Hamilton

City of Hamilton
Watercourse 5 & 6 Class Environmental Assessment Study
Draft Report

November 2007

Submitted by:

DILLON CONSULTING

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1. BACKGROUND

The City of Hamilton, which now includes all the municipalities of the former Regional Municipality of Hamilton-Wentworth, identified the need to undertake a Municipal Class Environmental Assessment Study (Class EA Study) for Watercourse System Improvements of Watercourse 5 and 6 situated in the community of Stoney Creek. The study area for the Watercourse 5 & 6 Class Environmental Assessment Study includes the watersheds of Watercourse 5.0, Watercourse 6.0, Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3, bounded by Lake Ontario to the north, the Escarpment to the south, Fruitland Road to the west and Glover Road to the east (see ***Figure 1.0***).

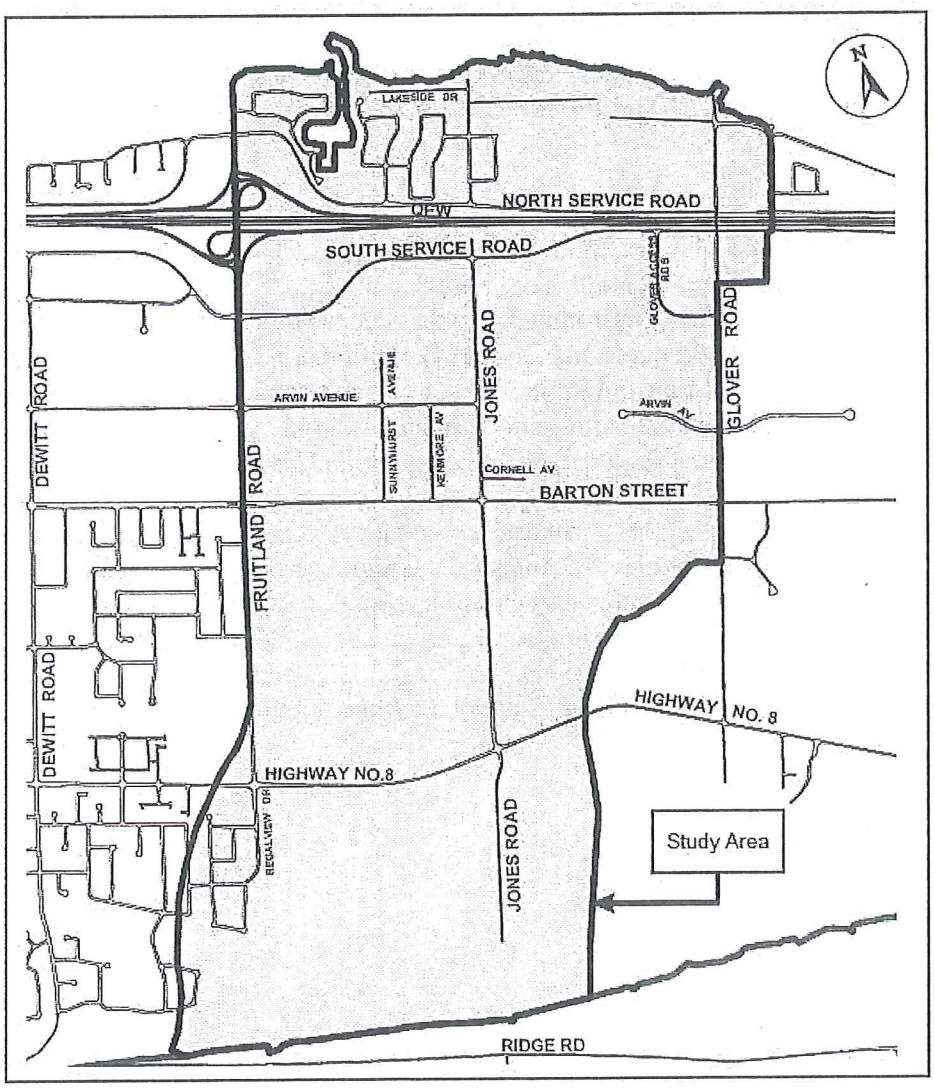


Figure 1.0 Study Area Map

Previous studies, as described below, were completed within the study area and will be used with recent field investigations and analysis to determine required watercourse system improvements and address any environmental impacts associated with the proposed alternatives for watercourse system enhancements.

In 1989, Philips Planning and Engineering Limited completed a detailed hydrologic and hydraulic analysis of Watercourses 5.0 and 6.0 under the Canada/Ontario Flood Damage Reduction Program (FDRP) sponsored by Environment Canada and the Ministry of Natural Resources. Topographic mapping was prepared and checked in accordance with FDRP standards which established the regulatory flood plain for Watercourse 5.0 and Watercourse 6.0.

The Corporation of the City of Stoney Creek produced a Master Drainage Plan (MDP) of the Industrial Corridor which was finalized in 1990 by Philips Engineering Limited. The MDP addressed future drainage requirements and established ultimate watershed boundaries for Watercourses 5.0, Watercourse 5.1, Watercourse 6.0, Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3. The following recommendations were proposed to improve drainage conditions:

- Stormwater management (SWM) storage upstream of Barton Street to attenuate post development peak flows to pre development levels for all lands south of Barton Street on Watercourse 5.0 and Watercourse 6.0;
- Culvert replacement at Barton Street on Watercourse 5.0;
- Culvert underpinning at Arvin Avenue on Watercourse 5.0;
- Culvert replacement at the C.N.R on Watercourse 5.0;
- Culvert underpinning at the South Service Road (SSR) on Watercourse 5.0;
- Culvert replacement at Barton Street on Watercourse 6.0;
- Construct new culvert at Arvin Avenue (future initiative) on Watercourse 6.0;
- Culvert replacement at the C.N.R. on Watercourse 6.0;
- Culvert underpinning at the SSR on Watercourse 6.0;
- Addition of supplementary 2.1 m wide by 1.80 m high culvert cell at the North Service Road on Watercourse 5.0;
- Culvert replacement at the QEW corridor lanes on Watercourse 5.0, Watercourse 6.0 and Watercourse 6.2;
- Flexible mat diversion channel from Watercourse 6.0 to Watercourse 5.0 at the QEW;
- Channel lining and regarding along Watercourse 5.0, Watercourse 6.0 and Watercourse 6.2;
- Diversions from Watercourse 5.1 to Watercourse 5.0 and Watercourse 6.0;

- Diversions from Watercourse 6.1 to Watercourse 6.0;
- Diversions from Watercourse 6.1 and Watercourse 6.3 to Watercourse 6.2; and,
- Diversions from Watercourse 6.3 to Watercourse 7.0.

An investigation of the existing aquatic habitat conditions and potential impacts from the implementation of the MDP proposed drainage works was conducted in 1991 by SNC Lavalin and submitted to the City of Stoney Creek. While no fish were observed, Watercourse 5.0 and Watercourse 6.0 were described as having minimal and moderate potential as fish habitat, respectively. Based on the policies of the time, the study concluded that the proposed drainage works would result in small net impacts and therefore compensation would not be required. It also acknowledged that proposed culvert works coincide with C.N.R operations.

Watercourse system improvements recommendations outlined in the MDP were revisited with the QEW Drainage Report (QEWDR) prepared by UMA Engineering Limited. Additional watercourse drainage enhancements were proposed coincident with MTO's QEW expansion objectives, including:

- Culvert replacement at S. Ramp, QEW and N. Ramp on Watercourse 5.0;
- Additional culvert installation at the NSR on Watercourse 5.0;
- Additional culvert installation from NSR to the Marina on Watercourse 5.0;
- Culvert replacement at the QEW on Watercourse 5.1;
- Construct a diversion ditch from Watercourse 5.1 to Watercourse 5.0;
- Construct a diversion ditch from Watercourse 6.0 to Watercourse 5.1 on the south side of the QEW and remove existing QEW and NSR culverts on Watercourse 6.0;
- Culvert replacement at NSR, QEW and SSR on Watercourse 6.2 with new inlet located at the south west corner of the SSR and Glover Road loop.
- Channel lining and regarding along Watercourse 6.2 from NSR to Lake Ontario (to be completed by City of Stoney Creek);
- Diversion of Watercourse 6.1 to Watercourse 6.2 on the south side of SSR;
- Culvert removal at SSR, QEW and NSR on Watercourse 6.1;
- Diversion of Watercourse 6.3 to Watercourse 6.2 along the south side of the SSR. This also requires installation of a culvert through the Glover Road paved slope and the installation of a culvert under the Glover Road loop at the SSR; and,
- Culvert removal at SSR, QEW and NSR on Watercourse 6.3.

A preliminary servicing report (PSR) was prepared in 1996 by Planning Initiatives Limited in support of the Trillium Neighbourhood Secondary Plan which included portions of the

Watercourse 5.1, Watercourse 6.0, Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3 watersheds. The report addressed storm drainage, stormwater management and servicing requirements resulting in additional watercourse system recommendations for implementation as development proceeds.

In May 2005, A.J. Clarke and Associates Limited completed the Hydrologic and Hydraulic Analysis for Bridgeport Watercourses to support the Bridgeport commercial and residential subdivision application within the Trillium Neighbourhood Secondary Planning area (revised in January 2006). This study considers the conclusions and recommendations outlined in the MDP, the QEWDR and the PSR in determining the following preferred proposed drainage works for Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3:

- Relocate and design Watercourse 6.1 using Natural Channel Design principles from NSR to Lake Ontario to convey 100 year peak flows;
- Construct three new culverts downstream of the QEW on Watercourse 6.1;
- Since the deepening of Watercourse 6.2 is discouraged, Watercourse 6.2 should remain "as is" from NSR to Lake Ontario to convey baseflow while higher flows will be directed by an overflow grate into a storm sewer within the watershed of Watercourse 6.3; and,
- Construct three new culverts downstream of the QEW on Watercourse 6.2.

During the course of this study, the proposed drainage works for the Bridgeport development have been approved and construction on Phase I is underway.

As an update to previous Master Drainage Plans within Stoney Creek, the City of Hamilton completed the Stormwater Quality Management Strategy, Community of Stoney Creek Master Plan in April 2006 (Philips Engineering). This report provides recommendations for an integrated stormwater management approach (quantity and quality control) for existing and new developments on a watershed basis. Confirmation of the completed and remaining works proposed in the MDP is also included. Diversions completed as part of the MTO QEWDR works are listed and forms the basis of the current sub-catchment drainage boundaries shown in the figures.

In May 2006, Hamilton Region Conservation Authority (HCA) filed Ontario Regulation 161/06, Regulation of development, interference with wetlands and alterations to shoreline and watercourses which allows HCA to regulate a broader scope of natural features and activities, including development within regulated areas and any interference or alteration to watercourses, wetlands and shorelines. By regulating these areas, conservation authorities can is manage

changes to watercourses, shorelines, floodplains, wetlands and steep slopes to prevent and minimize loss of life and property damage from floodwaters and to maintain natural features. Therefore, the main objective of Ontario Regulation 161/06 is to ensure public safety with regards to natural hazards through issuance of permits for works within or in proximity to lakes, rivers, streams or wetlands, as may be required. Lands adjacent to Watercourse 5.0, Watercourse 6.0, Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3 are regulated by HCA as shown in ***Figure 1.1***. The approval requirements for any proposed works within these regulated must be considered when assessing the proposed alternatives.

Also ongoing is the City of Hamilton's Growth Related Integrated Development Strategy (GRIDS) project and Integrated Stormwater Master Plan. The GRIDS project recommends an expansion to the urban boundary within the watersheds of Watercourse 5.0 and Watercourse 6.0 south of Barton Street. The Integrated Stormwater Master Plan is a city wide comprehensive stormwater (quantity and quality) servicing master plan, concentrating on areas of Hamilton serviced by separate storm sewer systems. Watercourse 5 & 6 Class EA Study alternatives should consider the recommendations of the GRIDS project and coincide with the stormwater management policies and strategies developed through the Integrated Stormwater Master Plan.

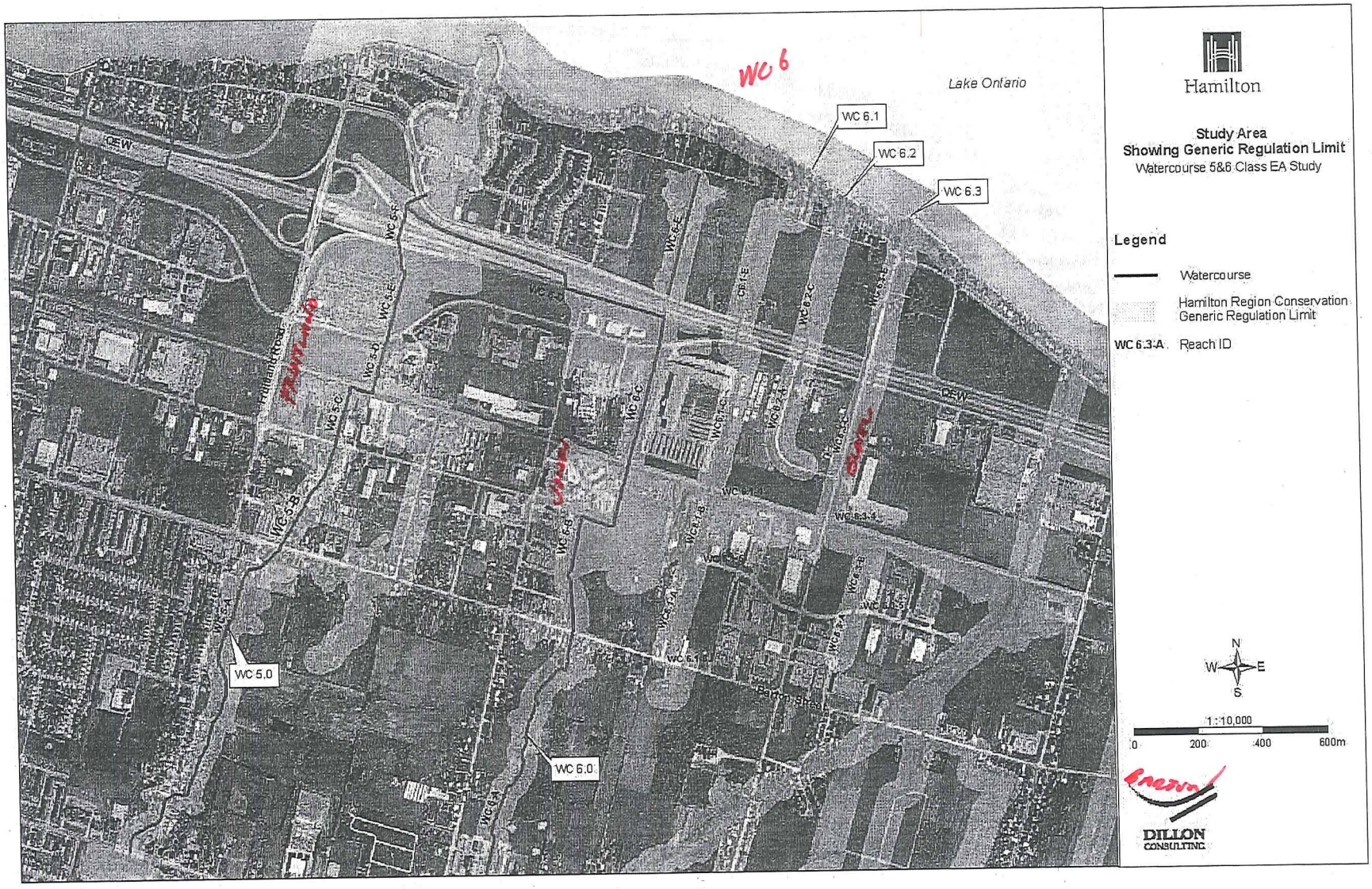


Figure 1.1 Study Area and Generic Regulation Limit

1.1 Problem/Opportunity

It is anticipated that the areas surrounding Watercourses 5.0, Watercourse 6.0, Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3 will experience significant development in the coming years.

On Watercourse 5.0 and Watercourse 6.0, the lands south of Barton Street are described as areas of urban expansion (i.e. building out the current urban boundary) based on conclusions from the recent GRIDS project. Recent discussions with City staff indicate that commercial/industrial developments are proposed for the vacant lands between Barton Street and the QEW. Previous studies, as described above, indicate that these watersheds are characterized as having wide and undefined flood plains due to the following drainage constraints: relatively flat topography, undersized watercourse crossings, inadequate watercourses capacities, and deficient outlets to Lake Ontario. As a result, flooding problems impacts existing and proposed developments.

As noted above, commercial and residential development is underway adjacent to Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3, north of the QEW (i.e. Bridgeport). To date, the completion of the certain works recommended in the MDP and associated with the QEW expansion, namely diversions between Watercourse 6.1, Watercourse 6.2, Watercourse 6.3 and Watercourse 7.0 have not been confirmed. South of the QEW, limited studies have been undertaken that characterize the flood plain, channel conveyance and culvert capacities. However, it is reasonable to conclude that previously proposed works would improve deficient drainage conditions and alleviate potential flooding problems. Based on recent discussions with City of Hamilton staff, new infill commercial/industrial developments are proposed along these watercourses between Barton Street and the QEW, which may results in, further flooding problems.

Watercourse 5.0 and Watercourse 6.0 (Primary Watercourses) have been studied and characterized with like problems compared to those described for Watercourses 6.1 to 6.3 (Secondary Watercourses). While the approach to analysing these sets of watercourses are different, it is evident that without watercourse system improvements on both the Primary and Secondary Watercourses, flooding problems would persist in existing development areas and opportunities for future development would be limited. Therefore, the City of Hamilton must determine the most appropriate course of action for addressing current deficiencies in Watercourses 5 and 6 and their tributaries to support further development within these watersheds.

1.2 E A Process

The Municipal Class EA (June 2000) provides a decision-making process to ensure that all relevant engineering and environmental features are considered in the planning and design of municipal infrastructure. The process requires public and agency involvement at a number of points. The Watercourses 5 and 6 improvements area generally categorized as a "watercourse management project", which is intended to minimize the impacts of flooding, erosion and bank and valley wall instabilities (Page C-16, Municipal Class EA).

The Watercourse 5 and 6 project is classified as a "Schedule B" Class EA. The Class EA identifies the following as a Schedule B project, "works undertaken in a watercourse for the purposes of flood control or erosion control, which may include: bank or slope regarding; deepening the watercourse; relocation, realignment or channelization of watercourse; revetment including soil bio-engineering techniques; and reconstruction of a weir or dam.." (Page I-15, Municipal Class EA) Schedule B projects have the potential for some adverse environmental effects. Schedule B projects are approved under the EA Act provided they follow Phases 1 and 2 of the Class EA process and are "screened". Based on the objective of avoiding or minimizing adverse environmental impacts, the screening process involves the identification and evaluation of design options, the preparation of an inventory of the "environment" potentially affected by the project, public and agency consultation and an assessment of the impacts of the preferred Preliminary Design, including measures to mitigate adverse impacts. The screening process is documented in an Environmental Screening Report.

For this project, the planning process involved the first two phases of the Class EA as follows:

- Phase 1: Identify problem or opportunity.
- Phase 2: Identify and evaluate alternative solutions taking into account the full definition of the environment as well as public and agency input to select a preferred solution.

Upon completion of Phase 2 of the Class EA process, the project schedule is confirmed.

Figure 1.2 - Municipal Class Environmental Assessment Process outlines the Class EA process for Schedule B projects and key dates for this study.

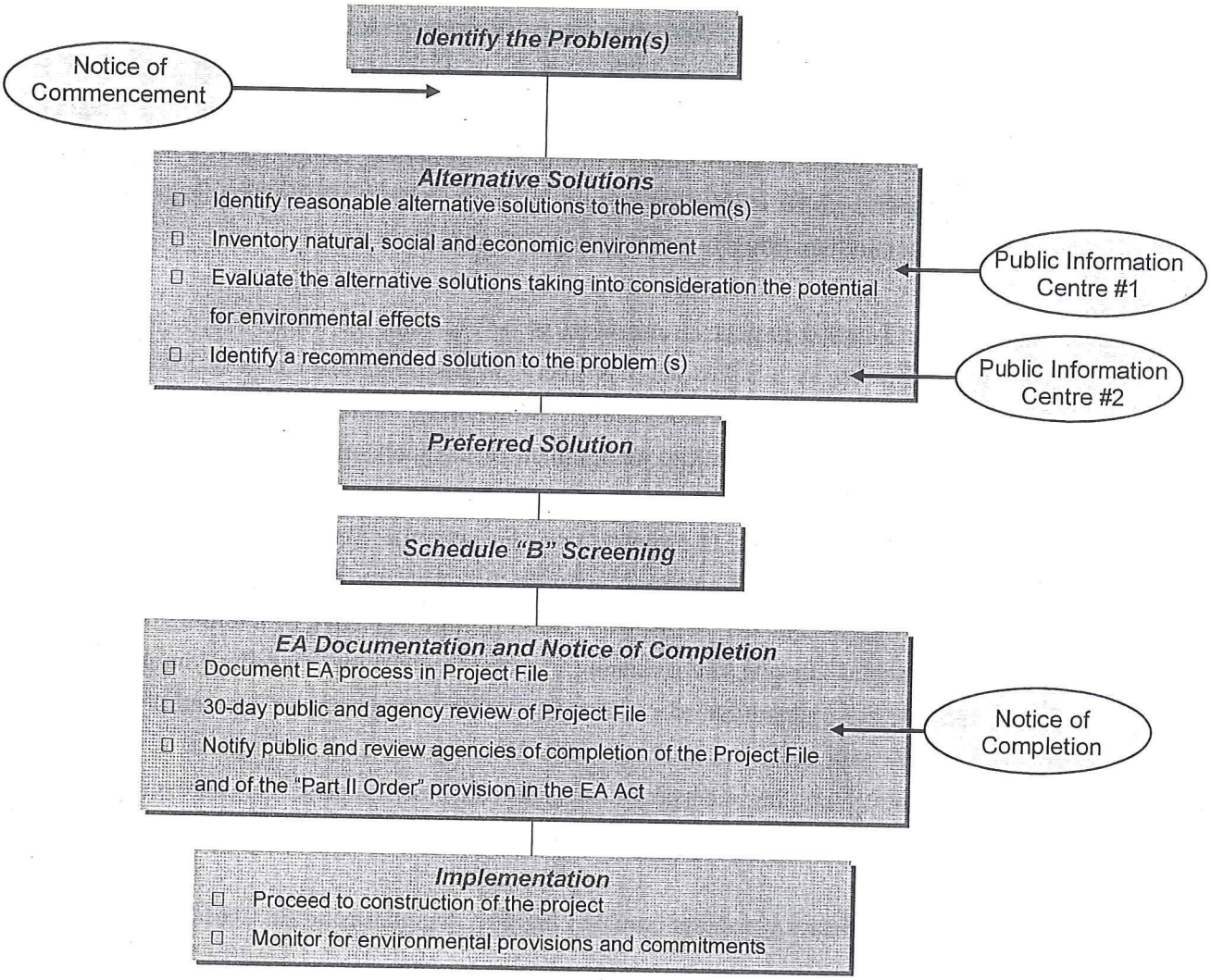


Figure 1.2 Municipal Class Environmental Assessment Process - Schedule B Projects

1.3 Public and Agency Consultation

Consultation with the public and agencies is required by the Class EA process and is considered by the City as an important part of all infrastructure projects. The Class EA specifies two mandatory points of contact for Schedule B projects:

- Invitation for public and agency comment on the problem identified and the alternative solutions considered; and
- Notice of completion for the project outlining the opportunity for public and agency review of the documentation.

The following subsections document how the City has met these requirements.

1.3.1 Notice of Study Commencement and Public Information Centre

A Notice of Study Commencement and Public Information Centre (PIC) was placed in the *At Your Service* page of the Hamilton Spectator on March 30, 2007 and April 5, 2007 advising residents and local businesses of the project and inviting attendance at the April 12, 2007 PIC. The notice was also posted to the project website (http://www.hamilton.ca).

In addition, the City distributed notices on March 22 to Provincial Ministries, local agencies, various City Department, local interest groups, developers and residents in the Study area. The distribution list for residents in the Study Area was produced via a bulk mailout that the City contracts out to a company. This mailout company produces a grid distribution area that will meet the requirements of the Study Area provided. As such some residents outside the direct Study Area are issued notices. The grid distribution is not distance dependent from the Watercourses but rather a blocked out area that the mailout company produces to sufficiently cover the Study Area needs. A copy of the notice and contact list are included in ***Appendix A.***

Public Information Centre #1

A Public Information Centre (PIC) was held on April 12, 2007 at the Stoney Creek Municipal Building, from 6:00 p.m. to 8:30 p.m. Display panels provided attendees with background information on the project, an overview of the Municipal Class EA process, problem statement, summary of existing conditions, evaluation criteria, list of alternatives for consideration, evaluation of the alternatives, technically preferred solution, and next steps in the study. The PIC was an informal event with staff available to discuss the project and respond to further questions. A copy of the displays can be found in ***Appendix A.*** Fifty-four people signed in and attended the PIC. Several residents in attendance stated concerns with existing flooding of the watercourses onto their properties. A few residents brought photographs to show the flooding from several storm events. A few residents indicated the Study Area should be expanded to include from Barton Street south to the escarpment. Attendees were asked to fill out a comment form recording their thoughts on the project. Eight comment forms were received at and following the PIC (***Appendix A)***.

1.3.2 Public Information Centre # 2

A second PIC was held on June 21, 2007 from 6:00 p.m. to 8:00 p.m. at the Stoney Creek Municipal building. Display panels provided attendees with information on the Class EA process, summary of the previous PIC, evaluation of alternatives and selection of the

recommended alternatives, potential impacts and proposed mitigation and information on the next steps in the study. Twenty people signed in and attended the PIC. Several of the attendees agreed with the recommended alternatives and asked about the timeline of the project. Two comment forms were received at and following the PIC.

1.3.3 Consultation with Agencies

The following table outlines the Agencies contacted for this project.

Table 1.1 - List of Agency Contacts

AGENCY TYPE	AGENCY/DEPARTMENT
Federal Agencies	Fisheries and Oceans Canada
Provincial Ministries	Ministry of Agriculture and Food
	Ministry of Culture (Regional Office)
	Ministry of Culture (Heritage and Libraries Branch)
	Ministry of the Environment (Hamilton Regional Office)
	Ministry of the Environment (Hamilton District Office)
	Ministry of Natural Resources
	Ministry of Transportation
	Niagara Escarpment Commission
City of Hamilton	Planning and Economic Development Department, Long Range Planning
	Capital Planning and Implementation, Public Works Department
City Councillors	David Mitchell, Ward 11 Councillor
Local Agencies	Hamilton Conservation Authority
	Hamilton-Wentworth District School Board
	Hamilton-Wentworth Catholic Schools
Utilities and Railways	Canadian Pacific Railway
Local Interest Groups	Bay Area Restoration Council (BARC)
	Hamilton Waterfront Trust
First Nations Representatives	Ontario Secretariat for Aboriginal Affairs

	Indian and Northern Affairs Canada

1.3.4 Comments Received

Project staff received comments in the form of written correspondence (letters and emails) and phone calls from agencies and members of the public throughout the study. Comment forms and letters are included in ***Appendix A***.

Table 1.2 summarizes the comments received about the project and the City response.

Table 1.2 - Comments Received

Key Issues Raised	City Response
Agencies	
Indian and Northern Affairs Canada stated the project may impact First Nations and recommended that the City identify and notify potentially impacted First Nations early in the study.	None required since no First Nations lands within the study area.
Public Comments	
Whose responsibility is it to maintain flows from the escarpment and keep the watercourses and culverts free from debris?	The study did not focus on drainage from the escarpment as these areas were not identified in previous studies as areas of flooding concern. Include a note regarding City inspection of culverts
Existing yard flooding during storm events. Resident requested City staff come out to site for a field visit.	Filed visit completed. Flooding results from under capacity road-side ditch not from Watercourse 5.0 or 6.0. Local drainage issue that could be addressed through maintenance of ditches.
Stormwater runoff concerns along rear of property. The culvert north of the property is often plugged with debris. The resident also stated there is a muskrat problem in the area.	Cause of flooding in this location has not been assessed as it was not highlighted as a flooding concern in previous reports. Muskrat issue has been forwarded to include contact name
Resident had extensive flooding surround house during a December 2006 storm event.	Proposed alternative will address frequency of flooding by upgrading culvert capacity.
There is an extensive rat and erosion problem in the drainage ditch at the front of the property.	Field visit was completed to investigate erosion concerns. No extensive erosion was evident. Muskrat issue has been forwarded to include contact name
A resident provided information on wildlife in and around the marina. The resident also stated there are groundwater concerns in the study area.	The City stated the wildlife information provided will be used when evaluating the alternative watercourse systems. The City also responded the proposed alternatives will not have groundwater impacts.
The resident is unable to obtain a building permit from the City for his property and would like to sell the	At this time, land acquisition needs have yet to be determined.

Table 1.2 - Comments Received	
Key Issues Raised	**City Response**
property back to the City.	
Resident would like the flows from Watercourse 5 diverted to Watercourses 5.1. The resident is concerned the flows from Watercourse 5 are causing poor water quality in the New Port Marina.	The focus of the current study is surface water drainage and not water quality. The source of poor water quality in the Marina has not been investigated as part of this study. Also the impacts to Watercourse 5.1 must be considered prior to diverting flows.

1.3.5 Notice of Completion

The City will place an advertisement in the *At Your Service* page of the Hamilton Spectator advising residents that the Watercourse 5 and 6 Class EA has been completed and that documentation is available at the City offices at the following locations for a 30-day public review:

Office of the City Clerk
71 Main Street West
City Hall, 2nd Floor
Hamilton, Ontario, L8P 4Y5
Tel: 905.546.CITY
Hours : 8 :30 to 4 :30 business days

Capital Planning and Implementation Division
Public Works Department
320-77 James Street North
City of Hamilton, Ontario, L8R 2K3
Tel : 905.540.2424 Ext. 2218
Hours : 8 :30 to 4 :30 business days

The notice will also be mailed to those on the mailing list, including all stakeholders that provided comments and distributed to residences in the vicinity of the study area. A copy of the Notice of Completion is included in ***Appendix A***.

Any person may request that the Ministry of Environment issue a Part II Order of this Class EA Project File following the procedures set out in the Municipal Class Environmental Assessment (June 2000). The procedure is summarized as follows:

1. Any party with a concern can bring it to City of Hamilton's attention at any time during the planning process.

2. If a concern is not resolved to the satisfaction of the party through discussions with the City, the party may request that the City voluntarily proceed with additional phases of the Class Environmental Assessment planning process (e.g. a Schedule B project to a Schedule C project).

3. If City of Hamilton declines and the party wishes to pursue the concern by seeking a Part II Order, the party may request that the Minister issue a Part II Order by writing to the Minister of the Environment (copying the request to the City) before the expiry of the 30 day notice period. The Notice of Completion will state the date of expiry of the 30 day notice period. Part II Order requests made after the end of this period will not be considered by the Ministry of the Environment.

Comments, at any time, may be directed to:
Mr. Enzo Florio, B.A., A.Sc.T.
Project Manager – Strategic & Environmental Planning
Capital Planning and Implementation Division, Public Works Department
City of Hamilton
320-77 James Street North
Hamilton, Ontario, L8R 2K3
Tel: 905.546.2424 Ext. 6413
Fax: 905.546.4435

2. EXISTING CONDITIONS

This chapter describes the existing conditions within the study area on both the Primary Watercourses (Watercourses 5.0 and 6.0) and Secondary Watercourses (Watercourses 6.1, 6.2 and 6.3).

2.1 Existing Conditions Approach

The field study limits for Watercourse 5.0, Watercourse 6.0, Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3 include the channels and contributing drainage areas from just south of Barton Street to Lake Ontario as these areas were identified as areas of flooding concern in previous studies. A review of background information and field surveys was undertaken to carry out an analysis of existing conditions within these watercourses. The existing conditions assessment has been described in terms of the technical environment components, such as hydraulic capacities of channels and crossings, and the structural details, and the natural environment components, such as fluvial geomorphology and the aquatic and terrestrial resources, and the socio-economic conditions as outlined in the following sections.

2.1.1 Technical Environment Approach for Primary Watercourses

A hydraulic assessment of Watercourses 5.0 and Watercourse 6.0 was completed using the Flood Damage Reduction Program (FDRP) mapping, the Mater Drainage Plan, and the QEW Drainage Report, described above in Section 1 Background, and observations made during site visits. The watercourses were examined on a reach basis using existing flood plain mapping, where applicable, and described in terms of conveyance of regulatory flows calculated in previous hydrologic modelling (100 year return period) and flood plain conditions. Each reach was characterized as having capacity concerns if any of the following conditions were present: wide floodplain, undefined floodplain (i.e. spills between watersheds), or development impacted. At each watercourse crossing, an assessment of conveyance capacities relative to the 100-year peak flow generated from FDRP mapping was completed. Culverts with a capacity less the 100-year peak flow were described as under capacity and likely result in flooding problems. Visual inspections at each culvert were undertaken to determine the structural condition and repair/replacement recommendations. This inspection was conducted by viewing the culverts from both the inlet and outlet and where conditions allowed, the culvert was viewed by walking through the structures. The physical features of the culverts were determined, including material, shape, and minor deficiencies. Measurements and photos of each structure, of culvert components and of significant areas of deterioration were taken. Where possible, concrete condition was assessed by hammering the surface and noting irregularities. Conditions for the

technical environment also include the status of the proposed drainage works outlined in the MDP and QEWDR, some of which have been confirmed in the Stormwater Quality Management Strategy, Community of Stoney Creek Master Plan in April 2006 (Philips Engineering). This analysis provides information on the general character of the area, and identifies problem areas and potential solutions.

A summary of the findings is presented below. Photos of the crossings are included in ***Appendix B*** with detailed hydraulic analysis included in ***Appendix C.***

2.1.2 Technical Environment Approach for Secondary Watercourses

A hydraulic assessment of Watercourses 6.1 to 6.3 was completed using the information available in the Mater Drainage Plan, the QEW Drainage Report, and the Hydrologic and Hydraulic Analysis for Bridgeport Watercourses described above in Section 1 Background. Observations made during site visits and simple computer modelling (i.e. CulvertMaster and FlowMaster) were used to fill any data gaps. The watercourses were examined on a reach basis using existing modelling and information where applicable, or simple modelling of representative sections. Each reach was described in terms of conveyance of regulatory flows (100 year return period) based on previous hydrologic modelling and was characterized as having capacity concerns if the flow was not conveyed in the channel with potential impacts to existing or future developments. At each watercourse crossing, an assessment of conveyance capacities relative to the 100-year peak flow generated in MDP hydrologic modelling. Culverts with a capacity less the 100-year peak flow (existing and/or future) were described as under capacity and likely result in flooding problems. Visual inspections at each culvert were undertaken to determine the structural condition and repair/replacement recommendations. Dimensional and photographic records were taken of each culvert at both the inlet and outlet and visual assessments of the structures were performed similar to the procedure noted above. With the exception of the QEW culverts, in all cases, due to either heavy silting of the culverts or limited headroom, access to the interior of the structures was limited and as such, a thorough structural assessment was not possible. The existing conditions for the technical environment also include the status of the proposed drainage works outlined in the MDP, QEWDR and the Bridgeport report. The Stormwater Quality Management Strategy, Community of Stoney Creek Master Plan indicates that diversions from Watercourse 6.1 and Watercourse 6.2 to Watercourse 6.3 have been completed, which conflicts with the previous studies recommendations and must be confirmed. This analysis identifies problem areas and potential solutions

A summary of the findings is presented below. Please see ***Appendix B*** for crossing details and ***Appendix C*** for the detailed hydraulic analysis.

2.1.3 Natural Environment

Watercourses within the area of interest were observed in the field and characterized as to their geomorphic attributes. The watercourses were examined on a reach basis and characterized as being either "in regime", in transition or in adjustment, hereafter referred to as stable or unstable. The nature of the reach's "sensitivity to erosion" was also assessed. Further to the empirical evidence for channel processes, a Rapid Geomorphic Assessment (RGA) Classification was completed. The information derived from the geomorphic assessment will be incorporated into the development of drainage improvement alternatives and will provide insight to, ideally, which watercourses may be better equipped, from a geomorphological perspective, to handle anticipated changes in flow. The findings are summarized below and the detailed fluvial geomorphology assessment, including the geomorphic photo record is included in ***Appendix D***.

Background documentation, such as the Aquatic Habitat and Fisheries Impact Assessment, Watercourses 5, 6, 7, and 9 (SNC Lavalin 1991), consultation with public agencies, such as HCA and the Ministry of Natural Resources (MNR), and field investigations were undertaken to establish the existing habitat conditions within Watercourse 5.0, Watercourse 6.0 and Watercourse 6.1 to 6.3, including observations pertaining to physical channel and flow characteristics, riparian/terrestrial cover, adjacent land use, in-stream cover value, and overall fish habitat potential. Watercourse/culvert locations investigated were labelled appropriately in the field and are represented on figures below. In addition to providing an overview of the environmental character of the area, this analysis will be used to determine potential effects associated with alternative solutions being considered. The prevalent habit conditions are provided below with a detailed analysis in ***Appendix E***.

Given the recommendations from previous studies which included diverting flows from Watercourse 6.3 to Watercourse 7.0, additional field work was undertaken along Watercourse 7.0 to characterize the natural environment of this system. Observations regarding the channel stability, and the aquatic and terrestrial habitats were completed. This information will be used to assess the potential impacts associated with diverting flows to this watercourse as per the proposed alternatives described in later sections.

2.1.4 Socio-Economic

In order to determine the existing socio-economic environment in the Study Area, a review of existing land uses was completed based on the Official Plan designations, aerial photography, site photographs and existing land use mapping provided by the City. In addition, the City provided information on development applications in the Study Area.

A Stage 1 Archaeological Assessment was completed to provide an overview of the history of the area and determine the archaeological potential in the Study Area.

2.2 Existing Conditions Summary for Primary and Secondary Watercourses

Watercourses 5.0 and 6.0 are located exclusively within the Stoney Creek community boundary. The watershed drainage area for Watercourse 5.0, which includes Watercourse 6.0 watershed drainage areas south of the QEW, is approximately 540 ha. The drainage area for Watercourse 6.0 from lands north of the QEW to Lake Ontario is approximately 14 ha. These watersheds drain north to Lake Ontario and extend beyond the study area, originating south of the Escarpment. The topography of the area is relatively flat.

2.2.1 Technical Environment

Based on the FDRP mapping, the flood plain along several reaches of Watercourse 5.0 and Watercourse 6.0 north of Barton Street to Lake Ontario can be described as wide and undefined with spills between watersheds. Within the study area boundary, there are six (6) watercourse crossings on Watercourse 5.0 and six (6) watercourse crossings on Watercourse 6.0, including crossings on the diversion channel. The MDP and the QEWDR determined that crossings along Watercourse 5.0 and Watercourse 6.0, especially at the QEW and the CNR, were under capacity. These reports also confirmed the presence of overbank flooding due to flat overbank topography and limited channel capacities as shown in the FDRP mapping. Where MDP and QEWDR drainage improvements were not implemented, flooding and conveyance issues as described above still exist within Watercourse 5.0 and Watercourse 6.0. Field inspections to assess the structural conditions of the culverts on Watercourse 5.0 and Watercourse 6.0 show that in general the crossings are in good condition and/or require some repairs. The only exceptions are the culverts on Barton Street on Watercourse 5.0 and Watercourse 6.0 which are deteriorated and require replacement.

The existing conditions related to technical components of these watersheds are summarized in ***Table 2.1*** and ***Table 2.2*** and in ***Figure 2.1***

Based on the hydraulic assessments undertaken using available data and models, the channel capacity along several reaches of Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3 north of Barton Street to just north of the North Service Road can be described as having capacity concerns. The small size channels (shallow and narrow) and the flat overbank topography results in limited channel capacities and overbank flooding. Within the study area boundary south of the QEW, there are six (6) watercourse crossings on Watercourse 6.1, three (3) watercourse crossings on Watercourse 6.2 and five (5) watercourse crossings on Watercourse 6.3. The MDP and the QEWDR determined that these secondary crossings, especially at the QEW and the CNR, were under capacity. Some of the recommendations outlined in the MDP and QEWDR were implemented and improved conveyance issues. However, the proposed diversions to reduce the number of secondary crossings or upgrades to these structures have not been implemented or confirmed, therefore culvert capacity issues are still a concern on Watercourse 6.1 and Watercourse 6.3. The CulvertMaster assessment also indicates that culvert capacities are inadequate at several crossings under existing and/or future flow conditions. Field inspections assessing the structural conditions of the culverts on Watercourses 6.1 to 6.3 show that in general the crossings are in good condition, and/or require some minor repairs. As noted above, the culverts and their openings are significantly silted in, limiting the conveyance capacity and visual inspection.

The existing conditions related to technical components of these watersheds are summarized in ***Table 2.3*** and ***Table 2.4*** and in ***Figure 2.1.***

2.1.4 Socio-Economic

In order to determine the existing socio-economic environment in the Study Area, a review of existing land uses was completed based on the Official Plan designations, aerial photography, site photographs and existing land use mapping provided by the City. In addition, the City provided information on development applications in the Study Area.

A Stage 1 Archaeological Assessment was completed to provide an overview of the history of the area and determine the archaeological potential in the Study Area.

2.2 Existing Conditions Summary for Primary and Secondary Watercourses

Watercourses 5.0 and 6.0 are located exclusively within the Stoney Creek community boundary. The watershed drainage area for Watercourse 5.0, which includes Watercourse 6.0 watershed drainage areas south of the QEW, is approximately 540 ha. The drainage area for Watercourse 6.0 from lands north of the QEW to Lake Ontario is approximately 14 ha. These watersheds drain north to Lake Ontario and extend beyond the study area, originating south of the Escarpment. The topography of the area is relatively flat.

2.2.1 Technical Environment

Based on the FDRP mapping, the flood plain along several reaches of Watercourse 5.0 and Watercourse 6.0 north of Barton Street to Lake Ontario can be described as wide and undefined with spills between watersheds. Within the study area boundary, there are six (6) watercourse crossings on Watercourse 5.0 and six (6) watercourse crossings on Watercourse 6.0, including crossings on the diversion channel. The MDP and the QEWDR determined that crossings along Watercourse 5.0 and Watercourse 6.0, especially at the QEW and the CNR, were under capacity. These reports also confirmed the presence of overbank flooding due to flat overbank topography and limited channel capacities as shown in the FDRP mapping. Where MDP and QEWDR drainage improvements were not implemented, flooding and conveyance issues as described above still exist within Watercourse 5.0 and Watercourse 6.0. Field inspections to assess the structural conditions of the culverts on Watercourse 5.0 and Watercourse 6.0 show that in general the crossings are in good condition and/or require some repairs. The only exceptions are the culverts on Barton Street on Watercourse 5.0 and Watercourse 6.0 which are deteriorated and require replacement.

The existing conditions related to technical components of these watersheds are summarized in ***Table 2.1*** and ***Table 2.2*** and in ***Figure 2.1***

Based on the hydraulic assessments undertaken using available data and models, the channel capacity along several reaches of Watercourse 6.1, Watercourse 6.2 and Watercourse 6.3 north of Barton Street to just north of the North Service Road can be described as having capacity concerns. The small size channels (shallow and narrow) and the flat overbank topography results in limited channel capacities and overbank flooding. Within the study area boundary south of the QEW, there are six (6) watercourse crossings on Watercourse 6.1, three (3) watercourse crossings on Watercourse 6.2 and five (5) watercourse crossings on Watercourse 6.3. The MDP and the QEWDR determined that these secondary crossings, especially at the QEW and the CNR, were under capacity. Some of the recommendations outlined in the MDP and QEWDR were implemented and improved conveyance issues. However, the proposed diversions to reduce the number of secondary crossings or upgrades to these structures have not been implemented or confirmed, therefore culvert capacity issues are still a concern on Watercourse 6.1 and Watercourse 6.3. The CulvertMaster assessment also indicates that culvert capacities are inadequate at several crossings under existing and/or future flow conditions. Field inspections assessing the structural conditions of the culverts on Watercourses 6.1 to 6.3 show that in general the crossings are in good condition, and/or require some minor repairs. As noted above, the culverts and their openings are significantly silted in, limiting the conveyance capacity and visual inspection.

The existing conditions related to technical components of these watersheds are summarized in ***Table 2.3*** and ***Table 2.4*** and in ***Figure 2.1.***

Table 2.1 – Status Primary Watercourse Crossings (December 2006)

Crossing ID	Location	Crossing Type and Opening Size	MDP Recommendation	MDP Recommendation Status	QEWDR Recommendation	QEWDR Recommendation Status	Hydraulic Assessment*	Structural Inspection and Visual Observations	Structural Recommendations
WC5-6	Barton St	· Non-rigid frame concrete culvert at north end with opening 1860 mm wide by 1035mm high from soffit to streambed · CSP at south end 2060 mm x 1400 mm · Culvert built in 1934	Replace/upsize culverts	Not implemented	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Soffit deteriorated with rust from reinforcing steel · west wall is honeycombed and there is a void approx. 1m wide x 300mm high to a maximum depth of 270mm	· Replacement
WC5-5	Arvin St	· Pre-cast concrete culvert · opening 4300mm wide by 1290mm high · Length 15.06m	Lower/underpin culvert	Not implemented	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Barrel generally in good condition. · Two areas of delamination on soffit near the south end (~1.5m^2) · no cover over culvert, asphalt roadway an handrail at each end of culvert · Silted in	· Repair of delaminated soffit possible
WC5-4	CNR	· South 11.1m length of culvert directly under railway tracks consists of armour stone walls with steel and concrete top slab. Opening dimensions, 1800mm wide by 1540mm high from soffit to streambed · North 6.7 m of culvert is a cast-in-place concrete box, with opening dimensions, 2230 mm wide and 1450 mm high from soffit to streambed.	Replace/upsize culverts	Not implemented	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Good condition	· n/a
WC5-3	SSR	· Non-rigid frame, cast-in-place concrete. · Opening dimensions, 3665 mm wide by 1400 mm high from soffit to streambed. · Approximately 27° skew. · Total length of culvert 27.4m	Lower/underpin culvert	Not implemented	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Three areas of delamination on the soffit (~7.4m^2) · Wide crack on soffit and walls with exposed rebar on soffit at 15.2m from south end. · Leaching crack at 24.6m from south end . · North end of culvert has chipped corner 470mm x 200mm.	· Repair of deteriorated concrete possible with replacement of 1.5m wide section at 15.2m from south end and waterproofing,
WC5-2	QEW (including ramps)	· Cast-in-place concrete culvert constructed 1994. · Opening dimensions, 5000 mm wide by 1600 mm high from soffit to streambed.	Replace/upsize culverts	Not implemented	Replace/upsize culvert	Implemented	· Q_{100} conveyed	· Good Condition	· n/a
WC5-1	NSR	· Cast-in-place concrete box culvert · Opening dimensions, 5000 mm wide by 1760 mm high.	Provide additional culvert	Not implemented	Provide additional culvert	Not implemented	· Q_{100} not conveyed***	· Good Condition	· n/a
	Marina Outlet	· Two concrete box culverts · Opening dimensions, 3970mm by 1200 mm · Opening dimensions, 1520mm x 850mm	No recommendation	n/a	No recommendation	n/a	· Q_{100} not conveyed***	· Good Condition	· n/a

Table 2.1 – Status Primary Watercourse Crossings (December 2006)

Crossing ID	Location	Crossing Type and Opening Size	MDP Recommendation	MDP Recommendation Status	QEWDR Recommendation	QEWDR Recommendation Status	Hydraulic Assessment	Structural Inspection and Visual Observations	Structural Recommendations
WC6-6	Barton St	· Two existing culverts side by side with west culvert a CSP and the east culvert a cast-in-place concrete culvert with CSP at the north end. · West CSP culvert opening is 1880mm wide and 1310mm high. · East concrete culvert opening is 1250mm wide and 1400mm high. The original concrete culvert was extended with a non-rigid-frame at the south end and also extended at the north end with a CSP (1300mm by 1000mm) placed under the sidewalk. · Total length of culvert 18.5m	Replace/upsize culverts	Not implemented	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Original concrete culvert deteriorated. · CSP culvert has a bulge at the north end under the sidewalk (one CSP section wide by approximately 1.5m long).	· Replacement
WC6-5	CNR	· CSP culvert · Opening dimensions 1150mm diameter	Replace/upsize culverts	Could not confirm	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Good Condition	· n/a
WC6-4	SSR	· Concrete cast-in-place non-rigid frame culvert. · Opening dimensions, 3050mm wide by 1500mm high · Total length of culvert 23.8m	Lower/underpin culvert	Not implemented	Beyond study	n/a	· Q_{100} not conveyed · Flooding Problems	· Two locations with narrow leaching cracks on soffit and walls. · At 9.1m from north end rebar is exposed the full width of the soffit with a leaching crack on both walls and delamination 300mm wide.	· Repair of deteriorated concrete possible with 1m wide replacement at 9.1m from north end and waterproofing
WC6-3	QEW	· Concrete cast-in-place culvert. · Opening dimensions, 3860mm wide by 1130mm height from soffit to streambed.	No recommendation**	n/a	No recommendation**	n/a	· n/a	· Good Condition	· n/a
WC6-2	NSR	· Concrete box culvert · Opening dimensions 2960 mm by 1100mm	No recommendation**	n/a	No recommendation**	n/a	· n/a	· No Inspection since flow diverted to WC 5.0	· n/a
WC6-1	Diversion Culvert 1	· Concrete box culvert · Opening dimensions 3970mm by 1200mm	Not existing at time of study	Implemented after the study	Not existing at time of study	Implemented after the study	· Q_{100} conveyed	· Good Condition	· n/a
	Cope's Ln	· Concrete Pipe 1000mm in diameter	No recommendations**	n/a	No recommendations**	n/a	· Conveys minor system flows	· Good Condition	· n/a

Notes:
n/a not applicable
* Hydraulic assessment based on FDRP mapping (future 100 year flow) with the exception as noted ***
**Improvements not required since diversion recommended
***Includes diversion of WC5.1 and WC6.0 to WC5.0

Table 2.2 – Status Primary Watercourses (December 2006)

Reach ID	Location	MDP Recommendation	MDP Recommendation Status	QEWDR Recommendation	QEWDR Recommendation Status	Hydraulic Assessment
WC5-A	Upstream of Barton St	Beyond study	n/a	Beyond study	n/a	Q_{100} not contained Wide flood plain affecting existing properties and could limit future development Flooding immediately u/s of Barton St due to undersized culverts
WC5-B	Barton St to Arvin St	Line/re-grade channel	Not implemented	Beyond study	n/a	Q_{100} not contained at Arvin Narrow flood plain Flooding u/s of Arvin Ave likely due to undersized crossing
WC5-C	Arvin St to CNR	Line/re-grade channel	Not implemented	Beyond study	n/a	Q_{100} not contained Undefined flood plain due to spills Additional studies required (i.e. split flow analysis) to assess spill zones and flooding due to crossing Roads and properties flooded
WC5-D	CNR to SSR	Line/re-grade channel	Not implemented	Beyond study	n/a	Q_{100} not contained Undefined flood plain due to spills Additional studies required (i.e. split flow analysis) to assess spill zones and flooding due to crossing Roads and properties flooded
WC5-E	SSR to QEW	Line/re-grade channel	Not implemented	New channel u/s QEW with new culvert	TBC	Flooding and channel conditions to be determined following flood plain update reflecting new culvert Additional studies required (i.e. split flow analysis) to assess spill zones and extent of flooding
WC5-F	QEW to NSR	Line/re-grade channel	Not implemented	No recommendations	n/a	Flooding conditions to be determined following flood plain update reflecting additional drainage from diversion channel No properties would be affected
WC5-G	NSR to Marina	No recommendations	n/a	Maintain existing improvements	n/a	Flooding conditions to be determined with flood plain update reflecting diversion channel drainage No properties would be affected
WC6-A	Upstream of Barton St	Beyond study	n/a	Beyond study	n/a	Q_{100} not contained No houses in flood plain except at Barton St Flooding problems due to undersized crossing
WC6-B	Barton St S to CNR	Line/re-grade channel	Not implemented	Beyond study	n/a	Q_{100} not contained Undefined flood plain due to spills upstream of CNR Additional studies required (i.e. split flow analysis) to assess spill zones and flooding due to crossing Wide defined flood plain downstream of Barton Street Roads and properties flooded
WC6-C	CNR to SSR	No recommendations	n/a	Beyond study	n/a	Q_{100} not contained and undefined flood plain due to spills upstream of SSR Additional studies required (i.e. split flow analysis) to assess spill zones and flooding due to crossing Roads and properties flooded Q_{100} and flood plain contained for a distance downstream of CNR Narrow flood plain with no properties affected
WC6-D	SSR to WC 5	Build diversion channel to WC 5.0	Implemented after study	Same as MDP	Implemented after study	Channel details still required however it is assumed that the channel has been designed to convey the 100 year flow (as has the culvert). No development affected
WC6-E	NSR to Cope's Ln	No recommendations*	n/a	No recommendations*	n/a	Q_{100} likely contained due to diversion

Notes:
*Improvements not required since diversion recommended
n/a – not applicable since no recommendations proposed or the reach/crossing is beyond study limits

Table 2.3 – Status Secondary Watercourse Crossings (June 2007)

Crossing ID	Location	Crossing Type and Opening Size	MDP Recommendation	MDP Recommendation Status	QEWDR Recommendation	QEWDR Recommendation Status	Hydraulic Assessment	Structural Analysis/ Visual Inspection	Structural Recommendations
WC6.1-6	Barton St	· 600mm diameter CSP under sidewalk and Barton Street · Overall length of CSP under Barton St 15.0m	Beyond Study Area	n/a	Beyond Study Area	n/a	· Q_{100} not conveyed	· Generally good condition · Slight deformation in CSP under Barton Street at approximately ⅓ length from each end	· n/a
WC6.1-5	Arvin St	· At outlet, two 900mm diameter CSP with 300mm thick endwall and wingwalls at 45°. · Northeast CSP outlet skewed goes to manhole in centre of Arvin Ave. · Northwest CSP outlet goes to inlet. · At inlet, single 900mm diameter CSP with 220mm thick endwall and wingwalls at 30°. · Overall culvert length 46.50m	No Recommendations**	n/a	Beyond Study Area	n/a	· Q_{100} not conveyed	· Concrete in good condition · Outlets almost fully submerged · Watercourse recently cleaned at outlet	· n/a
WC6.1-4	CNR	· At outlet, 880mm x 900mm stone opening with armour stone end walls. · At inlet, 650mm x 1000mm stone opening with armour stone end walls. · Overall culvert length 13.59m	No Recommendations**	n/a	Beyond Study Area	n/a	· Q_{100} not conveyed	· Stone in good condition	· n/a
WC6.1-3	SSR	· Opening dimensions 2440m m x 1400mm · Non-rigid frame, cast-in-place concrete culvert.	No Recommendations**	n/a	Replace and connect culverts	Implemented	· Q_{100} conveyed	· No access to culvert outlet · Generally in good condition · Concrete spalled at southeast corner 150mm x 150mm · Concrete scaling at southwest face · Silted through full length	· Should be cleaned
WC6.1-2	QEW	· Concrete box culvert · Opening dimensions 2400mm x 1800mm	No Recommendations**		Replace and connect culverts	Implemented	· Q_{100} conveyed	· NSR, QEW and SSR culverts connected together · Condition could not be determined · Unknown obstruction transverse through culvert at approximate mid-length of connected culverts	· Should be cleaned
WC6.1-1	NSR	· Opening dimensions 2440m m x 1400mm · Non-rigid frame, cast-in-place concrete culvert	No Recommendations**		Replace and connect culverts	Implemented	· Q_{100} conveyed	· No access to culvert inlet · Generally in good condition. · Culvert silted through for full length.	· Should be cleaned
WC6.2-3	SSR	· Oval Pipe · Opening 1500mm x 1300mm · 370mm thick wingwalls and endwall at 45° skew to CSP	Replace/upsize culvert	Not Implemented	Replace and connect culverts	Not Implemented	· Q100 conveyed · Bridgeport Assessment · Sedimentation may limit conveyance · d/s invert > u/s invert	· No access to culvert outlet · Distress in side of CSP at inlet · Unable to see through culvert · Concrete in good condition	· Should be cleaned

Table 2.3 – Status Secondary Watercourse Crossings (June 2007)

Crossing ID	Location	Crossing Type and Opening Size	MDP Recommendation	MDP Recommendation Status	QEWDR Recommendation	QEWDR Recommendation Status	Hydraulic Assessment	Structural Analysis/ Visual Inspection	Structural Recommendations
WC6.2-2	QEW	· Concrete culvert · 1200 mm dia	Replace/upsize culvert	Not Implemented	Replace and connect culverts	Not Implemented	· Q_{100} conveyed · Bridgeport Assessment · Sedimentation may limit conveyance · d/s invert > u/s invert	· No Access - condition could not be determined · Unknown obstruction transverse through culvert at approximate mid-length of connected culverts	· Should be cleaned
WC6.2-1	NSR	· Opening dimensions 1200mm x 1200mm · Non-rigid frame, cast-in-place concrete culvert	Replace/upsize culvert	Not Implemented	Replace and connect culverts	Not Implemented	· Q_{100} conveyed · Bridgeport Assessment · Sedimentation may limit conveyance · d/s invert > u/s invert	· No access to culvert inlet · Generally in good condition · Concrete spalled at northeast and northwest corners 450mm x 200mm · Culvert heavily silted	· Should be cleaned
WC6.3-5	Arvin St	· 730mm dia PVC pipe · At inlet, 1220mm x 630mm DICB · At outlet, 225mm thick endwall and wingwalls at 45° · Overall culvert length 24.30m	No Recommendations**	n/a	Beyond Study Area	n/a	· Q_{100} not conveyed (existing)	· Concrete in good condition	· n/a
WC6.3-4	CNR	· 750mm dia cast iron pipe with armour stone end walls · Overall culvert length 12.7m	No Recommendations**	n/a	Beyond Study Area	n/a	· Q_{100} not conveyed (existing)	· Stone in good condition	· n/a
WC6.3-3	SSR	· Non-rigid frame, cast-in-place concrete culvert · Opening dimensions 1830m m x 900mm	No Recommendations**	n/a	Connect to QEW culvert	Implemented	· Q_{100} conveyed	· No access to outlet · Generally in good condition. · Minor spalled concrete at end of culvert	· n/a
WC6.3-2	QEW	· Open concrete culvert · Opening dimensions 1800mm x 1200mm	No Recommendations**	n/a	Replace QEW culvert and connect to SR culverts	Implemented	· Q_{100} conveyed	· No access to culvert outlet · Unknown obstruction transverse through culvert at approximate mid-length of connected culverts	· Should be cleaned
WC6.3-1	NSR	· Opening dimensions 1830mm x 900mm · Non-rigid frame, cast-in-place concrete culvert	No Recommendations**	n/a	Connect to QEW culvert	Implemented	· Q_{100} conveyed	· No access to culvert outlet · Generally in good condition · Minor spalled concrete at end of culvert · Kink in alignment at ROW of QEW · Culvert heavily silted	· Should be cleaned

Notes:
n/a – not applicable since no recommendations made
* Hydraulic assessments based on previous studies where available and CuovertMaster analysis using MDP flows
** No analysis undertaken for proposed/new Bridgeport crossings
** No recommendations for crossings on WC 6.1 and WC 6.3 since diversion proposed

Table 2.4 - Status of Secondary Watercourses (May 2007)

Reach ID	Location	MDP Recommendation	MDP Recommendation Status	QEWDR Recommendation	QEWDR Recommendation Status	Hydraulic Assessment
WC6.1-A	Barton St to Arvin St	Divert flow to WC 6.0	Not Implemented	Beyond Study Area	n/a	· Q_{100} not conveyed (ex and fut)
WC6.1-B	Arvin St to CNR	Divert flow to WC 6.0	n/a	Beyond Study Area	n/a	· Q_{100} conveyed (ex and fut)
WC6.1-C	CNR to SSR	Divert flow to WC 6.2	Not Implemented	Divert flow to WC 6.2	Not Implemented	· Q_{100} not conveyed (ex and fut)
WC6.1-D	SSR to NSR	No Recommendations**	n/a	No Recommendations**	n/a	· Q_{100} conveyed (ex and fut)
WC6.1-E	NSR to Prop Palace Beach	No Recommendations**	n/a	No Recommendations**	n/a	· Q_{100} conveyed with minor overbank flooding on rt bank (< 0.5m)
WC6.2-A	Glover Access Road to SSR	Diversion Channel	Not Implemented	Beyond Study Area	n/a	· Q_{100} not conveyed in west ditch alone
WC6.2-B	SSR to NSR	Diversion Channel	Not Implemented	Same as MDP	Not Implemented	· Q_{100} conveyed (ex and fut)
WC6.3-A	Barton St to Arvin St	Divert flow to WC 6.0	Not Implemented	Beyond Study Area	n/a	· Q_{100} conveyed
WC6.3-B	Arvin St to CNR	Divert flow to WC 6.0	Not Implemented	Beyond Study Area	n/a	· Q_{100} conveyed
WC6.3-C	CPR to SSR	Divert flow to WC 6.2 & WC7.0	Diversion to WC6.2 not implemented Diversion to WC7 TBC	Diversion to WC6.2	Not Implemented	· Q_{100} conveyed
WC6.3-D	SSR to NSR	Divert flows to WC 6.2	TBC	No Recommendations**	n/a	· Q_{100} conveyed (ex and fut)
WC6.3-E	NSR to Storm Sewer inlet	Divert flows to WC 6.2	TBC	No Recommendations**	n/a	· Q_{100} conveyed (ex and fut)
WC6.3-E	Storm sewer to Lake	Upgrade sewer	Not Implemented	No Recommendations	n/a	· Q_{100} not conveyed

Notes:

Hydraulic assessments based on previous models (Bridgeport HEC-RAS), previous studies (FDRP, MDP, QEWDR) or recent FlowMaster Modelling

*No analysis undertaken for proposed/altered channel reaches through Bridgeport development

** No recommendations since diversion proposed

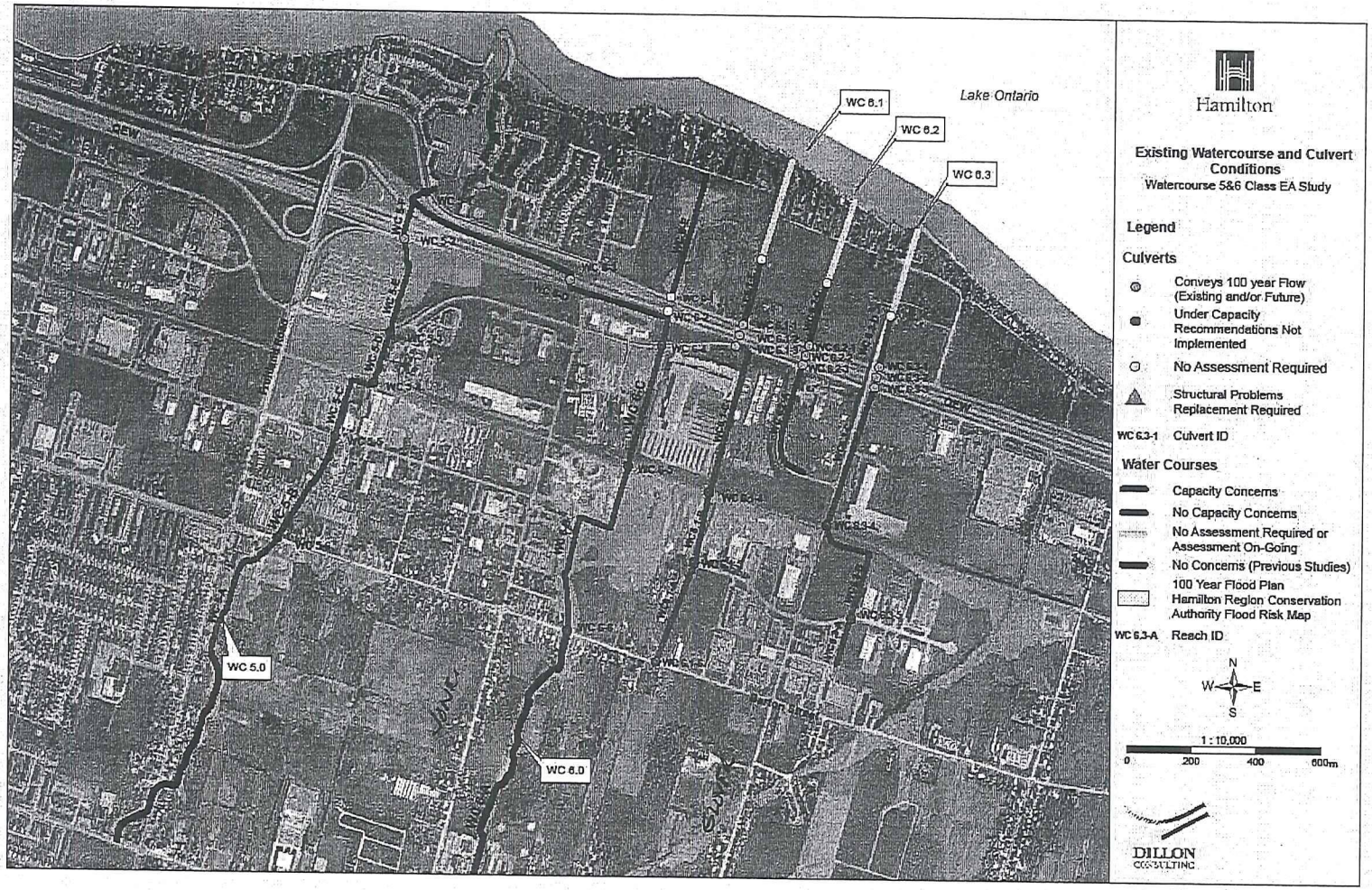
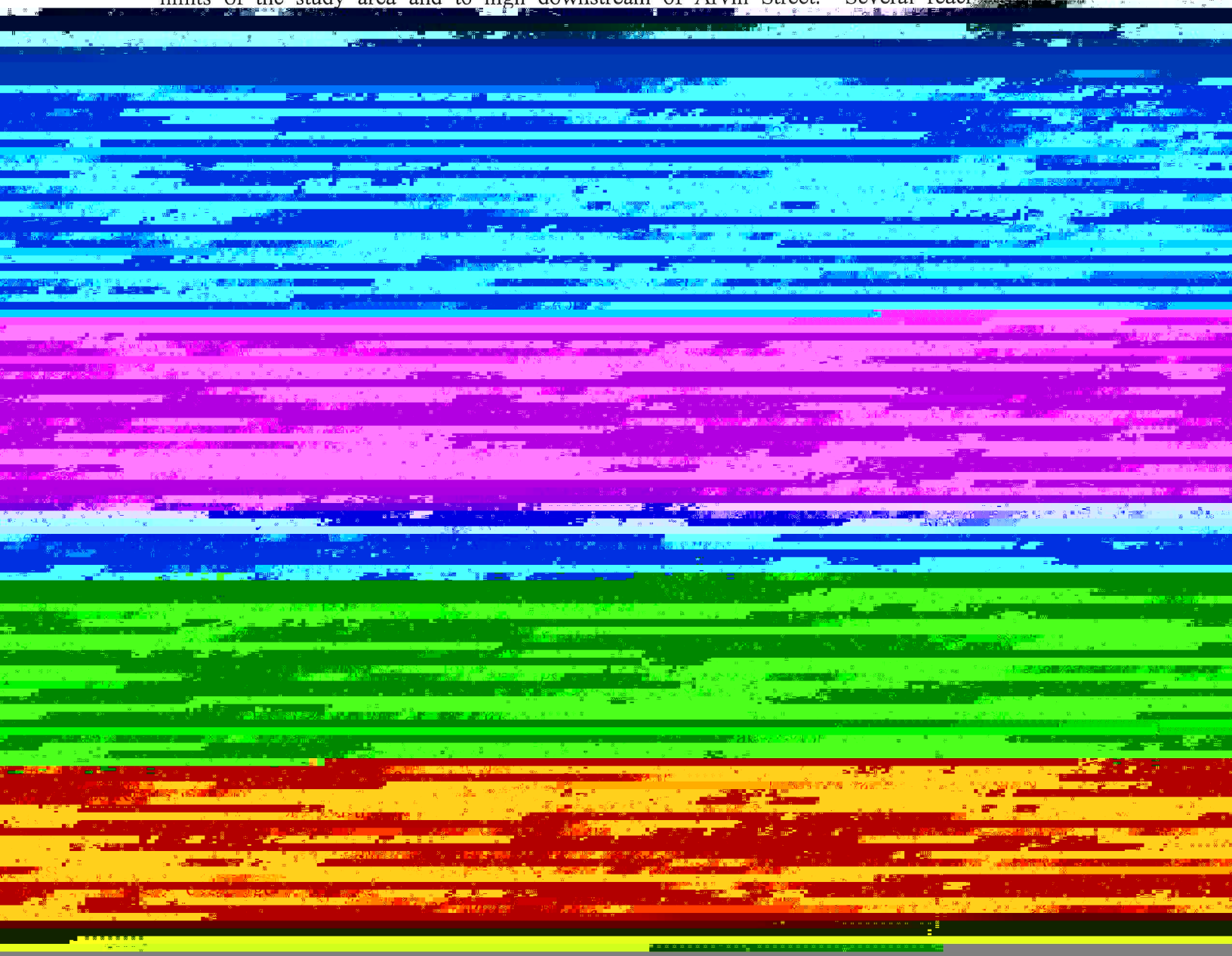


Figure 2.1 Existing Watercourse and Culvert Conditions

2.2.2 Natural Environment

In general, Watercourse 5.0 can be described as a highly altered channel with varying degrees of stability, from artificially stable, to unstable and on the cusp of transition, to unstable and deep in geomorphic transition. Channel straightening and hardening exists along the reaches of Watercourse 5.0 from Barton Street to the outlet to Lake Ontario. Upstream of Barton Street, the channel appears much more stable. The sensitivity to erosion is also variable along Watercourse 5.0 ranging from low downstream of the QEW, to moderate upstream of Arvin Street to the limits of the study area and to high downstream of Arvin Street. Several reaches along



restored. Watercourse 6.3 is primarily an intermittent watercourse, however sections north of the QEW are buried (i.e. underground pipe). While sections are described as both Type 2 and Type 3 Habitat Potential, overall Watercourse 6.3 is classified as Not Fish Habitat. Like Watercourses 6.1 and 6.2, the vegetation cover along Watercourse 6.3 in mostly open. As development proceeds in this sub-watershed, there maybe opportunities to enhance the vegetation cover.

The existing aquatic and terrestrial conditions for these watercourses are summarized in ***Figure 2.3*** and ***Figure 2.4*** below.

Existing information review and field investigations were also conducted for Watercourse 7.0 to address impacts to the aquatic and terrestrial habitat from the proposed alternatives which involve diversions of flows to this system. There is potential for this system to sustain fish populations based on decent base flows, diverse habitat, and relatively natural conditions. While fish were not observed during the field investigations, YOY white sucker have historically been caught in Watercourse 7.0. Even without the presence of fish today, this watercourse still serves as indirect fish habitat to Lake Ontario in terms of flow, nutrient, and food contribution. The riparian cover along WC 7.0 is dominated by Manitoba maple, red ash, and white willow for the majority of the reach under investigation. Much of the understory and ground cover is dominated by non-native plant species.

In general, canopy cover is dense throughout providing an appreciable amount of shade to the watercourse. Wildlife activity was greater along WC 7.0 due to increased cover and diversity.

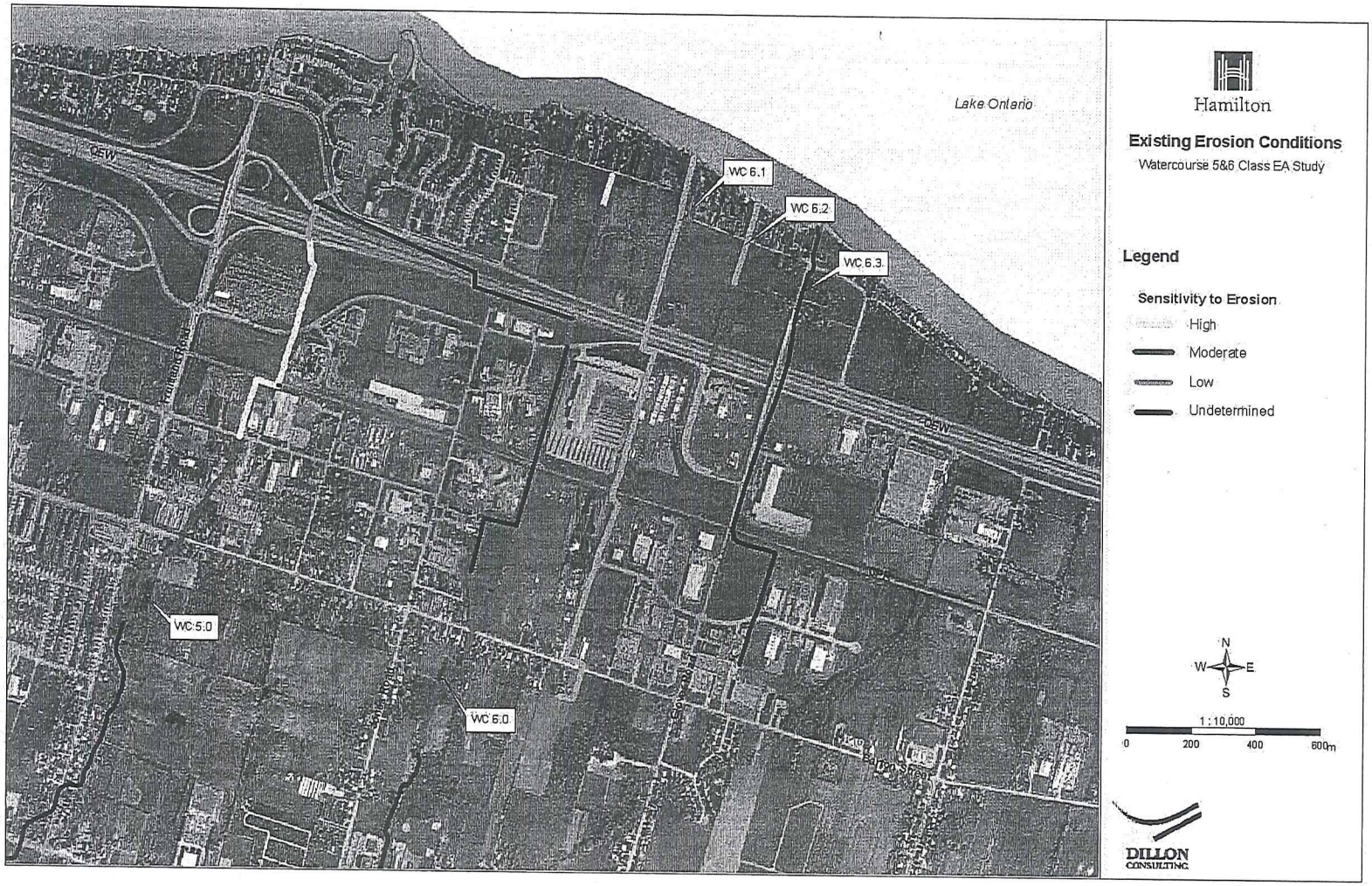


Figure 2.2 Existing Erosion Conditions

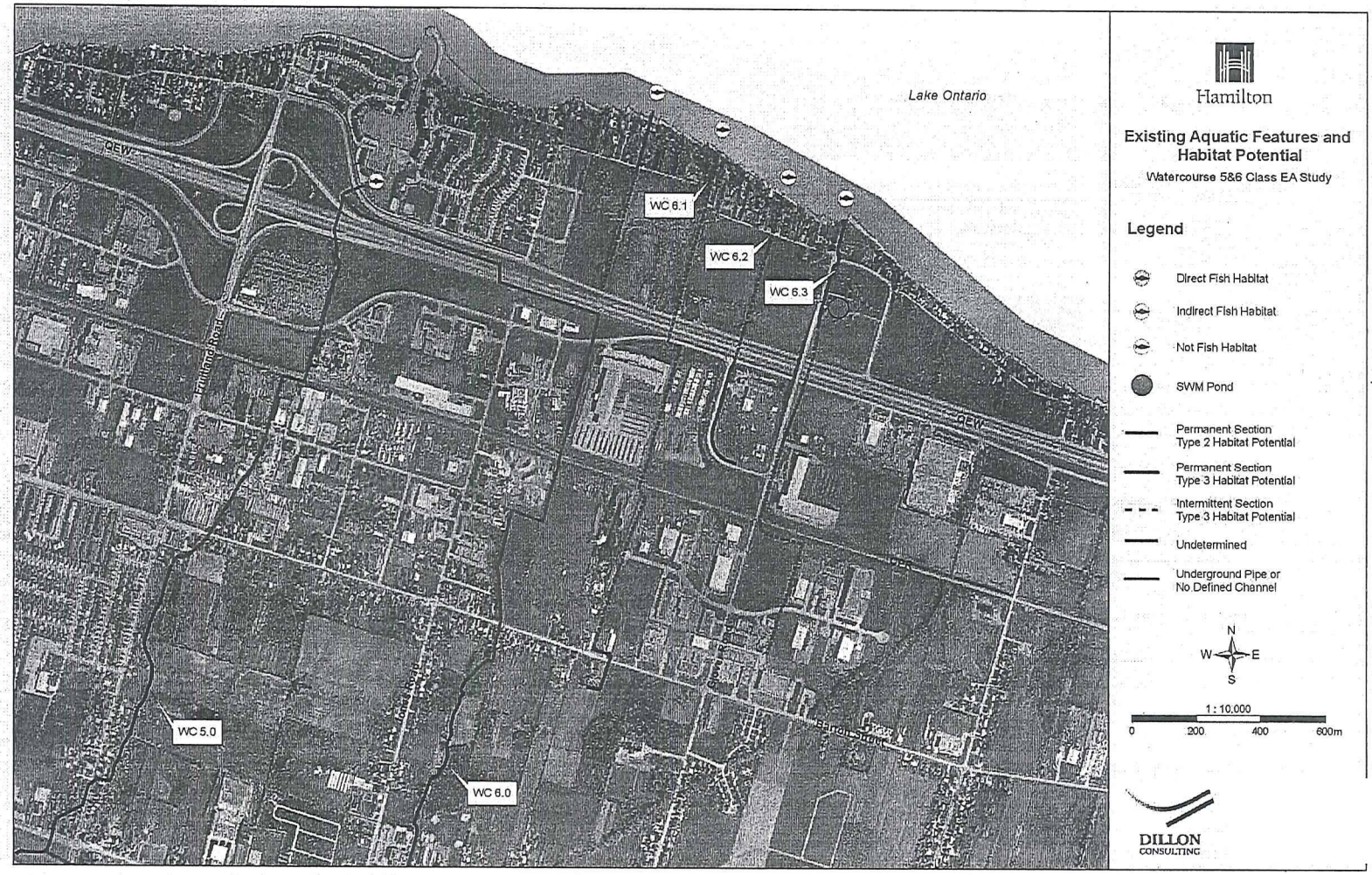


Figure 2.3 Existing Aquatic Features and Habitat Potential

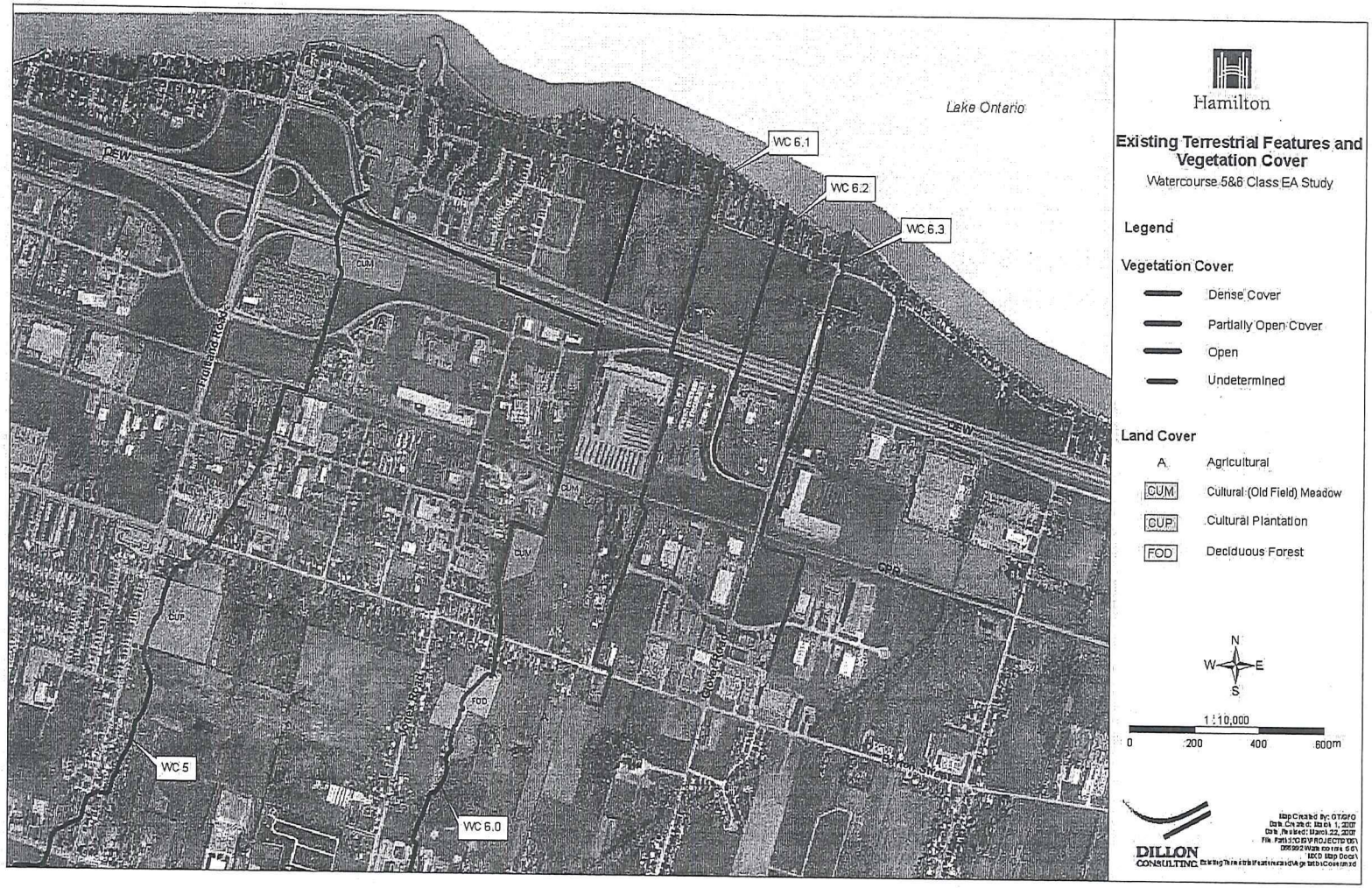


Figure 2.4 Existing Terrestrial Features and Vegetation Cover

2.2.3 Socio-Cultural Environment

Several municipalities, including the City of Stoney Creek were amalgamated with the City of Hamilton on January 1, 2002. The community of Stoney Creek is centrally located within the Golden Horseshoe adjacent to Lake Ontario and encompasses a portion of the Niagara Escarpment. With a population of 57,000 in 2001, Stoney Creek is one of the fastest growing areas in the City of Hamilton.

The City of Hamilton is currently completing a new Official Plan, which will include all of the amalgamated municipalities. In conjunction with the new Official Plan, the City of Hamilton recently completed the Growth Related Integrated Development Strategy (GRIDS). GRIDS was initiated in 2003 and is a planning process to identify a broad land use structure, associated infrastructure, economic development strategy and financial implications for the growth options to serve Hamilton for the next 30 years. The GRIDS process is part of the City's Building a Strong Foundation (BASF) initiative, which includes Vision 2020, GRIDS and the Official Plan Review. A preferred growth strategy for the city is outlined in the GRIDS report.

The Stoney Creek Official Plan (Consolidated November 1999) is currently in effect until the new City of Hamilton Official Plan is approved. As outlined on Schedule A of the plan, the Study Area is designated "Residential" north of the QEW, "Industrial-Business Park" between the QEW and Barton Street and "Agricultural" south of Barton Street to the Escarpment. The following outlines the major policies of the Official Plan:

- Residential (Section 1). The primary uses permitted in areas designated Residential shall be for dwellings, with the location and densities outlined in Secondary Plans. All development requires full municipal services, including paved roads, municipal sanitary and storm sewers and piped water
- Industrial-Business Park (Section 4). The primary uses permitted include manufacturing, processing of raw materials or goods, repairing and servicing operations, warehousing and storage, and transportation terminals. Development is required on full municipal services. No development is permitted without adequate storm drainage provisions to accommodate the proposed development
- Agricultural (Section 9). The goal of the Agricultural designation is to protect and enhance the natural amenities, character and lifestyle of the agricultural area. Agriculture and associated uses and the primary use permitted.

The Urban Lakeshore Area Secondary Plan covers a portion of the Study Area. The Lakeshore Area is located north of the QEW, south of Lake Ontario, west of the Grimsby/Stoney Creek boundary and east of the Stoney Creek/Hamilton boundary. Lands within the Study Area are part of the Trillium neighbourhood. As outlined in Section 13.4 of the Official Plan, the Lakeshore Area Planning District is expected to accommodate an ultimate population of 15,500 people on full municipal services.

Amendment 92 amended Schedule B of the Stoney Creek Official Plan (***Appendix F***). The purpose of the Amendment is to implement the Stoney Creek Open Spaces and Natural Environment System (SCONES) and replace the existing Schedule B with the new Schedule B, Stoney Creek Open Spaces & Natural Environment System. The following policies and designations apply to the Study Area:

- Class 1 Environmentally Sensitive Areas (ESA). The Niagara Escarpment borders the south end of the Study Area and is designated as a Class 1 ESA
- There are three Class 2 Core Areas within the Study Area. All of the Class 2 areas are south of Barton Street. As outlined in Section 1.2 of Amendment 92, Class 2 areas include significant fish habitat, significant woodlots and areas listed in the Hamilton-Wentworth Natural Areas Inventory but not listed as Regional ESAs.
- A portion of all of the watercourses is designated as Class 3 – Rehabilitation Areas. Class 3 areas include Regional Life Science and all Earth Science Areas of Natural and Scientific Interest not defined in the Regional Official Plan as ESAs. In addition, all lands within 50 metres of an ESA or Core Area will be considered as Class 3 in order to provide an adequate buffer zone and encourage ecological restoration where appropriate
- Land north of the QEW along the lakeshore, is designated Lakeshore Protection Area.
- The following information about Watercourse 5 is outlined under Section 1.3, Site Specific Policies:
    - *In the event Watercourse No. 5 is rechannelized or is subject to other remedial works, and the existing culvert located north of Barton Street between Fruitland and Arvin Road, is removed at that time, the culvert may be replaced with an appropriately sized culvert in the same general location as the existing culvert. Such replacement culvert shall be:*

        - *Used solely for internal traffic movement between the land abutting either side of the culvert in respect to the industrial uses existing at the date of the adoption of this Official Plan Amendment; and,*

- *Subject to the prior written approval of the municipality and the Conservation Authority, and, any other approvals which may be required at law in respect to its design and location.*

As shown on ***Figure 2.5*** Land Use Map, the study area is a mix of residential, industrial, commercial and institutional land uses. In addition, a significant portion of the Study Area south of Barton Street is open space/agricultural. In general, land along the lakeshore is a mix of residential and open space and land between the QEW and Barton Street is primarily industrial. The south portion of the study area, from Barton Street south, is generally open space, with some residential, institutional and commercial uses.

There are several new residential areas in the Study Area, between the QEW and Lake Ontario. There is currently one development under construction, north of the QEW and west of Glover Road. There is also a proposed residential subdivision along the lakeshore, between Glover Road and Jones Road. Please see Appendix F for the list and approximate location of these new developments.

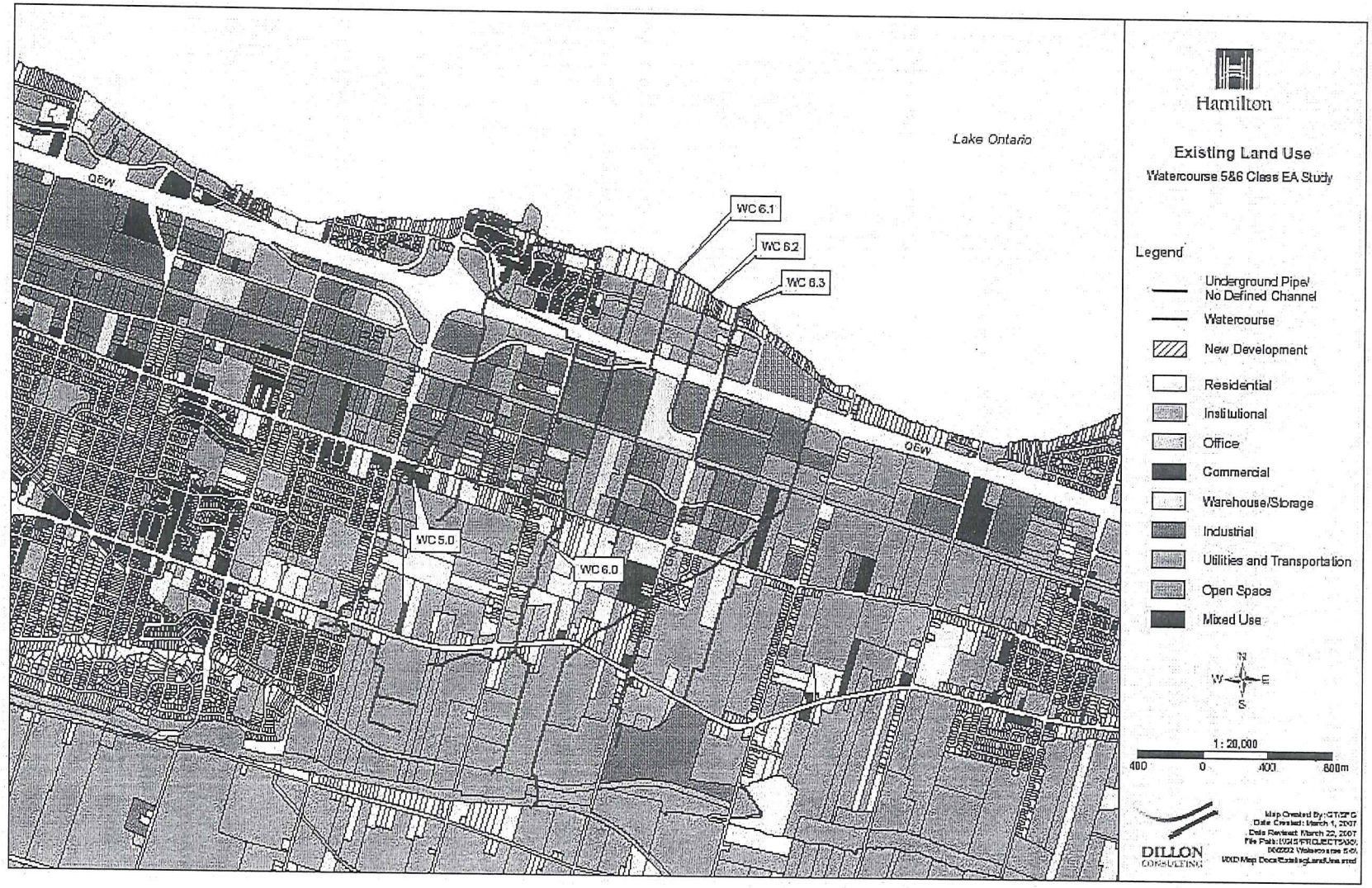


Figure 2.5 Existing Land Use

3. ALTERNATIVE SOLUTIONS

Phase 2 of the Class EA process requires consideration of alternative solutions or functionally different ways of solving the problem. This chapter describes the alternative solutions considered, the evaluation criteria used to compare these alternatives and the process to select a preferred solution.

3.1 Alternatives Considered

Alternatives considered for watercourse system improvements included:

- ***"Do Nothing"***: This alternative is always considered in the Class EA process and represents the status quo (i.e., existing watercourse system and management policies). The "do-nothing" alternative was included in the evaluation for comparison purposes. It was recognized that it would not address the problem statement and therefore limit future development opportunities. Furthermore, the "do-nothing" alternative would not address structural issues present at certain crossings which could result in unsafe conditions.

- ***Alternative 1 - Replace structurally deficient crossings and implement flood plain management policies and flood proofing measures:*** This involves replacing only culverts assessed as having structural deficiencies with new larger culverts. Where flooding issues still exists, flood plain management policies (i.e. limited development within flood plains) and flood proofing measures (i.e. filling) could be implemented on an as needed basis to protect existing and facilitate new developments. While this alternative results in lowest cost, it does not provide the best technical solution, i.e., highest level of service. Please note that this alternative also includes stormwater management quantity control (post-to-pre ponds or at-source measures) for new developments upstream of Barton Street and infill developments within the watersheds.

- ***Alternative 2 - Replace structurally deficient crossings and provide enhanced SWM upstream of culverts that are under capacity:*** This involves replacing culverts assessed as having structural deficiencies with new larger culverts and providing a SWM facility to control flows. Unlike Alternative 1, flows will be over-controlled by a SWM facility for areas upstream of hydraulically deficient culverts. The SWM facility will control the 100-year post-development flow to 5-year pre-development. This alternative may have extensive land requirements and therefore will be deemed impractical from a socio-economic

perspective. An additional constraint for this alternative includes implementation and whether or not these works will coincide with or precede future developments.

- ***Alternative 3 - Replace all culverts with hydraulic and structural deficiencies and undertake channel works:*** This alternative involves replacing all identified crossings to meet future regulatory flows. It also requires channel works at the crossing and along problem reaches, including diversions between watersheds. This alternative is most similar to the preferred alternative in the 1990 MDP. Channel works may include (a) hard-lining the channel to improve conveyance capacity or (b) natural channel design to maintain the required form and function of the watercourse. Alternative 3a, lining the channel, was previously considered in the alternatives proposed in the MDP but may result in significant environmental impacts. Alternative 3b, natural channel design, is the current accepted practice; however it may require additional land requirements and costs associated with wider valley corridors. This alternative also includes stormwater management quantity control (post-to-pre ponds or at-source measures) for new developments upstream of Barton and infill developments within the watersheds.

- ***Alternative 4 - Similar to Alternative 3 without diversions***: This alternative involves replacing all identified crossings to meet future regulatory flows assuming no diversions to the primary watercourse (i.e. to Watercourse 5.0, 6.0 and 7.0) or between secondary watercourses (i.e., to Watercourse 6.2). This alternative also includes stormwater management quantity control (post-to-pre ponds or at-source measures) for new developments upstream of Barton Street and infill developments within the watersheds. It also requires channel works at the crossing and along problem reaches using the most up-to-date and accepted practices (i.e., natural channel design). Similar to Alternative 3, this alternative could provide the best technical solution (i.e., highest level of service) but it could require improvements to additional roadway culverts and some culverts along driveways to prevent roadway flooding. The impacts of the diversions relative to the benefits associated with the highest level of service with lowest cost will be considered.

Each alternative proposed (excluding the "Do Nothing alternative") recommends replacement of structures based on structural and/or conveyance capacity deficiencies. As the objective of the study is to improve flooding conditions, the regulatory event (e.g., 100 year return period event) was set as the target design flow for proposed culverts capacities to ensure flows are conveyed through the structures without overtopping roads, flooding upstream lands or exceeding the top of bank downstream. While any works involving new or replacement crossings must ensure that regulatory flood levels do not increase, the design flood criteria (i.e., design flow) used to size

culverts and to meet freeboard and structural clearance criteria is based on the road classification as summarized in *Table 3.1* below. During detailed design, the freeboard and clearance requirements for required design flow based on the road classification must be confirmed using backwater hydraulic modelling.

Table 3.1 Design Flood Criteria Based on MTO Directive B-100

Road Classification	Bridges & Culverts	
	Total Span up to 6.0 m	**Total Span over 6.0 m**
Freeway Urban Arterial	50 year	100 year
Rural Arterial Collector Road	25 year	50 year
Local Road	10 year	25 year

Table 3.2 provides a summary of proposed crossing replacements for crossings identified as under capacity based on existing and/or future 100 year flows (existing or ultimate drainage boundary flows from the MDP). The number and location of the crossings to be replaced depends on the Alternative selected which results in different flow conditions (e.g., reduced flows, different drainage areas, etc)

For Alternative 3 and Alternative 4, considerable channel works are proposed to convey flows and eliminate or reduced flooding problems. In order to reduce the extent of flooding, proposed channel modifications were designed to convey the 100 year flow and therefore reduce the floodplain limits and ensure that flows currently impeded by undersized culverts (i.e., flow back-up behind CPR) would have a safe outlet and would not impact downstream lands. ***Table 3.3*** provides a description of typical cross-sections proposed for each reach requiring channel works. Please see ***Appendix G*** for detailed proposed culvert upgrades hydraulic assessments and channel works assessments.

Table 3.2 Summary of Proposed Crossing Upgrades

Crossing ID	Location	Recommendation	Proposed Culvert Hydraulic Assessment		Type of Control
			Flow (cms)	HW Elev. - 100 yr (m)	
WC5-6	Barton Street	Replace with 2.4 x 1.5 m box Lower Invert u/s 82.79	8.75/7.31	84.80/84.58	Outlet
WC5-5	Arvin Street	Replace with 4.3 x 3.0 m box Lower Invert u/s 80.69 m	10.22/7.77	83.67/83.56	Outlet
WC5-4	CNR	Replace with 3.0 m x 1.5 m box Lower Invert u/s 79.82	15.96/11.38	82.14/82.00	Inlet
WC5-3	SSR	Replace with 3.6 m x 2.86 m Lower Invert u/s 78.36	17.91/14.45	81.44/81.30	Outlet
WC5-1	NSR	Add 2.1 m x 1.8 m cell Lower Invert u/s 75.96 m	19.39/37.86	77.66/78.61	Outlet/Inlet
WC6-6	Barton Street	Replace with 1.8 x 1.2 m box Lower Invert u/s 83.20	4.58/6.28	84.78/85.30	Outlet/Inlet
WC6-5	CNR	Replace with 3.0 m x 1.8 m box Lower Invert u/s 80.10	5.30/11.50	81.90/82.24	Outlet
WC6-4	SSR	Replace with 3.6 m x 1.5 m Lower Invert u/s 78.80	5.26/13.83	80.29/80.87	Outlet
WC6.1-6	Barton Street	Replace with 2.1 x 1.2 m box Ex. Invert u/s 87.59 m	1.17	88.73	Outlet
WC6.1-5	Arvin Street S	Replace with 2.1 x 1.2 box Ex Invert u/s 84.76 m	3.99	86.07	Inlet
WC6.1-4	CNR	Replace with 1.35 m dia Ex Invert u/s 81.88 m Lower d/s 81.80 m	4.17	83.95	Outlet
WC6.3-5	Arvin Street S	Replace with 2.1 x 1.2 m box Ex Invert u/s 86.11 m	1.58	87.27	Outlet
WC6.3-4	CNR	Replace with 2.1 x 1.2 m box Ex Invert u/s 83.65 m	2.63	84.91	Outlet

Notes:
Hydraulic Analysis Using CulvertMaster modelling

Table 3.3 Summary of Proposed Channel Works

Reach	Location	Recommendation	Easement Available	Channel Details				
				Length (m)	Side Slope (H:V)	Depth (m)	Top Width (m)	Bottom Width (m)
WC5	Upstream of Barton	Natural Lining	No	110	2:1	3.54	15.16	1
	Barton St to Arvin Ave	Natural Lining	10 – 12 m	400	2:1	4.96	20.8	1
	Arvin Ave to CPR	Rip rap	12 – 15 m	280	2:1	1.4	9.6	4
	CPR to SSR	Rip rap	8 – 10 m	185	2:1	1.89	8.56	1
	SSR to QEW	Rip rap	No	320	2:1	2.46	12.34	2.5
WC 6	Upstream of Barton	Natural Lining	No	70	2:1	2.8	12.2	1
	Barton St to CPR	Natural Lining	8 m	880	2:1	2.73	11.92	1
	CPR to SSR	Natural Lining	12 m	310	2:1	1.84	11.86	4.5
WC 6.1	Barton St to Arvin Ave	Natural Lining	10 – 30 m	320	3:1	0.9	6.35	1
	CPR to SSR	Natural Lining	No	450	2:1	0.8	8.40	4.7

Notes:

Channel depths on Watercourse 5.0 and 6.0 are needed to facilitate diversions – potential to minimize depths depending on diversion method/location

Top-width minimized to the extent possible to accommodate existing easements

Channel details (i.e. side-slopes, treatments, depths and top-widths) must be finalized once land available through acquisition is confirmed

Channel capacity analysis using FlowMaster, assuming uniform flow conditions

3.2 Evaluation Results and Preferred Solution

3.2.1 Evaluation Criteria

The objective is to identify watercourse system improvements that will alleviate the deficiencies in a cost effective manner with minimal impacts to the natural, social and cultural environments. To accomplish this, evaluation criteria were identified as a framework for comparing the alternative solutions. The criteria were developed to cover the full definition of the environment as required in the Class EA process including: natural and socio-economic environments, cultural and technical considerations and the capital and long-term maintenance costs. Proposed criteria and indicators or measurements for the evaluation of the alternative solutions are presented in ***Table 3.4.*** In addition to the criteria outlined below, the preferred alternative should include works that coincide with the GRIDS project and SWM Plan.

Table 3.4 - Evaluation Criteria
Watercourse 5 & 6 Class EA

Evaluation Criteria	Indicator
Natural Environment	
Potential impacts on terrestrial environment	• Potential for displacement, disruption or improvement to vegetation/ wildlife habitat (including wetlands, ESAs, ANSIs)
	• Potential for displacement, disruption or improvement to wildlife during construction
Potential impacts on fisheries resources	• Potential for displacement, disruption or improvement of fisheries resources (including riparian zones, fish, aquatic wildlife and vegetation, wetlands)
Potential impacts on fluvial geomorphology of the watercourse	• Qualitative assessment of the potential to negatively impact downstream reaches of the watercourses (i.e. change in watercourse drainage area)
Potential impacts on groundwater/surface drainage	• Qualitative assessment of impact to groundwater and surface water flow regime for each alternative
Potential impacts on water and/or air quality	• Qualitative assessment of potential impact on water and/or air quality during construction and operation of each alternative
Socio-Economic Environment	
Potential for disruption or displacement of residents or community features	• Length of construction period as it relates to potential noise and dust issues for neighbouring residents and community features and industry
	• Need for new property/easements
	• Potential for traffic disruption effects
Potential for improvements to pedestrian/bike/transit	• Opportunities to enhance alternative modes of travel
Potential for disruption to businesses	• Length of construction period as it relates to potential noise and dust issues for businesses and potential road closures

Table 3.4 - Evaluation Criteria Watercourse 5 & 6 Class EA	
Evaluation Criteria	**Indicator**
Potential for impact on future land uses	• Potential for preferred alternative to impact (positively or negatively) on proposed future development in the area
Potential for contaminants	• Complete a screening for contaminated sites as per the City's contaminated sites management program.
Cultural Considerations	
Potential for impacts on archaeological resources	• Extent of work required outside of the current culvert footprint
	• Findings of the archaeological assessment
Technical Considerations	
Level of improvement	• Qualitative assessment of the ability of alternative to address capacity issues
	• Qualitative assessment of the ability for alternative to meet current design standards
	• Anticipated lifespan of alternative
Potential for impacts on the transportation network	• Timing and duration of potential road closures, lane restrictions
Ability to construct	• Qualitative assessment of the ability to construct each alternative
Potential need for maintenance	• Qualitative assessment of ability/need for on-going maintenance
Cost	
Relative costs	• Estimated construction and on-going maintenance costs

3.2.2 Evaluation of Alternative Solutions

The evaluation of alternatives was based on an assessment of potential impacts for each of the criteria/indicators noted above. For each alternative the existing conditions data was used to determine potential impacts and benefits. Alternatives were ranked for each criterion from most to least effect based on the data collected and technical analysis. The alternative(s) that had the most advantages and least disadvantages was (were) identified as the recommended alternative(s). For the purposes of this evaluation, it was assumed that the technical and cost criteria were of more importance to the overall decision, given the poor drainage conditions of the watercourse systems, structural problems at certain crossings, and the City's desire to achieve long-term cost effective solutions. This approach was considered reasonable since the majority of the potential natural, social, cultural and economic impacts are expected to be primarily temporary in nature. Given the different opportunities and problems for the Primary watercourses (Watercourses 5.0 and 6.0) compared to the Secondary watercourses (Watercourses 6.1 – 6.3), as described above, separate evaluations were undertaken.

The following tables (***Table 3.5*** and ***Table 3.6***) provide the detailed evaluation of all alternatives, including the "Do Nothing" Alternative, for the Primary Watercourses and Secondary Watercourses based on the evaluation criteria provided in ***Table 3.4***. Cost estimates for the proposed works associated with each alternative that were used to determine the relative costs of each alternative are included in *Appendix H.*

As the "do-nothing" alternative does not include immediate improvements to the watercourse systems, it results in less impact to the natural environment when compared to the other alternatives. However, if nothing is truly done, the drainage deficiencies will remain resulting in potentially unsafe conditions and future development opportunities will be limited. It is also noted that the "do-nothing" alternative results in no immediate costs, however the social and financial implications are inherent in terms of loss of developable land within these watersheds. For this reason, the "do-nothing" alternative was not considered in the final criteria evaluation.

Table 3.5 - Primary Watercourses Alternatives Evaluation

	Do Nothing Alternative	Alternative 1 – Replace structurally deficient crossings and implement flood plain management policies and flood proofing measures	Alternative 2 - Replace structurally deficient crossings and provide enhanced pond upstream of culverts that are under capacity	Alternative 3 - Replace all culverts with hydraulic and structural deficiencies and undertake channel works (Master Drainage Plan Recommendation)	Alternative 4 - Similar to Alternative 3 without diversions
Natural Environment (Potential impacts on terrestrial environment, fisheries resources, fluvial geomorphology of the watercourse, groundwater/surface drainage, and water and/or air quality)	*Most Preferred* • No displacement or disruption to terrestrial or aquatic features • Potential for long-term negative impacts on geomorphology including erosion and sedimentation resulting from drainage problems • No impacts on groundwater or surface water drainage	*Preferred* • Potential for minor displacement or disruption to terrestrial features in the vicinity of the crossings • Local channel grading at the replaced crossings resulting in temporary disruption/disturbance to fisheries and water quality. • Replacement/enhancement of creek substrate beneath crossings. • Potential for long-term negative impacts on geomorphology including erosion and sedimentation resulting from drainage problems • No impacts on groundwater or surface water drainage anticipated	*Least Preferred* • Potential for minor displacement or disruption to terrestrial features in the vicinity of the crossings • Potential for significant disruption to terrestrial features in proposed pond locations (specifically deciduous forest and wetland south of Barton on Watercourse 6.0) • Local channel grading at the replaced crossings resulting in temporary disruption/disturbance to fisheries and water quality. • Replacement/enhancement of creek substrate beneath crossings. • Potential for long-term negative impacts on geomorphology including erosion and sedimentation resulting from drainage problems which are not addressed • No impacts on groundwater or surface water drainage anticipated	*Preferred* • Potential displacement or disruption to terrestrial features in the vicinity of the crossings and along the banks of the channel where channel widening is proposed. • Channel works resulting in temporary disruption/disturbance (fisheries and water quality). • Replacement/enhancement of creek substrate beneath crossings. • Hard-lining of channel may be required and may result in some loss of aquatic habitat • Natural treatments and erosion controls will be implemented to the extent possible • Minor disruption to surface water drainage with proposed diversion but within the same water shed. Fluvial geomorphology impacts from diversions not anticipated	*Preferred* • Potential displacement or disruption to terrestrial features in the vicinity of the crossings and along the banks of the channel where channel widening is proposed. • Channel works resulting in temporary disruption/disturbance to the watercourses (fisheries and water quality). • Replacement/enhancement of creek substrate beneath crossings. • Hard-lining of channel maybe required and will result in some loss of aquatic habitat • Natural treatments and erosion controls will be implemented to the extent possible • No impacts on groundwater or surface water drainage anticipated
Socio-Economic Environment (Potential for disruption or displacement of residents or community features, improvements to pedestrian/bike, disruption to businesses, impact on future land uses and potential for contaminants)	*Less Preferred* • Limits future development opportunities • Unsafe conditions at structurally deficient crossings • Unsafe conditions due to flooding – existing properties in the flood plain • No improved drainage on east branch of WC 5.0 and WC 5.1 – therefore potential roadway flooding and potential disruption to residents to improve driveway culverts • No potential for contaminants anticipated	*Least Preferred* • Limits future development opportunities since filling will not be technically feasible in all cases • Replacement of structurally deficient culvert will improve unsafe conditions associated with the culverts and with flooding upstream of Barton only • No improved drainage on east branch of WC 5.0 and WC 5.1 • Minor disruptions anticipated with pond construction and closed roadway to facilitate culvert replacements • No potential for contaminants anticipated	*Less Preferred* • Pond area requirements (~ 9 ha for both ponds) limits future development opportunities • Limited approvability or buy-in by public/developers for such a large stormwater facility • Replacement of structurally deficient culvert will improve unsafe conditions associated with the culverts and with flooding upstream of Barton only • No improved drainage on east branch of WC 5.0 and WC 5.1 • Greater disruptions anticipated with larger pond construction • Minor disruption due to closed roadway to facilitate culvert replacements • No potential for contaminants anticipated	*Preferred* • Replacement of structurally deficient culvert will improve unsafe conditions associated with the culverts and with flooding • Diversion will improve drainage on east branch of WC 5.0 and WC 5.1 – therefore reduced roadway flooding and no disruption to residents to improve driveway culverts • Land area and easements required for channel improvements • Minor disruptions anticipated with pond construction • Potential for significant disruption due to a number of closed roadways and the railway to facilitate culvert replacements and diversion pipes • No potential for contaminants anticipated	*Preferred* • Replacement of structurally deficient culvert will improve unsafe conditions associated with the culverts and with flooding • No improved drainage on east branch of WC 5.0 and WC 5. • Greatest land area and easements required for channel improvements (wide and shallow channel) • Minor disruptions anticipated with pond construction • Potential for significant disruption due to a number of closed roadways and the railway to facilitate culvert replacements • No potential for contaminants anticipated
Cultural (Potential for impacts on archaeological resources)	*Preferred* ▪ No impact	*Equally Preferred* ▪ No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment	*Equally Preferred* ▪ No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment	*Equally Preferred* ▪ No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment	*Equally Preferred* ▪ No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment
Technical Considerations (Level of improvement, Potential for impacts on the transportation network, Ability to construct, Potential need for maintenance)	*Least Preferred* ▪ Does not address existing flooding issues and limits opportunities for future development	*Less Preferred* • Does not address existing flooding issues and limits opportunities for future development • Filling in the floodplain could have impacts on adjacent land owners • Implemented on a case by case basis and does not take a holistic approach to solving the problem • Life expectancy of culverts not replaced is approximately 25 – 40 years with maintenance and rehabilitation works required	*Less Preferred* • Problem statement not fully addressed – existing flooding issues still present and limits opportunities for future development • Implementation may be difficult – City initiative versus development driven initiative • Large stormwater management facility for the City to build and maintain • Life expectancy of culverts not replaced is approximately 25 – 40 years with maintenance and rehabilitation works required	*Preferred* • Existing flooding issues on WC 5.0 and WC 6.0 addressed as culvert and channels are designed to convey 100 year flow • Opportunities to address existing erosion problems with channel works/treatments • Roadway, driveway flooding adjacent to WC 5.0 east branch and WC 5.1 will be eliminated due to diversions • Stormwater management pond proposed with new development to control future flows • Life expectancy of replaced culverts is approximately 75 years	*Less Preferred* • Existing flooding issues on WC 5.0 and WC 6.0 addressed as culvert and channels are designed to convey 100 year flow • Opportunities to address existing erosion problems with channel works/treatments • Typical stormwater management pond proposed to be built with new development to control future flows • Life expectancy of replaced culverts is approximately 75 years

Table 3.5 - Primary Watercourses Alternatives Evaluation Continued

	Do Nothing Alternative	**Alternative 1 – Replace structurally deficient crossings and implement flood plain management policies and flood proofing measures**	**Alternative 2 - Replace structurally deficient crossings and provide enhanced pond upstream of culverts that are under capacity**	**Alternative 3 - Replace all culverts with hydraulic and structural deficiencies and undertake channel works (Master Drainage Plan Recommendation)**	**Alternative 4 - Similar to Alternative 3 without diversions**
Cost (Relative costs)	*Most Preferred* • No cost	*Preferred* • Cost includes Capital costs for Barton Culverts, SWM Pond, Land for SWM Pond, Engineering Costs for culvert and pond design • Lowest Relative Cost	*Less Preferred* • Cost includes Capital costs for Barton Culverts, SWM Pond, Land for SWM Pond, Engineering Costs for culvert and pond design • High Relative Cost	*Less Preferred* • Cost includes Capital costs for Culverts replacements, SWM pond, Channel works, Diversion pipes, Land for SWM pond, Engineering Costs for culvert, pond, channel and diversion pipe design • High Relative Cost	*Less Preferred* • Cost includes Capital costs for Culverts replacements, SWM Pond, Channel works, Land for SWM Pond, Engineering Costs for culvert, pond, and channel design • High Relative Cost
Overall Rank	Least Preferred	Less Preferred	Less Preferred	Recommended Alternative	Less Preferred

Table 3.6 - Secondary Watercourses Alternatives Evaluation

	Do Nothing Alternative	Alternative 1 – Replace structurally deficient crossings and implement flood plain management policies and flood proofing measures	Alternative 2 - Replace structurally deficient crossings and provide enhanced SWM upstream of culverts that are under capacity	Alternative 3 - Replace all culverts with hydraulic and structural deficiencies and undertake channel works (MDP Recommendations)	Alternative 4 - Similar to Alternative 3 without diversions
Natural Environment (Potential impacts on terrestrial environment, fisheries resources, fluvial geomorphology of the watercourse, groundwater/surface drainage, and water and/or air quality)	*Most Preferred* • No displacement or disruption to terrestrial or aquatic features since no construction proposed • Potential for long-term negative impacts on geomorphology including erosion and sedimentation resulting from drainage problems • No impacts on groundwater or surface water drainage	*Preferred* • No structurally deficient culverts identified – therefore no impacts associated with culvert or channel works • Potential for long-term negative impacts on geomorphology including erosion and sedimentation resulting from drainage problems • No impacts on groundwater or surface water drainage anticipated	*Less Preferred* • No structurally deficient culverts identified – therefore no impacts associated with culvert or channel works • Potential for disruption to terrestrial features in proposed pond locations • Potential for long-term negative impacts on geomorphology including erosion and sedimentation resulting from drainage problems which are not addressed • No impacts on groundwater or surface water drainage anticipated	*Least Preferred* • Potential displacement or disruption to terrestrial features in the vicinity of the crossings and along the banks of the channel where channel widening is proposed. • Channel works resulting in temporary disruption/disturbance (fisheries and water quality). • Replacement/enhancement of creek substrate beneath crossings. • Natural treatments and erosion controls will be implemented to the extent possible • Disruption to surface water drainage with proposed diversion to different watershed (WC 7.0) – flows during wet weather events only and will not maintain or improve baseflow • Potential for fluvial geomorphology and aquatic impacts to WC 7.0 (relatively stable, healthy system)	*Less Preferred* • Potential displacement or disruption to terrestrial features in the vicinity of the crossings and along the banks of the channel where channel widening is proposed. • Channel works resulting in temporary disruption/disturbance (fisheries and water quality). • Replacement/enhancement of creek substrate beneath crossings. • Natural treatments and erosion controls will be implemented to the extent possible • No impacts on groundwater or surface water drainage anticipated
Socio-Economic Environment (Potential for disruption or displacement of residents or community features, improvements to pedestrian/bike, disruption to businesses and impact on future land uses)	*Least Preferred* • Limits future development opportunities • Unsafe conditions due to flooding – existing properties in the flood plain	*Less Preferred* • Limits future development opportunities since filling will not be technically feasible in all cases • Safety concerns due to flooding will not be addressed • Minor disruptions anticipated with pond construction	*Less Preferred* • Greater pond area requirements could limit future infill development opportunities • Limited approvability or buy-in by public/developers for larger stormwater facility • Safety concerns due to flooding will not be addressed in all cases • Minor disruptions anticipated with pond construction	*Preferred* • Replacement of culvert will improve unsafe flooding conditions • Land area and easements required for channel improvements • Minor disruptions anticipated with pond construction • Potential for significant disruption due to a number of closed roadways and the railway to facilitate culvert replacements and construction of diversions • Easements may be required for diversion pipes	*Preferred* • Replacement of culverts will improve unsafe flooding conditions • Land area and easements required for channel improvements • Minor disruptions anticipated with pond construction • Potential for significant disruption due to a number of closed roadways and the railway to facilitate culvert replacements
Cultural	*Most Preferred* • No impact	*Equally Preferred* • No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment	*Equally Preferred* • No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment	*Equally Preferred* • No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment	*Equally Preferred* • No impact anticipated, to be confirmed by a Stage 2 Archaeological Assessment
Technical Considerations	*Least Preferred* • Does not address existing flooding issues and limits opportunities for future development	*Less Preferred* • Does not address existing flooding issues and limits opportunities for future development • Filling in the floodplain could have impacts on adjacent land owners and removes flood storage • Implemented on a case by case basis and does not take a holistic approach to solving the problem • Life expectancy of culverts not replaced is approximately 25 years with maintenance works required	*Less Preferred* • Does not address existing flooding issues and limits opportunities for future development • Implementation may be difficult – City initiative versus development driven initiative • Life expectancy of culverts not replaced is approximately 25 years with maintenance works required	*Preferred* • Existing flooding issues on WC 6.1 to 6.3 addressed culvert and channels are designed to convey 100 year flow • Fewer culvert replacements required compared to Alternative 4 • Typical stormwater management pond proposed to be built with new development to control future flows • Life expectancy of replaced culverts is approximately 75 years, while culverts which are not replaced have a life expectancy of approximately 25 years and require maintenance	*Preferred* • Existing flooding issues on WC 6.1 to 6.3 addressed culvert and channels are designed to convey 100 year flow • Typical stormwater management pond proposed to be built with new development to control future flows • Life expectancy of replaced culverts is approximately 75 years

Table 3.6 - Secondary Watercourses Alternatives Evaluation Continued

	Do Nothing Alternative	Alternative 1 – Replace structurally deficient crossings and implement flood plain management policies and flood proofing measures	Alternative 2 - Replace structurally deficient crossings and provide enhanced SWM upstream of culverts that are under capacity	Alternative 3 - Replace all culverts with hydraulic and structural deficiencies and undertake channel works (MDP Recommendations)	Alternative 4 - Similar to Alternative 3 without diversions
Cost	*Most Preferred* • No cost	*Preferred* • Cost includes Capital costs for SWM Pond and/or SWM Controls, Land for SWM Pond, and Engineering Costs • Low Relative Cost	*Preferred* • Cost includes Capital cost for SWM Pond and/or SWM Controls, Land for SWM Pond, and Engineering Costs • Low Relative Cost	*Less Preferred* • Cost includes Capital costs for Culverts replacements, SWM pond and/or SWM Controls, Channel works, Diversion pipes, Land for SWM pond, Engineering Costs For Culvert, Pond, Channel and Diversion Pipe Design • High Relative Cost	*Less Preferred* • Cost includes Capital costs for Culverts replacements, SWM Pond and/or SWM Controls, Channel works, Land for SWM Pond, Engineering Costs for Culvert, Pond, and Channel Design • High Relative Cost
Overall Rank	Least Preferred	Less Preferred	Less Preferred	Less Preferred	• Recommended

A summary of the results of the evaluation for the Primary Watercourses and Secondary Watercourses in provided in ***Table 3.7*** and ***Table 3.8***, respectively.

Table 3.7 - Evaluation Summary for Primary Watercourses

Criteria Group	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Natural Environment Rank	✓✓	XX	✓	✓
Socio-Economic Rank	XX	✓	✓✓	✓✓
Cultural Rank	✓✓	XX	✓✓	✓✓
Technical Rank[1]	XX	X	✓✓	✓
Cost Rank[2]	✓✓	✓	XX	X
Overall	XX	X	✓✓	✓

✓✓ Most Preferred
✓ Preferred
X Less Preferred
XX Least Preferred

- Alternative 1 and Alternative 2 do not fully address the problem statement
- Alternatives 3 and 4 have comparable costs (approximately $9.8 to $11.2 million)
- Based on technical and socio-economic considerations, Alternative 3 is the recommended alternative

[1 and 2] The Technical and Cost Criteria Groups were considered most important in the overall evaluation given the poor drainage conditions of the watercourse systems, structural problems at certain crossings that could result in unsafe conditions and to achieve long-term cost effective solutions

Table 3.8 - Evaluation Summary for Secondary Watercourses

Criteria Group	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Natural Environment Rank	✓✓	✓	xx	✓
Socio-Economic Rank	xx	✓	✓✓	✓✓
Cultural Rank	✓✓	xx	✓✓	✓✓
Technical Rank[1]	xx	✓	✓✓	✓✓
Cost Rank[2]	✓✓	✓	xx	x
Overall	xx	x	✓	✓✓

✓✓ Most Preferred x Less Preferred

✓ Preferred xx Least Preferred

- Alternative 1 and Alternative 2 do not fully address the problem statement
- Alternatives 3 and 4 have comparable costs (approximately $2.3 to $ 3.2 million)
- Based on natural environment and technical considerations, Alternative 4 is the recommended alternative

3.3 Project Description and Environmental Effects and Mitigation

As noted above, Alternative 3 is the Preferred Alternative for the Primary Watercourses and includes replacing all structurally and hydraulically deficient culverts, channel works, watercourse diversions and traditional stormwater management for new developments. These works are consistent with recommendations of the Master Drainage Plan. Culvert upgrades are proposed at Barton Street, Arvin Avenue, CP Rail, South Service Road and North Service Road. Given land constraints, the channel works will involve both naturalized and lined sections. Examples of these channel works are shown in the following ***Figures 3.2 and 3.3***. Stormwater management as part of this study is required for quantity control only, however the City's Integrated Stormwater Master Plan, shows water quantity and quality control stormwater management ponds for new developments areas adjacent to Watercourses 5.0 and 6.0. The recommendations from the Integrated Stormwater Master Plan should be incorporated into the proposed works. ***Figure 3.1*** provides a schematic of the proposed works along the Primary Watercourses.

In the case of the Secondary Watercourses, Alternative 4 is the Preferred Alternative. While this alternative is similar to Alternative 3 since it includes replacing all structurally and hydraulically deficient culverts, channel works, and traditional stormwater management for new developments, it does not include diversions between watercourses. Culvert upgrades are proposed at Barton Street, Arvin Avenue and CP Rail. Channel works on Watercourse 6.1 will involve naturalized sections. An example of the natural channel works proposed for reaches of Watercourse 6.1 is shown in ***Figure 3.5*** below. Stormwater management control includes end-of-pipe facilities for Watercourse 6.1 and on-site storage (e.g., roof top or surface) for Watercourse 6.3 and is required for post-to-pre water quantity control. The City's Integrated Stormwater Master Plan, shows water quantity and quality control stormwater management ponds for new developments areas adjacent to Watercourses 6.1. The recommendations from the Integrated Stormwater Master Plan should be incorporated into the proposed works along with any opportunities to promote water quality control for infill development areas not considered in the plan. ***Figure 3.4*** provides a schematic of the proposed works along the Secondary Watercourses.

This project is confirmed as a Schedule B Class EA project.

Table 3.9 provides a summary of potential effects associated with the proposed improvements and the City of Hamilton's commitment to mitigate these effects.

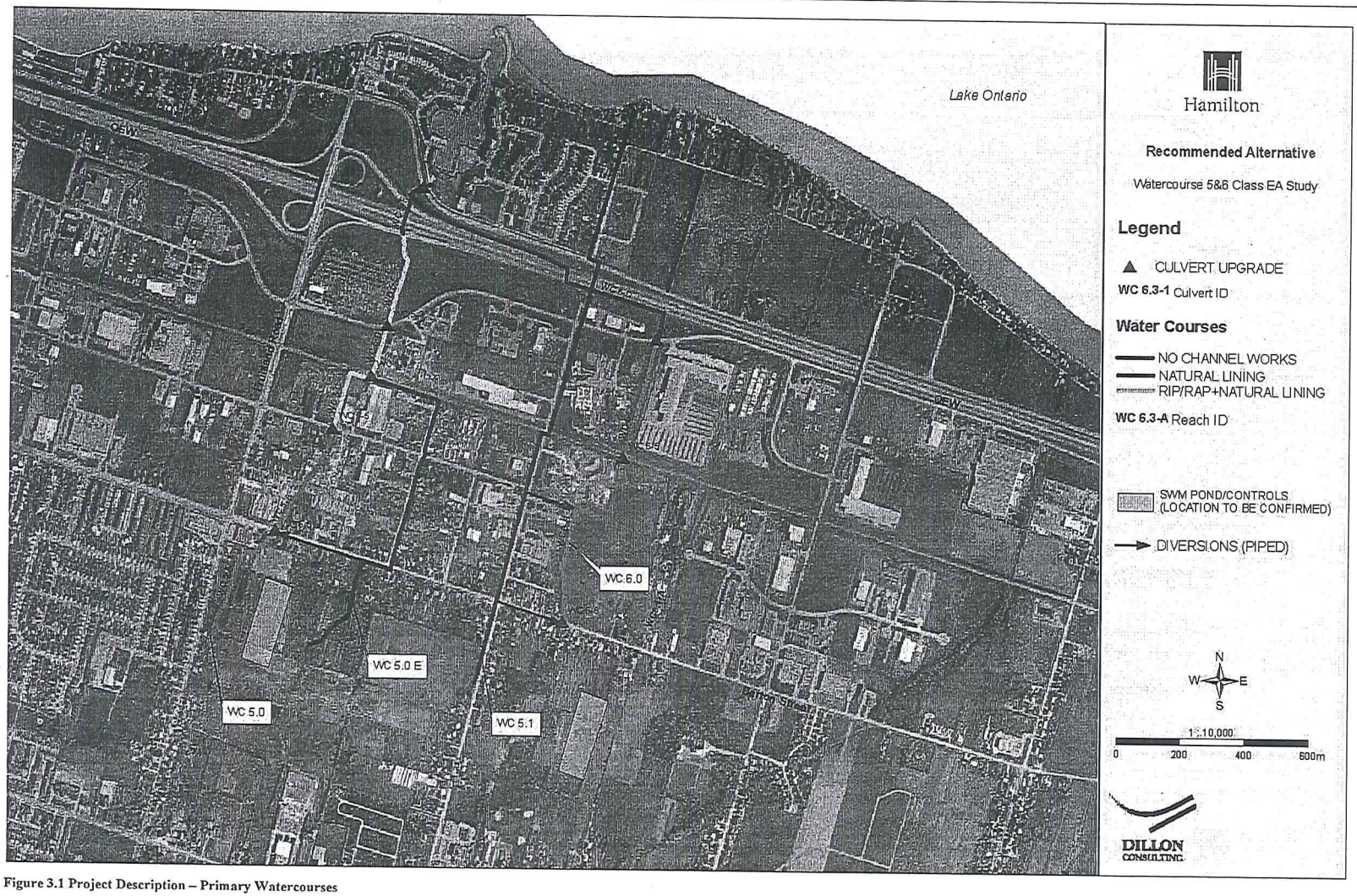


Figure 3.1 Project Description – Primary Watercourses

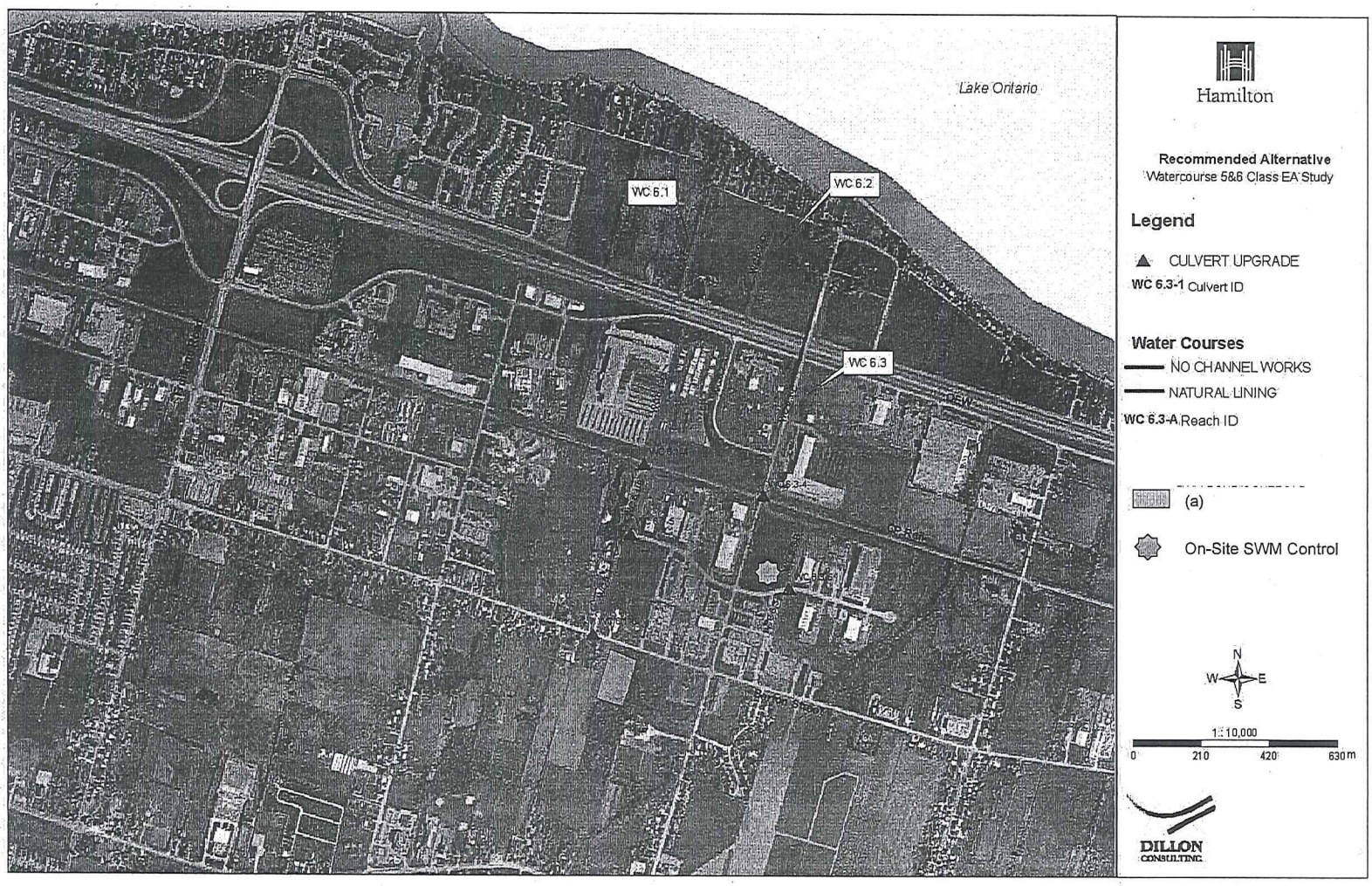
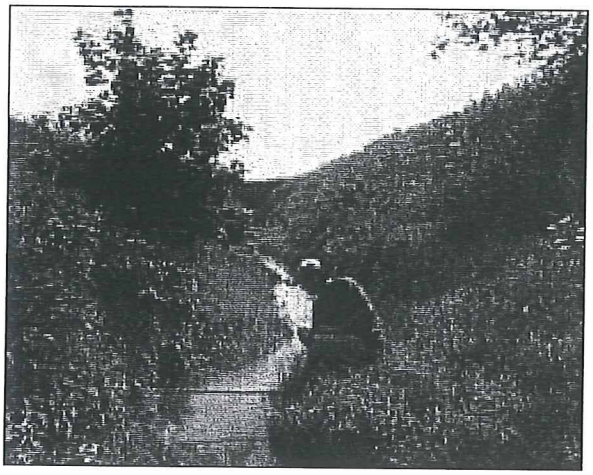
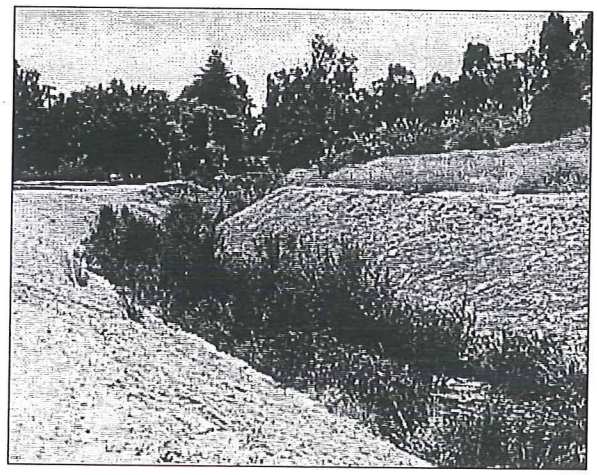


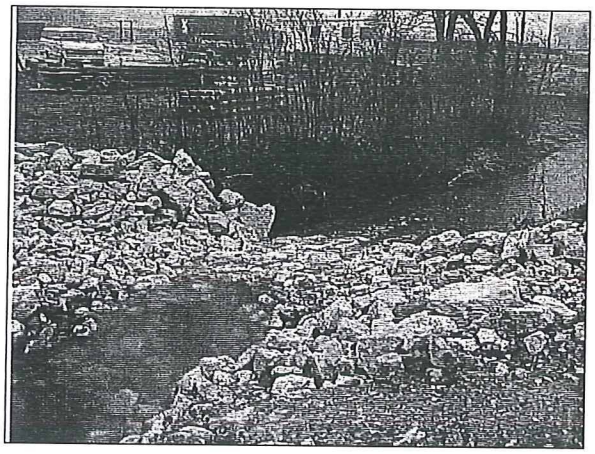
Figure 3.2 Project Description – Secondary Watercourses



(a)

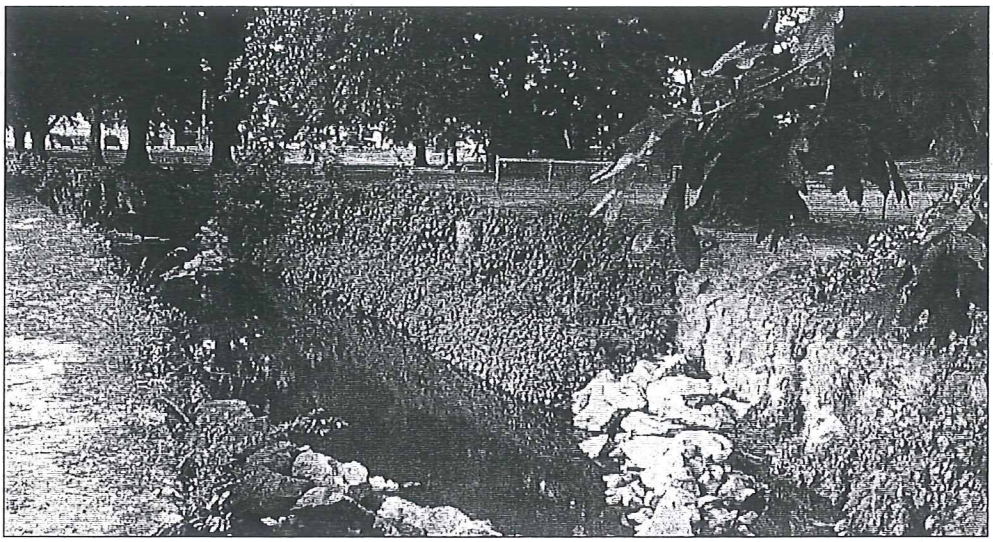


(b)



(c)

Figure 3.3 (a) Examples of Naturalized Sections
Figure 3.3 (b) and (c) Examples of Lined Sections



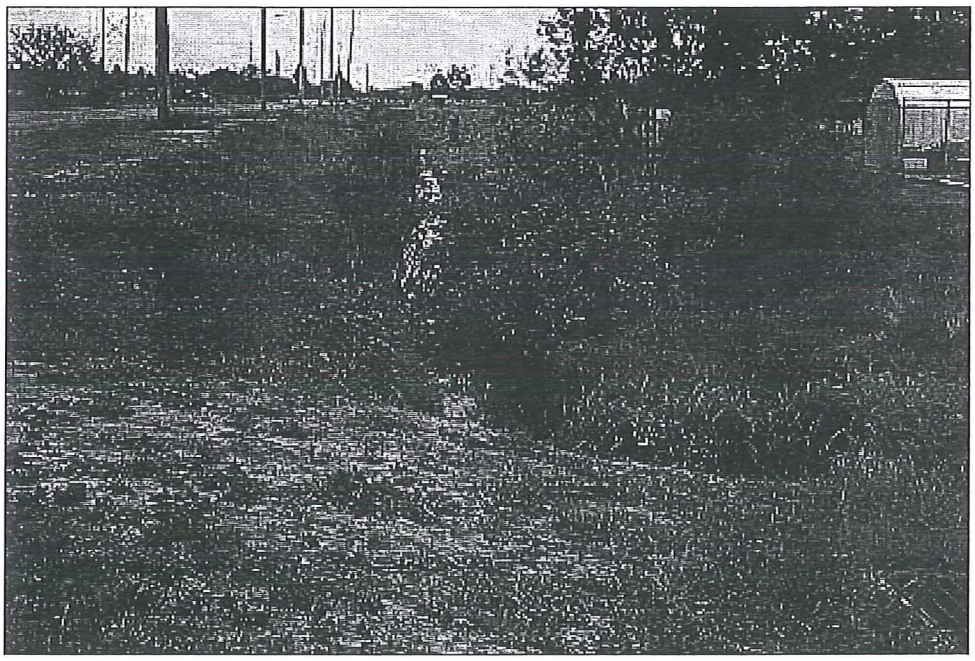


Figure 3.4 Examples of Naturalized Channel Sections for Watercourse 6.1

Table 3.9 - Potential Effects and Proposed Mitigation
Watercourse 5 & 6 EA Improvements

Potential Effect	Proposed Mitigation
Vegetation removal	• Vegetation removal will be kept to a minimum. • Naturalization and enhancement of terrestrial features where possible with proposed channel works • Landscaping will be incorporated into detailed design of pond. • Vegetation will be replaced with native species. • Disturbed areas will be restored as soon as possible to minimize the duration of soil exposure. • A Tree Protection Plan will be implemented during construction. • A monitoring/maintenance program will be developed until vegetation is established. • Erosion control measures to mitigate impacts to watercourses
Potential for aquatic habitat impacts	• Timing constraints for in-water work (i.e. work in the dry, during appropriate fisheries windows) • Vegetation planting and replacement/enhancement of creek substrate beneath crossings • Sediment and erosion control to minimize erosion and sedimentation/water quality impacts to the watercourse • Hard-lining of channels will be minimized to the extent possible with a focus on natural substrates incorporated into the design
Potential for noise and dust during construction activities	• Construction duration will be kept to a minimum. • All construction activities will adhere to the City's noise by-law. • Mitigation to reduce dust levels (such as wetting soils or use of dust suppressants) will be implemented as appropriate.
Private Property requirements	• Land requirements will be minimized to the extent possible (SWM pond detailed design) to facilitate future development opportunities • Final property requirements will be determined during design stage of channel works to minimize property requirements • Property owners will be contacted during detail design to determine the fair market value of the property required.
Temporary disruption during construction	• Notification to adjacent owners of construction scheduling • Phasing of road/lane closures to minimize traffic problems and railway usage • Maintain local and emergency access • Coordinate construction activity to mitigate impacts on municipal servicing and transit

4. APPROVALS REQUIRED

It is anticipated the following approvals will be required prior to construction:

- **Hamilton Conservation Authority - Development, Interference with Wetlands and Alterations to Shorelines and Watercourses: Regulation 161/06 under Ontario Regulation 97/04.** Lands within the study area that fall within the generic regulation line will require a permit by Hamilton Conservation Authority. The permit application must be accompanied by drawings detailing the location of the works, detailed design brief, which will include the required hydraulic modelling analysis, as well as proposed sediment and erosion control and restoration plans.

- **Hamilton Conservation Authority (HCA) "Letter of Advice"** regarding fish habitat management. HCA will determine during detailed design if a Habitat Alteration, Disruption or Destruct (HADD) of fish habitat will occur during construction. If a HADD is identified, approval is required from Fisheries and Oceans Canada (DFO) prior to construction

- **Ministry of Culture.** construction of the improvements may not proceed until clearance has been granted by the Ministry of Culture. As recommended in the Stage 1 Archaeological Assessment Report, a Stage 2 Archaeological Assessment is required is the final location of the diversion channel and stormwater management facilities is on previously undisturbed area. The need for a Stage 2 assessment will be determined during detailed design.