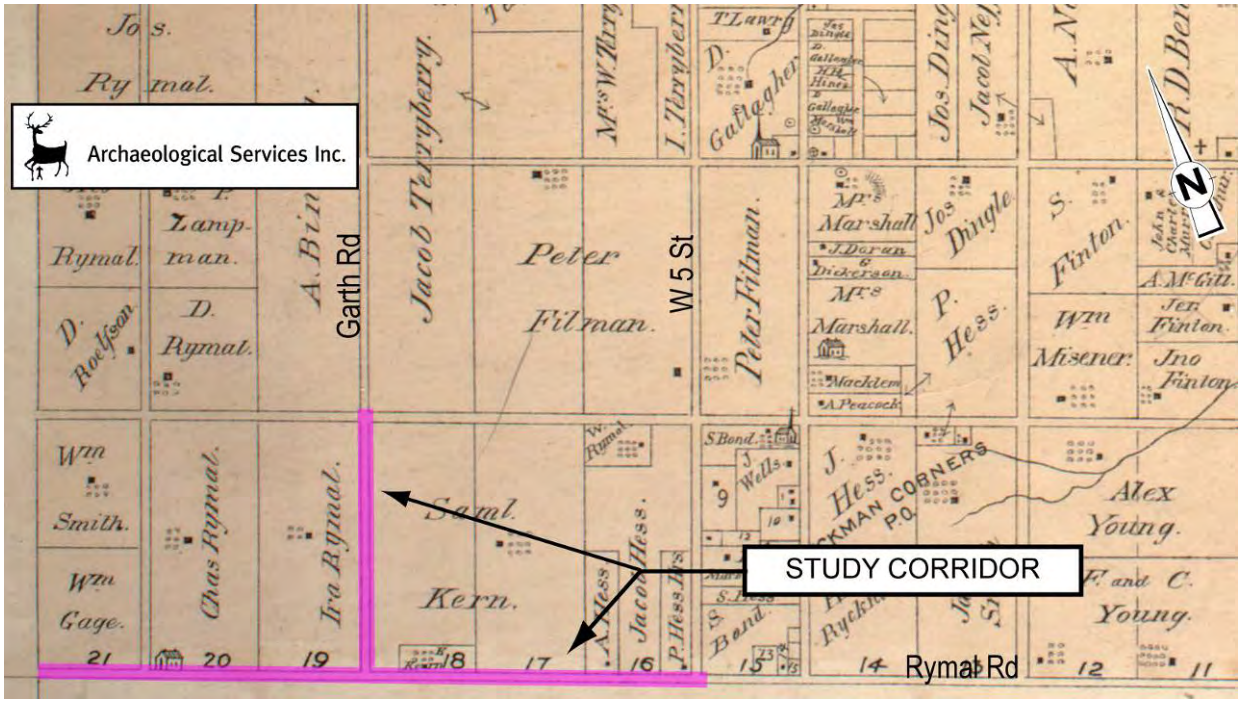

Figure 3: A portion of the study corridor overlaid on the map of the Township of Barton.
Base Map: 1875 *Illustrated Historical Atlas of the County of Wentworth*

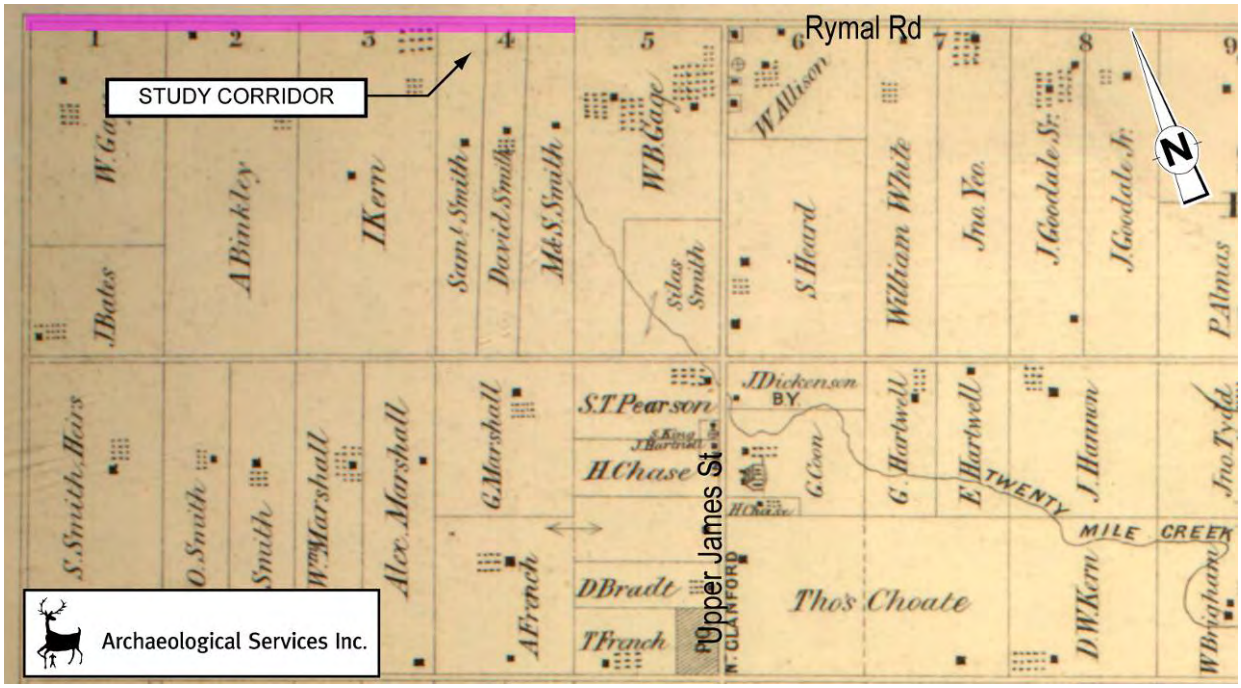

Figure 4: A portion of the study corridor overlaid on the map of the Township of Glanford.
Base Map: 1875 *Illustrated Historical Atlas of the County of Wentworth*

Table 2: Historical Property Owners Illustrated within or adjacent to the study corridor

Lot	Conc.	Property Owner	Historic Feature
Township of Ancaster			
46	III	A. Sweazey	
47		S. Olmstead	Church, cemetery
48		Garner Hanes H. Smith A. Gage	Homestead Homestead Homestead
49		J. Filman W. Filman	Homestead, orchard
50		J. Spohn	Homestead, orchard
51		Jacob Spohn	Orchard
52		Lampman Estate P. Lampman	Homestead, orchard Homestead, orchard
53		B. Olmsted	Homestead, orchard
54		S. Almos	
46	IV	Alan Smith	2 homesteads, 2 orchards
47		Alan Smith William S. Smith	
48		William S. Smith	
49		I. Rymal	Homestead
50		J. Hagle J. McGregor	Homestead Homestead
51		P. Spohn	

52		P. Spohn	
53		P. Spohn	Church
Township of Barton			
16	VIII	P. Hess Jacob Hess A. Hess	Homestead Homestead
17		Samuel Kern	
18		Isaiah Kern Samuel Kern	Orchard
19		Ira Rymal	
20		Charles Rymal	School House
21		William Gage	
Township of Glanford			
1	I	W. Gage	
2		Aley Binkley	Homestead
3		I. Kern	Orcahrd
4		Samuel Smith David Smith M & S Smith	

The *Draft Standards and Guidelines* stipulates that that areas of early Euro-Canadian settlement (pioneer homesteads, isolated cabins, farmstead complexes), early wharf or dock complexes, pioneer churches and early cemeteries, are considered to have archaeological potential. There may be commemorative markers of their history such as local, provincial, or federal monuments or heritage parks. Early historical transportation routes (trails, passes, roads, railways, portage routes), properties listed on a municipal register or designated under the *Ontario Heritage Act* or a federal, provincial, or municipal historic landmark or site, and properties that local histories or informants have identified with possible archaeological sites, historical events, activities, or occupations are also considered to have archaeological potential (MCL 2009: 6).

Therefore, based on the proximity to early Euro-Canadian settlements and early settlement roads, it may be concluded that there is potential for the recovery of historic cultural material along the study corridor.

3.0 ANALYSIS: ARCHAEOLOGICAL POTENTIAL EVALUATION

The *Draft Standards and Guidelines* list characteristics that indicate where archaeological resources are most likely to be found (MCL 2009: 7). Archaeological potential is confirmed when one or more feature of archaeological potential is present.

Per Section 1.3.1 of the standards and guidelines, the study corridor meets the following criteria used for determining archaeological potential:

- Previously identified archaeological sites (i.e. AhGx-333, AhGx-540);
- Water sources: primary, secondary, or ancient water sources (i.e. Ancaster Creek, Twenty Mile Creek);
- Areas of early Euro-Canadian settlement (i.e. churches, cemetery, pioneer homesteads);
- Early historical transportation route (i.e. Garner Road, Rymal Road, Garth Street); and

- Property designated under the Ontario Heritage Act or listed on a municipal register (i.e. 581 & 701 Garner Road).

These criteria characterize the study corridor as having potential for the identification of Aboriginal and Euro-Canadian archaeological sites.

4.0 PROPERTY INSPECTION

A property inspection of the study corridor was conducted by Peter Carruthers (P163), ASI, on July 28 2010, in order to gain first-hand knowledge of its geography, topography, and current conditions, and to evaluate and map its archaeological potential. The property inspection was a visual inspection only and does not include excavation or collection of archaeological resources. Weather conditions during the property inspection were sunny, with a few clouds, and 28°C.

Typically, rights-of-way (ROW) can be divided into two areas: the disturbed ROW, and ROW lands beyond the disturbed ROW. The typically disturbed ROW extends outwards from either side of the centerline of the traveled lanes, and it includes the traveled lanes and shoulders and extends to the toe of the fill slope, the top of the cut slope, or the outside edge of the drainage ditch, whichever is furthest from the centerline. Subsurface disturbance within these lands may be considered extreme and pervasive, thereby negating any archaeological potential for such lands.

ROW construction disturbance may be found to extend beyond the typical disturbed ROW area, and this generally includes additional grading, cutting and filling, additional drainage ditching, watercourse alteration or channelization, servicing, removals, intensive landscaping, and heavy construction traffic. Areas beyond the typically disturbed ROW generally require archaeological assessment in order to determine archaeological potential relative to the type or scale of disturbances that may have occurred in these zones.

The overall Class EA study includes improvements to widen Garner Road to four lanes, to widen Rymal Road from two to four/five lanes, and to widen Garth Street from two to three lanes. The property inspection proceeded from west to east, starting just west of Southcote Road.

The Garner Road, Rymal Road, and Garth Street ROWs have been subject to extensive and deep land alterations that have severely damaged the integrity of any archaeological resources. ROW disturbances can be attributed to typical road construction, exhibiting ditching, grading, some utility installation (Plates 1, 3, 5-6, 9, 13-14, 23, 28, 31, 34-35, 37-38, 41, 44-45, 47), residential (Plates 4, 26, 28, 46), and commercial development (Plates 6, 10, 15, 20, 27, 43). Due to the extent of previous disturbance, the Garner Road, Rymal Road, and Garth Street ROWs do not exhibit archaeological site potential. No further archaeological assessment is required on these lands (Figures 6 to 11: areas marked in yellow).

A number of previous archaeological assessments have been undertaken on land adjacent to Garner Road. This work includes the new Highway 6 alignment (MTO 1992), the property for an earth borrow source for the new Highway 6 (Dolling 2002, ASI 2006, FAC 2007), the Mattamy subdivision development at the Ancaster Fairgrounds (ASI 2007), and the Paletta Lands subdivision (ASI 2004). Further work should be carried out at the Mitsu site (AhGx-333), if the proposed project extends beyond the disturbed Garner Road ROW. The remaining areas that have been subject to previous archaeological assessment do not require further assessment, if the proposed project extends into these areas.

Beyond the disturbed ROW, a number of areas have remained undisturbed. These area include agricultural fields (Plates 3, 5, 14), open lots (Plates 8, 16, 23, 28, 32), woodlots (33-34), front lawns of residential properties that have experienced minor landscaping (Plates 21, 36, 40), and the land surrounding 19th century homesteads (Plates 11-12, 19, 24, 39, 42). These areas have remained relatively undisturbed, and they exhibit archaeological site potential due to their proximity to primary water sources and historic transportation routes. Should road improvements encroach upon undisturbed land with archaeological potential beyond the disturbed ROW, a Stage 2 archaeological assessment should be conducted (Figures 6 to 11: areas marked in green).

As mentioned Section 2.3.1, two cemeteries are situated adjacent to the study corridor. At the Garner's Corners Cemetery (Figure 6), if road improvements impact land beyond the ditch along Garner Road (Plate 7) or land immediately adjacent to Southcote Road, a cemetery investigation will be necessary in order to determine the presence and extent of burial features adjacent to and within the proposed disturbance area. Similarly, at the Bowman Cemetery (Figure 7), if road improvements impact land beyond the disturbed ROW at the west portion of the cemetery (Plate 17), a cemetery investigation will also be necessary in order to determine the presence and extent of burial features adjacent to and within the proposed disturbance area. The installation of a sidewalk adjacent to the east portion of the cemetery (Plate 18) has in all probability disturbed the land between the ROW and the sidewalk.

5.0 RECOMMENDATIONS AND COMPLIANCE ADVICE

The Stage 1 Archaeological Assessment was completed to assist with the Garner Road/Rymal Road and Garth Street Widening Class EA. The background research determined that 72 archaeological sites have been registered within 500 m of study corridor, two of which are located immediately adjacent to the study corridor. A review of the geography and local nineteenth century land use of the study corridor suggested that it has potential for the identification of Aboriginal and Euro-Canadian archaeological sites.

Based on the results of the property inspection, it was determined that the Garner Road, Rymal Road, and Garth Street ROWs have been subject to extensive and deep land alterations. However, minimal disturbances have occurred beyond the disturbed ROW.

In light of these results, ASI makes the following recommendation:

1. The existing Garner Road, Rymal Road, and Garth Street ROWs do not retain archaeological site potential due to previous ground disturbances. Additional archaeological assessment is therefore not required along this portion of the study corridor;

2. If construction extends beyond the disturbed ROWs, a Stage 2 assessment is recommended on any lands along the study corridor where there is potential for archaeological sites (Figures 6 to 11: areas marked in green), in accordance with the *Draft Standards and Guidelines for Consultant Archaeologists* (MCL 2009); and

3. Prior to any land-disturbing activities adjacent to Garner's Corners Cemetery or Bowman Cemetery, a Cemetery Investigation should be conducted. This work will be done in accordance with the *Draft Standards and Guidelines for Consultant Archaeologists* (MCL 2009), in order to confirm the presence or absence of unmarked graves within the ROW. This work will involve the removal of the topsoil with a Gradall followed by the shovel shining of the exposed surfaces and subsequent inspection for grave shafts.

ASI advises compliance with the following legislation:

- This report is submitted to the Minister of Tourism and Culture as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, RSO 1990, c 0.18. The report is reviewed to ensure that the licensed consultant archaeologist has met the terms and conditions of their archaeological licence, and that the archaeological fieldwork and report recommendations ensure the conservation, preservation and protection of the cultural heritage of Ontario;

- Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with sec. 48 (1) of the *Ontario Heritage Act*;

- The *Cemeteries Act* requires that any person discovering human remains must immediately notify the police or coroner and the Registrar of Cemeteries, Ministry of Small Business and Consumer Services; and

The documentation related to this archaeological assessment will be curated by Archaeological Services Inc. until such a time that arrangements for their ultimate transfer to Her Majesty the Queen in right of Ontario, or other public institution, can be made to the satisfaction of the project owner(s), the Ontario Ministry of Tourism and Culture, and any other legitimate interest groups.

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7.0 OVERSIZED GRAPHICS

Figure 5: Key Plan
Figures 6 to 11: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

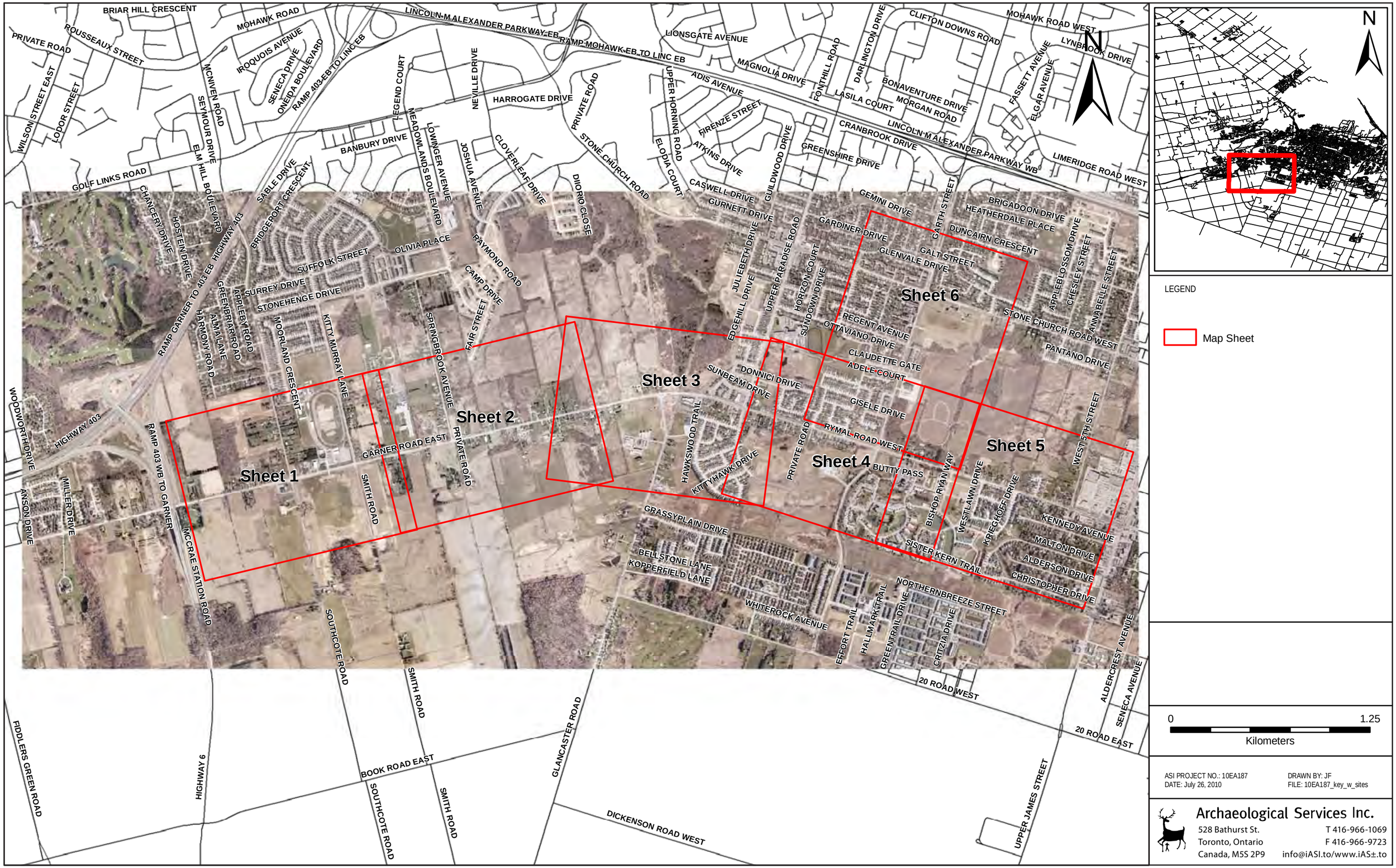

Figure 5: Key Plan

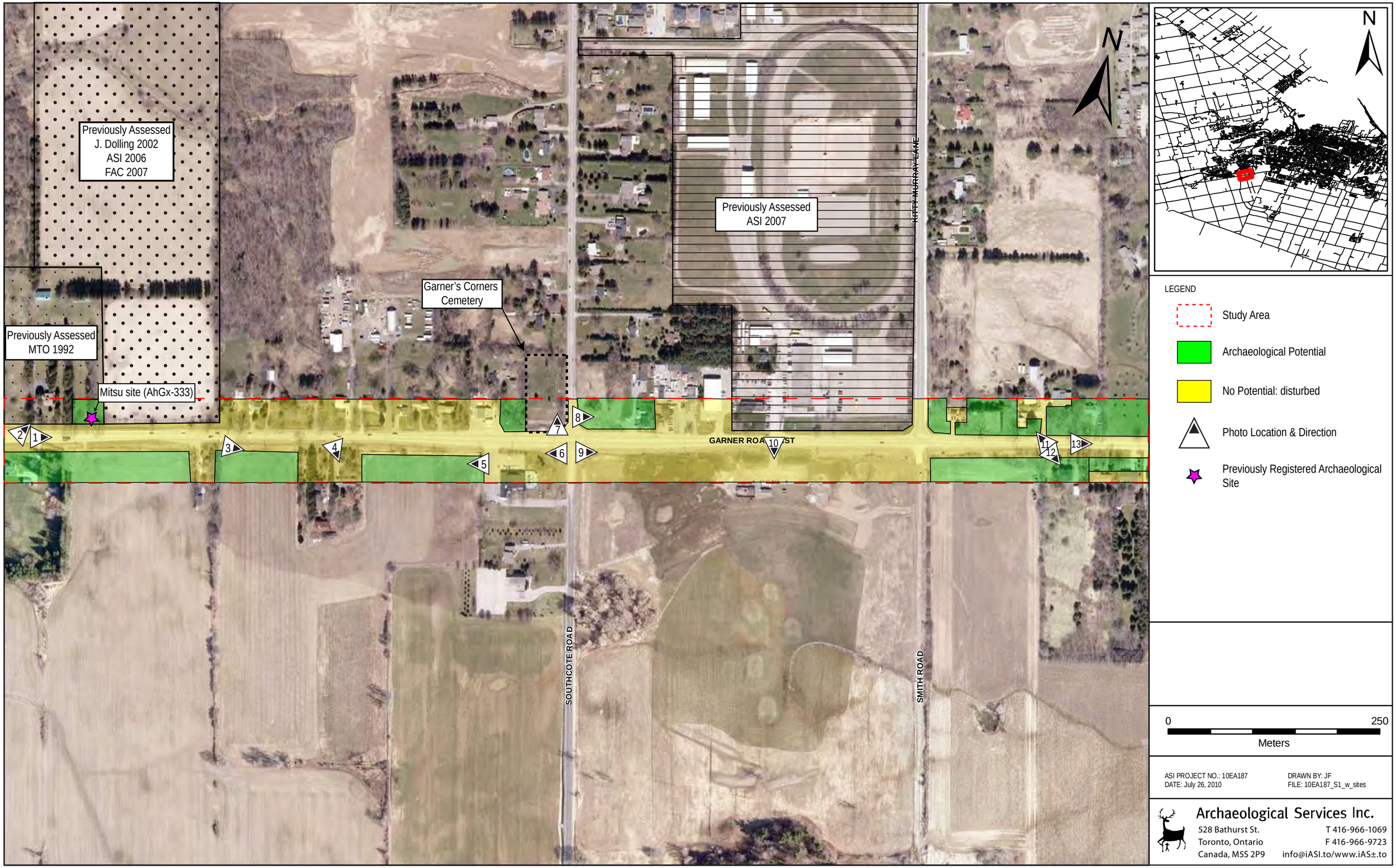

Figure 6: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

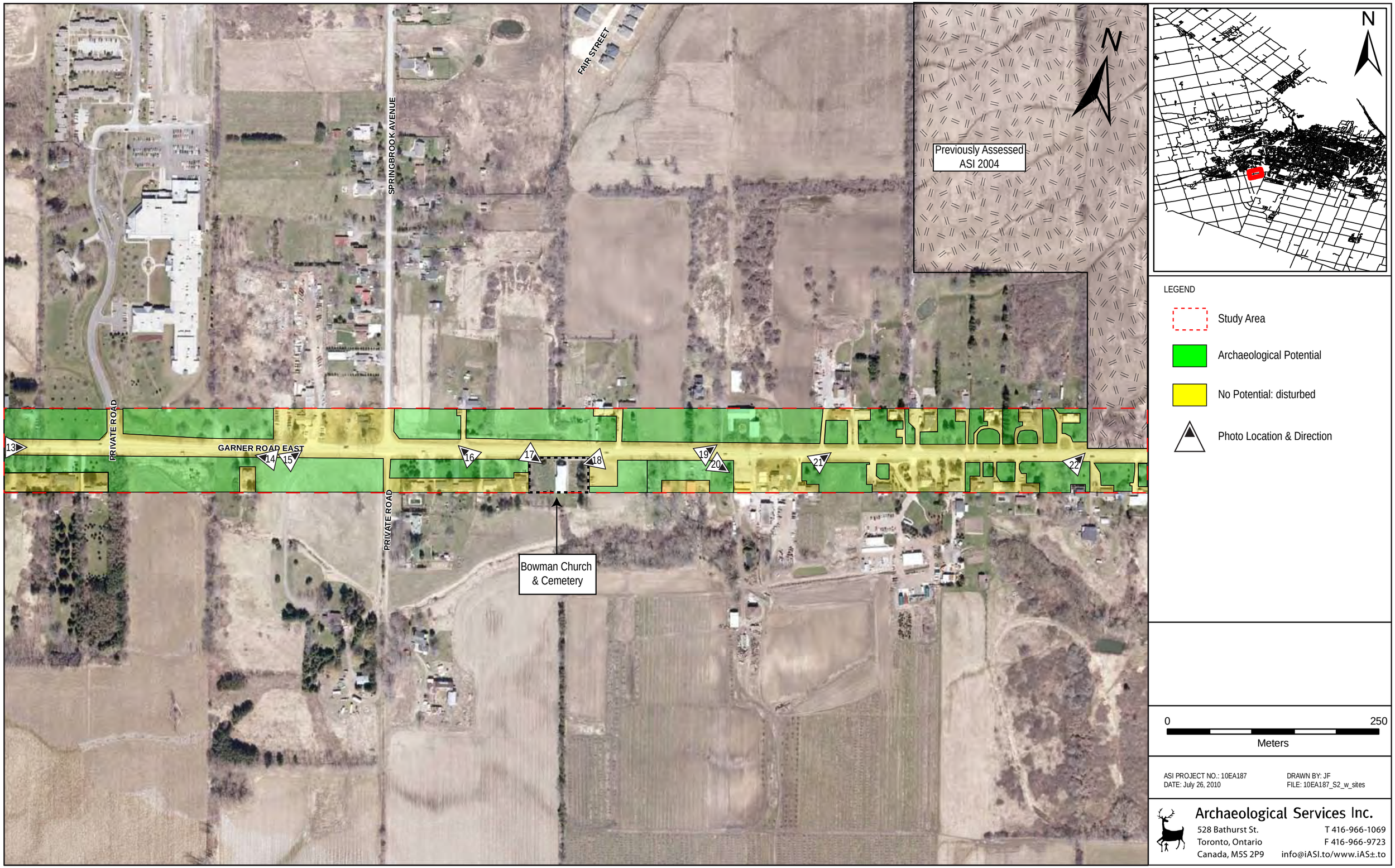

Figure 7: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

Figure 8: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

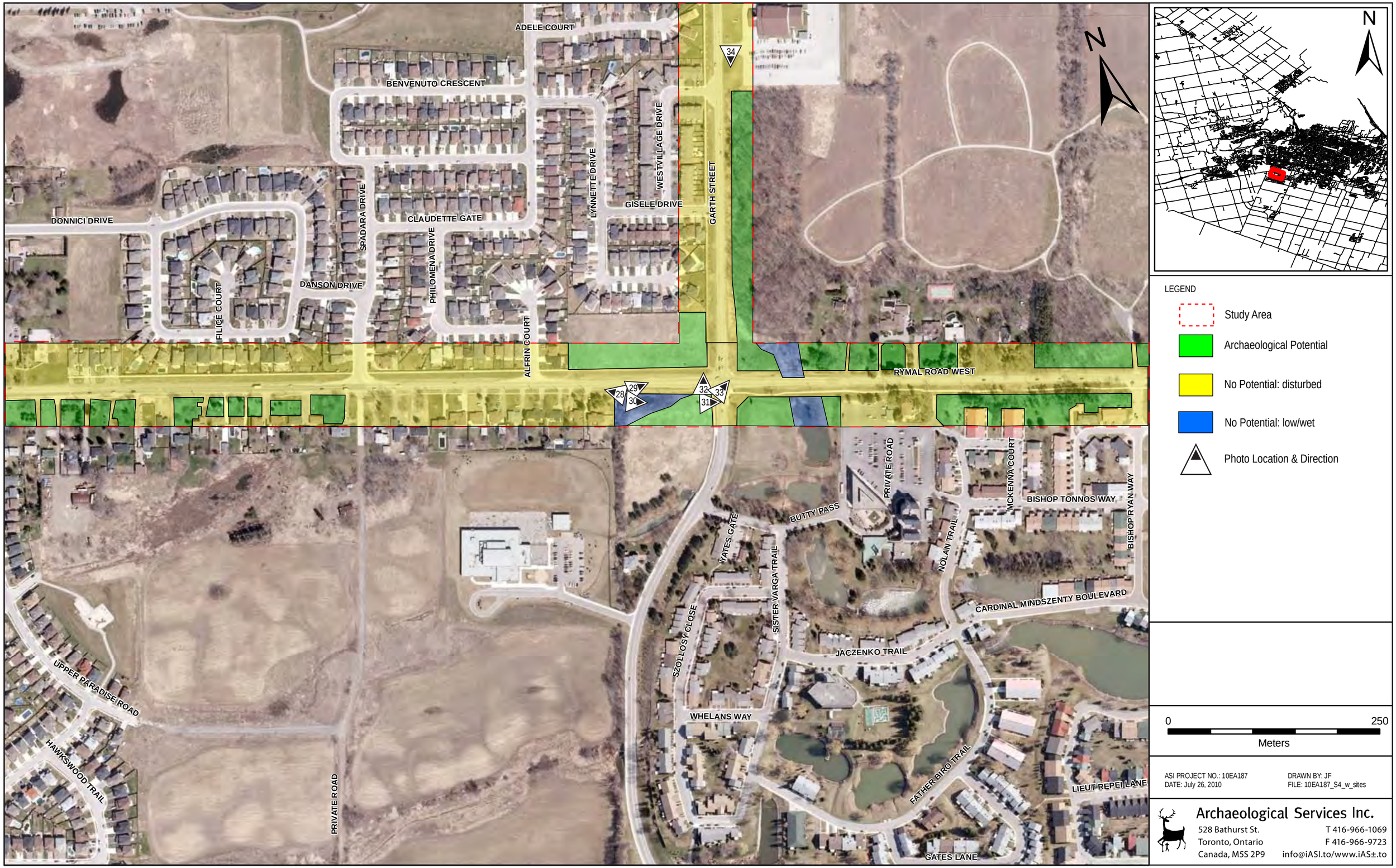

Figure 9: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

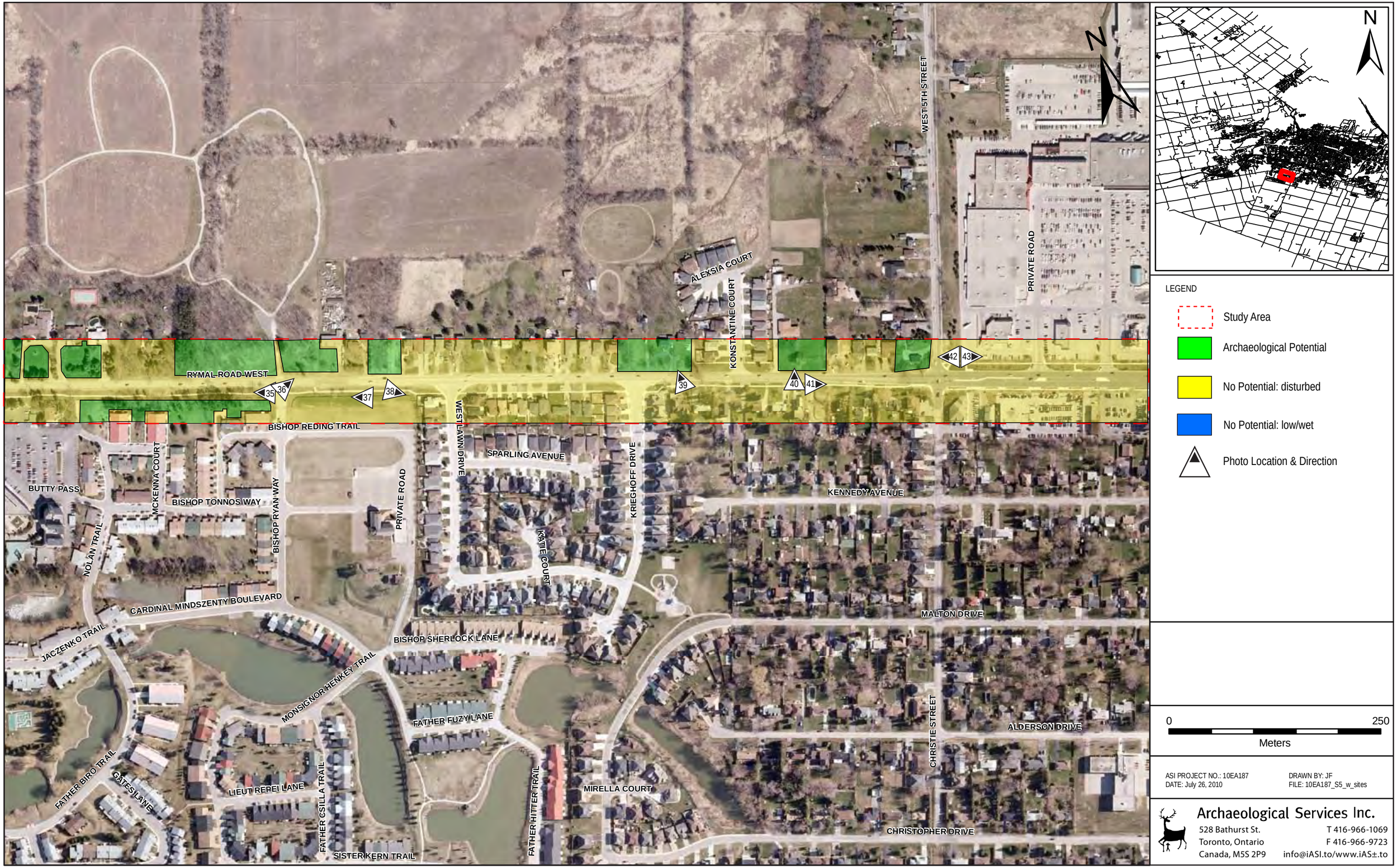

Figure 10: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

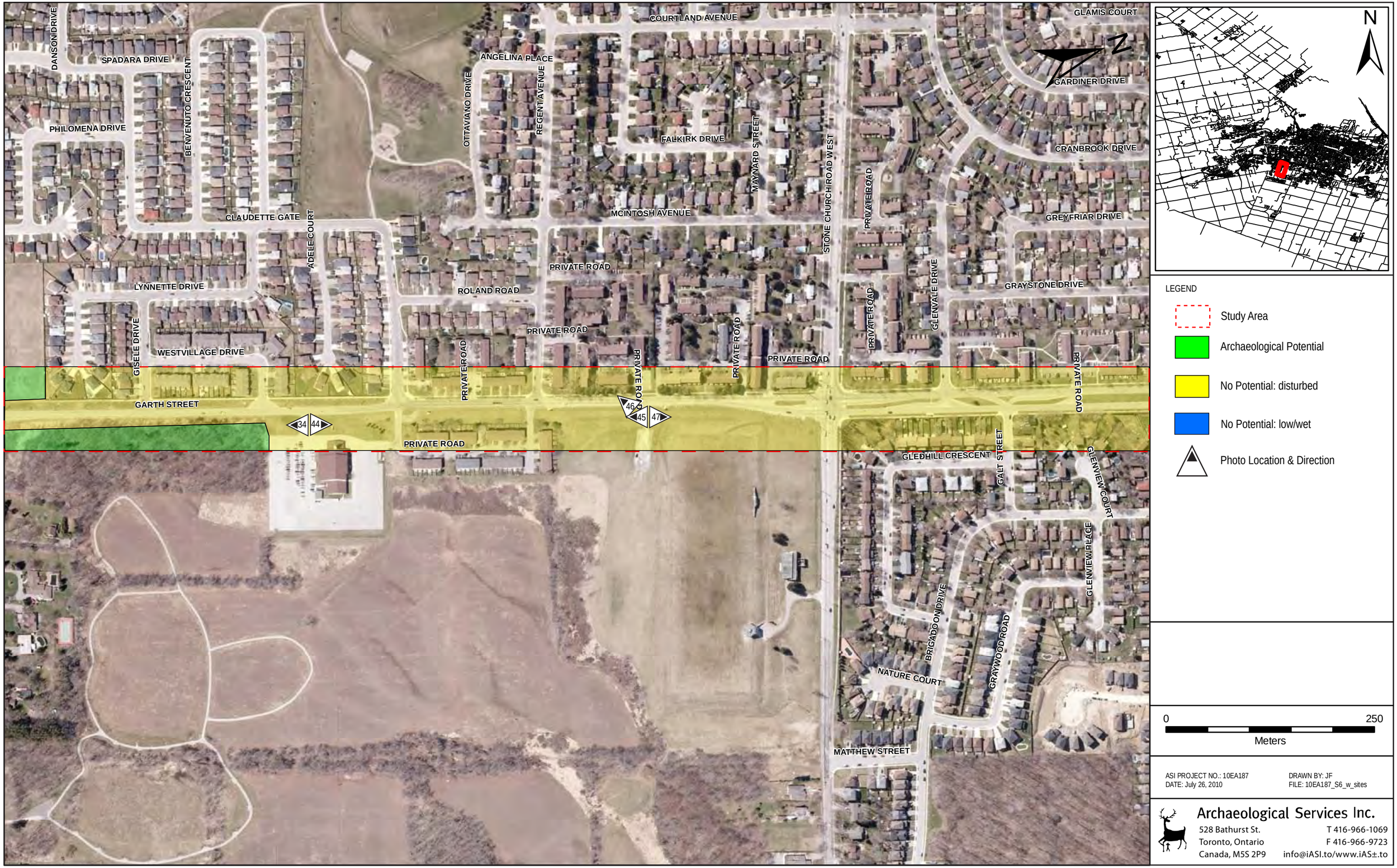

Figure 11: Garner Road/Rymal Road and Garth Street Widening Class EA – Results of the Stage 1 Archaeological Assessment

8.0 PHOTOGRAPHY

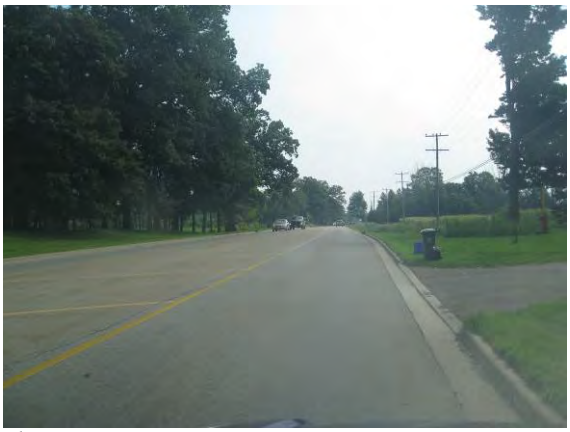

Plate 1: View east-northeast along Garner Rd. ROW has been previously disturbed.

Plate 2: View northeast toward 19th century farmstead. Property was previously assessed (MTO 1992).

Plate 3: View east along disturbed Garner Rd ROW. Potential exists in agricultural field.

Plate 4: View south-southeast toward modern residential development. Grading activities have disturbed ground surrounding house.

Plate 5: View west-southwest along disturbed ROW. Potential exists in agricultural field.

Plate 6: View west-southwest along disturbed ROW. Commercial development has disturbed land beyond ROW.

Plate 7: View north-northwest toward Garner's Corners Cemetery.

Plate 8: View east-northeast across open lot that has remained undisturbed.

Plate 9: View east-northeast along disturbed Garner Rd ROW.

Plate 10: View south-southeast into golf centre. Area has been heavily altered.

Plate 11: View northwest toward historic tree line.

Plate 12: View southeast toward 19th century homestead.

Plate 13: View east-northeast along Garner Rd.

Plate 14: View west across Garner Rd. Note hydrant adjacent to garvel shoulder. Undisturbed ground exists beyond disturbed ROW.

Plate 15: View northeast across Garner Rd with commercial development in distance. Area has been previously graded.

Plate 16: View west-northwest across Garner Rd toward open lot with potential.

Plate 17: View east-southeast toward Bowman Church and Cemetery.

Plate 18: View west-southwest toward Bowman Church and Cemetery.

Plate 19: View northeast across Garner Rd toward 19th century farmstead.

Plate 20: View east-southeast toward commercial development.

Plate 21: View northeast across Garner Rd. to stretch of residential development. Potential exists beyond ROW.

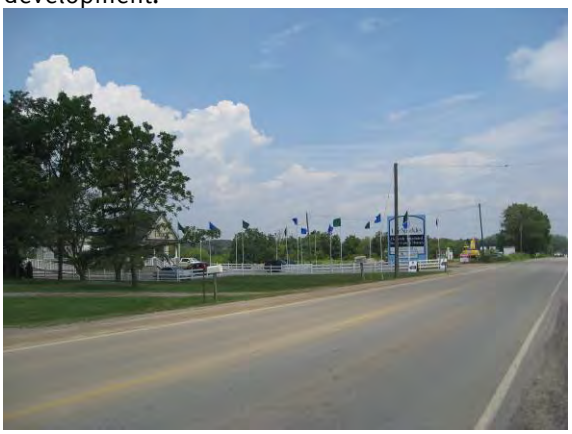

Plate 22: View northeast toward proposed subdivision development (ASI 2004).

Plate 23: View east-northeast along disturbed Garner Rd ROW. Potential exists beyond hydro poles.

Plate 24: View north toward 19th century homestead.

Plate 25: View east-northeast along Garner Rd. Road slopes down to low/wet area.

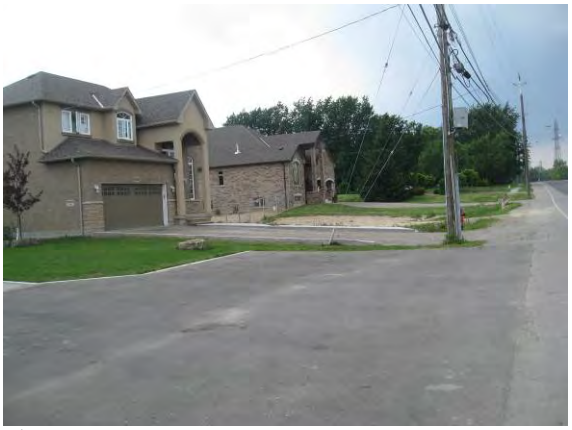

Plate 26: View west-northwest at recent residential development.

Plate 27: View north-northeast toward recent commercial development.

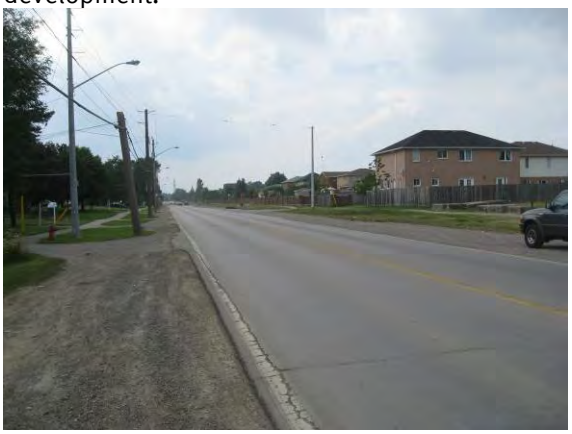

Plate 28: View west-northwest along wide Rymal Rd ROW. Residential development has disturbed adjacent lands.

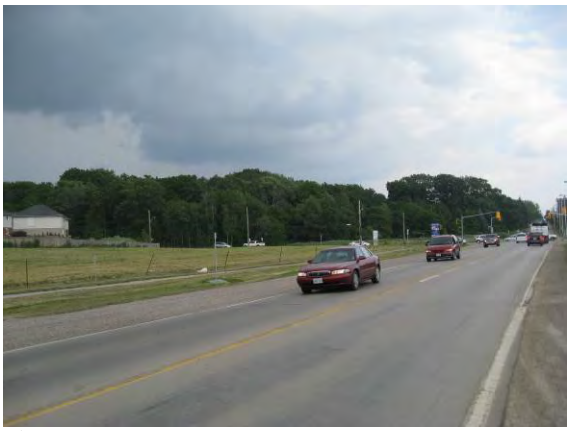

Plate 29: View east along Rymal Rd. Open lot on left has archaeological potential.

Plate 30: View east-southeast along disturbed ROW. Note low/wet ground adjacent to ROW.

Plate 31: View east-southeast across Garth St. Previous construction activities have disturbed the ROW.

Plate 32: View north-northeast across Rymal Rd. Open lot has archaeological potential.

Plate 33: View northeast across intersection to area with archaeological potential.

Plate 34: View south-southwest along disturbed Garth St. ROW. Area between road and parking lot has been graded, but archaeological potential exists in woodlot in distance.

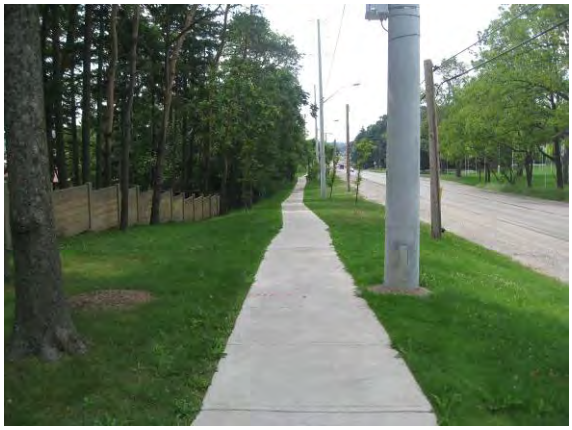

Plate 35: View west-northwest along sidewalk adjacent to Rymal Rd.

Plate 36: View east-northeast across Rymal Rd. Archaeological potential is present beyond fence line.

Plate 37: View west-northwest along fence line with graded slope on either side.

Plate 38: View east-southeast along disturbed Rymal Rd ROW.

Plate 39: View north toward historic property.

Plate 40: View north-northeast toward property with archaeological potential.

Plate 41: View east-southeast along disturbed Rymal Rd ROW.

Plate 42: View west-northwest toward historic property at northwest corner of Rymal Rd and West 5th St.

Plate 43: View east-southeast toward commercial development.

Plate 44: View north-northeast along Garth St ROW. Both sides of road have been graded.

Plate 45: View south-southeast along Garth St ROW. Land adjacent to ROW has been graded.

Plate 46: View west-southwest across Garth St toward residential development.

Plate 47: View north-northeast along Garth St. ROW. Land adjacent to ROW has been graded.

APPENDIX E
COST ESTIMATES

Hamilton Garner/Rymal Road Widening
Road Construction Estimates

Garner/Rymal			Option 1		Option 2		Option 2A	
Item	**Unit**	**Unit Prices**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**
Grading								
Earth Excavation (Grading)	m3	$16	130,853	$2,093,644	67,816	$1,085,057	59,414	$950,622
Asphalt Surface Course	tonne	$114	16,812	$1,916,584	16,825	$1,918,012	14,760	$1,682,618
Asphalt Base Course	tonne	$83	40,714	$3,379,234	34,846	$2,892,235	34,956	$2,901,325
Granular A	tonne	$26	37,031	$962,812	28,582	$743,134	28,740	$747,235
Granular B	tonne	$21	123,437	$2,592,185	95,274	$2,000,746	95,799	$2,011,785
Concrete Sidewalk	m2	$57	21,075	$1,201,265	21,560	$1,228,944	20,178	$1,150,144
Curb & Gutter, New	m	$64	11,761	$752,677	12,514	$800,882	12,527	$801,724
Removal of Asphalt Pavement (Partial Depth)	m2	$2.5	59,990	$149,975	59,990	$149,975	59,990	$149,975
Curb & Gutter, Removal	m	$12	1,726	$20,717	1,726	$20,717	1,726	$20,717
Traffic Control	LS	$310,000	1	$310,000	1	$310,000	1	$310,000
Permanent Pavement Markings	LS		1	$200,000	1	$150,000	1	$150,000
Temporary Concrete Barrier	m	$59	11,761	$693,874	12,514	$738,313	12,527	$739,090
Temporary Concrete Barrier, Relocation	m	$28	11,761	$329,296	12,514	$350,386	12,527	$350,754
Temporary Energy Attenuator	Each	$7,200	27	$194,400	27	$194,400	27	$194,400
Temporary Energy Attenuator, Relocation	Each	$4,100	27	$110,700	27	$110,700	27	$110,700
Environmental Mitigation Measures	LS	$310,000	1	$310,000	1	$310,000	1	$310,000
Landscaping	LS	$103,000	1	$103,000	1	$103,000	1	$103,000
Drainage								
300 mm DIA. PVC CB Leads	m	$34	2,685	$91,290	2,130	$72,420	2,135	$72,590
600 mm x 600 mm Manholes Catch Basins and Ditch Inlets	Each	$1,846	200	$369,200	200	$369,200	200	$369,200
600 mm x 1200 mm Manholes Catch Basins and Ditch Inlets	Each	$2,902	20	$58,040	20	$58,040	20	$58,040
1200 mm Manholes Catch Basins and Ditch Inlets	Each	$3,275	10	$32,750	10	$32,750	10	$32,750
1500 mm Manholes Catch Basins and Ditch Inlets	Each	$4,980	3	$14,940	3	$14,940	3	$14,940
1800 mm Manholes Catch Basins and Ditch Inlets	Each	$7,364	16	$117,824	16	$117,824	16	$117,824
400 mm Pipe Sewer	m	$226	325	$73,473	325	$73,473	325	$73,473
500 mm Pipe Sewer	m	$267	496	$132,352	496	$132,352	496	$132,352
600 mm Pipe Sewer	m	$267	3,711	$990,730	3,711	$990,730	3,711	$990,730
Electrical								
Permanent Illumination (Est. # of Poles)	Each	$8,250	247	$2,041,074	245	$2,017,375	244	$2,014,392
Traffic Signals (3-leg)	Each	$155,000	5	$775,000	5	$775,000	5	$775,000
Traffic Signals (4-leg)	Each	$206,000	1	$206,000	1	$206,000	1	$206,000
Structure								
N/A								
Sub-Total (Grading, Drainage, Electrical, Structures)				$20,223,036		$17,966,605		$17,541,380
Contingency (15%)		15%	15%	$3,033,455	15%	$2,694,991	15%	$2,631,207
TOTAL (Grading, Drainage, Electrical, Structure)				$23,256,492		$20,661,595		$20,172,587
Construction Administration, Sundry, Force Account (10%)	LS	10%	10%	$2,325,649	10%	$2,066,160	10%	$2,017,259
TOTAL CONSTRUCTION COST ESTIMATE				**$25,582,141**		**$22,727,755**		**$22,189,846**
			3%					
Utility Relocation	LS	$800,000	1	$800,000	1	$800,000	1	$800,000
Property Acquisition								
GRAND TOTAL				**$26,382,141**		**$23,527,755**		**$22,989,846**

Hamilton Garth Road Widening
Road Construction Estimates

Garth			Option 1		Option 2		Option 2A	
Item	**Unit**	**Unit Prices**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**
Grading								
Earth Excavation (Grading)	m3	$16	32,713	$523,411	16,954	$271,264	14,853	$237,655
Asphalt Surface Course	tonne	$114	8,575	$977,505	7,298	$831,948	7,503	$855,316
Asphalt Base Course	tonne	$83	3,492	$289,822	3,354	$278,354	3,065	$254,384
Granular A	tonne	$26	8,097	$210,529	6,259	$162,725	6,554	$170,400
Granular B	tonne	$21	26,991	$566,809	20,862	$438,107	21,846	$458,768
Concrete Sidewalk	m2	$57	2,508	$142,964	2,960	$168,706	2,571	$146,541
Curb & Gutter, New	m	$64	2,501	$160,042	2,430	$155,524	2,471	$158,153
Removal of Asphalt Pavement (Partial Depth)	m2	$2.5	11,806	$29,515	11,806	$29,515	11,806	$29,515
Curb & Gutter, Removal	m	$12	605	$7,260	605	$7,260	605	$7,260
Traffic Control	LS	$310,000	1	$310,000	1	$310,000	1	$310,000
Permanent Pavement Markings	LS		1	$50,000	1	$37,500	1	$37,500
Temporary Concrete Barrier	m	$59	1,185	$69,917	1,193	$70,364	1,239	$73,127
Temporary Concrete Barrier, Relocation	m	$28	1,185	$33,181	1,193	$33,393	1,239	$34,704
Temporary Energy Attenuator	Each	$7,200	10	$72,000	10	$72,000	10	$72,000
Temporary Energy Attenuator, Relocation	Each	$4,100	10	$41,000	10	$41,000	10	$41,000
Environmental Mitigation Measures	LS	$310,000	1	$310,000	1	$310,000	1	$310,000
Landscaping	LS	$103,000	1	$103,000	1	$103,000	1	$103,000
Drainage								
300 mm DIA. PVC CB Leads	m	$34	180	$6,120	180	$6,120	180	$6,120
600 mm x 600 mm Manholes Catch Basins and Ditch Inlets	Each	$1,846	20	$36,920	20	$36,920	20	$36,920
600 mm x 1200 mm Manholes Catch Basins and Ditch Inlets	Each	$2,902	4	$11,608	4	$11,608	4	$11,608
1200 mm Manholes Catch Basins and Ditch Inlets	Each	$3,275	5	$16,375	5	$16,375	5	$16,375
1500 mm Manholes Catch Basins and Ditch Inlets	Each	$4,980	7	$34,860	7	$34,860	7	$34,860
1800 mm Manholes Catch Basins and Ditch Inlets	Each	$7,364	3	$22,092	3	$22,092	3	$22,092
400 mm Pipe Sewer	m	$226	0	$0	0	$0	0	$0
500 mm Pipe Sewer	m	$267	178	$47,627	178	$47,627	178	$47,627
600 mm Pipe Sewer	m	$267	785	$209,574	785	$209,574	785	$209,574
Electrical								
Permanent Illumination (Est. # of Poles)	Each	$8,250	47	$391,059	48	$393,560	50	$409,017
Traffic Signals (3-leg)	Each	$155,000	0	$0	0	$0	0	$0
Traffic Signals (4-leg)	Each	$206,000	1	$206,000	1	$206,000	1	$206,000
Structure								
N/A								
Sub-Total (Grading, Drainage, Electrical, Structures)				$4,879,189		$4,305,395		$4,299,517
Contingency (15%)		15%	15%	$731,878	15%	$645,809	15%	$644,927
TOTAL (Grading, Drainage, Electrical, Structure)				$5,611,067		$4,951,204		$4,944,444
Construction Administration, Sundry, Force Account (10%)	LS	10%	10%	$561,107	10%	$495,120	10%	$494,444
TOTAL CONSTRUCTION COST ESTIMATE				**$6,172,174**		**$5,446,324**		**$5,438,889**
			3%					
Utility Relocation	LS	$200,000	1	$200,000	1	$200,000	1	$200,000
Property Acquisition								
GRAND TOTAL				**$6,372,174**		**$5,646,324**		**$5,638,889**

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