MILTON URBAN EXPANSION
CONCEPTUAL FISHERIES COMPENSATION PLAN
BOYNE SURVEY AREA
"Milton Phase 3"

DRAFT FINAL

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"FOREWORD TO USERS"

This report was commissioned by the Town of Milton as a companion document to the *Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Secondary Planning Area* (AMEC, 2012). It is intended that the Conceptual Fisheries Compensation Plan be used along with the Functional Stormwater and Environmental Management Strategy and the Subwatershed Update Study, to support individual applications for DFO authorization and Conservation Halton approval for the Boyne Secondary Planning Area.

During the course of the FSEMS for the Boyne Survey Secondary Plan, agreement has been reached between the Town of Milton, Conservation Halton, Halton Region, and the Milton Phase 3 Landowners Group with respect to the NHS proposed by the Landowner's Group, as well as certain components of the stormwater and watercourse management system as provided in the Tertiary Plans. These agreements have been compiled into the Implementation Principles for the Boyne Survey Natural Heritage System and are included in Appendix 'I' of the FSEMS, along with the corresponding schedules. In the event of any discrepancies between the FSEMS report text and the IP, the Secondary Plan Policies will prevail.

The objectives of this study are to:

(i) *Develop a Conceptual Fisheries Compensation Plan to allow for a holistic assessment and management of cumulative fish habitat impacts, and mitigation of such impacts throughout the Boyne Development Area.*

(ii) *Provide design guidelines and submission requirements for future design and permit submissions/applications to the Regulatory Agencies.*

(iii) *Streamline the review and approval process for applicants and Public agencies.*

Submission Protocol

The following section, and Appendix A, outline the submission requirements and process for individual component works:

(i) All individual site specific development applications potentially affecting fish habitat are to be submitted to Conservation Halton for screening and review. In order for Conservation Halton staff to properly evaluate the individual development plans, it will be necessary to have Subwatershed Impact Study(s) completed prior to, or in conjunction with, the design of component works. Among other aspects, the Subwatershed Impact Study(s) will define coordinated plans of any proposed watercourse and floodplain, verify hydraulic capacity, identify interim works and monitoring requirements (ref. Appendix 'M' of Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Secondary Planning Area (AMEC, 2011)).

(ii) In situations where authorization under the Fisheries Act is not required and the site specific design submissions are in conformance with the approved Conceptual Fisheries Compensation Plan, as determined through Conservation Halton review, then a single approval will be issued by Conservation Halton with no other approval required by DFO [see Note (v) regarding Ministry of Natural Resources (MNR) approval].

(iii) If an authorization under the Fisheries Act is required, Conservation Halton would then forward the appropriate information to Department of Fisheries and Oceans for review. DFO would review the application in conjunction with any applicable Subwatershed Impact Study and this Conceptual Fisheries Compensation Plan. Approval would be issued where the proposed works are in conformance with the principles of this Plan.

(iv) Where works are proposed that are not in conformance with this Plan, the proponent would be required to evaluate the cumulative impacts of the proposed non-conforming work with respect to the overall Compensation Plan objectives. This investigation would need to be completed as part of the individual area SIS. Furthermore, other regulatory processes and associated review may also be required (i.e. Conservation Halton – Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162/06, MOE - Ontario Water Resources Act/Certificate of Approval, Public Utilities, etc.). This document would not clear the applicant of these processes.

(v) In most proposed watercourse works, the proponent should pre-consult with the Ministry of Natural Resources in order to confirm whether or not there will be approval required from the Ministry (ref. Sections i to iv above). This includes whether or not proposals are in conformance with the principles of the CFCP, and whether or not a DFO Authorization is required. Should Ministry approval be required, submission protocols under previous projects for which a Conceptual Fisheries Compensation Plan has been completed have required that the submission of applications and supporting documents such as Subwatershed Impact Studies be made to all approval agencies concurrently. This will assist in the coordination of the overall review, and reduce the potential for unexpected delays in obtaining approvals.

Specific information requirements for DFO review of component works are outlined in Appendix A, (based on standard DFO requirements, revised to provide reference to this document as appropriate).

1. INTRODUCTION

Background

During preparation of the Secondary Plan for the Bristol Survey (Phase 1) urban expansion in the Town of Milton, an issue was identified with respect to the need for planning level input from the Department of Fisheries and Oceans Canada (DFO). The DFO administers the Fisheries Act, and Fisheries Act authorization is required if a harmful alteration, disruption or destruction (HADD) of fish habitat will occur as a result of a project, ensuring the principles of "no net loss" are appropriately realized. The Town, the Phase 1 Consulting Team and lead agencies recognized a concern regarding the lack of planning input by DFO and the potential risk to the Town and development proponents if support is not secured early in the planning and design process. Hence through senior level consultation, a new approach was established whereby DFO would participate during the planning phases working toward the provision of a conceptual-level endorsement for works affecting their mandate under the Fisheries Act. DFO's involvement at this early stage would provide insights into which development components, as planned, may require a Fisheries Act Authorization. Unambiguous conformance with the CFCP should avoid triggering a HADD, and therefore essentially pre-approves the subject works from a DFO process perspective.

All parties recognized the advantages of this process insofar as streamlining the approvals process and associated administration, allowing for better planning and design of the environmental systems and providing a higher level of confidence to the Town and developers regarding land use and infrastructure decisions. Therefore, a similar process has been initiated for the Phase 3 Development Area: Boyne Survey development area at the outset. This document provides partial fulfillment of the Fisheries Act requirements.

Proponents

The *Sixteen Mile Creek, Areas 2 and 7, Subwatershed Update Study (SUS), 2013* and the *Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (SMS), 2004* covered a broad study area comprised of Areas 2 and 7 within the Sixteen Mile Creek watershed and the Indian Creek Subwatershed, specifically, but not entirely focused on future development lands within Urban Milton. The focus of this study (Conceptual Fisheries Compensation Plan) is the Boyne Survey (Phase 3) area in the Town of Milton.

The proponents for the CFCP are two-fold. The Town of Milton is the proponent for the overall CFCP study. This study provides "master plan" level guidance to address DFO requirements for screening and clearance in accordance with the applicable legislation.

The proponents of the future works having direct impact on fish habitat will be the land developers. Subwatershed Impact Studies (SIS) for logical land areas will establish the specific scope of work, timing, management approach, cost-sharing and individual proponency. Proponency, depending on the land base and area, could be individual landowners or collections of landowners. All parties would need to adhere to the senior-level direction offered by this CFCP in preparing individual SIS, which will facilitate review by Town, Conservation Halton (CH), DFO, Ministry of Natural Resources (MNR) and other agencies having interest.

Study Area

Drawing 1 depicts the Boyne Survey lands, south of Milton Phase 1 (Bristol Survey) and Phase 2 (Sherwood Survey) lands. The area is approximately 964 hectares (2,382 acres) in size and is bounded on the north by Louis St. Laurent Avenue, on the east by James Snow Parkway, on the south by Britannia Road, and on the west by Tremaine Road. Most of the area is within the Sixteen Mile Creek Subwatershed 2, with a small eastern portion lying within the Sixteen Mile Creek Subwatershed 7, and a small western portion lying within the Indian Creek Subwatershed. The Omagh Tributary in Subwatershed 7, downstream of the Boyne Survey, has also been examined due to the possibility that technical drainage issues may require some diversion of water from Subwatershed 7 to Subwatershed 2.

Need and Rationale for Project

The preferred management strategies, as outlined in the Subwatershed Update Study and advanced in the Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Planning Area, have been developed to be consistent with the requirements of the Federal Fisheries Act and the "no net loss" policy. It is intended that this Conceptual Fisheries Compensation Plan provide specific criteria for construction activities, facilities and structures which will impact, or could potentially impact, upon fish habitat. Notwithstanding the direction outlined within this plan, final design plans will still require approval by the various regulating agencies, however the adherence to the design criteria outlined herein will facilitate both planning and design, as well as ultimate agency review.

The *Fisheries Act* states that no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat [Section 35(2)] without authorization by the Minister of Fisheries and Oceans. As well, no person shall deposit or permit the deposit of any deleterious substance into water frequented by fish [Section 36(3)]. The *Policy for the Management of Fish Habitat* (1986) provides policy direction for interpreting the broad powers mandated in the *Fisheries Act* in a way that is consistent with the concept of sustainable development.

The long-term policy objective is to achieve an overall net gain in the productive capacity of fish habitats. A fundamental strategy for achieving this is to prevent further erosion of the productive capacity of existing habitat by applying the "No Net Loss" Guiding Principle to habitat management decisions related to the review of proposed development projects. In the cases where losses to fish habitat are unavoidable, compensation through habitat replacement or enhancement are undertaken by the proponent on a project-by-project basis. The hierarchy of preferences for applying this principle to development, or other activities, is as follows:

1. Maintain, without disruption, the natural productive capacity of habitats through redesign or mitigation.
2. If the former proves impossible or impractical, then compensation by either creating new habitat, or by increasing the productive capacity of existing habitat, will be considered. It should be noted, however, that compensation may not be acceptable in some cases where the habitats in question are deemed especially important or sensitive.

Recently, the *Fisheries Act* has undergone revision, scheduled to come into effect on January 1, 2013. However, the exact nature of how the *Fisheries Act* changes will affect the protection fish habitat within the Boyne Survey Area are not currently defined, and will likely not become fully apparent for some time, therefore it is suggested that the status quo be considered going forward until such time as an updated process has been adopted by DFO and its partners.

The presence of fish or mussel species considered at risk triggers protection of these individuals and their habitat under federal and provincial legislation. The *Species At Risk Act* (SARA) is the federal legislation for the protection of species assigned a conservation status by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed in Schedule 1 of the SARA. The purposes of the SARA are to prevent wildlife species from being Extirpated or becoming Extinct, to provide for the recovery of wildlife species that are Extirpated, Endangered or Threatened as a result of human activity, and to manage species of Special Concern to prevent them from becoming Endangered or Threatened. Once a species is listed under the SARA, it becomes illegal to kill, harass, capture or harm it in any way. Critical habitats are also protected from destruction. The Minister of Fisheries and Oceans is responsible for aquatic species listed under the SARA, including freshwater fishes and mussels.

In Ontario, the Committee on the Status of Species at Risk in Ontario (COSSARO) reviews species based on the best available science, including community knowledge, and Aboriginal Traditional Knowledge, and, if appropriate, adds them to the Species at Risk in Ontario (SARO) list. Endangered, threatened and extirpated species on this list, as well as their habitats, automatically receive legal protection under the provincial *Endangered Species Act* (2007). The presence of fish species classed as *Endangered* or *Threatened* elevates the fish habitat to MNR *Class 1* habitat, and triggers Provincial protection of habitat under the *Planning Act.* Under Section 3 of the *Planning Act,* the Province requires that, in exercising any authority that affects planning matters, planning authorities "shall have regard to" policy statements issued under the *Act*. Under Section 2.1.3 of the Provincial Policy Statement it is stated that development and site alteration shall not be permitted in significant habitat of endangered species and threatened species.

2. EXISTING CONDITIONS

This section provides an overview of the baseline inventory of existing conditions within the Boyne Survey area. A detailed discussion of the existing terrestrial and watercourse resources within the Boyne Survey area is provided within the 2012 Subwatershed Update Study. Unless sufficient justification is provided to indicate otherwise, field data greater than 5 years old cannot be used in a Subwatershed Impact Study (SIS), and must be redone, or at a minimum, validated.

2.1. Geology, Physiography and Soils

The geology and physiography of Subwatershed Area 2 was presented in the *Sixteen Mile Creek Subwatershed Planning Study, Areas 2 and 7*, Philips Planning and Engineering Limited, January, 2000 and the overall characterization updated in the Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study (AMEC, 2012); the geology and physiography of the Indian Creek Subwatershed of the Bronte Creek Watershed was presented in the *Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study* (Philips Engineering Ltd., December 2004). The Boyne Survey area spans the Indian Creek Subwatershed and Areas 2 and 7 of the Sixteen Mile Creek Watershed.

Physiography and Geology

- The study area consists of the physiographic regions identified as the Peel Plain, the South Slope and the Niagara Escarpment.
- The shape of the bedrock surface as well as the occurrence of the overburden units which make up the above regions is a result of the repeated glacial advances and retreats which have occurred in Southern Ontario.
- The surficial overburden of the South Slope physiographic unit in the study area is comprised of the silty to clayey Halton Till. The surficial material in the Peel Plain, which covers the majority of the study area, consists of glaciolacustrine silts and clays.
- The topography has a gentle, somewhat undulating form sloping southwest.
- The bedrock underlying the glacial deposits consists of the Queenston shale. The upper 5 metres of the shale can be weathered and fractured.
- The overburden thickness in the Boyne Survey study area varies from 3-20 metres. It is less than 5 metres within Area B on Map 1 (Appendix B) and increases in thickness to the south and east (based on overburden thickness map OGS Map 2179 in Appendix 'B').

2.2. Hydrogeology

Conceptual Groundwater Flow System Characterization

- Within the Boyne Survey study area, much of the surficial overburden consists of clay material which typically is of a low permeability, that is, it does not transmit water readily.

Relative to the thick clay till there are areas with other hydrostratigraphic characteristics which may provide an increased potential for groundwater recharge. Within the Boyne Survey area this would include Area "B" a localized area of thin, fractured till overburden less than 5 m thick.

- The underlying bedrock is a low permeability shale which will not provide a significant underdrain and as such will likely not lead to extensive fracturing in the overlying clay tills. Areas where the overburden is thinner may allow for a higher level of infiltration compared to the thicker silt/clay deposits.

- The general direction of horizontal groundwater flow within the shallow overburden/shale system will be northwest to southeast, reflecting the general bedrock and overburden topography. The horizontal component of groundwater flow, particularly within the overburden, will be weak due to low permeability of the silt/clay sediments.

- Discharge can occur where the watercourses cut into the upper fractured shale or sand and gravel lenses but this has not been observed within the Boyne Survey area.

- Groundwater recharge is expected to be relatively low and may be directed to the surface watercourses but the existing hydrostratigraphy indicates that this groundwater movement would be minor.

- The shallow groundwater mapping (Appendix B) indicates some minor groundwater divides which to a degree follow the surface water divides. Shallow flow appears to be directed more to the south in the eastern portion of the Boyne Survey area and to the southeast in the western portion. The deeper groundwater flow tends to follow the general pattern of the shallow groundwater flow to the east/south-east (Appendix B).

Reach Specific Groundwater Function

For the Subwatershed Update Study spot baseflows were measured in the field at selected sites (Map 1 Appendix 'B'). Within the Boyne Survey study are these included sites IC21, IC20 and sites 53, 54, 55, 58, 59 and 60. These sites were visited 3 times in 2007, twice in 2008 for the Subwatershed Update Study and 3 times in 2010 for the Boyne Survey study for indications of baseflow. At no time was baseflow observed in these reaches within the Boyne Survey area.

2.3. Watercourses

2.3.1. Fluvial Geomorphology

The fluvial geomorphology of streams in Subwatershed Areas 2 and 7 is discussed in the "*Sixteen Mile Creek, Areas 2 and 7 Subwatershed Update Study"* (AMEC Environment & Infrastructure, March 2013) and "*Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Plan Area"* (AMEC Environment & Infrastructure, March 2013). This work has built further upon the fluvial geomorphology characterization undertaken as part of the original "*Sixteen Mile Creek, Subwatershed Planning Study, Areas 2 and 7",* (Philips Planning and Engineering Limited, January 2000).

Historical assessment

In order to document changes in land use and planform adjustment over time, a historical assessment was undertaken, with the aid of aerial photographs from 1954 and 1983, in addition to digital imagery from 2008. This assessment also quantified migration rates, where possible, for the different reaches, to account for channel migration over the likely planning timeframe. Typically, these rates would be quantified using aerial photographs dating back to 1954. However, due the lack of available physical aerial photographs from that period, photographs dating back to 1983 were used instead.

The following describes the key changes in land use observed:

- In 1954, land use within the Boyne Survey study area was dominated by agricultural land. The Main Branch of Sixteen Mile Creek flows through this area, and was bounded by forests in several sections.

- In 1983, agricultural land use remained dominant but some residential buildings were observed near the channel in a few locations. Further new buildings were constructed between 1983 and 2008. Some of the forests had been clear cut to allow this development to take place.

Table 2.3.1 highlights lateral migration rates calculated for reaches within the study area, which ranged 0.03-0.18 m/yr. Streams with lower migration rates can be said to be more stable, and of lower geomorphic risk than those with higher migration rates. It is notable that Reach 2-II, the Main Branch of Sixteen Mile Creek, has the highest migration rate, reflecting the fact that this reach is a state of active adjustment.

Table 2.3.1: Average Migration Rates for Reaches in the Study Area

Reaches	Absolute Mean Lateral Migration Rate (m/yr)
BP-4-C	0.10
SWS-1-A – SWS-1-A-2	0.17
SWS-2-A	0.11
2-II	0.18
SE-2-A – SE-2-B	0.04
SE-3-A – SE-3-C	0.03

Field Assessment

As part of the additional assessment undertaken to update the Subwatershed Planning Study, geomorphological reaches were defined throughout the Boyne Survey (Phase 3) lands. These reaches were subject to rapid assessment using Rapid Geomorphological Assessment (RGA) and Rapid Stream Assessment Technique (RSAT) protocols. The RGA documents indicators of channel instability (MOE, 1999), while the RSAT provides a broader indication of the ecological function of the stream (Galli, 1996). Results of the rapid assessment are summarized in Table 2.3.2 and Figure 2.1.

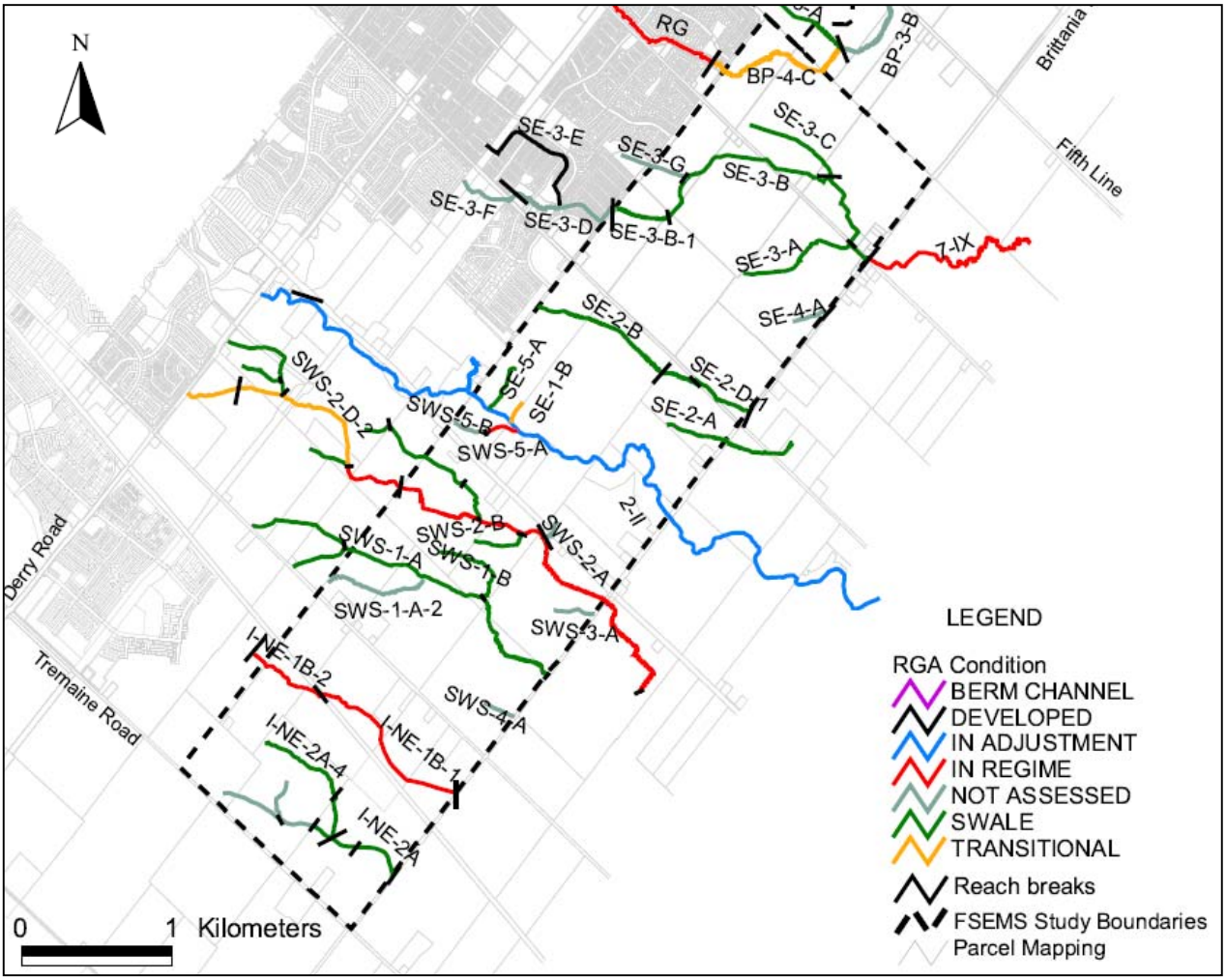

Figure 2.1:
Rapid Geomorphological Assessment results for Boyne Survey Lands

Table 2.3.2: Rapid Assessment Results for the Study Area				
REACH	**RSAT SCORE**	**RSAT CONDITION**	**RGA SCORE**	**RGA CONDITION**
Within Boyne Survey Lands				
Tributary I-NE-2A				
I-NE-2A	14.5	SWALE	0.04	SWALE
I-NE-2A-1	14.5	SWALE	0.04	SWALE
I-NE-2A-2	14.5	SWALE	0.04	SWALE
I-NE-2A-3	16.5	SWALE	0.07	SWALE
I-NE-2A-4	16.5	SWALE	0.07	SWALE
Tributary I-NE-IB				
I-NE-1B-1	13	LOW	0.04	IN REGIME
I-NE-1B-2	13	LOW	0.04	IN REGIME
Tributary SWS-1				
SWS-1-A	12	LOW	0.26	TRANSITIONAL
SWS-1-A -2	9	SWALE	0.06	SWALE
SWS-1-B	--	SWALE	--	SWALE
Tributary SWS-2				
SWS-2-A	14.5	LOW	0.04	IN REGIME
SWS-2-B		SWALE		SWALE
SWS-2-C	13.5	SWALE	0.04	SWALE
2-II				
2-II	27	MODERATE	0.46	IN ADJUSTMENT
SWS-5-A	10.5	LOW	0.19	IN REGIME
SWS-5-B		NOT ASSESSED		NOT ASSESSED
SE-5-A	--	SWALE	--	SWALE
SE-1-B	12	LOW	0.26	TRANSITIONAL
Tributary SE-2				
SE-2-A	--	SWALE	--	SWALE
SE-2-B	14	SWALE	0.04	SWALE
SE-2-D-1	15	SWALE	0.04	SWALE
SE-2-D-2	15	SWALE	0.04	SWALE
Tributary SE-3				
SE-3-A	11	SWALE	0.04	SWALE
SE-3-B	14.5	SWALE	0.10	SWALE
SE-3-B-1	14.5	SWALE	0.10	SWALE
SE-3-C	--	SWALE	--	SWALE
SE-3-G	--	NOT ASSESSED	--	NOT ASSESSED
Tributary SE-4				
SE-4-A	--	NOT ASSESSED	--	NOT ASSESSED
BP-4-C				
BP-4-C	24	MODERATE	0.25	TRANSITIONAL
Downstream of Boyne Survey Lands				
7-IX	17	LOW	0.14	IN REGIME

The results of the rapid assessments indicate that the drainage characteristics of the Boyne Survey (Phase 3) lands are typical of headwater systems within Southern Ontario, with the majority of drainage features characterized as swales (i.e., features lacking a defined bed and banks). These swale features represent the headwaters of Sixteen Mile Creek and Indian Creek and are considerably impacted by agricultural practices. Key exceptions are the portions of Sixteen Mile Creek Main Branch (Reach 2-II) and the Centre Tributary (Reach BP-4-C) which flow through the Boyne Survey lands (ref: Figure 2.1).

- **Reach 2-II** displays well-defined riffle-pool morphology and channel widening was the prevailing geomorphic process at the time of survey as indicated by fallen/leaning trees, extensive basal scour and exposed bridge footings. Degradation and planform adjustment were also observed, as indicated by exposed underlying clay till and the formation of chutes and islands respectively. This reach was classified as being "In Adjustment" according to the RGA results and of "Moderate" stream health according to the RSAT results.

- **Reach BP-4-C** also displayed defined riffle-pool sequences at the time of survey and was classified as being "Transitional" according to the RGA results and of "Moderate" stream health according to the RSAT results. This reach is immediately downstream of the Bristol Survey (Phase 1) lands. The dominant processes at the time of survey were aggradation, as indicated by lateral bars, siltation in pools and soft, unconsolidated bed conditions. This reflects the fact that, at the time of survey, in-channel works were ongoing along the Centre Tributary within Bristol Survey lands and upstream portions of this reach as part of the Phase 1 development.

The remaining defined drainage features took the form of selected higher order streams accumulating flows from the upstream swale features. In general, these lower order streams were found to be stable or 'in regime'.

Downstream of the Boyne Survey

Reaches comprising the Omagh Tributary (Tributary SE-3) were characterized in terms of stream morphology as part of the inventory of streams. Reaches within the Boyne Survey area were assessed to be of low constraint for geomorphological purposes as they are ephemeral swale features. However, Reach 7-IX is of "Medium" geomorphological constraint and located immediately downstream of the Boyne Survey lands. This reach may therefore potentially be affected by changes resulting from the diversion of water from the Omagh Tributary to Subwatershed 2.

Although Reach 7-IX is assessed by RSAT to be "low" in terms of overall stream health, there is some definition of channel form. Findings indicate that the reach is an agricultural channel, but which has a low flow channel (though this is not continuous). A cross-section at this site has been monitored between November 2007 and December 2009 (ref. Figure 2.2).

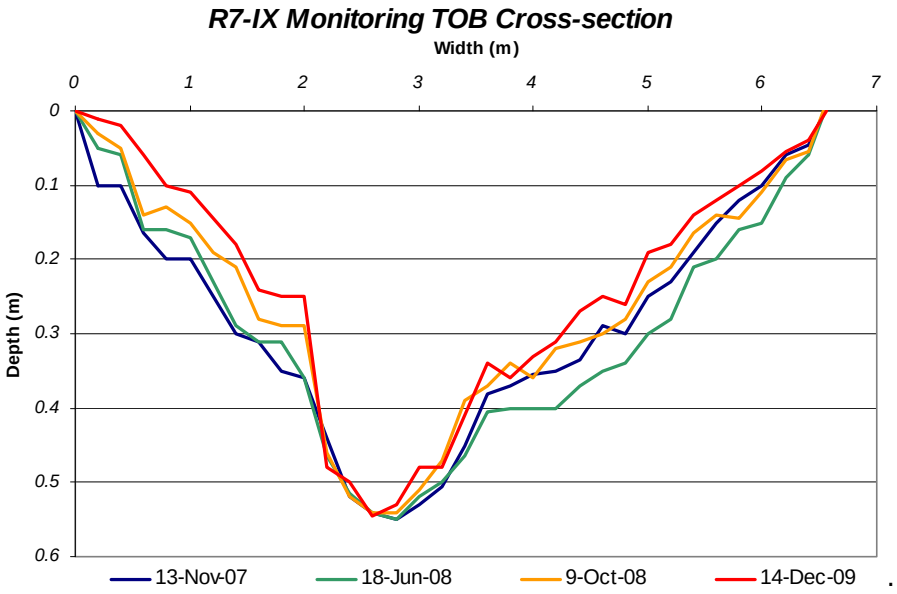

Figure 2.2: Monitoring cross-sectional survey at Reach 7-IX

Aggradation appears to be occurring either side of the bankfull channel at this cross-section, while the depth and dimensions of the bankfull channel itself are more constant, with some aggradation on the right hand side. Some flow was recorded in the bankfull channel at this location in June 2008. October 2008 and December 2009. These results support the suggestion that bankfull flow is the dominant channel-forming flow.

2.3.2. Hydrology

The hydrology and runoff response of the Boyne Survey area is characterized by the following factors:

- The Boyne Survey area spans the Indian Creek Subwatershed of the Bronte Creek Watershed, and Area 2 of the Sixteen Mile Creek Watershed, with the majority of the study area residing within the latter.
- Boyne Survey area exhibits relatively flat topography with ground slopes generally ranging from 0.001 to 0.005 m/m (0.1 – 0.5 %)
- Surficial soils consist primarily of Chinguacousy clay loam and Jeddo clay loam (Hydrologic Group C) which exhibit medium to high runoff potential
- Channel slopes within the Boyne Survey area exhibit typical slopes of 0.003 to 0.005 m/m (0.3 - 0.5 %).
- Drainage channels and swales (bankfull) are not well defined, typical depths of 0.25m to 1.25m.
- Existing floodplains through the Boyne Survey area are typically broad with shallow flood depths and exhibit moderate stream flow velocities (< 2.5 m/s).

Streamflow monitoring was conducted as part of the Subwatershed Update Study in order to further characterize the current hydrology within the Boyne Survey Study Area. The monitoring locations are provided on Drawing 1 of the Subwatershed Update Study. The gauges were installed between August 13, 2007 and November 26, 2007 at which time frozen winter

conditions prevailed within the study area, and were re-installed from April 1, 2008 until August 18, 2008.

Drought conditions prevailed through the 2007 monitoring period, whereas significant rainfall occurred during the 2008 monitoring period. A full discussion of stream flow monitoring results is provided in the *Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study,* AMEC, October 2012.

The low flow/baseflow response of the Boyne Survey area has also been assessed using the results of the hydrologic model (HSP-F) completed.

Table 2.3.3 provides a summary of year round surface flow rates for existing land use, generated using the calibrated hydrologic model. The corresponding flow node locations are provided on Drawing 5 of the Subwatershed Update Study.

Table 2.3.3: Summary of Simulated Flow Duration (%) for Boyne Survey Area – Existing Land Use Conditions

Flow Range (m^3/s)	Node						
	8.530	9.120	2.402	2.509	2.514	2.802	7.111
0.0 – 0.001	12.68	5.31	83.91	5.18	0.05	61.38	0.02
0.001 – 0.005	14.63	18.59	10.71	46.77	13.89	19.84	0.1
0.005 – 0.05	60.93	65.12	4.85	44.68	75.02	14.88	43.48
0.05 – 0.25	10.36	9.71	0.52	2.97	10.11	3.15	49.23
0.25 – 1.0	1.25	1.16	0.01	0.39	0.88	0.72	6.84
1.0 – 2.5	0.14	0.11	0	0.01	0.04	0.03	0.3
2.5 – 5.0	0.01	0.01	0	0	0	0	0.03
> 5.0	0	0	0	0	0	0	0

2.3.3. Fish Habitat

Fish Habitats and Communities

Fish habitat evaluation was conducted during the Subwatershed Update Study, using field information collected during the original Subwatershed Study and the Update Study, and was guided by the Credit Valley Conservation and Toronto and Region Conservation document "Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines" (CVC and TRCA, 2009). These guidelines classify watercourses into permanent (permanently flowing), seasonal (intermittent with fish present), contributing (indirect fish habitat), and not fish habitat. Watercourse number references have been based on the numbering system developed for *the Sixteen Mile Creek Subwatershed Areas 2 and 7 Update Study* (AMEC, 2012), and are provided in Figure 2.1.

Within the Boyne Survey area only the Main Branch of Sixteen Mile Creek (2-II) and the Centre Tributary (BP-4-C) flow continuously. The soils and parent material in the Boyne Survey area are fine textured, and there is generally little infiltration of water, and no groundwater discharge on the table lands. Therefore, all of the streams which originate within the Boyne Survey area are intermittent, and there are numerous ephemeral swales on the table lands which convey water only after precipitation or snow melt. Generally, there was little erosion along the tributaries in the Boyne Survey area. The habitat characteristics and fish communities of each of the principal drainage systems are discussed below.

Indian Creek (Bronte Creek watershed)

In September 2007, the two tributaries of Indian Creek that drain from the Boyne Survey area were completely dry at Britannia Road and upstream within the Boyne Survey area. These watercourses have mainly soil substrate, and are poorly defined in most locations. The most westerly of these two watercourses is defined as seasonal fish habitat at the downstream end of Reach I-NE-2A, and brook stickleback (*Culaea inconstans*) were captured at Britannia Road on June 6, 2007. Within most of Reach I-NE-2A, the watercourse, though essentially a swale, has some vegetative and physical characteristics that indicate a prolonged wet period, though no fish were captured here by electrofishing on April 18, 2007. Therefore, Reach I-NE-2A is considered complex contributing habitat. Immediately upstream, Reaches I-NE-2A-1, I-NE-2A-2 and I-NE-2A-3, are swales with soil substrate in a narrow strip of terrestrial vegetation, and are thus classified as simple contributing habitat. The headwaters of this small tributary are all swales that have been tilled and planted as part of the surrounding active agricultural fields, and are not considered fish habitat (Reaches I-NE-2A-4, I-NE-2A-5, I-NE-2A-6, I-NE-2A-7).

The most easterly of these two watercourses is a poorly defined channel through the Boyne Survey area; at some locations within a vegetated strip, and at other locations it is cultivated through. Reach I-NE-1B-1 was classed jointly in the field in early April 2008 by C. Portt and Associates, DFO, Conservation Halton, and Parish Geomorphic staff as simple contributing habitat, but because a single fathead minnow (*Pimephales promelas*) and single creek chub (*Semotilus atromaculatus*) were captured here later in April 2008, the classification was elevated to seasonal fish habitat. Farther upstream, Reach I-NE-1B-2 is not considered fish habitat.

West Tributary to the Main Branch (Subwatershed Area 2)

The West Tributary to the Main Branch of Sixteen Mile Creek was totally dry within the Boyne Survey area during the summer of 1998, except for the Britannia Road culverts at the downstream ends of Reaches SWS-1-A and SWS-2-A, which comprise two roughly parallel branches of the West Tributary. In September 2007 the instream conditions were essentially identical to those observed in 1998, except that the Britannia Road culvert of Reach SWS-2-A was also dry. Reaches SWS-1-A and SWS-2-A have mainly soil substrate, and are simple swales in many places, though at other locations they have defined channels in shallow valley features. Fish (brook stickleback) have only been observed in these tributaries within the Boyne Survey area at one location, which occurred on April 15, 2008, but have been collected in the Britannia Road culverts where brook stickleback have been collected in SWS-1-A and fathead minnow and pumpkinseed (*Lepomis gibbosus*) have been collected in SWS-2-A. As would be expected, the number of fish species present increases downstream from the Boyne Survey area, closer to the Main Branch, with white sucker (*Catostomus commersonii*) and creek chub also present. In consideration of the location of fish collections, and the habitat attributes within the Boyne Survey area, Reaches SWS-1-A and SWS-2-A have been classed as seasonal habitat. Reach SWS-2-A-1 and most of the downstream part of Reach SWS-2-C are classed as simple contributing habitat, because they are swale or ditch features with soil substrate and terrestrial vegetation. Reaches SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, and the upstream part of SWS-2-C are swales that have been tilled and planted as part of the surrounding active agricultural fields, and have been classified as not fish habitat.

Main Branch (Subwatershed Area 2)

Conditions within the Main Branch of Sixteen Mile Creek are not thought to have changed materially since the Subwatershed Area 2 and 7 Study was completed, and it was not re-examined during the update study. Downstream of Laurier Avenue, through the Boyne Survey area and to its confluence with the East Branch of Sixteen Mile Creek, the Main Branch typically has a pool/riffle/run structure. No evidence of significant groundwater inputs were observed during the field investigation of this section of creek. A total of 22 fish species were reported from this section of Sixteen Mile Creek in the subwatershed study (Philips, 2000). While the fish community is generally that of a warmwater stream, this is a migratory route for salmonids from Lake Ontario, and rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and Pacific salmon (*Oncorhynchus* spp.) have been captured upstream of urban Milton. The vicinity of Regional Road 25 is considered the farthest downstream where significant rainbow trout spawning occurs (FSAH, 1995).

The two small tributaries that discharge directly to the Main Branch of the Sixteen Mile Creek within the Boyne Survey area are seasonally dry within the flat Peel Plain physiographic region, and are heavily impacted by agriculture and past ditching activities, except at locations near the Main Branch channel where their gradient increases and they become more incised as they descend into the valley occupied by the Main Branch. Fish are not thought to ascend these steep watercourses from the Main Branch. As such, Reaches SWS-5-A and SE-5-A have been classed as complex contributing habitat, and Reach SWS-5-B is classed as not fish habitat because it is a swale that has been tilled and planted as part of the surrounding active agricultural field.

East Tributary to the Main Branch (Subwatershed Area 2)

The East Tributary to the Main branch of Sixteen Mile Creek was dry to a few standing pools, usually at road culverts, within the Boyne Survey area during the summer of 1998. In September 2007 the instream conditions were essentially identical to those observed in 1998. The watercourses of this tributary within the Boyne Survey area have mainly soil substrate, and have poor instream habitat conditions, being either swales (Reaches SE-2-A, SE-2-D-2, SE-2-D), or little better than a swale (Reach SE-2-D-1), except where it is briefly a roadside ditch at the upstream end of Reach SE-2-D-1. Reaches SE-2-A, SE-2-D-2 and SE-2-D are not considered to be fish habitat. Reach SE-2-D-1 might also have been classed as not fish habitat, but fathead minnows were captured at the downstream end of this reach at the Britannia Road culvert in April 2008, and there is a record of longnose dace (*Rhinichthys cataractae*) being captured here in 1973. In streams, longnose dace are a riffle-dwelling species, typically found in permanently flowing watercourses with coarse substrate. At station S-141 the flow is intermittent and the substrate is soil. Unless stream conditions here have changed radically since 1973, which appears unlikely given the condition of the associated catchment area, we suspect that this record is a result of either an incorrect species identification or an incorrect station location.

Omagh Tributary

The Omagh Tributary arises within the present Milton urban area, then flows generally southeast through the Boyne Survey area, and then to the East Branch of Sixteen Mile Creek. Throughout most of the Boyne Survey area, this watercourse exists as a swale or ditch with soil substrate through cropland and pasture, but it exists as a roadside ditch just upstream of Britannia Road. Only downstream of Britannia Road, outside of the Boyne Survey area, does it occupy a shallow valley feature. At all locations examined within the Boyne Survey area, this watercourse was completely dry when examined in the summer of both 1998 and 2007, with the exception of the culvert at Britannia Road. Low numbers of brook stickleback and creek chub were captured in the Omagh Tributary within the Boyne Survey area on April 24, 2008, and brook sticklebacks were collected at the Britannia Road culvert on July 29, 1998. Based upon the observed habitat, the fact that most of the watercourse dries during the summer, and the locations where fish were found, Reach SE-3-B has been classed as seasonal fish habitat. Reach SE-3-G was classed as complex contributing habitat, as this swale is likely inaccessible to fish from SE-3-B, and it contains some hydrophilic plants. Reaches SE-3-B-1 and SE-3-C are not classed as fish habitat because of lack of flow and the watercourse is tilled and cropped as part of the surrounding agricultural fields. Similarly, the watercourse of Reach SE-3-A is not differentiated from the active pasture that surrounds it, and is therefore not classed as fish habitat.

Reach SE-4-A is not part of the Omagh Tributary, but is the extreme headwater of another tributary that connects to the East Branch of Sixteen Mile Creek just downstream from the Omagh Tributary mouth. Reach SE-4-A is a barely perceptible swale that is tilled and cropped as part of the surrounding active agricultural field, and is not classed as fish habitat.

Centre Tributary

Upstream of the Boyne Survey area in the Phase 1 lands, the Centre Tributary used to mainly consist of straightened or ditched watercourses, was intermittent, and dried to standing pools at culverts, prior to the development of Phase 1. Now, most of the Centre Tributary within the Phase 1 lands has been reconstructed using natural channel design, and now flows permanently, apparently due to a combination of stormwater management facilities included in the development of Phase 1, as well as the importation of water that residents use around their homes. Permanent flow in the Centre Tributary now extends downstream through reaches BP-4-C, BP-3-B, BP-3-C, BP-3-C1, and 7-VI-C to its confluence with the Middle Tributary of Sixteen Mile Creek. The fish community in the Centre Tributary in 1998, prior to development, consisted of fishes, such as pumpkinseed and brook stickleback, that are adapted to surviving in small isolated pools during the summer months. In 2005 and 2008, the fish community also had creek chub, fathead minnow, bluntnose minnow (*Pimephales notatus*), goldfish (*Carassius auratus*), common carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosus*), brook stickleback, pumpkinseed and white sucker young-of-the-year. Juvenile northern pike (*Esox lucius*) have also been reported from this watercourse in recent years (Cory Harris, Conservation Halton. Personal Communication). Creek chub and spawning white sucker tend to be found in pool/riffle habitats with some coarse substrate and flowing water. Fish are found everywhere in the Centre Tributary now, compared to a few isolated locations prior to the Phase 1 development.

Reach BP-4-C is the only section of the Centre Tributary that passes through the Boyne Secondary Plan Area, and has been straightened and is situated in a relatively narrow buffer among agricultural fields, though it is beginning to naturalize. Substrate is often clay or soil, but has some coarser (sand, gravel) in patches. Considering the available habitat, permanent flow, and relatively diverse fish community, Reach BP-4-C has been classed as permanent fish habitat with rehabilitation potential.

Fisheries Significance

From a fisheries perspective, the most significant characteristic of almost all of the tributaries in the Boyne Survey area is the absence of base flow, which severely limits fish production. They do, however, convey water to Sixteen Mile Creek at certain times of the year and thus influence the characteristics of downstream habitats (flow, water quality, temperature, sediment and organic matter supply).

2.3.4. Navigability

The Main Channel of Sixteen Mile Creek through the centre of the Boyne Survey is considered navigable by the Department of Fisheries and Oceans, Canadian Coast Guard. All works that may interfere with the public right to navigation (e.g. construction of bridges) must then be approved pursuant to the *Navigable Waters Protection Act*. All other watercourses within the Boyne Survey area are not considered navigable.

2.3.5. Terrestrial Resources

Section 3.6 of the Subwatershed Update Study (SUS) (March 2013) presents a detailed summary of the known terrestrial resources within the Subwatershed Update Study areas, including the Boyne Secondary Plan Area, based on background data and field studies conducted in 2007-2008, plus supplementary scoped investigations in 2009-2011 (wetland evaluations). Literature and background data pertaining to terrestrial resources in the study areas (including Boyne Survey) was obtained from the Region of Halton, Conservation Halton, Ministry of Natural Resources, and the Natural Heritage Information Centre (Peterborough). Additional background information was assembled including earlier subwatershed studies, published documents, and other literature relevant to resources in the study area.

Summary of Observations

Physical and Land Use Context

- The Study Area is flat to gentle in topography, containing gentle slopes except along the Main Branch of the Sixteen Mile Creek. Most of the study area is dominated by imperfectly drained, fine-textured soils.

- Intensive agriculture has eliminated most natural cover within the tablelands of the Study Area. The remaining habitats are undergoing continued fragmentation primarily for agriculture.

- Most remnant features have experienced various levels of repeated disturbance from human activities such as dumping, encroachment by agriculture, filling, firewood cutting and informal access.

Vegetation

- *The Sixteen Mile Creek ESA (#16) extends into the detailed Subwatershed Update* Study Area, located within the Boyne Survey lands. A portion of the Sixteen Mile Creek Valley ESA (#16) is also designated as a candidate Life Science Area of Natural and Scientific Interest (ANSI); MNR (2006) mapping indicates that this candidate designation does not extend north of Britannia Road. There is also an Earth Science ANSI located downstream of Britannia Road.

- A total of 63 ELC vegetation polygons were documented from the Boyne Survey study area (Figure T2 in Appendix 'F' of FSEMS). Eleven ELC community series were observed.

- A total of 19 vegetation polygons were identified as wetlands and 9 are forest communities. Natural forest and wetland comprise less than 5% of the total landscape within the Secondary Plan area.

- The most extensive natural communities are associated with the Main Branch of Sixteen Mile Creek, which are protected under Regional and Town policies. Lands are located along the Main Branch within 120 meters of the Greenbelt, which is south of Britannia Rd.

- Natural communities outside the Sixteen Mile Creek valleylands occur as isolated pockets within the landscape. Tributaries generally lack well defined, continuous riparian cover.

- Forest species composition consists of deciduous cover (bur oak, shagbark hickory, sugar maple).

- Six features outside of the ESA meet the criteria for Significant Woodlands set out in the Halton Region Policies. Given the limited natural cover present, these features and associated semi-natural communities represent key opportunities for woodland habitat within the Natural Heritage System as identified on Figure NHS-2A in Appendix C of the CFCP.

- Other woody vegetation cover consists of cultural woodlands, plantations, savannahs and thickets as well as open-grown trees and hedgerows. Although they are often isolated in the landscape, these represent some local opportunities to enhance linkages along stream corridors and between features.

- Wetland cover is rare within the Study Area although small wetland pockets can be found scattered throughout the landscape, usually associated with upland vegetation communities or watercourses. Wetlands in the landscape consist of deciduous swamp,

meadow marsh and swamp thicket communities. The dominant swamp species are bur oak and swamp maple. The dominant meadow marsh species observed are cattail and reed canary grass.

- Small aquatic features (including remnant wetlands and excavated ponds) were identified as supporting amphibian activity. These contained fringes of typical wetland species such as cattails and bulrushes. Submerged and floating aquatic vegetation was observed in some ponds. These features are often isolated in the landscape, making it difficult to connect them to other natural heritage features.

- Riparian cover associated with smaller tributaries of the Sixteen Mile Creek is either very limited, or lacking due to agricultural encroachment. The enhancement of riparian cover along tributaries, which will be integrated into future development, represents a significant opportunity to create linkage corridors and achieve a 'net gain' of natural cover in the Study Area.

- The riparian corridor along the Main Branch of 16 Mile Creek represents the most significant opportunities for habitat enhancement, restoration and creation. The creation of a hierarchy of wetland habitats in stream corridors could provide a variety of ecosystem functions suitable to amphibian species and other biota.

Wildlife

- A total of 400 site-specific wildlife observations were made within the Boyne Survey lands in 2008 by Dougan & Associates staff. This was based on numerous field visits made in spring, summer and autumn. It included 268 bird observations, 46 amphibian observations, four reptile observations, five mammal observations, 58 odonate (i.e. damselflies and dragonflies) observations, 18 butterfly observations, and one crayfish observation.

- Field surveys conducted in 2008 documented 93 species of wildlife from the Boyne Survey lands. Ninety species of wildlife were documented during their breeding seasons including 54 species of birds, 3 species of amphibians, 1 species of reptiles, 3 species of mammals, 16 species of odonates (i.e. damselflies and dragonflies), 12 species of butterflies, and one species of crayfish. Three additional bird species observed in September were migrants passing through on their way south.

- Bobolink, Barn Swallow, and Eastern Meadowlark (provincially Threatened 'open country' birds) are present in Boyne; this requires consultation with MNR regarding strategies and potential permitting.

- The majority of breeding bird species are associated with habitats other than woodlands or forests. This is not surprising given that the Boyne Survey lands are predominantly agricultural; open habitat species are most likely to be displaced by urban development.

- Amphibians were documented on 16 sampling events within the Boyne Survey lands in 2008 by Dougan & Associates staff. This total may include repeat observations of the same individual where sites were visited more than once. Three species were

represented, including Spring Peeper (13 observations), Western Chorus Frog (2 observations) and Green Frog (1 observation). Western Chorus Frog is a species designated "Threatened" in Canada by COSEWIC but is not of concern in Ontario.

- Two species of reptiles were documented from the Boyne Survey lands between 2008 and 2011 by Dougan & Associates staff. This included Snapping Turtle (one sighting) and Eastern Garter snake (four sightings). Snapping Turtles are designated "Special Concern" in Ontario by OMNR and in Canada by COSEWIC. A Snapping Turtle carcass was observed adjacent to the main branch valley of Sixteen Mile Creek just south of Louis St. Laurent Blvd. Specific turtle surveys were not undertaken; there is likely good habitat availability in the main branch. Site visits specifically to detect snakes within the Boyne Survey study area were undertaken in the fall of 2008; no active hibernacula or species of concern were detected.

- Three (3) common mammal species were documented from the Boyne Survey lands in 2008 through incidental observations. It is highly likely that other urban tolerant species are present within the study area, however no specific mammal or deer surveys were undertaken.

- Sixteen (16) species of odonates (i.e. damselflies and dragonflies) were documented from the Boyne Survey lands in 2008 by Dougan & Associates staff. Four (4) are listed as rare and 2 are listed as uncommon in Halton Region. The majority of the species were associated with Sixteen Mile Creek. A few others were associated with small wetlands and a woodlot.

- Twelve (12) species of butterflies were documented; one is considered locally uncommon in Halton Region (Compton Tortoiseshell), and one is locally rare (Giant Swallowtail – not resident). The Monarch is designated Special Concern in Ontario and Canada. The others observed are all considered common species.

In summary, the most significant wildlife habitat areas were the riparian corridors and scattered woodlots / successional habitat complexes. The corridor associated with the Main Branch of Sixteen Mile Creek exhibits the greatest diversity and greatest enhancement opportunities and serves as a wildlife movement corridor. Efforts to establish vegetated links along the smaller tributaries would be beneficial. Wildlife diversity could also be enhanced if the existing woodlots could be enlarged and linked to expanded riparian cover systems.

Constraints

The current habitats and linkages in the Boyne Survey are highly constrained by an intensive history of fragmentation under agricultural as well as anthropogenic uses (farmsteads, residential). While in general this has resulted in reduction of habitat for most native biota to critical levels, some biota which are somewhat adapted to agricultural land uses, such as open country birds, have benefited from the existing land uses.

Terrestrial constraints have been identified based on the identification and field verification of significant ecological features and functions; and the application of available screening criteria

for federal, provincial and regional level legislative and policy designations, and others under the mandate of Conservation Halton.

Resources that form the fundamental 'significant' features and attributes within the Boyne Survey study areas have been identified, including Significant Woodlands, wetlands, and sites known to support plant and wildlife species of concern. Wetland cover has been reviewed in accordance with criteria in the Ontario Wetland Evaluation System (MNR, 1993), and three wetlands / complexes were evaluated and are recommended as locally significant (ref. Section 3.6.4 of the SUS for more details). Significant features and locations of significant species observed are summarized on Figure T5 in Appendix 'F' of the FSEMS. In addition, Significant Wildlife Habitats have been identified using the MNR Significant Wildlife Habitat Technical Guide (MNR 2000) in conjunction with the expertise of our wildlife ecologists on the interpretation of these guidelines; these are summarized later in this section.

The Sixteen Mile Creek Subwatershed Update Study screened all features and records of significance for potential Significant Wildlife Habitat (SWH), and this information is summarized in Appendix H of the SUS. Under the PPS (2005), the determination of Significant Wildlife Habitat is assigned to planning authorities, requiring the development of specific criteria applicable to that jurisdiction, and supported by specific field studies to corroborate evidence that criteria are met. The Town of Milton and Region of Halton have not undertaken such a study, and the SUS represents a snapshot of subwatershed conditions that may not detect complete evidence of SWH triggers. For the purposes of the SUS and FSEMS, potential Significant Wildlife Habitat was identified based on MNR (2000) categories and criteria. More detailed site specific studies (such as the SIS) are intended to gather greater detail on the potential SWH. The identified species and/or habitats were reviewed to ascertain whether they justify SWH designation at the SUS level of study based on the habitat size, numbers of individuals, and sustainability in the existing and future landscape. On this basis several categories of SWH were assigned (see below). Other potential SWH triggers detected in the SUS (such as the Isolated Specialized Habitats), and in SIS studies, may result in further delineations of SWH.

As part of the multidisciplinary team, the terrestrial ecologists ranked all watercourses in the Boyne Survey study area according to their current functional roles in linking significant features both within and beyond the study area. Watercourses with high terrestrial constraints link core significant features within and beyond the study area. Medium terrestrial constraint watercourses intersect lower level features, while low terrestrial constraint watercourses currently do not provide more than local scale habitat opportunities.

Natural Heritage features in the Boyne Survey study area that conform with one or more of the constraint categories are summarized in Table 2.3.4. Key features are summarized on Figure NHS-2B in Appendix C. The total areas representing constraints include complexes of habitat containing forest, wetland, thicket and/or meadow units with attributes which triggered their inclusion in one or more constraint categories.

Table 2.3.4: Terrestrial Features and Constraint Summary for the Boyne Survey/Phase 3 Lands Ref. FSEMS Figure 5.3 (Key Map) And T2 (Polygon Locations)

Key Map #	Area (ha)	Component Vegetation Units	Constraint Factors						
			ESA	Significant Woodland	Wetland	Forest Interior	Significant Valleyland	Linkage	Significant Species/ Potential SWH
A	7.19	216a(SW), 216b(SW), 216c(MM), 216d(MM), 216e(TH), 216f(TH), 216g(ME), P3-28(ME), P3-64 partial (HR)	No	Yes	Yes	No	No	No	Yes
B	2.80	227a(DF), 227b(M)	No	Yes	Yes	No	No	No	Yes
C	1.89	229a(MM), 229b(M)	No	No	Yes	No	No	Yes	No
D	3.27	225a(MM), 225b(TH), 225c(SWT), 225d(ME), 225e(ME)	No	No	Yes	No	No	Yes	No
E	2.37	31a(ME), 31b(P), 31c(DF)	No	Yes	No	No	No	Yes	No
F	61.92	108a(DF), 108b(W), 108c(MM), 118 partial (HR), 125a(W), P3-21(AG), P3-24(ME), P3-46(ME), P3-47(ME), P3-48(ME), P3-49(ME), P3-75(P), P3-78(ME), P3-79(ME), P3-80(ME), P3-81(TH), P3-82(DF), P3-83(DF), P3-84(DF), P3-85(MM), P3-86(MM), P3-88(MM), P3-89(MM), P3-90(MM), P3-91(SWT), P3-92(SWT)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
G	8.50	123a(ME), 123b(MM), 213a(HR), 602(HR), P3-73(HR)	No	Yes	Yes	No	No	Yes	Yes
H	6.45	124(SW), P3-39 partial (ME)	No	Yes	Yes	No	No	Yes	Yes
Total Complex Habitat Coverage: 94.39 ha									

Table 2.3.4: Terrestrial Features and Constraint Summary for the Boyne Survey/Phase 3 Lands Ref. FSEMS Figure 5.3 (Key Map) And T2 (Polygon Locations)									
Key Map #	Area (ha)	Component Vegetation Units	Constraint Factors						
			ESA	Significant Woodland	Wetland	Forest Interior	Significant Valleyland	Linkage	Significant Species/ Potential SWH
	ESA "Yes" indicates that portions of the feature are part of an Environmentally Sensitive Area **Significant Woodland** "Yes" indicates that portions of the feature meet the criteria for Significant Woodlands as set out in the Halton Region Official Plan (2006) **Wetland** "Yes" indicates that portions of the feature have been identified as a wetland by Dougan & Associates. "Yes*" indicates that these wetlands are part of an evaluated wetland; evaluation submitted to MNR in November 2011). **Forest Interior** "Yes" indicates that based on size and shape, portions of identified terrestrial feature could support forest interior species **Significant Valleyland** "Yes" indicates that portions of the feature have been identified as having well-defined valleys for the Main Branch of Sixteen Mile Creek **Linkage** "Yes" indicates that the feature provides a linkage function along a primary or secondary stream corridor, or rail corridor. **Significant Species** "Yes" indicates documented occurrence(s) of plant or animal species considered rare or uncommon on a regional, provincial or national scale								
DF = Deciduous Forest MF = Mixed Forest W = Woodland		PL = Plantation TH = Thicket ME = Meadow				SWT= Swamp Thicket SW = Swamp M = Marsh MM=Meadow Marsh			

The previous subwatershed studies (i.e. Sixteen Mile Creek Subwatersheds 2&7 Study; Indian Creek Subwatershed Study) contained NHS opportunity figures (ref. Figures 3.1 to 3.3 in the Boyne FSEMS) which addressed the current study area in the SUS.

The following is a brief summary of existing resources in the Boyne Survey study area that offer key features to become future core habitats, and major linkages and other opportunities. Significant features are summarized in Figure T5 in Appendix 'F' of the FSEMS.

Core areas:

- Natural cover outside of the Main Branch valley of Sixteen Mile Creek is very limited both in extent and in terms of available linkages.
- Five smaller woodlots that qualify as Significant Woodlands were identified; the ESA also contains forested features that constitute Significant Woodland.
- Two individual wetlands, and a complex comprised of two small wetlands, have been evaluated as locally significant in the study area; the complex could potentially be added to the Indian Creek PSW Complex, which is located in the Greenbelt.
- The data records for two wetland evaluations in the Boyne Survey study area (ref. Figure. T5 in Appendix 'F' of FSEMS) were submitted to MNR in November of 2011, but the Town has received no comments at date of publication. The first evaluation (SMC-1) contains one Swamp Maple Mineral Deciduous Swamp located along the corridor of the Centre Tributary of Sixteen Mile Creek. The evaluation scoring indicated that the wetland is locally significant. The second evaluation includes several wetland pockets located

within 750 m of the Indian Creek PSW Complex. The draft data record indicates that either as part of the existing PSW Complex or as a stand-alone evaluation, this complex could be considered provincially significant; however the final assignment of status has not been released by MNR (October 2011 staked wetland mapping yet to be confirmed by MNR).

Corridors and Linkages:

- There are limited connections to features located beyond the study area, apart from the Main Branch and Centre Tributaries, which afford significant linkage opportunities.
- The Main Branch of Sixteen Mile Creek meets criteria for Significant Valleylands.
- Other linkage opportunities are confined to improvements to watercourse connections (existing are largely poorly defined due to flat topography);
- The CN railway corridor provides topographic form and traverses wetlands and watercourses in the study area and southward.
- Workable east-west linkage opportunities are very limited and hypothetical rather than feature based, due to existing and future road crossings.

Significant Wildlife / Significant Wildlife Habitat:

- Specialized Habitat for Wildlife, i.e. foraging habitat presence of abundant mast is present in the ESA and in smaller Significant Woodlands.
- Bobolink, Barn Swallow, and Eastern Meadowlark (provincially Threatened 'open country' birds) are present in Boyne; this requires consultation with MNR regarding strategies and potential permitting.
- Western Chorus Frog breeding evidence was observed in several features, one of which was removed between 2002 and 2008; two sites provide potential summer habitat in the immediate vicinity of breeding pools and warrant further study; frog populations are apparently small and not currently supported by habitat linkages to other habitats.
- The Main Branch would qualify as supporting habitat for Species of Concern, and as an Animal Movement Corridor under the MNR SWH guidelines; it is also potentially a deer wintering area.

Enhancement Opportunities:

- The enhancement and extension of the Sixteen Mile Creek ESA represents a significant opportunity to enhance core habitat functions, and the diversity of cover.
- Degraded primary and secondary watercourse corridors offer major opportunities for enhancement
- Smaller features warrant consideration for enhancement and improved habitat linkage

Comments:

- There are opportunities for specialized habitat restoration within the Main Branch valley north, east and west of the existing ESA; this would be compatible with the NAI (2006) recommendation to extend the regionally-designated ESA northward.
- The integration of Western Chorus Frog breeding habitats, which are generally small, isolated features, will be a significant challenge, and other options such as habitat creation and species rescue will need to be explored.

- Features and linkages, when enhanced and buffered, would in most cases meet key criteria for Sustainable Halton, including upland forest, meadow and wetland components.
- Isolated specialized habitats support amphibians located outside of key natural features (locations shown in Appendix C, Figure NHS-2).
- Developments within 120 m of Greenbelt (located immediately south of Britannia Rd.) have specific natural heritage evaluation and buffer requirements

Downstream of the Boyne Survey

In 2007, the Development Proponents completed preliminary analyses for the servicing requirements within the Boyne Survey area. The results of these analyses indicated that conventional storm servicing within the portion of the Boyne Survey area drainage to the Omagh Tributary would require such quantities of fill as would render the development of that area, cost and functionally prohibitive. Consequently, an alternative strategy was advanced by Development Proponents whereby the extended detention component of specific stormwater management facilities would be diverted to the Sixteen Mile Creek Main Branch via a dedicated trunk sewer, with the flood storage component discharging to the Omagh Tributary. Further details regarding the servicing requirements and assessment of this area, referred to as the Water Quality Diversion Area for the Boyne Survey, are provided in Section 4.2.3 of the FSEMS.

Terrestrial systems located along reaches of the Omagh Tributary, downstream of the proposed water quality diversion (i.e. along the Omagh Tributary south of Britannia Road) were evaluated from available resource mapping, August 2010 field survey findings provided by LGL Limited, interpretation of recent aerial photographs, and supplementary field reconnaissance in early September 2010 by Dougan & Associates staff. Existing flow conditions at key cross-section locations were reviewed to interpret flood frequency and likely floodplain conditions on a seasonal basis. The focus was to identify terrestrial habitats that could be sensitive to changes in the annual flow regime, such as riparian wetlands that are hydrologically reliant on flood characteristics. The following is a summary of findings.

- There are no evaluated wetlands within the tributary between Britannia Road West and the confluence with the East Branch of Sixteen Mile Creek.
- The riparian zone located between Britannia Rd. and Fifth Line consists of active agricultural uses and sections with cultural meadow; natural riparian cover is limited, with Reed Canary Grass along the flattest reach, and reliable wetland indicator species confined to linear strips along the edges of the channel.
- There is a relatively flat reach between Cross Sections BB and CC where the stream exhibits a stronger meandering pattern, with evidence of small oxbows and backwater pools. Elsewhere the channel is relatively straight and well-defined by agricultural practices.
- Amphibians observed in August 2010 included Leopard Frog and Green Frog; tadpoles were observed in remnant pools along the channel.
- Just upstream of Fifth Line, valley form is better defined, with no wetlands observed.
- Downstream of Fifth Line there is forested cover which eventually merges with the forested ravine of the East Branch of 16 Mile Creek.

The relatively flat reach between 500 and 1100 metres downstream of the Boyne Survey lands, was noted as potentially sensitive from the standpoint of terrestrial biota, specifically amphibians. Annual inundation of the floodplain in the spring freshet period would likely contribute to wetland formation. However, the hydrologic modelling, which referenced 42 years of precipitation data, indicated that spring-time floodplain events do not occur on an annual basis, and are even less frequent in the vicinity of the upstream end of this section. This infrequency of spring flooding is corroborated by the limited wetland cover observed despite the gentle gradient. Therefore the terrestrial functions within this reach are considered to be limited at present.

3. PROJECT DESCRIPTION

3.1. Overview

Type of Development

The proposed development fabric within the Boyne Survey area has been established through an integrated detailed planning process, originating with the requirements of the Town of Milton Official Plan, and building on the precedent set with the community structure developed through the *Bristol Survey Secondary Plan (Official Plan Amendment No. 3), December 1998,* and *Sherwood Survey Secondary Plan (Official Plan Amendment No. 15) July 2006*

Table 3.1.1 provides a summary of the Official Plan designations for the Boyne Survey area.

Table 3.1.1: Official Plan Designations

DESIGNATION	DESCRIPTION
Residential Area	Approximately 75% of the land is designated "Residential Area" which permits mix of low and medium density residential development.
Residential Employment Area	An area that is located to the east of the CNR railway, west of First Line, is designated as "Residential Employment" and permits a fully integrated range of uses including residential, institutional and employment uses.
Residential Office Area	An area that is located to the on either side of Fourth Line is designated as "Residential Office" and permits primarily attached multiple residential, but may also include office and accessory local commercial uses which are located in the residential or office buildings.
Parkway Belt West Plan Area	An area that is located just east of the Regional Road #25 and runs north-south along the Sixteen Mile Creek north to Derry Road..
Natural Heritage Sysem	The valleys and associated floodplains of the proposed realigned and existing high constraint streams, which flow through the Boyne Survey Area. Environmental Linkage Areas are also identified.

Based on the foregoing designations, through the Secondary Planning exercise a preferred community structure was developed (ref. Drawing 2 – Schedule C-10-A). Key design elements of the Secondary Plan (as stated in the plan)) include:

a) Linked Greenlands/Natural Heritage and Open Space System

A linked greenlands/natural heritage and open space system including Greenlands Restoration Areas, Environmental Linkages, and parkland, as well as a trail system, which collectively form the basis of the natural heritage system (NHS), is a central feature of the community and forms a strong connection to the Greenbelt Plan Protected Countryside, and the Niagara Escarpment Plan Area through the planned Milton Education Village. The road pattern is designed to give maximum accessibility to the greenlands/natural heritage and open space system both physically and visually (e.g. single loaded roads along key features in a manner as directed in the urban design guidelines). Parks are also used as central "meeting places" for neighbourhoods and sub-neighbourhoods.

b) Bicycle/Pedestrian Trail System

The natural heritage and open space system provides for the development of an extensive system of recreational trails. In addition, sidewalks or, in certain locations, multi-use trails, will be provided on all roads and separate bicycle lanes or paths will be incorporated into the right-of-way on collector and arterial roads to ensure a community which provides maximum opportunities for pedestrian, bicycle and other similar movement. In particular, any development must conform with the guiding principles of the Town's Trail Master Plan Update and other relevant Town standards including provision of on-road bike lanes, safe linkages within the Secondary Plan Area and connections to trails and bike routes outside the Secondary Plan Area.

c) Greenbelt Plan Protected Countryside/Niagara Escarpment/Milton Education Village

The Plan has been designed to provide an appropriate interface with the planned Milton Education Village along Tremaine Road (RR 22), including the location of mixed-use nodes at the intersections of Louis St. Laurent Avenue and Britannia Road (RR 6) with Tremaine Road (RR 22). Provision is also made for the potential of environmental linkages and trail connections to the Greenbelt Plan Protected Countryside (Greenbelt/Protected Countryside) through the Milton Education Village and the protection of views to the Escarpment.

d) Road System

The road system within the framework of the Active Transportation Plan will be designed with a modified grid pattern. The grid pattern reflects the historical pattern of the established urban area and the development pattern of the Boyne Survey. This ensures:

i) maximum connections within the Planning District and with other areas of the Town, particularly the planned Milton Education Village and with the arterial road system;
ii) maximum potential for provision of transit service;
iii) ease of pedestrian/bicycle movement;
iv) maintenance of views to the Niagara Escarpment; and,
v) potential for the creation of views of key public facilities and landmark structures.

e) Community Structure

The Planning District includes:

i) significant portions of two secondary mixed use nodes which provide facilities for the District and the entire Milton Urban Area of the Town, including substantial commercial uses;
ii) a range of opportunities for higher density mixed use development at key intersections (nodes) and in corridors (residential/office areas, nodes) along both arterial and local roads to provide for a wide range of housing, and commercial and other services for the community, as well as transit-supportive development densities;
iii) a major Community Park which serves the Town as a whole with a wide range of active and passive recreation facilities;

iv) five neighbourhoods, each of which is focused on a neighbourhood centre, which includes a range of park and community facilities and four of which are also located adjacent to the greenlands/natural heritage system; and,
v) a number of sub-neighbourhoods focused on small parks known as "Village Squares".

f) Gateway Streets/Enhanced Streetscape Design

Regional Road 25, Britannia Road (RR 6), James Snow Parkway (RR 4), Tremaine Road (RR 22) and Louis St. Laurent Avenue represent major access roads in and through the Boyne Survey and the Milton Urban Area, as well as being potential major transit routes, and as such they require enhanced streetscape design. The design of Tremaine Road will also be critical to ensuring an appropriate interface with the planned Milton Education Village. An essential focus of its design in this area will be to mitigate any "barrier" effects.

Internal to the Boyne Survey, an east/west system of collector roads identified as "Green Connectors" and "Potential Future Green Connector Link" will ultimately link the neighbourhoods in the Secondary Plan Area and provide opportunities for the full range of transportation modes. This road system will be designed as a focal point for the community with an enhanced and co-ordinated approach to landscaping, street tree plantings, sidewalks, lighting, public/private utilities, bike paths and boulevards in accordance with the direction in the Urban Design Guidelines.

In addition, the Town shall through the subdivision, zoning by-law and site plan approval processes, control development along these roads to ensure both a high quality of site design and built form. In particular, buildings will be designed to face on these roads, and any significant parking areas will be at least partially screened.

g) Gateways

"Gateways" are recognized as key points of entry to the Milton Urban Area of the Town which require special design treatment of both the road allowance and any development adjacent to the road allowance.

The Gateway intersections are located at:

a) Tremaine Road (RR 22) and Britannia Road (RR 6)
b) Regional Road 25 and Britannia Road (RR 6); and,
c) James Snow Parkway and Britannia Road (RR 6).

Total Area by Development Type

The statistical summary of the approved Secondary Plan (June 2010) is as follows:

Town of Milton Boyne Survey Secondary Plan

Land Use Areas (hectares)

Land Use	**Gross Area (ha)**	**Takeouts of Gross Area (ha)**		**Net Area (ha)**
		Local Road	SWM Ponds	
NODES				
Secondary Nixed Use Node	25.7	0.3	1.7	23.7
Node	38.1	0.4	2.5	35.2
Sub-node	16.9	0.2	1.1	15.6
Residential	427.9	64.2	28.2	335.5
Residential/Office	40.5	0.4	2.7	37.4
Total Developable Land Area	**549.0**	**65.4**	**36.2**	**447.4**
Greenlands/NHS	133.1			
Greenlands/NHS Buffers	30.8			
Elementary School Sites	19.3			
High School Sites	20.9			
Roads				
Local	65.4			
Collector	46.4			
Green Arterial	34.1			
Arterial	5.2			
Existing + Road Widenings	25.1			
Canadian National Railway	4.8			
Village Squares	7.0			
Neighbourhood Parks	34.9			
Community Park	30.7			
District Parks	7.2			
Stormwater Management Ponds	36.2			
Total Land Area	**948.5**			

3.2. Preferred Stormwater Management Strategy

Guiding Principles

The preferred stormwater management strategy for the Boyne Survey area has been predicated upon the following guiding principles:

(i) Stormwater Quality/Erosion Control Storage to be provided throughout development area for all new development areas.
(ii) Stormwater Flood Control Storage to be provided as required in order to achieve post-to-pre control within the Boyne Survey area and along the receiving systems.
(iii) Generally limit drainage area to SWM facilities to a maximum of 40 to 80 ha, notwithstanding there may be local exceptions.
(iv) Thermal mitigation practices should be incorporated into all stormwater management facilities.
(v) Implement water quality diversions within strategic diversions so as to optimize the balance between sustaining the resources to key terrestrial and aquatic features, satisfying current Provincial standards for stormwater quality, erosion, and flood control, and providing a cost effective servicing plan for the planned community.

Quality

The Sixteen Mile Creek is Type 1 or high constraint fisheries habitat, hence *Enhanced protection* criteria (formerly Level 1) has been recommended as per MOE, 2003.

Table 3.2.1: Water Quality Storage Requirements (from MOE 2003)

Protection Level	SWMP Type	Storage Volume (m^3/ha for Respective Impervious Levels)			
		35%	55%	70%	85%
Enhanced (Level 1)	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Wet Pond	140	190	225	250
	Hybrid	110	150	175	195

Erosion

The Sixteen Mile Creek Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Planning Area established criteria/target extended detention storage volumes for all development within the Boyne Survey area. These criteria vary by location across the Study Area, based upon the erosion sensitivity of the receiving systems.

Flooding

The Sixteen Mile Creek Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Planning Area, established 100 year storage targets for all development within the Boyne Survey area. These criteria vary by location across the Study Area, based upon the land use and related flood sensitivity of the receiving systems.

In addition to providing post- to pre- control for events up to and including the 100 year storm event, peak flow rates for the Regulatory (Regional) Storm event are required to be controlled to pre-development levels downstream of the proposed development area. The Regional Storm flood control requirements provided in the FSEMS have been established based upon the concept of online Regional storage and the siting of a Regional Storm flood control facility at the outlet of each of the tributaries at (or near) Britannia Road. The final siting of Regional Storm flood control facilities is to be completed as part of the SIS. The provision of on-line Regional Storm flood controls would need to incorporate design elements for the accommodation of fish and small wildlife passage and target species, thermal impacts and mitigation, and sediment and fluvial impacts assessment.

Infrastructure

The stormwater management requirements of the Preferred Management strategy include the following communal infrastructure components:

- Watercourses
- Stormwater Management Facilities
- Major Road/Rail Crossing Bridges or Culverts
- Strategic water quality diversions

Stormwater Management Facilities

A network of stormwater management facilities has been sited and designed to a functional level as indicated on Drawing 2. The facilities, as reported in the Functional Stormwater and Environmental Management Strategy for the Boyne Survey Secondary Planning Area, have been sized based on general drainage areas and impervious coverage and are detailed in Section 4.

Low Impact Development

The Functional Stormwater and Environmental Management Strategy for the Boyne Survey Secondary Planning Area has identified opportunities where stormwater management requirements may be provided through the implementation of Low Impact Development Best Management Practices (LID BMP's). These techniques consist of various source controls which are designed to provide stormwater management for small drainage areas (i.e. generally less than 2 ha). Depending upon the specific type of LID BMP and its application as part of a "treatment train", this approach toward stormwater management is recognized as providing benefit by way of achieving stormwater quality control, erosion control, groundwater recharge, and mitigation of thermal impacts resulting from urban development.

Water Quality Diversions

Initial analyses for the servicing of the Boyne Survey area identified that conventional storm servicing of the entire of the Boyne Survey area would require the importation of a substantial amount of fill. The volume of fill material required was considered to be cost and functionality prohibitive, hence alternatives were advanced in order to address the grading constraints and storm servicing requirements of these lands. Through an iterative, collaborative, and

consultative process between the Study Team, the Town of Milton, Conservation Halton, and the area landowners, a storm servicing strategy was advanced whereby the extended detention component of specific stormwater management facilities within the Boyne Survey lands would be diverted toward the deeper Sixteen Mile Creek Main Branch via a dedicated trunk sewer, with the flood storage component (i.e. the portion above the extended detention cell) continuing to discharge to the receiving watercourse. It was through this collaborative process that the area for which water quality diversions would be implemented was scoped to include only the drainage areas within the Omagh Tributary subcatchment. Hydrologic, hydraulic, and scoped environmental assessments were completed in order to assess and refine the spatial of this diversion scenario, and consultation with representatives from the various stakeholders on the Steering Committee for this study was held at key points in the process (ref. Functional Stormwater and Environmental Management Strategy, Boyne Secondary Plan Area, Appendix 'A').

3.3 Watercourses

Location and Description of Watercourses

The location, extent and estimated width of the watercourse corridor system for the Boyne Survey area has been based on integration of a number of functional objectives as follows:

- major flow conveyance (i.e. where required major system flow conveyance exceeds the capacity of roadways within the development)
- aquatic habitat
- width required for natural channel processes (meanders, pools and riffles)
- terrestrial linkages
- separation between roadways/railways and differing land usage

Table 3.3.1 provides a summary of estimated characteristics of the open watercourse system (ref. Drawing 3):

Table 3.3.1: Summary of Boyne Survey Watercourse Requirements

Channel Segment No.[1.]	Drainage Area (ha)	Belt width + 10% Safety (m)	Estimated Flood Width (m)	Topwidth Plus 10 m and 15 m Setbacks (m)	Estimated Corridor Width (m)	Channel Corridor Length (m)	Estimated Land Requirement (ha)	Estimated Regional Peak flow (m^3/s)	Estimated 2 year Peak flow (Bankfull) (m^3/s)
Tributary 1-NE-2A									
I-NE-2A	138.62	30	39.69	64.69	65	302	196	21	1.26
I-NE-2A-1	100.41	30	37.96	62.96	65	151	0.98	15.21	0.91
I-NE-2A-3	46.29	30	35.06	60.06	65	365	2.37	7.01	0.42
Tributary 1-NE-1B									
I-NE-1B-1	126.30	30	38.95	63.95	65	1229	7.99	18.6	1.11
Tributary SWS-1									
SWS-1-A	132.05	30	38.51	63.51	65	1648	10.71	17.06	0.49
Tributary SWS-2									
SWS-2-A	182.20	30	39.17	64.17	65	1800	11.20	19.42	0.69
SWS-2-A-1	12.0	n/a	N/A	N/A	0	169	0.00	N/A	0.05
2-II									
2-II	232.6	120.0	79.37	104.67	varies*	2224	varies*	428	26
SWS-5-A	5.0	n/a	N/A	N/A	varies*	229	varies*	9.20	0.56
SE-5-A	5.5	n/a	N/A	N/A	varies*	190	varies*	10.12	0.61
Tributary SE-3									
SE-3-B	284.68	30	39.11	64.11	65	2066	13.43	19.20	0.76
SE-3-G	35.80	30	N/A	N/A	65	377	2.45	NA	NA
BP-4-C									
BP-4-C	129.37	33.6	33.99	58.99	68.6	747	5.12	4.69	1.63

NOTE: [1.] A standard width of 30m has been applied to many of the medium net constraint watercourses throughout the Boyne Survey area. Individual meander belt widths were not calculated for these reaches as they are of low geomorphological constraint. A width of 30m reflects the final belt width of Reach SWS-2-A, which is considered appropriate based on the fact that the reaches are similar in planform and will be more defined within stream corridors post-development.
Corridor width for watercourses 2-II, SWS-5-A and SE-5-A have been established based upon Conservation Halton's Regulatory Limit, and thus vary along the length of the feature.
N.B. Belt Width is indicated as not applicable (n/a) for those reaches of low geomorphological constraint. Belt Widths were only calculated for reaches of medium or high geomorphological constraint.

The estimated channel widths as outlined in Table 3.3.1, as well as the watercourse alignments, would need to be verified and modified as required through Subwatershed Impact Studies and the Detailed Design Process. These subsequent design stages would also verify natural channel characteristics and conveyance capacity of the watercourse systems, up to the Regulatory flow rate.

3.4 Stream Crossings

Sewer and Utility Crossings

There are proposed to be a number of wastewater, storm sewer, watermain and pipeline utility crossings of watercourses, however the majority are anticipated to be located within the road right-of-ways.

The depth of watermain crossings will be determined based on detailed design, however, as water distribution systems are pressure driven, there is greater flexibility for design than gravity based systems, and minimum clearances can be incorporated at the detailed design stage.

There will also be a number of local wastewater and watermain crossings associated with specific Draft plan developments that are not known at this time. Design criteria, as outlined in this document (Section 4), should be followed for any additional crossings as required. Specifics would be defined as part of local SIS's.

Hydraulic Road/Rail Crossings

Road and rail crossing structures for the watercourses in the Boyne Survey area are proposed as shown on Drawing 4. The current location for the crossings are depicted to coincide with existing watercourse crossings within the study area; notwithstanding, it is anticipated that a number of "minor" or local road crossings may be proposed as future plans of subdivision are developed and submitted. There are a number of principles which should be incorporated into the design and location of road crossings as outlined in Section 4, these include minimum spacing between road crossings, and provision for the safe passage of targeted terrestrial wildlife.

3.5 Natural Heritage System

3.5.1 Natural Heritage Management Opportunities

The following NHS opportunities were identified Section 3.9 of the Boyne Survey Functional Stormwater and Environmental Management Strategy (March 2013).

a) Sustainable Halton identifies a larger regional Natural Heritage Strategy to guide local scale actions. The general intent of that program has been considered, although its application in the Study Area in not required. Enhancement of linkages with local resources to the Main Branch corridor will provide the greatest benefits to this regional system.

b) The Main Branch of Sixteen Mile Creek supports regional wildlife corridor functions; these form a primary connection of the Regional Natural Heritage System to the Natural Heritage System within the Boyne Survey development area (as identified on Figure NHS-2A in Appendix C of the CFCP).

c) Opportunities to protect and integrate the remaining natural habitats and linking them through the development fabric should be considered as follows:

- Protect and integrate all terrestrial features that have been identified as significant based on the terrestrial resource analysis,
- Restore degraded natural features, develop and implement management strategies for invasive plant species, provide buffers, and integrate connections with buffered riparian corridors and other terrestrial linkages,
- Provide adequate wildlife passageways at road crossings

- Integrate stream corridors with railway corridor for habitat and linkage benefits (where feasible),
- Initiate land stewardship programs,
- Integrate the natural system with supportive land uses where feasible.

d) Smaller isolated features occur along watercourses and provide nodes along riparian and other linkages.

e) Some hedgerows and other cultural features offer linkage opportunities where watercourses are not present or will not be retained.

f) Watercourses identified to remain offer significant linkage opportunities through the future urban landscape. Terrestrial elements can be included such as floodplain wetlands and seasonal wetland pools; clean runoff sources from adjoining land uses can help to sustain more sensitive plant and wildlife species. Manage urban drainage design to provide approximate hydroperiods in wetland habitats associated with tributaries.

g) Provide adequate wildlife passageways at road crossings.

h) Some urban land uses can support natural heritage functions such as habitat cover and linkage/connectivity. These uses include parks, trail linkages, and stormwater management blocks, and campus uses (with enhanced landscaping standards); buffer adjustments are addressed in the FSEMS.

i) Stewardship programs can encourage landowners and the Town to incorporate principles of habitat management for woodlands and successional habitats, and to consolidate smaller fragments into larger habitat blocks.

j) Factors affecting linkages include extensive agricultural activities, existing urban development, and existing roadways which fragment natural features and corridors:
   - Ensure that Regional and Town Policies (Secondary Plans & Subwatershed Management Plans) reflect the Provincial Policy Statement on Natural Heritage.
   - Maintain and enhance remaining linkage features (stream corridors, valleys, hedgerows, etc.)
   - Utilize rail corridor as habitat linkage.
   - Re-establish functional corridors and linkages, including crossings adapted to safe use by terrestrial wildlife
   - Establish buffers around existing natural features and setbacks along watercourse corridors.
   - Integrate Natural Heritage System with Regional system beyond the Study Area.

3.5.2 Detailed Assessment

Updated NHS Objectives

The following updated objectives and targets build upon those previously defined for the Natural Heritage System in the Sixteen Mile Creek Subwatershed 2&7 Study (Philips Engineering Ltd.,

2000). They have been updated based on the current study approach, available Natural Heritage System policies, and further refined based on comments received from Conservation Halton staff.

a) Identify and classify natural/semi-natural terrestrial features and assess their significance according to their conformity with significance categories established by the Province, Region and Conservation Authority, based on criteria regarding size, biophysical attributes and ecological functions for the purposes of developing a sustainable natural heritage system for the urban and rural portions of the watershed.

b) Given the depleted, degraded and fragmented state of existing terrestrial resources in the subwatershed study area, the key objective of the subwatershed plan is to achieve a 'net gain' in terms of the extent of natural terrestrial habitat and associated functions and linkages. The goal is a well-linked system within the urban setting which promotes the maintenance and enhancement of key subwatershed resources.

c) All identified 'Significant' terrestrial features should be protected and enhanced within a recommended Natural Heritage System, to be defined as part of the Secondary Plan processes.

d) The Subwatershed Update Study and Functional Stormwater and Environmental Management Strategy (FSEMS) will define standards for protection and linkage of these resources. These protection and enhancement requirements will be integrated into detailed Subwatershed Impact Studies (SIS).

e) Other terrestrial features not meeting policy-based significance criteria should be integrated into a linked system which optimizes their integrity and functions within the future urban landscape. The system can be further enhanced with habitat restoration, and integration of protected natural areas with land uses that support the functionality of natural features (such as parkland, golf courses, school campuses and other uses that can incorporate naturalized elements).

f) All identified linkage features in the subwatershed study area represent constraints to future land uses and are to be protected and enhanced. Within the Milton Business Park / Derry Green and Phase 3 / Boyne Survey urban expansion areas, some linkage features may be modified, and their relocation and enhancement should place a high priority on natural heritage system objectives wherever feasible and practical in the urbanizing landscape.

g) The functioning components of linkages should be protected and enhanced. Terrestrial linkage features can be used to accommodate trail systems.

h) Stormwater management facilities should generally be integrated outside the NHS but due to their related hydrologic functionality, contribute complementary landscape connectivity functions and naturalized cover that is routinely utilized by wildlife.

i) The SIS for each detailed study area will refine desirable riparian corridors and other linkage features following an integrated multi-disciplinary assessment. This will include

recommended corridor dimensions as well as structural components to be considered at subsequent planning and design stages. The identified terrestrial system should also accommodate existing and new wetland and pond features that can support identified species of concern in the urban setting.

In the original Sixteen Mile Creek Areas 2 and 7 Subwatershed Study, and the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study, relatively aggressive programs were outlined which targeted an overall 'net gain' principle in terms of protection of natural cover and enhancement of functions over existing conditions. The application and refinement of this principle in the Boyne Survey study area represents the only feasible means to maintain and improve Natural Heritage features and functions. Cumulative change to habitat quality and functions is considered largely inevitable as the future development areas are converted from rural to urban uses.

NHS Targets

The development of identified targets for optimal levels of natural cover has been the subject of study by federal and provincial agencies for more than a decade. In 2004 a document entitled "*A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern*" was released jointly by Environment Canada, the Ontario Ministry of Natural Resources, and the Ontario Ministry of Environment. This document included general guidelines for the establishment of forest and wetland targets in watersheds and subwatersheds. These included the identification of the following watershed-based targets:

- Ten percent of a watershed, and six percent of any sub-watershed should be comprised of wetlands
- The Critical Function Zone and Protection Zone (i.e. buffer) of a wetland should be naturally vegetated
- 75% of stream length should be naturally vegetated
- Streams should have a minimum 30 m wide naturally vegetated land area on both sides, greater depending on site specific conditions
- a minimum forest cover target of 30% is desirable for watersheds
- Forest patches should be circular or square in shape
- Forest patches should be within two kilometres of one another
- At least 10% of watersheds should consist of forest cover with more than 100 m from the forest edge; 5% of the watershed should have forest cover with more than 200 m from the forest edge
- Watershed forest cover should be representative of the full diversity of forest types found at that latitude
- Corridors designed to facilitate species movement should be a minimum of 50 to 100 m wide
- Less than 10 percent of an urbanized watershed should be impervious

The past application of these guidelines to highly fragmented landscapes in southern Ontario, which have been under intensive use for agriculture for more than a century, has been challenging, and jurisdictions (such as TRCA with its Terrestrial Natural Heritage System) have generally applied these targets outside of urbanizing areas. The importance of balancing

environmental, social and economic objectives satisfying important growth and infrastructure renewal efforts initiated by the Province, has required and allowed for a balanced approach to planning in urbanizing jurisdictions. In this regard, the Second Edition of the Natural Heritage Reference Manual (MNR, 2010) advises (ref. Section 3.4.6.2):

> "*Every natural heritage system, however, will be different. There is no minimum size for a system or minimum percentage of a planning area or its natural features that must be included in the system. Therefore, the extent of the natural heritage systems identified in the noted examples represents what was appropriate and achievable in those situations.*"

Therefore, while the Environment Canada guidelines represent useful considerations in defining watershed priorities for natural heritage protection, their application in designated growth areas that are already highly fragmented may not be feasible except where opportunities exist to integrate highly functional lands within identified development areas. The restoration of the Main Branch valley upstream of the existing ESA represents a logical opportunity to achieve a higher level of restoration given the existing concentration of features and functions.

In the case of the Boyne Survey lands, existing limitations of the landscape (e.g. 4.5% existing natural cover; 1.2% wetland cover) must be recognized, while approaches for habitat enhancement and diversification are identified, based on opportunities to protect and link viable natural features, as well as reinforcement of the NHS with complementary existing and future land uses that support important ecological functions. Based on contemporary subwatershed experience in similar landscapes of the Peel Plain and South Slope Physiographic Regions, the NHS as identified in Figure NHS-2 will achieve a substantial increase in natural cover within the Boyne study area that reflects the protection of significant features based on policy, the net gain in riparian corridor cover, and the degree to which habitat restoration is feasible to enhance existing functions and sustain key species guilds. This does not include long term NHS supportive land uses (i.e. stormwater facilities, rail corridor, other NHS Supportive uses).

3.5.3 Evaluation Summary

This section builds upon the general process for NHS evaluation to be applied in the areas which were identified for future urbanization in the HUSP (1996) process. The NHS which are developed in these future urban areas are intended to encompass existing features and functions, with reinforcement to ensure their continued presence and function, and where feasible, their restoration and enhancement. The key legislation, policies, and guidelines, and the updated subwatershed objectives that form the basis of this approach are summarized in Section 4.2 of the Boyne Survey FSEMS. The future Natural Heritage System needs to conform to the guiding policy frameworks and objectives, as well as integrate with the Natural Heritage Systems within adjoining developed areas, and the regional scale system.

Table F1 in Appendix 'F' of the Boyne Survey FSEMS summarizes the evaluation of actions and options, and the recommended approach at each step in the NHS identification process, with general implications for the Secondary Plan and subsequent SIS level studies.

3.5.4 Preferred Management Strategy

The recommended Natural Heritage System for the Boyne Survey Secondary Plan area is presented in Figure NHS-2A, located in Appendix 'C'. The Secondary Plan is intended to provide conceptual direction to general land uses and policy direction. The NHS shown on Figure NHS-2A, will be refined through the SIS and site design process in a manner consistent with the Secondary Plan policies. There are instances where proposed roads will potentially impact specific natural features; the implementation of the Plan in these areas will need to address concerns through EA and SIS processes. Key areas of stakeholder discussion to date have included the treatment of the Main Branch of Sixteen Mile Creek, restoration areas, wetlands, and the use of corridors and linkages to address significant features that are currently poorly connected by watercourses.

NHS Implementation Principles and associated Schedules which are located in Appendix 'I' of the FSEMS, were prepared by landowner consultants in consultation with the Town, Region of Halton and Conservation Halton. These represent refinements to the recommended NHS reflecting the Secondary Plan policies, with specific conditions identified in the Principles. The Principles address a number of NHS design principles including, but not limited to, the treatment of the Main Branch of Sixteen Mile Creek, restoration areas, wetlands, and the use of corridors and linkages to address significant features that are currently poorly connected by watercourses. The Implementation Principles provide specific NHS design direction to be addressed in further detail during the preparation of SIS.,

The NHS builds on frameworks that were first outlined in the 2000 Subwatersheds 2&7 and 2004 Indian Creek Subwatershed studies, which has been refined based on updated field data, current environmental legislation, policies, guidelines, and practices. It also reflects the character, opportunities and constraints imposed by the recommended NHS context (i.e. the intended residential uses of the Secondary Plan area). There has been consideration of existing land uses that will continue (i.e. major roads and a rali corricor). The plan includes restoration and enhancement of ecological features and their functions as envisioned in the PPS, with the emphasis placed on consolidation of natural cover and functions in core areas, maintenance of small linked features, and support of other management strategies (such as stormwater management and drainage density maintenance) to yield land use efficiency.

Table 3.5.1 summarizes the key attributes of the NHS. The table also indicates that the status of the key categories for protection of significant features and functions under the PPS (2005), based on the recommended Secondary Plan. The following sections describe the key components of the recommended NHS, how specific features and functions are addressed to meet requirements of guiding legislation and policies, the intended approaches for implementation, and the responsibilities of landowners and approval agencies through the development process and post development.

Table 3.4: Summary of Recommended Natural Heritage System (Boyne Survey)								
Study Area	**Key Approaches**	**Significant Habitat of Endangered and Threatened Species**	**Significant Wetlands**	**Significant Woodlands**	**Significant Valleylands**	**Significant Wildlife Habitat**	**Significant Areas of Natural and Scientific Interest**	**Fish Habitat**
Boyne Survey	Corridor Widths; including 10 + 15 buffers 16 Mile Creek Valley Corridor Width average including NHS supporting uses and buffers: 250 m Outside the Sixteen Mile Creek Valley, three existing wetlands will be protected and new wetlands created in the proposed NHS. Buffers: To be established in accordance with Section C.10.8.5.6 of the Secondary Plan Policy.. Habitat Restoration: Recommended NHS includes restoration in 16 Mile Creek Valley/ESA, and creek blocks, wetlands and woodlots elsewhere in Boyne.	Significant habitat of provincially Endangered or Threatened species is potentially present; to be confirmed with MNR	Provincially Significant Wetlands potentially present; locally significant wetlands protected or otherwise integrated within recommended NHS	Significant Woodlands present; all retained within recommended NHS	Significant Valleyland present within and immediately downstream of study area (Main Branch of 16 Mile Creek); to be protected and restored	Significant Wildlife Habitat present; protected within recommended NHS.	No Significant Areas of Natural and Scientific Interest within study area; Sixteen Mile Creek Valley Candidate Life Science ANSI located >120 m downstream	Intermittent and permanent fish habitat present; protected within recommended NHS; net gain in permanent habitat is expected

3.5.5 Buffer Considerations

All watercourses that have been identified to remain through the multi-disciplinary ranking are included within the recommended NHS and are identified on Figure NHS-2. Some watercourses may be relocated but in all cases where core natural features are located along the existing watercourses, the intention is that the riparian connections will be maintained and enhanced, and the watercourse reaches located within core natural features will not be significantly disturbed or modified.

The minimum planning corridors for watercourses to be retained within or immediately adjacent to the Boyne Survey Secondary Plan area will be comprised of floodplain (comprised of meander belt width plus 10% safety factor), side slopes (3:1 typical but variable slopes and treatments are desirable), and buffers (10 m and 15 m as specified by Secondary Plan Policies).

A pedestrian trail will be placed within the buffer along only one side of the corridor; it should not be placed in the vicinity of sensitive habitat features, and should be placed close to the periphery of the development edge within the setback. This will help to address potential impacts from dogs, which should always be on a leash. The planning corridors generally achieve minimum stream corridor targets recommended by Environment Canada (2004) (i.e. 50 to 100 m wide to facilitate wildlife passage; minimum 30 m wide naturally vegetated riparian zone on both sides; more than 75% of stream length to be naturally vegetated). The development of enhanced NHS watercourse corridors presents an opportunity to 'recycle' existing bio-diversity materials through salvage of seed banks and plant materials that would otherwise be lost during development.

The FSEMS includes a *Town of Milton Planting and Restoration Framework* which provides detailed guidance for planting and layout within NHS corridors in Boyne.

4. PRELIMINARY DESIGN AND MITIGATION

This section provides the design principles which are recommended for incorporation into the detailed design of stormwater management facilities, watercourses and stream crossings. Adherence to these principles will be one of the primary aspects for streamlining the agency review of project proposal. In situations where *Fisheries Act* authorizations are required and significant departure from these design principles is proposed for any given work, there may be a requirement for the proponent to individually evaluate the impacts of the work on the fish habitat objectives identified for the Boyne Survey area (ref. Foreword).

4.1 Stormwater Management Facilities

Each of the proposed stormwater management facilities identified within the Boyne Survey area will be designed in accordance with current Ministry of Environment design guidelines [ref. *Stormwater Management Practices Planning and Design Manual, MOE, March 2003*]. Primary design principles outlined in the Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Planning Area (AMEC, 2013) include:

- SWM Facility Type
- Required Volume and Approximate Surface Area Requirements
- Depth
- Grading considerations and facility configuration
- Discharge rates
- Outlet considerations
- Landscaping principles

Stormwater management requirements also include the requirement to implement LID infiltration BMP's to maintain groundwater recharge and to enhance baseflow conditions within the receiving watercourses, particularly the designated high constraint watercourses with rehabilitation potential. In addition, various LID BMP's are recognized to provide water quality enhancements through their implementation as source controls and/or as part of an overall treatment train. The specific location and types of LID BMP's are to be established as part of future studies, and will be designed in accordance with the current design standards (ref. Low Impact Development Stormwater Management Planning and Design Guidelines, Version 1.0, CVC/TRCA, 2010).

4.1.1 Preliminary Design Elements

SWM Facility Type

Recognizing that the proposed development within the Boyne Survey area consists of residential land uses, end-of-pipe stormwater management facilities are anticipated to consist primarily of wet ponds or hybrid facilities, due to the hazard potential associated with potential public access to the area, as well as more contemporary design practice which encourages a deeper permanent pool in order to limit the potential for undesirable or nuisance species (i.e. mosquitoes) which are perceived to be associated with facilities with shallower permanent pool

volumes. Notwithstanding, it is recognized that as detailed design proceeds, there may be sufficient cause for the implementation of a different end-of-pipe facility. In such instances, the following site-specific rationale for constructing wetland, wet pond, or hybrid systems, which has been applied in previous studies, is suggested for guidance:

(i) Wetlands are considered to be more productive in terms of environmental benefits, typically providing more organic matter and food material for receiving watercourse habitats. Wetlands are also considered more compatible than wet ponds where the facility is located adjacent to, or provides a linkage to, a watercourse, or terrestrial habitat (natural heritage systems) or open space system.
(ii) Wet Ponds are considered more appropriate as features in the urban landscape where they are relatively isolated from terrestrial/watercourse habitats or in tableland settings. Wet Ponds are also preferred over Wetlands under current Town of Milton standards, as they are generally recognized to reduce the number of nuisance species (i.e. mosquitoes) due to the deeper permanent pool.
(iii) Hybrid facilities combine the benefits of Wet Ponds and Wetlands, affording linkage opportunities to watercourses and terrestrial habitats or open spaces, as well as reducing the number of nuisance species compared to constructed Wetlands.
(iv) Low Impact Development techniques are particularly well-suited for small sites which may be surrounded by infrastructure (i.e. roads) and/or proximate to environmental features, or which may be adjacent to deep valley features which do not currently include a drainage feature from the table land to the valley floor. An appropriate application of LID practices could satisfy requirements for stormwater quality and potentially erosion control, however these practices are generally recognized as having little, if any, benefit, with respect to flood control; as such, these techniques are particularly well-suited for areas not requiring flood control for stormwater management.

Water Quality Diversion Area

Management opportunities for stormwater management within the Water Quality Diversion Area to the Omagh Tributary are generally consistent with those previously identified above for conventionally draining areas, in order to satisfy current standards and requirements for stormwater management (i.e. stormwater quality control, erosion control, flood control, water balance). The diversion of the water quality control volume from some of the end-of-pipe facilities within the water quality diversion area would reduce the supply of water to the downstream Omagh Tributary for certain months of the year compared to existing conditions. While these impacts are not anticipated to adversely affect the downstream natural system, additional opportunities to increase the volume of water supplied to the receiving system include:

(i) Increase area draining directly to the Omagh Tributary through land use planning and/or application of lot-level BMP's for stormwater quality control.
(ii) Integration of a collector pipe to collect rooftop runoff and direct toward the Omagh Tributary.

Increase Drainage Area to Omagh Tributary

The amount of area draining directly to the Omagh Tributary may be increased through the planning for relatively large open spaces adjacent to the watercourse within the Boyne Survey area (i.e. parks, rear yards for schools), or through the application of lot-level BMP's for the directly draining areas. The former of the two approaches would generally be preferable, as the direction of runoff from open spaces would not require stormwater quantity controls, and may afford the direction of runoff from relatively larger areas. Increasing the amount of urban area draining to the Omagh Tributary would require the application of lot-level BMP's for stormwater quality control, hence the amount of drainage area to the Omagh Tributary would be limited by the capacity of the BMP (generally 5 ha or less); nevertheless, through this approach, local roadways may be able to drain directly to the Omagh Tributary, and thereby further increase the supply of water to the receiving system post-development.

Rooftop Collector Pipe

The direction of clean runoff to the Omagh Tributary may be achieved through the implementation of a rooftop collector pipe within the adjacent residential communities. This pipe would be separate from the storm sewer network, and would convey runoff from rooftops without requiring stormwater management for the collected discharge. The construction of this collector pipe would impose an additional maintenance requirement upon the Municipality, and the amount of rooftop coverage which could be collected would be limited to those in relative proximity to the watercourse, and would necessarily need to consider any grading constraints or conflicts with infrastructure. While this approach is considered less preferable than the increase in directly draining area, it is nevertheless an alternative in order to increase the supply of water to the Omagh Tributary under proposed conditions with the diversion area.

Stormwater Management Facility Volume

Stormwater Quality Management Criteria

In accordance with the fisheries resources of the Sixteen Mile Creek (Main Branch), stormwater management facilities sizing has been recommended to meet the MOE "Enhanced (formerly Level 1 Habitat) protection" sizing guidelines.

Erosion and Flood Control Approach

Each stormwater management facility (wet pond, wetland, or hybrid) will be required to incorporate storage to mitigate erosion and flood impacts in accordance with the relevant Subwatershed and Watershed Plan objectives.

- *Erosion Control Criteria*

Erosion control will be provided in each stormwater management facility, through extended detention storage (i.e. slow release).

The recommended flow rates and storage values may be optimized depending on development site size and location within the subwatershed, type of land use, and topography of the area, however, the unitary (non-optimized) storage and flow rates would be as follows:

- Unitary storage volume of 375 m^3/impervious hectare and unitary discharge rates of 0.0004 m^3/s/ha for areas within Indian Creek Subwatershed (ref. SIS Areas 1 and 2)
- Unitary storage volume of 400 m^3/impervious hectare and unitary discharge rate of 0.0003 m^3/s/ha for areas within Sixteen Mile Creek west of the Sixteen Mile Creek Main Branch, and area within Sixteen Mile Creek discharging to former watercourse SE-2-D-1 located east of the Sixteen Mile Creek Main Branch (ref. SIS Areas 3 and 4 and 6)
- Unitary storage volume of 400 m^3/impervious hectares and discharge rate of 0.002 m^3/s/ha for area tributary to the Sixteen Mile Creek Main Branch (ref. SIS Area 5a)
- Unitary storage volume of 550 m^3/impervious hectare and unitary discharge rate of 0.0005 m^3/s/ha for Water Quality Diversion Facilities within drainage area to the Omagh Tributary, and no extended detention erosion control volume beyond water quality extended detention storage and discharge requirements for conventionally draining facilities within drainage area to the Omagh Tributary (ref. SIS Area 5b).

➢ *Flood Control Criteria*

The hydrologic analysis completed as part of the Subwatershed Update Study Technical Appendix for the Boyne Survey, indicated that the outflow rates from each stormwater management facility would be dependent on the location of the site within the subwatershed, soils, topography and the downstream tributary conditions. Generally the stormwater facility outflow rates would be as follows:

- Flood Control Storage would be 450 m^3 per impervious hectare with 100 year outflow rates of 0.024 m^3/s/ha for areas within the west tributary of the Indian Creek Subwatershed (ref. SIS Area 1)
- Flood Control Storage would be 450 m^3 per impervious hectare with 100 year outflow rates of 0.023 m^3/s/ha for areas within the east tributary of the Indian Creek Subwatershed (ref. SIS Area 2)
- Flood Control Storage would be 525 m^3 per impervious hectare with 100 year outflow rates of 0.024 m^3/s/ha for areas within the westerly limit of Sixteen Mile Creek Watershed west of the Sixteen Mile Creek Main Branch (ref. SIS Area 3).
- Flood Control Storage would be 575 m^3 per impervious hectare with 100 year outflow rates of 0.035 m^3/s/ha for areas within the Sixteen Mile Creek Watershed west of the Sixteen Mile Creek Main Branch (ref. SIS Area 4)
- Flood Control Storage would be 575 m^3 per impervious hectare with 100 year outflow rates of 0.035 m^3/s/ha for areas discharging to the former watercourse SE-2-D-1 east of the Sixteen Mile Creek Main Branch (ref. SIS Area 6)
- Flood Control Storage would be 400 m^3 per impervious hectare with 100 year outflow rates of 0.035 m^3/s/ha for areas within the Sixteen Mile Creek Watershed west of the Sixteen Mile Creek Main Branch (ref. SIS Area 5a)
- Flood Control Storage would be 800 m^3/impervious hectare with 100 year outflow rates of 0.035 m^3/s/ha for conventionally draining facilities to the Omagh Tributary and flood

control storage would be 245 m^3/impervious hectare with 100 year outflow rates of 0.08 m^3/s/ha for Water Quality Diversion Facilities within the drainage area to the Omagh Tributary (ref. SIS Area 5b).

- Regional Storm flood control requirements are to be determined as part of the SIS. Preliminary sizing criteria based upon conceptual facility locations are provided in Section 4.2.5 of the FSEMS.

Table 4.1.1 provides a summary of the typical stormwater management volumetric storage requirements based on average values:

Table 4.1.1: Summary of Stormwater Quality/Quantity Management Storage Requirements for Boyne Survey

Quality				Quantity		Total Stormwater Management Storage [m^3/ impervious ha]
Impervious Level (%)	Water Quality (Permanent Pool)			Erosion Control [1] (Extended Detention) [m^3/ impervious ha]	Storage to 100 year Level [m^3/impervious ha]	
	Wetland (m^3/ha)	Wet Pond (m^3/ha)	Hybrid (m^3/ha)			
30	32	85	58	375 (SIS Areas 1 and 2) 400 (SIS Areas 3, 4, and 6) 400 (SIS Area 5a) 550 (Water Quality Diversion Facilities in SIS Area 5b) 0 (Conventionally Draining Facilities to Omagh Tributary in SIS Area 5b)	450 (SIS Areas 1 and 2) 525 (SIS Areas 3, 4, and 6) 650 (SIS Area 5a) 245 (Water Quality diversion Facilities in SIS Area 5b) 800 (Conventionally Draining Facilities to Omagh Tributary in SIS Area 5b)	825 + Permanent Pool (SIS Areas 1 and 2) 925 + Permanent Pool (SIS Areas 3, 4, and 6) 800 + Permanent Pool (SIS Area 5) 795 + Permanent Pool (Water Quality Diversion Facilities in SIS Area 5b) 800 + Permanent Pool (Conventionally Draining Facilities to Omagh Tributary in SIS Area 5b)
35	40	100	70			
40	47	113	80			
45	53	125	89			
55	65	150	110			
60	70	162	116			
75	85	193	139			

[1] A minimum of 40 m^3/ha Extended Detention storage would be required for all Stormwater quality facilities; this storage is included in the Erosion mitigation storage rates

Stormwater Management Facility Discharge/Storage Characteristics

Table 4.1.2 provides a summary of the total storage required for each stormwater management facility, in accordance with the general drainage boundary as modeled using the HSP-F model (ref. AMEC, 2013).

Table 4.1.2. Summary of Boyne Survey Stormwater Management Facility Characteristics

Facility Reference #	Imp. Coverage (%)	Drainage Area (ha)	Required Volume (m^3)					Estimated Facility Area Requirements (ha)
			Permanent Pool	Extended Detention		Flood Control	Total	
				Water Quality	Erosion			
S1-1	46	26.57	3412	1063	4572	7809	15792	1.11
S1-2	47	25.99	3412	1040	4572	7809	15792	1.11
S1-3	53	41.28	5954	1651	8179	13646	27779	1.7
S1-4	46	24.33	3174	977	4264	7420	14858	1.07
S2-1	66	35.48	6473	1419	8802	14449	29724	1.79
S2-2	56	49.17	7411	1967	10274	17003	34688	2.03
S2-3	41	12.61	1489	504	1930	3243	6662	0.69
S3-1	53	10.07	1464	402	2120	3347	6930	0.57
S3-2	50	27.43	3734	1097	5436	8962	18132	1.24
S3-3	51	19.20	2669	768	3908	6769	13346	1
S3-4	48	21.86	2944	874	4224	6951	14119	1.03
S3-5	58	22.84	3590	914	5320	8700	17610	1.22
S4-1	52	9.12	1308	365	1900	2882	6090	0.65
S4-2	44	24.15	3020	966	4296	6398	13714	1.02
S4-3	51	16.48	2305	659	3352	5242	10899	0.89
S4-4	46	35.42	4706	1417	6556	9808	21069	1.37
S5a-1	49	29.02	4406	1161	5712	9850	15562	2.28
S5a-2	32	11.42	1564	457	1464	2674	5698	0.82
S5b-1	35	42.70	4467	1708	NA	13421	17887	1.21
S5b-2	65	53.60	9226	2144	19140	8662	37029	2.06
S5b-3	65	34.50	6270	1780	12320	5706	24296	1.47
S5b-4	66	26.90	4975	1076	NA	15761	20736	1.33
S5b-5	52	38.65	6601	6381	8690	8495	22847	1.69
S6-1	53	43.52	6039	1740	9184	15539	30763	1.88
S6-2	46	36.20	4884	1448	6648	11378	22911	1.47
S6-3	53	51.97	7607	2079	11060	18621	37288	2.17
S6-4	55	38.12	5433	1524	8460	14311	28645	1.76

Note: [1] Flood control is not proposed for development draining to the Middle Branch of the Sixteen Mile Creek
[2] Drainage area is too small to support a SWM facility – LID BMP's are recommended.

Table 4.1.3 provides a summary of the proposed discharge characteristics for each facility.

Table 4.1.3. Summary of Boyne Survey Area Stormwater Management Facility Discharge Characteristics

SWM Facility No.	Impervious Coverage (%)	Drainage Area (ha)	Peak Facility Outflow rates (m^3/s)			Normalized Facility Outflow Rates ($m^3/s/ha$)		
			Extended Detention	25 Yr.	100 Yr.	Extended Detention	25 Yr.	100 Yr.
S1-1	46	26.57	0.009	0.32	0.64	0.0003	0.012	0.024
S1-2	47	25.99	0.009	0.31	0.62	0.0003	0.012	0.024
S1-3	53	41.28	0.014	0.50	0.99	0.0003	0.012	0.024
S1-4	46	24.33	0.009	0.29	0.59	0.0004	0.012	0.024
S2-1	66	35.48	0.012	0.35	0.82	0.0003	0.010	0.023
S2-2	56	49.17	0.017	0.49	1.13	0.0003	0.010	0.023
S2-3	41	12.61	0.004	0.13	0.29	0.0003	0.010	0.023
S3-1	53	10.07	0.003	0.10	0.24	0.0003	0.010	0.024
S3-2	50	27.43	0.008	0.27	0.66	0.0003	0.010	0.024
S3-3	51	19.20	0.006	0.19	0.46	0.0003	0.010	0.024
S3-4	48	21.86	0.007	0.22	0.52	0.0003	0.010	0.024
S3-5	58	22.84	0.007	0.23	0.55	0.0003	0.010	0.024
S4-1	52	9.12	0.003	0.09	0.32	0.0003	0.010	0.035
S4-2	44	24.15	0.007	0.24	0.85	0.0003	0.010	0.035
S4-3	51	16.48	0.005	0.16	0.58	0.0003	0.010	0.035
S4-4	46	35.42	0.011	0.35	1.24	0.0003	0.010	0.035
S5a-1	49	29.02	0.058	0.44	1.02	0.0020	0.015	0.035
S5a-2	32	11.42	0.023	0.17	0.40	0.0020	0.015	0.035
S5b-1	35	42.70	0	0.06	1.49	0.0000	0.001	0.035
S5b-2	65	53.60	0	0.05	4.25	0.0000	0.001	0.079
S5b-3	65	34.50	0	0.03	2.74	0.0000	0.001	0.079
S5b-4	66	26.90	0	0.03	0.94	0.0000	0.001	0.035
S5b-5	52	38.65	0.04	0.39	1.31	0.0010	0.010	0.034
S6-1	53	43.52	0.013	0.44	1.52	0.0003	0.010	0.035
S6-2	46	36.20	0.011	0.36	1.27	0.0003	0.010	0.035
S6-3	53	51.97	0.016	0.52	1.82	0.0003	0.010	0.035
S6-4	55	38.12	0.011	0.38	1.33	0.0003	0.010	0.035

Note: [1] Flood control is not proposed for development draining to the Middle Branch of the Sixteen Mile Creek
[2] Drainage area is too small to support a SWM facility – LID BMP's are recommended.

The facility characteristics presented in Tables 4.1.2 and 4.1.3 have been established, based on the modeled drainage discretization completed as part of the *Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Planning Area* (AMEC, 2013). The sizing criteria and release rates are subject to verification and refinement as part of the SIS, based upon the final contributing drainage areas to the outlets of the Boyne Survey area. The drainage area and impervious coverage to each facility is subject to refinement through the detailed design process. The facility outflow rates would be adjusted based on the final drainage area and areal release rates. Final facility storage would be adjusted on the basis of

areal storage values as appropriate for final drainage area and impervious coverage, as well as the final sizing criterion established through the SIS's.

Depth

The stormwater management facilities would collect all minor (storm sewer) system flow (i.e. no urbanized lands are allowed to drain untreated to an open watercourse system). This requirement sets the minimum outlet elevation necessary to allow construction of storm sewer systems. Each facility must also drain via gravity flow to the receiving watercourse. The required operating levels of each of the facilities will largely be determined by these two constraints. In addition, the depth of the permanent pool within each facility would be set according to the current Ministry of Environment Guidelines (ref. *Stormwater Management Practices Planning and Design Manual, MOE, 2003*) for wetlands, wet ponds and hybrids. The required depth of each facility is based on the following:

- Minimum depth of the contributing storm sewer system
- Minimum permanent pool elevation would be equivalent to the downstream watercourse invert
- Extended detention storage for water quality and erosion control volume would be provided below the storm sewer outlet invert within the Municipal Right-of-Way (i.e. extended detention volume should not surcharge the storm sewer system within the Municipal roadway system) and the outlet pipe to the stormwater management facility would be appropriately sized to account for any submerged condition at the outlet to the stormwater management facility
- Flood control volume (above the storm sewer invert - surcharges storm sewer).
- For wetlands, approximately 75% of the surface area should have an average permanent pool depth of less than 300mm, 25% of the facility (i.e. forebay and outlet area) may have depths greater than 1 metre.
- For wetlands the depth of extended detention storage should typically not exceed 1 metre since some plants cannot withstand prolonged water level fluctuations greater than 1 metre. Where extended detention depths greater than 1 metre are required, the planting strategy should be designed in accordance with the increased depth requirements.
- For wet pond systems, the permanent pool depth should range from 1 to 2 metres, with a maximum depth of 3 metres.
- For wet pond systems, the extended detention storage should typically not exceed 1.5 metres. Maximum depths of 3 metres have been recommended to avoid formation of anoxic conditions within the facility

Grading and Configuration

Facilities should be constructed to incorporate the following considerations, in accordance with current Ministry of Environment Guidelines (ref. *Stormwater Management Practices Planning and Design Manual, MOE, 2003):*

- Maximum 5:1 side (overall) slopes (in areas 3 m beyond above and 3 m below the permanent pool elevation), with minimum 3:1 (4:1 preferable) slopes elsewhere. These

requirements would be supplemented by Municipal Design Criteria which encourage flatter slopes where possible. Use of compound slopes is also recommended in constrained areas or where compound slopes may allow flatter grading of 7:1 (preferred).

- Use of fencing around facilities would not be recommended; safety issues should be addressed through slope grading, signage and use of deterrent plantings.
- Variation in side slopes is recommended to enhance the aesthetics of the facility, as well as to allow variation in flood fringe depth regime.
- Grading should include provision/location for emergency overflow.
- Facilities to include forebays designed to provide required settling and dispersion performance; typically forebays would have a minimum depth of 1.0 metre and would provide a length to width ratio of 3:1 or greater.
- Facilities shall provide maintenance/inspection access to the inlet, forebay and outlet locations.

Thermal Mitigation

SWM Facilities are recommended to incorporate thermal mitigation measures, where deemed appropriate during the SIS. The assessment should consider, at a minimum, the quality of receiving fish habitat, as well as the anticipated increase in water temperature within the receiving fish habitat, which can be influenced by the volume and seasonality of discharge, as well as the distance between stormwater management facility discharge and downstream fish habitat. These measures may include:

- Bottom draw.
- Extended detention discharge via rock cooling trench or buried drain/sewer.
- Facility configuration - facilities which incorporate high length to width ratios provide increased opportunities for riparian planting along the facility shoreline thus reducing thermal impacts.
- Increased riparian vegetation along the permanent pool and outlet.
- Pond orientation and configuration.
- Floating islands and other emerging technology.

Inlet/Outlet

Use of reverse slope pipe outlets with an outlet structure/chamber would be preferred over perforated riser pipe (Hickenbottom type) designs for the following reasons:

- Reverse pipe/outlet structure provide for major system capacity in the facility outlet structure
- Variable flow rate control valves should be implemented to provide flexibility in outflow control (Adaptive Management).
- Outlet structure provides opportunities to vary the regulated water level through use of weirs with removable stop logs (Adaptive Management).
- Reverse slope pipe/outlet structures provide improved maintenance access and provision for maintenance drainpipe.

- Reverse slope pipe/outlet structures provide for bottom draw operation to assist in thermal mitigation.

Facility Location and Configuration Relative to Recommended Natural Heritage System

Stormwater management facilities are by their nature important features to be considered as adjunct to the Natural Heritage System because: i) they are fundamental linkages between landscape hydrological functions and receiving watercourses, and their corridors; ii) they will occupy a significant area of the built landscape (typically 5% or more); and iii) it has been well documented that they are functionally important to, and regularly utilized as habitats by upland, wetland and aquatic biota.

According to their performance objectives, they are viewed as posing a potential risk of exposing biota to contaminants. Urban facilities are currently designed to be regularly monitored and managed in the built landscape, and assuming that due diligence is respected in this maintenance, these facilities are intended to provide net functional benefits to the ecosystem. Standards for construction, management and monitoring are regularly reviewed by the Ministry of the Environment; progressively smaller and more numerous facilities are being designed, which makes risk detection more transparent, and which has resulted in demonstrated benefits in Milton i.e. the restoration of baseflow in formerly intermittent watercourses located in Phase 1 (Bristol). New initiatives such as Low Impact Development are bringing stormwater management practices into the built fabric, thereby providing green infrastructure opportunities within employment uses. Efforts to better integrate these systems will form a useful adjunct to the future NHS, especially as applied on the conceptual NHS-Oriented Areas identified in Figure NHS-2A in Appendix C of the CFCP.

Stormwater management facilities are not included within the recommended NHS (with the exception of some that discharge directly into Sixteen Mile Creek), although they are considered to contribute to ‘net gain’ of naturalized cover. They represent nodal opportunities to expand naturalized cover in key locations along corridors. SWM facility blocks may encompass over 1 ha in area, and may be shaped and positioned to provide separation of intensive development from corridors or natural features.

Wherever feasible, stormwater management blocks should be massed adjacent to NHS corridors and habitat complexes identified in the Secondary Plan, and adjacent to linkages to provide buffering and habitat opportunities. Facilities may reinforce linkages by integrating Other Wooded Features (see Figure NHS-2 in Appendix C of the CFCP) such as hedgerows. It is also desirable to integrate compensation swales within facility footprints to help achieve the drainage density targets. Alignment with suitable development may enable provision of clean runoff from landscaped areas or rooftops on development sites, or supplementary water from foundation drain collectors. The benefits of these elements as linkages, localized wetland pool creation opportunities that contribute to the overall wetland target, and associated plantings, should be given careful consideration in the placement and design of the facility footprints.

Figure 4.1 presents a typical cross-section showing the integration of a stormwater facility with a riparian corridor. The example indicates that the 10 m Regulatory Setback is integrated with the SWM facility setback; the placement of facility infrastructure such as access roads and

treatment ponds is not recommended within the setback, but side slopes and naturalized elements are acceptable.

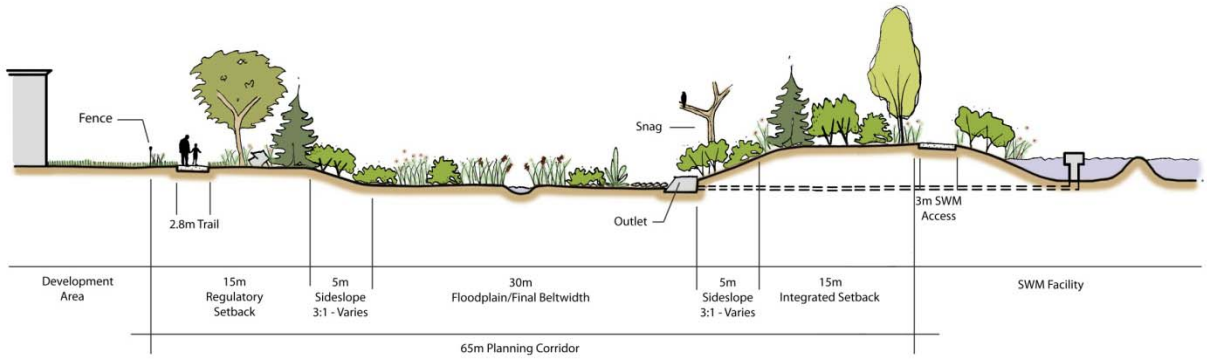

Figure 4.1 – Cross-Section of Watercourse Planning Corridor Adjacent to Stormwater Facility

Landscaping

It is intended that stormwater facilities be integrated with naturalized landscaping to minimize landscape maintenance and to provide supporting cover to adjoining corridors. Native plant materials indigenous to the Sixteen Mile Creek watershed should be utilized in landscaping of facilities, to provide benefits such as wetland cover and shading of facility pools. Conservation Halton's Landscape Planting and Tree Preservation Guidelines (Conservation Halton, 2010) include application to stormwater facilities, and provide lists of appropriate native species. Section 5.2.3 of the Boyne FSEMS, and the Town of Milton Planting and Restoration Framework (see Appendix 'K' in FSEMS) also addresses landscape plantings in, including techniques such as reforestation and direct seeding, that are suited to large naturalization projects.

4.1.2 Construction Practices for Stormwater Management Facilities

Construction of SWM Facilities should be completed in accordance with the following principles:

Sediment and Erosion Control

- Preparation of a Sediment and Erosion control plan in accordance with Town of Milton and Conservation Halton Guidelines (ref. *Engineering and Parks Standards Manual, Erosion and Sediment Control Guidelines for Urban Construction, Greater Golden Horseshoe Area Conservation Authority, 2006 and Guidelines for Evaluating Construction Activities Impacting on Water Resources, MOE*), for each area including specification of the following:

  - ✓ Method of conveyance of channel flow to maintain "dry" construction area
  - ✓ Erosion control measures (including phasing of grading, revegetation and timing of revegetation)
  - ✓ Sediment control measures
  - ✓ Measures to minimize sediment washoff during dewatering of excavated areas

- Construction of SWM Facilities to occur in the "dry" wherever possible, this may require the construction of temporary flow diversion of upstream drainage areas or grading to separate facilities from adjacent watercourse.

- Where possible, facilities should be constructed and disturbed areas stabilized with vegetation in advance of other infrastructure construction (i.e. roads, sewer, services), and in advance of site clearing/grading.

- During the construction period facilities will need to be maintained as sediment control basins and temporary outlets/ and additional storage may be required to meet performance objectives (ref. *Erosion and Sediment Control Guidelines for Urban Construction, Greater Golden Horseshoe Area Conservation Authority, 2006 and Guidelines for Evaluating Construction Activities Impacting on Water Resources, MOE*).

- Final planting of the facility should be undertaken after completion of service construction, site grading, and clean out of sediment accumulated during the construction phase, and restored to the approved design condition prior to transferring ownership to the Town of Milton.

Timing and Sequencing

Although the primary facility construction will occur in the "dry", outside of the watercourse channel, it may be necessary to complete a limited amount of in-stream works such as facility outlet channels. Where such works are necessary, timing restrictions on in-stream works would apply.

Timing restrictions are imposed on instream work to avoid interference with resident fish during their spawning and nursery periods when they are very susceptible to disturbances. In Ontario, most fish species spawn in the spring, however, the charrs and Pacific salmons spawn in the autumn. Rainbow trout (*Oncorhynchus mykiss*) are typically spring spawners, however, spawning can begin in late winter.

Based on the fish species present, in-stream work for most of the streams in the Boyne Survey area should not occur between April 1 and July 1. In the Main Branch of Sixteen Mile Creek, which provides a migration route to upstream spawning habitat for both spring (e.g. rainbow trout) and fall (e.g. Pacific salmonids) spawning fish, instream work should not occur between September 15 and July 1.

4.2 Watercourses

The objective of any watercourse alteration should be an improvement in its function. This is not necessarily limited to physical function (i.e. flow and sediment conveyance), but also includes consideration of inter-relationships with biological and chemical functions, for example ensuring structural diversity that contributes dissolved oxygen content.

4.2.1 Preliminary Design Elements

Constraints

Specific Constraints

As part of the "*Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Plan Area"* (AMEC Environment & Infrastructure, 2013), a number of specific constraints have been identified:

- Many of the reaches within the Boyne Survey (Phase 3) lands have been extensively modified by agricultural practices. These reaches could potentially be enhanced, including through the reduction of agricultural impacts.
- The majority of the reaches within the study area are of low geomorphological constraint, with the key exceptions of Reaches 2-II (Main Branch of Sixteen Mile Creek) and BP-4-C (Centre Tributary). SWS-2-A was also classified as of Medium geomorphological constraint.
- Reach 2-II is in a state of active adjustment and experiencing some natural bank erosion, therefore, peak flows should not increase and flow volumes should not change within this reach.
- Sediment being transported downstream within the Boyne Survey lands consists of a substantial portion of fine materials conveyed in suspension; thus on-line ponds should be avoided.

Watercourse Constraint Rankings

In addition to specific constraints, all watercourses within the Boyne Survey lands have been rated based on a combination of fisheries, water quality, terrestrial, stream morphology and flooding/conveyance considerations. The criteria for assigning constraints are as follows.

Fisheries Constraint Ranking

For aquatic (fisheries) habitat the following general management recommendations for each class of watercourse aquatic habitat are presented in the *Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines* (ref. CVC and TRCA, March 2009). Habitat class definitions are provided in Section 5.1. Broad-level constraints (High, Medium, Low) have been assigned to each sub-class of management recommendations to feed into the Integrated Constraint Rating for each watercourse section.

1. Protection – Permanent Fish Habitat, Critical Habitat and Species at Risk (SAR).

Protection 1 ***(High Constraint)*** – permanent, critical fish habitat or habitat associated with species at risk. Generally associated with permanent groundwater discharge or wetland storage – either habitat and/or flow source characteristics may be difficult to replicate or maintain.

- Preserve the existing drainage feature and groundwater discharge or wetland in-situ, particularly if species at risk are present;
- Maintain external drainage;
- Incorporation of shallow groundwater and base flow protection techniques such as infiltration treatment;
- Use natural channel design techniques or wetland design to restore and enhance existing habitat features, if necessary; realignment not generally permitted;
- Drainage feature must connect to downstream watercourse/habitat;
- Stormwater management (e.g. extended detention outfalls) are to be designed and located to avoid and/or minimize impacts (i.e. sediment, temperature) to fish habitat;
- Examine need to incorporate groundwater flows through infiltration measures (i.e. third pipes, etc.) to ensure no net loss and potential gain.

Protection 2 ***(High Constraint with rehabilitation potential)*** – permanent fish habitat generally with permanent standing surface water associated with a wetland and/or pond flows.

- Preference is to maintain existing surface water source;
- Maintain external drainage or if catchment drainage has been previously removed due to diversion of stormwater management flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage) as necessary;
- Replicate on-site surface water sources including wetland creation and incorporating extended detention outlets, if necessary;
- Use natural channel design techniques to replace and enhance existing habitat features only if features are easily replicated;
- Drainage feature must connect to downstream watercourse/habitat;
- Examine need to incorporate groundwater flows through infiltration measures (i.e. third pipes, etc.) to ensure no net loss and potential gain.

2. Conservation – Seasonal Fish Habitat.

Conservation 1 ***(Medium Constraint)*** – seasonal fish habitat associated with seasonally high groundwater discharge or seasonally extended contributions from wetlands potential permanent refuge habitat may be provided by a storage feature.

- Maintain existing seasonal groundwater or wetland surface flows,
- If catchment drainage has been previously removed due to diversion of stormwater management flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage), as feasible;
- Replicate on-site seasonal groundwater or surface flows using infiltration measures and/or wetland creation, if necessary;
- Maintain external flows,
- Use natural channel design techniques to replace existing habitat features to maintain overall fish productivity of the reach;
- Drainage feature must connect to downstream habitat.

Conservation 2 ***(Medium Constraint)*** – seasonal fish habitat associated with intermittent surface flows.

- Replicate on-site surface flows;
- Maintain external flows; or if catchment drainage has been removed restore lost functions through enhanced lot level controls, as feasible;
- Use natural channel design techniques to replace existing habitat features to maintain overall fish productivity of the reach;
- Drainage feature must connect to downstream habitat.

3. Mitigation – Contributing Fish Habitat

Mitigation 1 ***(Medium Constraint)*** – Complex contributing fish habitat: flows conveyed through natural vegetation communities that support complex, contributing fish habitat i.e. influences water quality, sediment, organic matter, food and nutrients to the downstream habitat.

- Replicate functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features;
- Replicate on-site flow and outlet flows at the top end of system to maintain feature functions. If catchment drainage has been previously removed due to diversion of stormwater management flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage);
- Feature form and flow that connects directly to downstream fish habitat (i.e. direct connection to other drainage features/watercourse or wetlands);

Mitigation 2 ***(Medium Constraint or Low Constraint)*** – Simple contributing fish habitat: flows that support simple contributing fish habitat, i.e. influences flow conveyance, attenuation and storage to downstream reaches.

- Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development (LID) stormwater options (refer to TRCA's Water Management Guidelines for details);
- Replicate on-site flows and outlet flows at the top end of vegetated swales, bioswales, etc. to maintain feature functions.

4. No Management Recommendation Required *(Low Constraint)* – Not Fish Habitat.

- The pre-screened drainage feature has been field verified to confirm that no feature and/or functions associated with headwater drainage features are present – generally characterized by evidence of cultivation, furrowing, presence of a seasonal crop, and lack of natural vegetation.

<u>Terrestrial Constraint Ranking</u>

Terrestrial resource constraints relate to whether or not the watercourse flows through or is directly adjacent to significant terrestrial habitat complexes, as well as whether or not the

watercourse feature provides a linkage function or opportunity within the study area and/or off site. The terrestrial constraints are defined as follows.

1. High Terrestrial Constraint: Assigned to reaches that flow through or directly adjacent to identified core/significant natural features and/or provide a linkage function between core/significant natural features.
2. Medium Terrestrial Constraint: Assigned to stream reaches that flow through non-core terrestrial features or provide a terrestrial linkage and enhancement opportunities between existing non-core features.
3. Low Terrestrial Constraint: Assigned to stream reaches that do not flow through terrestrial features or provide a terrestrial linkage opportunity.

With respect to watercourses ranked as high or medium terrestrial constraint, these watercourses may be relocated (subject to overall ranking) but the terrestrial linkage functions must be maintained or enhanced. Contiguous reaches receive the same terrestrial constraint ranking as the highest ranked reach.

Geomorphic Constraint Ranking

The role of the stream corridors is multipurpose from a geomorphic standpoint. It not only provides flow and sediment storage during high flow events, it also acts as a filter to prevent sediment and particulate inputs from surface runoff from embedding coarse substrates within the streams. The maintenance of riparian vegetation within the stream corridor acts to stabilize banks and also provides inputs of organic materials and debris which aid in creating a diverse morphology. The meander belt width incorporated into the corridor allows the channel to migrate naturally within its floodplain without the loss of property or structural integrity. For the purposes of this study, a constraint ranking system was developed based on the findings of the desktop and field assessments. The constraint system identifies three categories of high, medium and low constraint which essentially establish the preferred management approach of the stream on a reach basis from a geomorphic perspective. The basis for each category of geomorphic constraint level and associated recommended management strategy is described below:

1. High Geomorphic Constraint: Reaches that comprise a defined channel with well-developed channel morphology (i.e., riffle-pool) and/or a well-defined valley. These reaches possess both geomorphological form and function and are high-quality systems that could not be re-located and replicated in a post-development scenario.

   Watercourse to be protected/enhanced in current form and location. Modification through enhancement may be acceptable.

2. Medium Geomorphic Constraint: Reaches that may or may not have a well-defined morphology (form) but do maintain geomorphic function and have potential for rehabilitation. In many cases, these reaches may exhibit evidence of geomorphic instability or environmental degradation due to historic modifications and land use practices.

   Watercourse to remain open. Realignment may be acceptable.

3. Low Geomorphic Constraint: Ephemeral headwater systems that lack defined bed and banks (form) but do perform a geomorphic function through the conveyance of flow and sediment.

   Watercourse may remain open and realignments would be acceptable, subject to meeting drainage density targets; no riparian corridor or setbacks required.

Flood Conveyance Constraint Ranking

The constraint ranking for the flood conveyance function of the drainage features has been based upon the conveyance afforded by the feature itself, as well as the adjacent floodplain. Essentially, this assessment has considered the physical condition of the system (i.e. well-defined valley, swale with altered floodplain, etc.), the size of the contributing system drainage area as an indication of the magnitude of storm flows to the system, the presence or absence of a regulatory floodplain for the system, as well as any attenuation function which may be afforded by the riparian storage of the system. The foregoing functions of the features have been used in order to determine whether or not functions of specific features and adjacent floodplain system could be replicated by a constructor system. The following summarizes the general classification hierarchy which has been applied for this constraint ranking.

1. High Flood Conveyance Constraint: These features lie within well-defined natural valley corridors, convey runoff from large system areas (i.e. several hundred or thousand hectares), and have a Regulatory floodplain associated with the system. The conveyance function offered by these systems cannot be readily replicated by a constructed corridor, hence these systems are afforded a high constraint and cannot be altered or relocated.

2. Medium Flood Conveyance Constraint: These features convey runoff from relatively moderately sized drainage areas (i.e. between 50 and 250 ha), may or may not have a Regulated floodplain, and typically have a less defined corridor (i.e. not within a deep, well-defined and naturalized valley). The conveyance function and riparian storage of these systems can be replicated by a constructed system, but would require the construction of an open watercourse and corridor in order to achieve the same capacity and hydraulic efficiency (i.e. flood depth) within the system.

3. Low Flood Conveyance Constraint: These systems are generally depressional features or swales which convey runoff from a relatively small drainage area (i.e. generally less than 50 hectares), may or may not have a Regulatory floodplain, and do not lie within a well-defined corridor. The conveyance and attenuation functions afforded by these features can be replicated through the implementation of urban infrastructure (i.e. swales, ditches, storm sewers, major overland conveyance system, stormwater management facilities, etc.) hence these features are afforded a low constraint ranking.

All watercourses within the Boyne Survey lands have been rated based on a combination of fisheries, water quality, terrestrial, stream morphology and flooding/conveyance considerations (Table 4.2.1).

Table 4.2.1: Watercourse Constraint Rankings for Boyne Survey					
Watercourse ID	**Fisheries/ Water Quality**	**Terrestrial Resources**	**Stream Morphology**	**Flooding/ Conveyance**	**Net Rating**
Tributary 1-NE-2A					
I-NE-2A	MEDIUM	HIGH	LOW	LOW	MEDIUM
I-NE-2A-1	MEDIUM	HIGH	LOW	LOW	MEDIUM
I-NE-2A-2	LOW	LOW	LOW	LOW	LOW
I-NE-2A-3	MEDIUM	HIGH	LOW	LOW	MEDIUM
I-NE-2A-4	LOW	HIGH	LOW	LOW	LOW/HIGH[3.]
I-NE-2A-5	LOW	LOW	LOW	LOW	LOW
I-NE-2A-6	LOW	LOW	LOW	LOW	LOW
I-NE-2A-7	LOW	LOW	LOW	LOW	LOW
Tributary 1-NE-1B					
I-NE-1B-1	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM
I-NE-1B-2	LOW	LOW	LOW	LOW	LOW
Tributary SWS-4A					
SWS-4-A	LOW	LOW	LOW	LOW	LOW
Tributary SWS-1					
SWS-1-A	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM
SWS-1-A-2	LOW	LOW	LOW	MEDIUM	LOW
SWS-1-B	LOW	LOW	LOW	LOW	LOW
Tributary SWS-2					
SWS-2-A	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
SWS-2-A-1	LOW	HIGH	LOW	LOW	LOW/HIGH[3.]
SWS-2-B	LOW	LOW	LOW	LOW	LOW
SWS-2-C	LOW	LOW	LOW	MEDIUM	LOW
2-II					
2-II	HIGH	HIGH	HIGH	HIGH	HIGH
SWS-5-A	MEDIUM	HIGH	MEDIUM	LOW	HIGH[3.]
SWS-5-B	LOW	MEDIUM	LOW	LOW	LOW
SE-5-A	MEDIUM[5]/LOW	HIGH	LOW	LOW	HIGH[3.]/LOW
Tributary SWS-3					
SWS-3-A	LOW	LOW	LOW	LOW	LOW
Tributary SE-2					
SE-2-A	LOW	LOW	LOW	LOW	LOW
SE-2-B	LOW	LOW	LOW	LOW	LOW
SE-2-D-1	LOW	LOW	LOW	LOW	LOW[2.]
SE-2-D-2	LOW	LOW	LOW	LOW	LOW
Tributary SE-3					
SE-3-A	LOW	MEDIUM	LOW	LOW	LOW
SE-3-B	MEDIUM	HIGH	LOW	HIGH[1]	MEDIUM[1.]
SE-3-B-1	LOW	LOW	LOW	MEDIUM	LOW
SE-3-C	LOW	LOW	LOW	LOW	LOW
SE-3-G	MEDIUM	MEDIUM	LOW	LOW	MEDIUM
Tributary SE-4					
SE-4-A	LOW	LOW	LOW	LOW	LOW
BP-4-C					
BP-4-C	HIGH	HIGH	MEDIUM	MEDIUM	HIGH[4]

1. Note: "High" ranking for flooding /conveyance reflects requirement for offsite risk management due to presence of downstream Flood Damage Centre, which is satisfied by the stormwater management flood control strategy and requirements provided in this FSEMS. Net constraint ranking for watercourses within Boyne Survey is "Medium".
2. Drainage Density function of Watercourse SE-2-D-1 is to be replicated as part of development, as outlined in Appendices 'E' and 'J' and supporting direction in this FSEMS. Feature is not required to be maintained as a regulated open watercourse.
3. Reaches within woodlots are designated as a High Constraint by virtue of their location within a High Constraint Terrestrial feature.
4. Reaches represent High Constraint with Rehabilitation Potential
5. Reach designated medium fisheries constraint within Sixteen Mile Creek Valley and low fisheries constraint on tableland.

Building on the stream constraint rankings, management strategies have been developed on a reach-by-reach basis for streams within the Boyne Survey study area. An overview of the main management strategies and how they correspond to the net watercourse constraint rankings is provided in Table 4.2.2 and on Drawing 3.

Table 4.2.2: Watercourse Constraint Rankings and Corresponding Management Strategies for the Boyne Survey Area

Net Constraint	Management Strategy
HIGH (red)	Watercourse to be protected/enhanced in current form and location.
HIGH (red dashed)	Watercourse may be realigned subject to maintaining baseflow conditions and low flow contribution from upstream areas.
MEDIUM (blue)	Watercourse to remain open. Realignment may be acceptable. Realignment may require Authorization under the *Fisheries Act*
LOW (green)	Watercourses may be eliminated and drainage incorporated into SWM systems, if not required to meet drainage density targets. Alternatively, watercourse may remain open and realignments would be acceptable if it is required to meet drainage density targets; no riparian corridor or setbacks required.

Design Elements

Meander belt widths

Meander belt widths have been delineated for all high and medium constraint reaches within the Boyne Survey lands (i.e. those reaches with a defined channel), according to standard protocols for subwatershed level planning studies (Parish Geomorphic, 2004). Table 4.2.3 indicates the meander belt width for each reach within the study area, as well as an additional erosion setback component. Due to the broad-scale nature of this Functional Stormwater and Environmental Management Strategy, in lieu of calculating the 100-year migration rate for each reach, a factor of safety was calculated as 20% of the meander belt width (10% on either side of the meander belt width).

Table 4.2.3: Meander Belt Widths on a Reach Basis for Streams in the Study Area

Reach	Belt Width (m)	10% Factor of Safety Either Side of Channel	Final Belt Width (m)
2-II	100.0	10.0	120.0
SWS-2-A	25.0	2.5	30.0
BP-4-C	28.0	2.8	33.6
7-IX	42.0	4.2	50.4

Drainage density

A preliminary drainage density assessment was undertaken based on potential channel lengths identified in the Boyne Survey Secondary Plan. The same approach used in assessing the overall management strategy in the *Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study* was adopted, calculating the stream lengths present in each subcatchment. Results are summarized in Table 4.2.4.

Table 4.2.4: Preliminary Drainage Density Assessment of Land Use Plan & Sensitivity Analysis						
Basis of Analysis	**Total Stream length based on this study (km)**	**Total Stream length based on 1:10 000 OBM (km)**	**Stream length based on Land Use Plan (June 2010) (km)**	**Target Stream Length (km)**	**Drainage deficit / surplus (km)**	**Overall Drainage Density (km / km^2)**
Sixteen Mile Creek	16.74	15.96	21.59	11.18	+10.40	2.92
Indian Creek	4.34	3.43	7.90	2.70	+5.21	3.15

The findings show that, when all channels are considered, the overall drainage density under the Land Use Plan could potentially far exceed the minimum drainage density target of 1.451 km/km^2 within both watersheds, as well as the regional average drainage density (2.74 km/km^2). Within Sixteen Mile Creek, considering individual subcatchments, the surplus stream length far exceeds the drainage density deficit that is indicated in certain subcatchments. Within the Indian Creek watershed, all subcatchments more than meet the drainage density targets.

It should also be noted that additional swales could be incorporated into the land use plan, including:

- Swales within private property ownership (residential/employment)
- Low Impact Development Best Management Practices

These swales were not identified as part of the preliminary assessment since lengths are currently unavailable and it is possible to meet drainage density targets through swales in public ownership only. Efforts to incorporate such additional swales should be concentrated within the subcatchments of Sixteen Mile Creek that are highlighted as not meeting drainage density targets.

Water Quality Diversion

Based on the low constraint of the reaches within the Boyne Survey lands the key concern related to the diversion of water from the Omagh Tributary to Subwatershed 2 is to replicate the function of these reaches and to limit downstream impacts through Reach 7-IX. The hydraulic modeling outcomes indicate that the seasonality of the flow regime will be altered so that, compared with existing conditions, runoff volumes will become more consistent throughout the year:

- Monthly runoff volumes would typically be within a narrower range.
- The spring freshet (March) would be reduced.
- Greater runoff volumes would be experienced in the summer months (May to October)

Increased erosion and fine sediment transport downstream is unlikely to be an issue due to the reduction of the spring freshet and attenuation of high flow events through stormwater management. The potential for reduced occurrence of bankfull flows that flush materials through the channel may, if unmanaged, potentially lead to increased propensity for sedimentation and some reduction in channel dimensions. Measures to mitigate this potential impact have

therefore been specifically considered as part of the Watercourse Management Strategy for the Diversion Area as part of the FSEMS. These measures include:

- Integration of new swales within public lands (e.g. parks and schools) joining the Natural Heritage System upstream of the Omagh Tributary to mitigate potential impacts by maintaining drainage density, channel length and provision of flows downstream.
- Enhancement of Reach R7-IX appropriate to the new prevailing flow regime and mitigating agricultural impacts – e.g. as part of future Sustainable Halton development downstream of Boyne Survey.

Streamcourse Corridor Revegetation and Habitat Creation Principles

Figure 4.2 presents a typical cross-section demonstrating the representative components within a 65 m planning corridor, including naturalized cover, and habitat enhancements such as snags (dead trees to serve as perches for raptors and herons) and hibernacula (excavated pits filled with large rocks and logs for snake overwintering). Given the intentions to integrate created terrestrial habitats and open water features fed with clean runoff supplemented (where feasible) with water from nearby rooftops or foundation drain collectors, and to integrate corridors with stormwater management facilities and Greenlands, some structural flexibility within the corridor footprint is desirable. Figure 4.3 presents an example where buffers are utilized to provide space for creation of an off-line pool with wetland fringe, suitable for turtles and amphibians. This is shown as an example only and requires approval by the Town and Conservation Halton as a site-specific treatment. The section also indicates how materials may be introduced to provide habitat enhancement i.e. snags, rocks as a basking location for reptiles.

Section 5.2.3 in the Boyne Survey FSEMS and the *Town of Milton Planting and Restoration Framework* (see Appendix “K” in FSEMS) provide detailed strategies and standards for NHS corridor planting. The development of enhanced watercourse corridors presents an opportunity to ’recycle’ existing bio-diversity materials through salvage of seed banks and sod mats that would otherwise be lost during development.

One of the intentions of the recommended NHS is to ensure that the Boyne Survey riparian corridors provide for passage, foraging and residency by as many terrestrial species as possible. This necessitates that trails are carefully placed to minimize their impact on the functioning of the overall corridor, and that core habitats and supportive land uses will reinforce the corridor functions in key areas. Small berms and/or more intensive shrub plantings may be warranted to buffer sensitive features (e.g. natural or created habitats) from trails. Wetland and upland terrestrial habitat elements are recommended to be placed along the corridors at regular intervals to enhance opportunities for seasonal use by species. Section 5.2.3 in the Boyne Survey FSEMS discusses wetland creation locations and targets in more detail.

A key function of vegetation in urban riparian corridors is the maintenance of water quality through buffering and shading. Although this does not mean that corridors should be completely forested, regular placement of tree and shrub plantings that will shade the watercourse is considered essential. Section 5.2.3 of the Boyne Survey FSEMS provides a discussion of cover targets and landscaping standards for corridors.

The strategies for corridor vegetation planting should include:

- Shading of the watercourse by regular planting of trees and shrubs, especially on the west and south sides of the floodplain; establishment of fast-growing, colonizing species such as native poplars, sumac, dogwoods and willows will be most effective
- Seeding with a blend of native riparian, wetland and upland species
- Species that provide significant food sources for wildlife (mast, berries etc.) should be included in all plantings
- Application of salvaged riparian/wetland soil seed banks to new floodplains; this requires pre-identification of donor and recipient sites, and careful phasing
- Large scale planting of woody material by direct seeding or reforestation techniques
- Provision for monitoring, and management at regular intervals to adjust for identified problems (such as invasives)

The *Town of Milton Planting and Restoration Framework* (see App. “K” in FSEMS) provides detailed guidance for intensified corridor planting where intensive screening, aesthetic and buffer cover is considered an immediate priority.

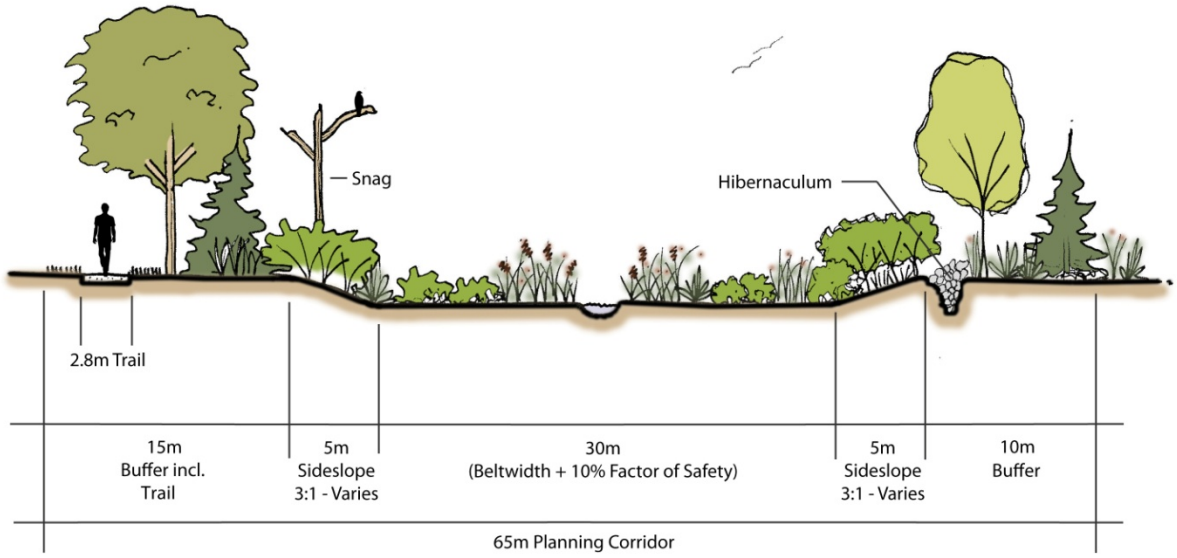

Figure 4.2 – Typical Cross-Section of NHS Watercourse Corridor

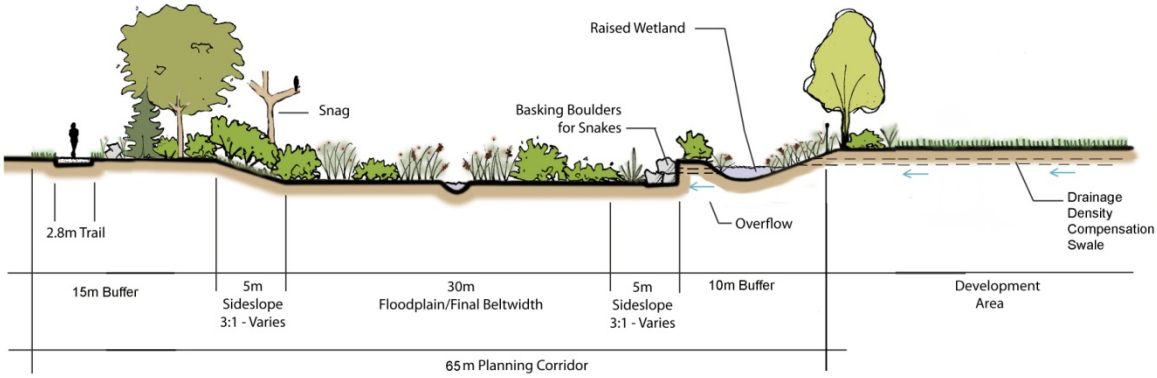

Figure 4.3 – Typical Cross-Section of NHS Watercourse Corridor with Off-line Wetland Pool

Natural channel design should incorporate geomorphic as well as hydraulic factors in the determination of meander belt widths and functional floodplains. This implies the provision of habitat area(s) sufficient in size, structure and function to sustain identified target plant and wildlife species. Habitats created along streamcourses should include the following general types: shallow open water, wetland (marsh, shrub thicket swamp, treed swamp) and upland (old field meadow, shrub thicket, open woodland, forest). Sideslopes and floodplains should be shaped to maximize micro-topography, and planted to provide a range of habitat sizes and irregular edges.

On-line wetlands with seasonal pools usually consist of overflow pools and secondary channel areas that are recharged whenever bankfull events are exceeded. Pool depths ranging from 15 to 50 cm are recommended depending on available space, to ensure a mosaic of wetland cover from meadow marsh to critical zone pockets of open water with potential to sustain turtles as well as amphibians. The wetland design must be integrated with natural channel design to achieve the habitat coverage and range of wetland types. Wetlands should be located to avoid scouring by major flows. Diversification of structure can be provided with irregular feature edges, boulders, root wads, and snags.

4.2.2 Construction Practices for Watercourses

Construction of watercourses should be undertaken in the “dry” wherever possible, within all crossing locations within the Boyne Survey area. Using this method of construction, the channel would be excavated and disturbed soils stabilized prior to the diversion of flow to the new channel section. There are also areas where the new channel is coincident with the existing channel. In these areas it will be necessary to time construction to occur during the typical dry season, as well as provide conveyance measures to isolate channel flow from the construction area to the greatest extent possible.

Construction requirements will include:

- Preparation of a Sediment and Erosion control plan, in accordance with Town of Milton and Conservation Halton Guidelines (ref. *Erosion and Sediment Control guidelines for Urban Construction, Greater Golden Horseshoe Area Conservation Authorities, 2006,*

and Guidelines for Evaluating Construction Activities Impacting on Water Resources, MOE, 1995), for each area including specification of the following:

- ✓ Method of conveyance of channel flow to maintain "dry" construction area
- ✓ Erosion control measures (including phasing of grading, revegetation and timing of revegetation)
- ✓ Sediment control measures
- ✓ Measures to minimize sediment wash-off during dewatering of excavated areas

Timing and Sequencing

Timing restrictions are imposed on instream work to avoid interference with resident fish during their spawning and nursery periods when they are very susceptible to disturbances. In Ontario, most fish species spawn in the spring, but the charrs and Pacific salmons spawn in the autumn. Rainbow trout are typically spring spawners, but spawning can begin in late winter.

Based on the fish species present, in-stream work for most of the streams in the Boyne Survey area should not occur between April 1 and July 1. In the Main Branch of Sixteen Mile Creek, which provides a migration route to upstream spawning habitat for both spring (e.g. rainbow trout) and fall (e.g. Pacific salmonids) spawning fish, instream work should not occur between September 15 and July 1.

The recommended NHS reflects existing resources and functions associated with the current agriculture-dominated landscape, supported by restoration and enhanced corridors. However, because the implementation of the NHS will be carried out in conjunction with development activities, it is important to recognize that many resources and functions can be lost or heavily disturbed during development, such that NHS goals and targets are less likely to be achieved. In order to address this problem, a clear strategy should be identified in the SIS to protect key resources, and to manage their transition into the finalized NHS. The following key steps are recommended:

- Updated information on natural features and species, including focused attention on species at risk, other significant species, and systems known to be sensitive to change and/or to have significant status are fully documented in the pre-development condition;
- Understanding of key reliances of feature and system functions i.e. hydrologic and ecologic conditions that sustain wetlands and woodlands, and the significant attributes;
- Impact assessment and implementation of finalized protection measures (i.e. buffers, hydrologic protection, protective fencing) in consultation with relevant agencies;
- Identification of adequate interim measures such as development phasing and temporary buffers to minimize disturbance in vicinity of known resources and functions until mitigation, rescue or other measures are in place
- Careful timing of clearing, grading and servicing to avoid key activity periods of species and systems (especially birds, amphibians, turtles etc.) (ref. Sections 5.2.3 and 6.1 in FSEMS);
- Surveys of key biota immediately prior to construction activity, and proactive management to avoid impacts (e.g. isolated significant habitats – see Fig NHS-2A in Appendix C, and Section 5.2.2 in FSEMS; nesting birds - the federal Migratory Birds Convention Act prohibits destruction or disturbance of nesting birds);

- Maintenance of alternative connections (e.g. existing watercourses that are to be relocated, hedgerows, expanded interim buffers around natural features) until new corridors and linkages have been constructed, plantings established, and internal elements such as created wetlands and pools are functioning.
- Monitoring of construction activities in the vicinity of features and key corridors, and training of construction staff in best management of any biota that are encountered during construction; an Environmental Management Plan which addresses issues such as spills, tree protection and emergency measures, can also address natural system protection.

4.3 Stream Crossings

4.3.1 Preliminary Design Components

Road/Railway Crossings

The estimated size of each hydraulic opening for the respective crossing has been based on the estimated minimum conveyance geometry to sustain natural channel form at each location and approximate 25 year flow rate. The final size determination is to be completed as part of future SIS's and site plan applications, based on a detailed assessment of hydrologic and hydraulic conditions, and required road/railway geometrics including conveyance of the Regulatory flood event, which will likely overtop most local roadways.

A number of recommended design principles have been identified for the siting of new road and railway crossings. These principles, which have been based on achieving suitable stream corridor and stream morphology functions, are as follows:

(a) The number of stream crossings should be minimized.
(b) Crossings should be 500 m apart on average.
(c) A minimum separation of 100 m should be observed between crossings.
(d) In situations where a minimum spacing is required, two full channel wavelengths should be incorporated into the stream planform
(e) Locations with mature vegetation should be avoided where possible.

Table 4.3.1 provides a summary of estimated crossing characteristics based upon estimated hydraulic conveyance requirements. The final sizing of the structures will necessarily require more detailed analysis, including grading constraints, fluvial geomorphologic criteria, requirements for wildlife passage, and any requirements for Regional Storm flood control.

Table 4.3.1 Summary of Estimated Hydraulic Structures for Boyne Survey Area

Culvert ID	Location/Type	Drainage Area (ha)	Estimated Top of Road Elevation (m)	Estimated Maximum Height of Bridge/Culvert (m)	Estimated Culvert Dimensions (mm)	Estimated Culvert/Bridge Length (m)
R1	Britannia Rd., approx 270 m East of Bronte Rd / Culvert	126.3	185	0.75	3.6 x 0.75	25
R2	Britannia Rd., approx 900 m East of Bronte Rd / Culvert	10.7	186.25	0.75	2.5 x 0.5	25
R3	Britannia Rd., approx 720 m West of Regional Rd / Culvert	132.05	184.5	0.75	2.5 x 0.6	25
R4	Britannia Rd., approx 90 m West of Regional Rd / Culvert	182.2	183.5	0.75	2.5 x 0.75	25
R5	Britannia Rd., approx 630 m East of Regional Rd / Bridge	232.6	175	1.5	22.8 x 1.5	25
R9	Fourth ln., approx 600 m South of Louis St. Laurent Ave / Culvert	135.63	192.75	0.6	4.0 x 0.6	25
R10	Britannia Rd., approx 200 m West of Fourth ln / Culvert	284.68	191.25	0.75	5.8 x 0.75	25
R11	Britannia Rd., approx 500 m East of Tremaine Rd / Culvert	138.62	183.75	0.75	4.2 x 0.75	25
N1	East of Tremaine Rd., approx 360 m South of Louis. St. L. Rd / Culvert	25.3	188.5	0.76	2.5 x 0.5	15
N2	East of Tremaine Rd., approx 900 m South of Louis. St. L. Rd / Culvert	77.43	187	0.75	3.4 x 0.6	15
N4	East of Bronte Rd., approx 360 m South of Louis. St. L. Rd / Culvert	25.48	193.5	0.6	2.5 x 0.5	15
N5	East of Bronte Rd., approx 900 m South of Louis. St. L. Rd / Culvert	60.57	187.75	0.75	2.5 x 0.5	15
N6	East of Bronte Rd., approx 330 m North of Britannia Rd / Culvert	85.2	186.25	0.75	2.5 x 0.5	15
N7	West of Regional Rd., approx 680 m South of Louis. St. L. Rd / Culvert	110	188.75	0.6	2.8 x 0.5	15
N8	West of Fourth Ln., approx 290 m South of Louis. St. L. Rd / Culvert	125.25	194.75	0.6	3.7 x 0.6	15
N9	West of Fourth Ln., approx 410 m South of Louis. St. L. Rd / Culvert	128.56	194.5	0.6	3.8 x 0.6	15
N10	East of Fourth Ln., approx 630 m North of Britannia Rd / Culvert	185.86	193.5	75	3.8 x 0.75	15
N11	East of Fourth Ln., approx 100 m South of Louis. St. L. Rd / Culvert	100.58	195	0.6	5.7 x 0.6	15

Each of the road crossings should be designed and constructed to provide the following:

(a) Natural substrate through open footing design or through the use of an embedded culvert invert to a depth of 0.5m preferred (minimum 0.3m).
(b) Low flow channel through crossing. (this may involve staggering the depth of culvert inverts i.e. multiple culvert crossings to promote low flow through a single culvert.)
(c) Minimum span opening recommended to be approximately three (3) times the proposed bankfull width in order to maintain natural channel form.

Enhanced Wildlife Crossings

Standards for road crossings of wildlife corridors are becoming more advanced. In urban and agricultural settings, riparian-based crossings are the most effective from the standpoint of attracting wildlife movements, and managing the crossing from the standpoint of geometrics and cost. There is now a significant body of international research on the design or crossings, and monitoring results (ref. Forman et. al., 2003, ICOET 2001-2009). Key design considerations relate to the need to separate sensitive wildlife from human trail systems, targeting of appropriate (i.e., small mammal, amphibian and reptile species) wildlife species for safe passage, and design considerations to encourage use of passages by target species to avoid their exposure to the busy road network.

Figure NHS-2 in Appendix C identifies Enhanced Wildlife Crossing locations where existing and proposed roads will cross the NHS. These crossings are intended to be designed using current road ecology science, and equipped to provide safe passage. The new road locations are conceptual and subject to confirmation through the SIS process and related infrastructure planning and design work.

Road crossing design for corridors encompasses aquatic biology, stream morphology, hydrology and hydraulics, plus terrestrial connectivity. The riparian channels specified in Boyne will consist of naturalized corridors. Culverts or small bridge spans may be required based on floodplain characteristics, to be determined in FSEMS and CFCP standards and through detailed design. Finalized road widths and profiles will affect the opportunities for enhanced wildlife passage in each crossing location. The SIS must address all of these subjects and recommend typical crossing profiles in each location based on preliminary design level of detail.

The detailed design of road crossings will need to accommodate the 100 year erosion rate, as well as satisfying hydraulic criteria for freeboard and depth of overtopping during the Regional Storm event, and considering wildlife passage for small mammals (larger mammals in the Sixteen Mile Creek Valley), amphibians and reptiles. Considerations in crossing design will include provision of fluvial geomorphology through the crossing, benches to permit wildlife movement under low flow to bank-full conditions, planting, and fencing, wing-walls or curbs to direct wildlife movements (amphibians, reptiles, waterfowl, small mammals, potentially deer). Trail crossings may need to be integrated in some locations.

Accommodation of white-tailed deer in crossing structures is not feasible in most of Boyne Survey due to the relatively undefined character of watercourse features through the landscape. The Main Branch valley provides more opportunities in this regard. Deer will use crossing

structures 1.5 – 2 m in height particularly if broad, well-defined corridors are employed with directional fencing or features, and adequate terrestrial benches under structures. Structures ranging from 2-4 m wide culverts up to free spans will accommodate deer if headspace is adequate. Smaller wildlife can be fully accommodated at all the crossings identified on Figure NHS-2, if terrestrial benches are provided and protective cover afforded with plantings and strategically placed rock and gravel. Terrestrial benches should permit animal passage under a range of flow conditions, typically from low flow to bank-full. Road signage to warn of the potential presence of wildlife (particularly deer and turtles) at crossings of corridors or linkages is recommended.

Fish Passage

Fish passage must be assured at all crossings, when the watercourse is considered fish habitat. Section 5.3.5 details issues concerning fish passage, and further guidance is provided in the DFO position statement on watercourse crossings in Appendix A.

Utility and Sewer crossings

Utility and municipal sewer crossings of watercourses will be constructed to provide the following:

(a) Plan crossing to coincide with other infrastructure such as roads wherever possible
(b) Crossings shall be constructed to sufficient depth so as to provide natural substrate to a depth of 0.5 metres preferred (0.3 minimum). Erosion protection works may be installed as back-up protection below this depth; such measures will be designed to be compatible with the provision of a natural substrate channel.
(c) Reduced maintenance activity within the utility corridor where it crosses the watercourse would be preferred. This would include allowing growth of grass and shrubs within the corridor, with periodic (selective) clearing of woody vegetation, as necessary.
(d) Where manholes, valve chambers or other surface accesses to underground utilities are required, they should be located outside of the valley, and above the Regulatory floodplain, wherever possible. Where access points are required within the watercourse block, they should be located along or above the valley side slopes and should be located to provide a minimum 10 m clearance from the channel.

4.3.2 Construction Practices for Stream Crossings

Utility and Road Crossings would be constructed in the “dry” for all crossing locations within the Boyne Survey area.

Construction requirements will include:

- Preparation of a Sediment and Erosion control plan in accordance with Town of Milton and Conservation Halton Guidelines (ref. *Engineering and Paks Standards Manual, Erosion and Sediment control Guidelines for Urban Construction, Greater Golden Horseshoe Area Conservation Authorities, 2006, and Guidelines for Evaluating*

Construction Activities Impacting on Water Resources, MOE), for each area including specification of the following:

- Method of conveyance of channel flow to maintain “dry” construction area
- Erosion control measures (including phasing of grading, revegetation and timing of revegetation)
- Sediment control measures
- Measures to minimize sediment washoff during dewatering of excavated areas

Timing and Sequencing

Timing restrictions are imposed on instream work to avoid interference with resident fish during their spawning and nursery periods when they are very susceptible to disturbances. In Ontario, most fish species spawn in the spring, but the charrs and Pacific salmons spawn in the autumn. Rainbow trout are typically spring spawners, but spawning can begin in late winter.

Based on the fish species present, in-stream work for most of the streams in the Boyne Survey area should not occur between April 1 and July 1. In the Main Branch of Sixteen Mile Creek, which provides a migration route to upstream spawning habitat for both spring (e.g. rainbow trout) and fall (e.g. Pacific salmonids) spawning fish, instream works should not occur between September 15 and July 1.

5. ASSESSMENT OF NET IMPACTS ON FISH AND FISH HABITAT

5.1 Assessment of Existing Conditions

All watercourses within the Boyne Survey Secondary Plan Area were examined as part of the Subwatersheds 2 and 7 study (Philips Planning and Engineering Limited, 2000), with some of the western watercourses re-examined during the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (Philips Engineering Limited, 2004). A fish habitat classification system was developed specifically for those studies, based upon duration of flow, channel/substrate characteristics, and the presence/absence of fish. During the Subwatershed Update Study for Areas 2 and 7 (AMEC, 2012) the habitat evaluation was guided by the Credit Valley Conservation and Toronto and Region Conservation document "Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines" (2009). While the terminology and some of the class boundaries differed somewhat between the two systems, the resulting classification and attendant habitat values and recommended protection strategies, indicate that the change in classification system did not result in major differences between the outcomes of the Subwatershed study and the Subwatershed Update study. Based on field observations and aerial photograph interpretation, the watercourses in the Boyne Survey area were classified into the following categories, as illustrated in Drawing 5. These are:

1. *Permanent* - Provides direct habitat onsite (e.g. feeding, breeding, and/or migration) as a result of year round groundwater discharge and/or permanent standing surface water within a storage feature (i.e. ponds, wetlands, refuge pools, etc.). Habitat may be either existing or potential (i.e. isolated by a barrier). Permanent habitat also may include critical fish habitat (i.e. habitat that is limited in supply, essential to the fish life cycle, and generally habitat that is not easily duplicated or created). Hydrogeological studies and/or water balance calculations may be required to confirm groundwater contributions, as appropriate, with regard to the scale of the development application(s).

   The sub-class *Permanent with rehabilitation potential* has been added to allow Reach BP-4-C of the Centre Tributary to be moved and rehabilitated to improve fish habitat, should that be desired in the future. Currently, however, it is proposed that Reach BP-4-C will remain in-place and untouched. Though this watercourse will benefit from rehabilitation associated with its realignment, it is unknown at this time if realignment will constitute a HADD under the revisions to the *Fisheries Act* that were scheduled to take effect on January 1, 2013, and therefore trigger a *Fisheries Act* Authorization.

2. *Seasonal* - Provides limited direct habitat onsite (e.g. feeding, breeding, migration and/or refuge habitat), as a result of seasonally high groundwater discharge or seasonally extended contributions from wetlands or other surface storage areas that support intermittent flow conditions, or rarely ephemeral flow conditions. Occasionally, limited permanent refuge habitat may be identified within seasonal habitat reaches.

3. *Contributing* - Provides indirect (contributing) habitat to downstream reaches – functions generally increase with flow and/or as flows move downstream with increasing length of channel or channel density (e.g. extent of contributing area). There are two types of contributing habitat:

ii) Complex contributing habitat – generally as a result of intermittent (or less commonly ephemeral) surface flows, can have marginal sorting of substrates – generally well vegetated features that influence flow conveyance, attenuation, storage, infiltration, water quality, sediment, food (invertebrates) and organic matter/nutrients (i.e. there are two types of nutrients, e.g. dissolved nutrients, and course/fine matter). Generally, two structural types: a) defined features with natural bank vegetation consisting of forest, scrubland/thicket or meadow (as defined in OSAP or ELC); or b) poorly defined features (swales) typically distinguished by hydrophilic vegetation.

iii) Simple contributing habitat – generally as a result of ephemeral (or less commonly intermittent) surface flows – generally not well-vegetated features that influence flow conveyance, attenuation, storage, infiltration, water quality and sediment transport. Generally two types: a) defined features characterized by crop cultivation, mowing or no vegetation; or b) poorly defined features (swales) may contain terrestrial vegetation.

4. *Not Fish Habitat* - The pre-screened drainage feature has been field verified to confirm that no features and/or functions associated with headwater drainage features is present – generally characterized by no definition or flow, no groundwater seepage or wetland functions, and evidence of cultivation, furrowing, presence of a seasonal crop, lack of natural vegetation, and fine textured soils (i.e. clay and/or silt).

5.2 Treatment of Watercourses During Development

Development of the Boyne Survey area can affect fish habitat by directly altering fish habitat within the Boyne Survey area, by indirectly altering fish habitat in the Boyne Survey area, and by indirectly altering fish habitat outside of the Boyne Survey area. The types of potential habitat alterations are presented in Table 5.2.1.

Table 5.2.1: Potential Fish Habitat Alterations

Direct Effects in Boyne Survey Area	Indirect Effects in Boyne Survey Area	Effects outside of Boyne Survey Area
• channel length and form • riparian buffers • flow volume and duration • water quality • water temperature	• flow volume and duration on channel form • flow volume and duration on water temperature • riparian buffers on channel form • riparian buffers on water temperature • riparian buffers on water quality	• water quantity • channel form • water quality • water temperature

In order to protect or enhance existing fish habitat the following principles were adopted for the different watercourse classes described in Section 5.1:

- permanently flowing watercourses that provide direct fish habitat, including linkages to upstream fish habitat, as well as any hydrogeologic features that contribute to the viability and value of fish habitats, will be protected/enhanced in current form and location. With the exception of road and utility crossings, no direct modification of any of these streams is proposed, except where the rehabilitation of previously degraded watercourse sections is deemed appropriate to affect a net gain in the productivity/quality of fish habitat. Appropriately sized riparian corridors or setbacks are required. (Applies specifically to the mainstream of Sixteen Mile Creek (Reach 2-II)).

- permanently flowing watercourses that provide direct fish habitat, including linkages to upstream fish habitat, but lack hydrogeologic features that contribute to the viability and value of fish habitats, will generally be protected/enhanced in current form and location. However, where the rehabilitation of previously degraded watercourse sections is deemed appropriate to affect a net gain in the productivity/quality of fish habitat, realignment may be acceptable subject to the application of natural channel design principles, and no net loss of watercourse length. Appropriately sized riparian corridors or setbacks are required. This applies specifically to Reach BP-4-C of the Centre Tributary which would benefit from rehabilitation of channel form. However, discussions with DFO (ref. Coker-Mitton-Wilkie) in 2012 indicated that the reconstruction and/or realignment of this watercourse, given its present fish community and instream habitat conditions, would require a Fisheries Act Authorization. Recent changes to the *Fisheries Act* that are scheduled to come into effect January 1, 2013, may result in a different outcome, however, at the time of writing it is unclear what this outcome will be, and has therefore been evaluated as being maintained in place in the Department of Fisheries and Oceans Risk Assessment (see Section 5.7 below).
- intermittently flowing watercourses that provide seasonal and/or permanent direct fish habitat will remain open, but realignment may be acceptable subject to the application of natural channel design principles, and no net loss of watercourse length. Appropriately sized riparian corridors or setbacks are required.
- intermittently flowing watercourses that provide complex contributing (indirect) fish habitat will remain open, but realignment may be acceptable subject to the application of natural channel design principles, and no net loss of watercourse length. Appropriately sized riparian corridors or setbacks are required.
- intermittently flowing watercourses that provide simple contributing (indirect) fish habitatmay be eliminated and drainage incorporated into SWM systems, if not required to meet drainage density targets. Alternatively, watercourse may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.
- swales and ephemeral watercourses that do not provide fish habitat may be eliminated and drainage incorporated into SWM systems, if not required to meet drainage density targets. Alternatively, watercourse may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.

These principles were applied to determine the development constraints related to fish habitat. In many instances constraints relating to other disciplines (i.e. wildlife, vegetation communities, and fluvial geomorphology) were also applied to watercourses, including some watercourses that were not constraints due to fish habitat. The combination of all of the various constraints led to the overall watercourse constraint ratings and associated treatments that are described in the Functional Stormwater and Environmental Management Strategy.

In order to assess whether or not the Project (ref. Appendix A) will result in a harmful alteration, disruption or destruction of fish habitat (HADD) and meets the Department of Fisheries and Oceans policy criterion of no net loss of fish productive capacity, it is necessary to predict the future condition of fish habitats and communities and to compare this predicted condition to the existing condition. This has been done in the sections that follow both on an overall project

basis and within each Neighbourhood Area. The Department of Fisheries and Oceans Risk Management Framework was utilized to estimate the residual effects upon fish habitat.

5.3 Assessment of Future Conditions: Direct Effects

5.3.1 Channel Length and Form and Riparian Buffers

Direct alterations of channel length and form can occur as a result of road or utility crossings, ditching or channelization, watercourse re-alignment, or the elimination of watercourses by routing them through storm sewers and stormwater management systems. For permanent stream habitats the watercourse is to be protected/enhanced in current form and location within an appropriately sized corridor (including floodplain, meander belt width, side slopes and regulatory setbacks), however, realignment using natural channel design principles may be acceptable if its present condition is degraded and no significant hydrogeologic features are present. For seasonal fish habitat and complex contributing habitats, the watercourse is to remain open within an appropriately sized corridor, but realignment using natural channel design principles may be acceptable. For simple contributing habitats, and drainage features not considered fish habitat, the watercourse may remain open subject to meeting drainage density targets, though no riparian corridor or setbacks are required, and realignment would be acceptable. This should result in a no net loss of fish habitat.

5.3.2 Flow Volume and Duration

Table 5.3.1 provides a summary of surface flow rates within the Boyne Survey area which drain to Sixteen Mile Creek based on proposed future development with stormwater management facilities in place, (ref. Table 5.3.1). The same calculation method, as has been used to calculate surface flow response for existing conditions.

Table 5.3.1: Summary of Simulated Flow Duration (%) for Boyne Survey Area – Future Land Use Conditions with Stormwater Management In-Place

Flow Range (m^3/s)	Node						
	8.530	9.120	2.402	2.509	2.514	2.802	7.111
0.0 – 0.001	4.81	3.81	67.88	3	0.05	3.14	0.02
0.001 – 0.005	15.61	12.04	30.79	32.71	11.26	14.85	0.10
0.005 – 0.05	74.75	78.59	1.25	59.52	73.85	79.39	40.84
0.05 – 0.25	3.87	4.63	0.07	4.33	14.05	1.84	51.97
0.25 – 1.0	0.89	0.88	0	0.42	0.75	0.74	6.75
1.0 – 2.5	0.06	0.05	0	0.01	0.04	0.03	1029
2.5 – 5.0	0	0	0	0	0	0	0.03
> 5.0	0	0	0	0	0	0	0.00

Compared to the information provided in Table 2.3.3 for existing conditions, the foregoing results indicate that there would be a significant reduction in the length of time that there is no flow in tributaries throughout the Boyne Survey area (i.e. the duration of flows between 0.0 and 0.001 m^3/s). The results also indicate that for a significant period of time the Boyne Survey area watercourses would be expected to exhibit flows between 5 l/s to 50 l/s (0.005-0.05 m^3/s).

Monthly Runoff Volumes to Omagh Tributary from Water Quality Diversion Area

Hydrologic analyses to determine monthly runoff volumes to the Omagh Tributary have been completed in order to obtain the simulated monthly runoff volumes to the Omagh Tributary under existing land use conditions, as well as the currently proposed quality diversion strategy for the future development of the Boyne Survey lands. Statistical analyses have been completed, based upon these results, in order to determine the mean and median monthly runoff volumes; the results of this assessment are summarized in Tables 5.3.2 and 5.3.3 respectively.

Table 5.3.2: Simulated Mean Monthly Runoff Volumes for Boyne Survey Area to Omagh Tributary (m^3)

Month	Existing Land Use Conditions	Proposed Land Use and Drainage Conditions (as per Landowner Team)	Difference (%)
January	43907	26046	-40.7
February	70738	39420	-44.3
March	130161	73292	-43.7
April	57231	37903	-33.8
May	34326	28785	-16.1
June	22989	23295	1.3
July	21109	23046	9.2
August	31845	29934	-6.0
September	42126	35218	-16.4
October	39326	31935	-18.8
November	63366	43618	-31.2
December	59117	37120	-37.2
Annual Total (based upon Monthly Means)	616241	429612	-30.3

Table 5.3.3: Simulated Median Monthly Runoff Volumes for Boyne Survey Area to Omagh Tributary (m^3)

Month	Existing Land Use Conditions	Proposed Land Use and Drainage Conditions (as per Landowners Team)	Difference (%)
January	27000	18990	-29.7
February	47160	24120	-48.9
March	110250	57150	-48.2
April	55035	38160	-30.7
May	12465	19350	55.2
June	12105	18045	49.1
July	9225	16920	83.4
August	15795	22140	40.2
September	15660	20115	28.4
October	21060	21555	2.4
November	52920	37710	-28.7
December	39060	28170	-27.9
Annual Total (based upon Monthly Medians)	417735	322425	-22.8

The results presented in Tables 5.3.2 and 5.3.3 indicate that the average annual runoff volume to the Omagh Tributary under existing land use conditions is largely influenced by the high runoff volume during the spring freshet (i.e. principally the month of March). The results in Table 5.3.2 indicate that, in general, the proposed development runoff for the Boyne Survey area to the Omagh Tributary would be below the mean monthly runoff volumes as compared to existing land use conditions. The relative (percent) differences tend to be greatest during the

spring and fall months, when frozen or saturated ground conditions prevail under existing land use conditions. The results also indicate that the mean monthly runoff volumes for the months of June and July under proposed land use and drainage conditions would exceed existing levels. By comparison, the results in Table 5.3.3 indicate that the median monthly runoff volumes during the critical period from May to October under proposed land use and drainage conditions would exceed existing levels. This difference (from the results presented in Table 5.3.2) indicates that the calculated mean monthly runoff volumes are skewed by outliers of extreme high and low values within the sample population.

Additional analyses have been completed in order to determine the additional impervious cover from impervious surfaces (i.e. rooftops, patios, sidewalks, direct treated roadway runoff, etc.) which may be required to drain directly to the Omagh Tributary in order to better balance both the mean and median monthly runoff volumes during the critical period from May to October (inclusive). Initially, this assessment has assumed an additional 5 ha of impervious surfaces within the diversion areas toward the Omagh Tributary [Note: This could notionally represent a separate rooftop collection system]. The simulated monthly mean and median runoff volumes for existing land use conditions and the proposed development and drainage with an additional 5 ha of directly draining impervious cover from the diversion areas toward the Omagh Tributary are presented in Tables 5.3.4 and 5.3.5 respectively.

Table 5.3.4: Simulated Mean Monthly Runoff Volumes for Boyne Survey Area to Omagh Tributary (m^3)

Month	Existing Land Use Conditions	Proposed Land Use and Drainage Conditions (as per Landowners Team) with Additional Impervious Drainage	Difference (%)
January	43907	27746	-36.8
February	70738	41709	-41.0
March	130161	77507	-40.5
April	57231	40697	-28.9
May	34326	31504	-8.2
June	22989	25723	11.9
July	21109	25380	20.2
August	31845	32664	2.6
September	42126	38040	-9.7
October	39326	34425	-12.5
November	63366	47263	-25.4
December	59117	39837	-32.6
Annual Total (based upon Monthly Means)	616241	462495	-24.9

Table 5.3.5: Simulated Median Monthly Runoff Volumes for Boyne Survey Area to Omagh Tributary (m^3)			
Month	**Existing Land Use Conditions**	**Proposed Land Use and Drainage Conditions (as per Landowners Team) with Additional Impervious Drainage**	**Difference (%)**
January	27000	20340	-24.7
February	47160	26190	-44.5
March	110250	61830	-43.9
April	55035	40995	-25.5
May	12465	21780	74.7
June	12105	20295	67.7
July	9225	18900	104.9
August	15795	24435	54.7
September	15660	22365	42.8
October	21060	23715	12.6
November	52920	40860	-22.8
December	39060	31680	-18.9
Annual Total (based upon Monthly Medians)	417735	353385	-15.4

The results in Table 5.3.4 indicate that directly draining an additional 5 ha of impervious surface to the Omagh Tributary from the currently proposed diversion areas would increase the mean monthly runoff volumes during the critical period; in particular, this would increase the mean monthly volumes during the most critical months (i.e. June, July, and August), when the volumes would be the lowest of any time during the year.

The results in Table 5.3.5indicate that, based upon the monthly median runoff volumes, the proposed conditions with the additional 5 ha of directly draining impervious area would be well in excess of the existing median runoff volumes; in particular, the monthly median runoff volume for the month of July (i.e. the month with the lowest median runoff volume) under this proposed drainage scenario would be double that which would be anticipated under existing land use conditions.

5.3.3 Water Quality

As indicated in Section 4, stormwater management facilities will be either wetlands, wet ponds, or hybrids and all stormwater management facilities will need to meet the “Enhanced (former Level 1)” sizing criteria. This is the highest level of treatment currently prescribed for stormwater in Ontario. There are no water quality data for the existing intermittent watercourses, so direct comparison of existing and predicted future conditions is not possible. The Functional Stormwater and Environmental Management Strategy, using a mass balance approach, has predicted residual increases in the loadings of copper, and fecal coliform bacteria with future development and stormwater management in-place.

5.3.4 Water Temperature

The intermittent watercourses which drain the Boyne Survey area are warmwater habitats. However, since stormwater management facilities have the potential to further increase water temperatures downstream, these facilities will be constructed to minimize thermal impacts if deemed appropriate at the SIS stage (see section 4.1.1).

5.3.5 Fish Passage

The installation of infrastructure and transportation crossings over watercourses, especially culverts, has the potential to create barriers to upstream fish movement. Where the watercourse is susceptible to streambed erosion, the gradual lowering of the watercourse invert may result, leading to perched culverts and other exposed infrastructure that create small waterfalls that block upstream fish movement. When drought or other occasional environmental perturbances eliminate the fish community in an area, downstream barriers can block the re-establishment of these communities. The careful siting of culverts in locations with little or no streambed erosion can help prevent such barriers. Proper culvert sizing and structural design is also important in preventing perched culverts. Deliberately placing enclosed box culverts 0.5 m (0.3 m minimum) below the watercourse invert to allow the natural substrate bedload to pass through, and, be maintained within, the culvert can reduce the risk of a barrier forming. This will also allow the maintenance of fish habitat within the culvert. A culvert constructed with no bottom (open footing culvert) can accomplish the same thing and may be best under some watercourse conditions (e.g. steep watercourse gradient). All crossings within the Boyne Survey area will be constructed in such a way as to prevent the formation of barriers to fish movement. Further guidance is provided in the DFO position statement on watercourse crossings in Appendix A.

5.4 Assessment of Future Conditions: Indirect Effects

Flow volume and duration on channel form

The stormwater management measures to control flow volume and the natural channel design criteria were undertaken to ensure that flows and channel form are compatible, so that stable natural channels will result. Much of the impetus for stormwater management comes from the desire to mitigate potential impacts. The potential indirect effects of development have been taken into account during the preliminary design.

Flow volume and duration on water temperature

No adverse effects on water temperature are anticipated due to changes in flow volumes and durations.

Riparian buffers on channel form, water quality and water temperature

The enhanced riparian buffers along watercourses in the Boyne Survey area have been incorporated in order to enhance channel stability and water quality. Effect on water temperature is expected to be minimal.

5.5 Assessment of Future Conditions: Effects Outside the Boyne Survey Area

Water Quantity

The extended duration of low flows leaving the Boyne Survey area will, of course, extend the duration of flow downstream from the Boyne area. The effect on the intermittent tributaries is anticipated to be positive.

Channel Form

No negative impacts on channel form downstream from the Boyne Survey area are anticipated.

Water Quality

Any increase in total loadings of copper, nitrogen and fecal coliforms, will be carried downstream, however if no negative impacts on aquatic life are anticipated from exposure to 100% effluent, none should be experienced further downstream, as dilution increases.

Water Quality Diversion

The Omagh Tributary is unique within the Boyne Survey in that it is anticipated that some portion of the tributary's catchment area will be diverted to Subwatershed 2. The hydraulic modeling outcomes indicate that the seasonality of the flow regime will be altered so that, compared with existing conditions, runoff volumes will become more consistent throughout the year:

- Monthly runoff volumes would typically be within a narrower range.
- The spring freshet (March) would be reduced.
- Greater runoff volumes would be experienced in the summer months (May to October)

Increased erosion and fine sediment transport downstream is unlikely to be an issue due to the reduction of the spring freshet and attenuation of high flow events through stormwater management. However, the potential for reduced occurrence of bankfull flows that flush materials through the channel may, if unmanaged, potentially lead to increased propensity for sedimentation and some reduction in channel dimensions. Measures to mitigate this potential impact have therefore been specifically considered as part of the Watercourse Management Strategy for the Diversion Area as part of the FSEMS (AMEC, 2012), and are provided above in Section 4.2.1. Taking into account these mitigating measures and the already modified nature of the existing feature, the scale of potential change is not anticipated to represent a significant impact on the overall functionality of the system.

The diversion will not affect significant terrestrial features or functions in the existing riparian zone downstream of Britannia Road. Floodplain events will occur on a less than annual frequency basis under spring freshet conditions. The modelling also indicates that there will be increased floodplain event frequency from May to September, which would extend pool habitat availability for life cycle completion by common amphibian species, and will benefit avian pescivores.

It is expected that the reduced spring freshet will not have a detrimental effect upon the simple fish community of the Omagh Tributary. However, the increased duration of flow in the summer months may have a positive effect upon the fish community, which is limited at present by the almost complete lack of water during summer.

5.6 Summary of Predicted Effects on Fish and Fish Habitat

The predicted effects of the proposed Boyne Survey development on fish habitat and fish communities (summarized in Table 5.6.1) will arise from the protection of portions of watercourses, the reconstruction and enhancement of portions of watercourses, elimination of some watercourses, enhancement of buffer width, the management of stormwater, and construction of infrastructure associated with the Boyne Survey development.

Table 5.6.1. Predicted Effects of the Boyne Survey Development on Fish Habitat and Fish Communities

Factor	Predicted Effect on Habitat	Predicted Effect on Fish Productive Capacity
channel length and form	No changes to perennial streams with hydrogeological functions Re-alignment and enhancement of intermittent watercourses using natural channel design	No net loss, and possible net gain from increase in length and enhancement of habitat, depending upon flows.
flow volume and duration	Duration of flow increases in intermittent tributaries. Total volume of flow will decrease in Omagh Tributary, due to partial diversion of local catchment area, but duration of flow will be extended.	Net gain in fish productive capacity in intermittent tributaries if the number of pools which persist through dry periods increases. Possible net gain in fish productive capacity of perennial streams.
riparian buffers	Initial disruption of riparian buffers, followed by increase	Potential short-term negative effect on water quality during construction period, followed by potential improvement in water quality, channel stability, and cover once new buffers are established on intermittent streams.
fish passage	With proper design, culverts and other infrastructure crossings will not pose barriers to upstream fish movement, but may provide significant instream structures that are important low flow refugia.	No negative effect if barriers are not created. Potential positive effect from habitat structure and low-flow refugia.
Water quality	Increase in loadings of some contaminants	Concentrations will not reach levels which are expected to adversely effect aquatic biota
Water temperature	No effect in tributaries to Indian Creek and Sixteen Mile Creek.	No significant effect.

In summary, a net gain in fish productive capacity is anticipated, due primarily to the increase in flow duration which will result from the stormwater management facilities. It should be stressed, however, that there is little fish production in the intermittent streams within the Boyne Survey area under existing conditions. Increases in fish productive capacity in these streams will also be small in absolute terms, as long as flow remains intermittent. Significant increases in fish production will occur if these streams become permanently flowing. Another benefit that will likely occur, arises from the presence of the stormwater management facilities, because fish will almost certainly colonize them and, assuming that they retain some water, they will serve as new sources for re-colonization following droughts.

5.7 Department of Fisheries and Oceans Risk Assessment

The implementation of the 1986 Department of Fisheries and Oceans (DFO) "Policy for the Management of Fish Habitat", within the context of the *Fisheries Act*, has strongly influenced the

planning and implementation of projects that affect, or potentially affect, fish habitat. Since its inception the Habitat Management Program (HMP) has focused its efforts on reviewing development proposals forwarded to DFO. The Risk Management Framework is a relatively new initiative of the HMP to categorize risks to fish and fish habitat associated with development proposals (DFO, 2006). It is a structured approach to decision making with three main components: Aquatic Affects Assessment, Risk Assessment, and Risk Management. Within the Aquatic Affects Assessment component, Pathways of Effects (PoE) are used to describe development proposals in terms of the activities that are involved, the type of cause-effect relationships that are known to exist; and the mechanisms by which stressors ultimately lead to effects in the aquatic environment. It is in the PoEs that the mitigation strategies are applied to reduce the negative effects of the proposal. In the Risk Assessment component of the Framework, the residual negative effects are assessed relative to the sensitivity, resiliency, or rarity of the habitat being impacted, the duration, intensity and geographic extent of the negative effect, and the species or community sensitivity, dependence on habitat, and rarity. Risk Management most commonly includes “letters of advice” or *Fisheries Act* authorizations that may include conditions for monitoring, compensation, and financial security.

It should be noted that changes to the *Fisheries Act* that were scheduled to take effect January 1, 2013, may result in the modification of recommended actions to avoid a HADD. In particular this may impact the recommended treatment of Reach BP-4-C. While it is clear that this watercourse will benefit from rehabilitation associated with its realignment, it is unknown at this time if realignment will constitute a HADD under the revised *Fisheries Act,* and trigger a *Fisheries Act* Authorization. This uncertainty is reflected in following Risk Assessment.

The PoEs for the Boyne Survey development area are provided in Tables 5.7.1 to 5.7.6.

Table 5.7.1: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, I-NE-2A-2 downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Vegetation clearing	Change in habitat structure and cover.	• poor or non-existent riparian vegetation at present. • if watercourse retained, vegetation will regenerate. • *Insignificant*	• poor or non-existent riparian vegetation at present. • vegetation will regenerate. • *Insignificant*	• poor or non-existent riparian vegetation at present. • if watercourse retained, vegetation will regenerate. • *Insignificant*
	Change in sediment concentrations	• sediment control plan. • if watercourse retained, vegetation will regenerate. • *Insignificant*	• sediment control plan. • vegetation will regenerate. • *Insignificant*	• sediment control plan. • if watercourse retained, vegetation will regenerate. • *Insignificant*
	Change in water temperature	• vegetation, if existing, presently has little effect upon water temperature, given the ephemeral flows. • if watercourse retained, vegetation will regenerate. • *Insignificant*	• vegetation, if existing, presently has little effect upon water temperature, given the ephemeral flows. • vegetation will regenerate. • *Insignificant*	• vegetation, if existing, presently has little effect upon water temperature. • if watercourse retained, vegetation will regenerate. • *Insignificant*
	Change in food supply	• vegetation, if existing, provides some allochthonous organic matter to watercourse that is washed downstream. • if watercourse retained, vegetation will regenerate. • *Insignificant if watercourse retained.* • *Minor negative effect if watercourse eliminated.*	• vegetation, if existing, provides some allochthonous organic matter to watercourse that is washed downstream. • vegetation will regenerate. • *Insignificant*	• vegetation, if existing, provides some allochthonous organic matter to watercourse that is washed downstream. • if watercourse retained, vegetation will regenerate. • *Insignificant if watercourse retained.* • *Minor negative effect if watercourse eliminated.*
	Change in nutrient concentrations	• sediment control plan. • if watercourse retained, vegetation will regenerate. • *Insignificant*	• sediment control plan. • vegetation will regenerate. • *Insignificant*	• sediment control plan. • if watercourse retained, vegetation will regenerate. • *Insignificant*
	Change in contaminant concentrations	• no herbicide use anticipated • *None*	• no herbicide use anticipated • *None*	• no herbicide use anticipated • *None*
	See fish passage pathway			
	See industrial equipment pathway			

Table 5.7.1: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, I-NE-2A-2 downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Excavation	Change in baseflow	• no baseflow in these watercourses at present. • *None.*	• no baseflow in these watercourses at present. • *None.*	• no baseflow in these watercourses at present. • *None.*
	Change in water temperature	• no baseflow in these watercourses at present. • *Insignificant.*	• no baseflow in these watercourses at present. • *Insignificant.*	• no baseflow in these watercourses at present. • *Insignificant.*
	Change in sediment concentration	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*
Industrial equipment	Potential mortality of fish, eggs, ova from equipment	• no fish, eggs, ova present in watercourse. • *None*	• no fish, eggs, ova present in watercourse. • *None*	• no fish, eggs, ova present in watercourse. • *None*
	Change in sediment concentrations	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*
	Change in contaminant concentrations	• protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. • *Insignificant.*	• protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. • *Insignificant.*	• protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. • *Insignificant.*
Riparian planting	Change in sediment concentrations	• not applicable if watercourse not retained. • sediment control plan. • replanted watercourse will reduce sediment post-construction. • regardless if watercourse retained or not, sediment inputs likely will decrease over existing agricultural conditions. • *Insignificant.*	• sediment control plan. • replanted watercourse will reduce sediment post-construction. • *Insignificant*	• not applicable if watercourse not retained. • sediment control plan. • replanted watercourse will reduce sediment post-construction. • regardless if watercourse retained or not, sediment inputs likely will decrease over existing agricultural conditions. • *Insignificant*
	Change in contaminant concentrations	• best management practices for fertilizer application. • *Insignificant.*	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*
	Change in nutrient concentrations	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*

Table 5.7.1: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, I-NE-2A-2 downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in water temperature	• planting of vegetation along watercourse will tend to reduce water temperature. • *Insignificant, potential decrease in water temperature*.	• planting of vegetation along retained watercourse will tend to reduce water temperature. • *Insignificant, potential decrease in water temperature*.	• planting of vegetation along retained watercourse, or if watercourse is not retained, both scenarios will tend to reduce water temperature. • *Insignificant, potential decrease in water temperature*.
	Change in habitat structure and cover	• not fish habitat. • *Insignificant*.	• not fish habitat. • *Insignificant*.	• no fish. Contributing habitat only. • *Insignificant*.
	Change in food supply	• not fish habitat. • drainage density targets will be met. • *Insignificant to minor increase in allochthonous organic matter inputs to downstream habitat.*	• not fish habitat. • *Insignificant to minor increase in allochthonous organic matter inputs to downstream habitat.*	• no fish. Contributing habitat only. • drainage density targets will be met. • *Insignificant*.
Grading	Change in habitat structure and cover	• simple habitat structure at present. • not fish habitat. • *Insignificant*.	• simple habitat structure of watercourse will be retained or restored. • not fish habitat. • *Insignificant*.	• simple habitat structure along any retained watercourse will be restored in some form. • no fish. Contributing habitat only. • *Insignificant*.
	Change in sediment concentrations	• sediment control plan. • *Insignificant.*	• sediment control plan. • *Insignificant.*	• sediment control plan. • *Insignificant.*
	See fish passage pathway			
Explosives		• not applicable.	• not applicable.	• not applicable.
Cleaning and maintenance of bridges or other structures	Change in sediment concentrations	• not applicable.	• not applicable.	• not applicable.
	Change in contaminant concentrations	• not applicable.	• not applicable.	• not applicable.
	See industrial equipment pathway			

Table 5.7.1: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, I-NE-2A-2 downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Livestock grazing	Change in habitat structure and cover	• some livestock grazing now occurs in discrete locations. • urban land use will eliminate livestock. • *Potential improvement.*	• some livestock grazing now occurs in discrete locations. • urban land use will eliminate livestock. • *Potential improvement.*	• some livestock grazing now occurs in discrete locations. • urban land use will eliminate livestock. • *Potential improvement.*
	Change in sediment concentrations	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*
	Change in water temperature	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*
	Change in organic inputs/nutrient concentrations	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*
	Potential mortality of fish, eggs, ova from trampling.	• no fish. • not applicable.	• no fish. • not applicable.	• no fish. • not applicable.

Table 5.7.2: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Vegetation clearing	Change in habitat structure and cover.	• poor or non-existent riparian vegetation at present. • vegetation will regenerate. • *Insignificant*	• herbaceous or developing woody riparian vegetation at present. • vegetation will regenerate. • *Insignificant.*	• herbaceous or developing woody riparian vegetation at present. • if required, vegetation clearing will have a temporary effect during construction. • *Temporary minor effect until vegetation naturalizes, but insignificant long-term effect.*
	Change in sediment concentrations	• vegetation will regenerate. • sediment control plan. • *Insignificant*	• sediment control plan. • vegetation will regenerate. • *Insignificant.*	• sediment control plan. • vegetation will regenerate. • *Insignificant*
	Change in water temperature	• vegetation, if existing, presently has little effect upon water temperature. • vegetation will regenerate. • *Insignificant*	• vegetation likely has a small effect upon water temperature. • vegetation will regenerate. • *Insignificant.*	• vegetation presently likely has a small to medium effect upon water temperature. • if required, vegetation clearing will have a temporary effect during construction and until regeneration occurs. • warmwater fish habitat at present. • *Insignificant to minor impact.*
	Change in food supply	• vegetation, if existing, provides some allochthonous organic matter to watercourse that is washed downstream. • vegetation will regenerate. • *Insignificant*	• vegetation provides allochthonous organic matter to watercourse that is washed downstream. • vegetation will regenerate. • *Insignificant to minor negative effect*	• vegetation provides allochthonous organic matter to watercourse. • vegetation will regenerate. • *Insignificant to minor negative effect.*
	Change in nutrient concentrations	• sediment control plan. • vegetation will regenerate. • *Insignificant*	• sediment control plan. • vegetation will regenerate. • *Insignificant*	• sediment control plan. • vegetation will regenerate. • *Insignificant*
	Change in contaminant concentrations	• no herbicide use anticipated • *None*	• no herbicide use anticipated • *None*	• no herbicide use anticipated • *None*
	See fish passage pathway			
	See industrial equipment pathway			

Table 5.7.2: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Excavation	Change in baseflow	• no baseflow in these watercourses at present, but possible baseflow from future infrastructure. • *No change, or potential establishment of baseflow.*	• no baseflow in these watercourses at present, but possible baseflow from future infrastructure. • *No change, or potential establishment of baseflow.*	• no baseflow in these watercourses at present, but possible baseflow from future infrastructure. • *No change, or potential establishment of baseflow.*
	Change in water temperature	• no baseflow in these watercourses at present, but possible baseflow from future infrastructure. • *No change, or potential decrease in water temperature with baseflow.*	• no baseflow in these watercourses at present, but possible baseflow from future infrastructure. • *No change, or potential decrease in water temperature with baseflow.*	• no baseflow in these watercourses at present, but possible baseflow from future infrastructure. • *No change, or potential decrease in water temperature with baseflow.*
	Change in sediment concentration	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*
Industrial equipment	Potential mortality of fish, eggs, ova from equipment	• no fish, eggs, ova present in watercourse. • *None*	• no fish, eggs, ova present in watercourse. • *None*	• implementation of work timing restrictions. • relocation of fish prior to work. • simple fish community. • *Insignificant.*
	Change in sediment concentrations	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*	• sediment control plan. • *Insignificant*
	Change in contaminant concentrations	• protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. • *Insignificant.*	• protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. • *Insignificant.*	• protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. • *Insignificant.*
Riparian planting	Change in sediment concentrations	• sediment control plan. • replanted watercourse will reduce sediment post-construction. • *Insignificant*	• sediment control plan. • replanted watercourse will reduce sediment post-construction. • *Insignificant*	• sediment control plan. • replanted watercourse will reduce sediment post-construction. • *Insignificant to minor reduction in sediment concentrations*
	Change in contaminant concentrations	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*
	Change in nutrient concentrations	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*	• best management practices for fertilizer application. • *Insignificant*

Table 5.7.2: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in water temperature	• planting of vegetation along watercourse will tend to reduce water temperature. • *Insignificant temperature change, or potential decrease in water temperature*.	• planting of vegetation along watercourse will tend to reduce water temperature. • *Insignificant temperature change, or potential decrease in water temperature*.	• planting of vegetation along watercourse will tend to reduce water temperature. • *Potential decrease in water temperature*.
	Change in habitat structure and cover	• no fish. Contributing habitat only. • *Insignificant*.	• no fish. Contributing habitat only. • *Insignificant*.	• development of diverse riparian vegetation communities will contribute to improved habitat structure and cover over time. • *Potential significant improvement*.
	Change in food supply	• no fish. Contributing habitat only. • planted vegetation will provide some allochthonous organic matter to watercourse that is washed downstream. • *Insignificant*.	• no fish. Contributing habitat only. • planted vegetation will provide some allochthonous organic matter to watercourse that is washed downstream. • *Insignificant*.	• planted vegetation will provide allochthonous organic matter to watercourse. • *Potential improvement*.
Grading	Change in habitat structure and cover	• no fish. Contributing habitat only. • - *Insignificant*.	• no fish. Contributing habitat only. • *Insignificant*.	• habitat structure of watercourse will be retained or restored using natural channel design principles. • restored habitats will naturalize over time. • *Potential improvement*.
	Change in sediment concentrations	• sediment control plan. • *Insignificant.*	• sediment control plan. • *Insignificant.*	• sediment control plan. • *Insignificant.*
	See fish passage pathway			
Explosives		• not applicable.	• not applicable.	• not applicable.
Cleaning and maintenance of bridges or other structures	Change in sediment concentrations	• not applicable.	• not applicable.	• not applicable.
	Change in contaminant concentrations	• not applicable.	• not applicable.	• not applicable.
	See industrial equipment pathway			

Table 5.7.2: Pathways of Effects, Land-Based Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Livestock grazing	Change in habitat structure and cover	• some livestock grazing now occurs in discrete locations. • urban land use will eliminate livestock. • *Potential improvement.*	• some livestock grazing now occurs in discrete locations. • urban land use will eliminate livestock. • *Potential improvement.*	• urban land use will eliminate livestock. • *Elimination of this threat from livestock.*
	Change in sediment concentrations	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*
	Change in water temperature	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*
	Change in organic inputs/nutrient concentrations	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*	• urban land use will eliminate livestock. • *Potential reduction.*
	Potential mortality of fish, eggs, ova from trampling.	• no fish. • not applicable.	• no fish. • not applicable.	• urban land use will eliminate livestock. • *Elimination of this threat from livestock.*

Table 5.7.3: Pathways of Effects, Land-Based Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Vegetation clearing	Change in habitat structure and cover.	- herbaceous or developing woody riparian vegetation at present. - if required for isolated watercourse crossings by transportation or other infrastructure, vegetation clearing will have a temporary effect until it regenerates. - *Temporary effect until vegetation naturalizes, but insignificant long-term effect.*	- herbaceous, developing woody riparian, or forested vegetation at present. - if required for isolated watercourse crossings by transportation or other infrastructure, vegetation clearing will have a temporary effect until it regenerates. - *Temporary effect until vegetation naturalizes, but insignificant long-term effect.*
	Change in sediment concentrations	- sediment control plan. - *Insignificant*	- sediment control plan. - *Insignificant*
	Change in water temperature	- vegetation presently likely has a medium effect upon water temperature. - if required for isolated watercourse crossings by transportation or other infrastructure, vegetation clearing will have a temporary and likely insignificant effect during construction and until regeneration occurs. - warmwater fish habitat at present. - *Potential temporary but likely insignificant effect if extent is not great, but insignificant in long-term. Shading of watercourse will likely increase once riparian buffer is established.*	- vegetation presently likely has a significant effect upon water temperature. - if required for isolated watercourse crossings by transportation or other infrastructure, vegetation clearing will have a temporary and likely insignificant effect during construction and until regeneration occurs. - warmwater fish habitat, with transient coldwater species passing through during spawning runs. - *Potential temporary but likely insignificant effect if extent is not great, but insignificant in long-term.*
	Change in food supply	- vegetation provides allochthonous organic matter to watercourse. Temporary negative, but insignificant, effect during construction. - *Insignificant*	- vegetation provides allochthonous organic matter to watercourse. Temporary negative, but insignificant, effect during construction. - *Insignificant*
	Change in nutrient concentrations	- sediment control plan. - *Insignificant*	- sediment control plan. - *Insignificant*
	Change in contaminant concentrations	- no herbicide use anticipated - *None*	- no herbicide use anticipated - *None*
	See fish passage pathway		
	See industrial equipment pathway		
Excavation	Change in baseflow	- watercourse will stay in current location and form, but may be enhanced/restored at appropriate locations. - potential increase in baseflow from future infrastructure. - *No change, or potential increase in baseflow.*	- watercourse will stay in current location and form, but may be enhanced/restored at appropriate locations. - potential increase in baseflow from future infrastructure. - *No change, or potential increase in baseflow.*
	Change in water temperature	- watercourse will stay in current location and form, but may be enhanced/restored at appropriate locations. - potential increase in baseflow from future infrastructure. - *No change, or potential decrease in water temperature.*	- watercourse will stay in current location and form, but may be enhanced/restored at appropriate locations. - potential increase in baseflow from future infrastructure. - *No change, or potential decrease in water temperature.*
	Change in sediment concentration	- sediment control plan. - *Insignificant*	- sediment control plan. - *Insignificant*

Table 5.7.3: Pathways of Effects, Land-Based Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Industrial equipment	Potential mortality of fish, eggs, ova from equipment	- watercourse will stay in current location and form so no industrial equipment generally required, but enhancement/restoration may occur at appropriate locations. - implementation of work timing restrictions. - relocation of fish prior to work. - simple to complex fish communities. - *Insignificant.*	- watercourse will stay in current location and form so no industrial equipment generally required, but enhancement/restoration may occur at appropriate locations. - implementation of work timing restrictions. - relocation of fish prior to work. - simple to complex fish communities. - *Insignificant.*
	Change in sediment concentrations	- sediment control plan. - *Insignificant*	- sediment control plan. - *Insignificant*
	Change in contaminant concentrations	- protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. - *Insignificant.*	- protocols to avoid contamination by oil, grease, hydraulic fluids, and fuel. - *Insignificant.*
Riparian planting	Change in sediment concentrations	- watercourse will stay in current location and form, so minimum amount of riparian planting will be required. - sediment control plan. - replanted watercourse will reduce sediment post-construction. - *Insignificant*	- watercourse will stay in current location and form, so minimum amount of riparian planting will be required. - sediment control plan. - replanted areas will reduce sediment post-construction. - *Insignificant*
	Change in contaminant concentrations	- watercourse will stay in current location and form, so minimum amount of riparian planting will be required. - best management practices for fertilizer application. - *Insignificant*	- watercourse will stay in current location and form, so minimum amount of riparian planting will be required. - best management practices for fertilizer application. - *Insignificant*
	Change in nutrient concentrations	- watercourse will stay in current location and form, so minimum amount of riparian planting will be required. - best management practices for fertilizer application. - *Insignificant*	- watercourse will stay in current location and form, so minimum amount of riparian planting will be required. - best management practices for fertilizer application. - *Insignificant*
	Change in water temperature	- retaining and potential enhancement of vegetation along watercourse will tend to maintain or reduce water temperatures somewhat. - *Potential decrease in water temperature*.	- retaining and potential enhancement of vegetation along watercourse will tend to maintain or reduce water temperatures somewhat. - *Potential decrease in water temperature*.
	Change in habitat structure and cover	- development of diverse riparian vegetation communities will contribute to improved habitat structure and cover over time. - *Potential significant improvement*.	- retention and development of diverse riparian vegetation communities will contribute to improved habitat structure and cover over time. - *Potential improvement*.
	Change in food supply	- retained or planted vegetation will provide allochthonous organic matter to watercourse. - *Potential improvement*.	- retained or planted vegetation will provide allochthonous organic matter to watercourse. - *Potential minor improvement*.

Table 5.7.3: Pathways of Effects, Land-Based Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Grading	Change in habitat structure and cover	- habitat structure of watercourse will be mostly retained, however, limited restoration using natural channel design principles may occur at isolated locations. - restored habitats will naturalize over time. - *Potential improvement*.	- habitat structure of watercourse will be mostly retained, however, limited restoration using natural channel design principles may occur at isolated locations. - restored habitats will naturalize over time. - *Potential minor improvement*.
	Change in sediment concentrations	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	See fish passage pathway		
Explosives		- not applicable.	- not applicable.
Cleaning and maintenance of bridges or other structures	Change in sediment concentrations	- not applicable.	- not applicable.
	Change in contaminant concentrations	- not applicable.	- not applicable.
	See industrial equipment pathway		
Livestock grazing	Change in habitat structure and cover	- urban land use will eliminate livestock. - *Elimination of this threat from livestock.*	- urban land use will eliminate livestock. - *Elimination of this threat from livestock.*
	Change in sediment concentrations	- urban land use will eliminate livestock. - *Potential reduction.*	- urban land use will eliminate livestock. - *Potential reduction.*
	Change in water temperature	- urban land use will eliminate livestock. - *Potential reduction.*	- urban land use will eliminate livestock. - *Potential reduction.*
	Change in organic inputs/nutrient concentrations	- urban land use will eliminate livestock. - *Potential reduction.*	- urban land use will eliminate livestock. - *Potential reduction.*
	Potential mortality of fish, eggs, ova from trampling.	- urban land use will eliminate livestock. - *Elimination of this threat from livestock.*	- urban land use will eliminate livestock. - *Elimination of this threat from livestock.*

Table 5.7.4: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, -NE-2A-2, downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Placement of material or structures in water	Change in habitat structure and cover.	- not fish habitat. - ephemeral flow. - if retained as an open watercourse then any culvert or bridge may result in an associated pool, of either extended or permanent duration. - *Insignificant.*	- not fish habitat. - ephemeral flow. - any culvert or bridge may result in an associated pool, of either extended or permanent duration. - *Insignificant.*	- no fish. Contributing habitat only. - intermittent or ephemeral flow. - if retained as an open watercourse then any culvert or bridge may result in an associated pool, of either extended or permanent duration. - *Minor improvement.*
	Change in sediment concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in food supply	- water potentially retained under bridges or in culverts may provide a small amount of aquatic production. - *Insignificant*.	- water potentially retained under bridges or in culverts may provide a small amount of aquatic production. - *Insignificant*.	- water potentially retained under bridges or in culverts may provide a small amount of aquatic production. - *Minor improvement*.
	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	See fish passage pathway			
	See flow pathway			
Dredging	Change in food supply	- impacts from Dredging only applicable if watercourse is retained. - little change in flow regime, or substrate or vegetation type anticipated. - *Insignificant.*	- little change in flow regime, or substrate or vegetation type anticipated. - *Insignificant.*	- impacts from Dredging only applicable if watercourse is retained. - little change in flow regime, or substrate or vegetation type anticipated. - *Insignificant.*
	Change in habitat structure and cover.	- not fish habitat. - *Insignificant*.	- not fish habitat. - *Insignificant*.	- very poor instream habitat. - no fish at present. Contributing habitat only. - *Insignificant*.
	Change in sediment concentrations	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	Change in nutrient concentrations	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	See fish passage pathway			
	See placement of material or structures in water pathway			

Table 5.7.4: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, -NE-2A-2, downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Water extraction	Direct mortality of fish.	- not fish habitat. - *None*.	- not fish habitat. - *None*.	- no fish. Contributing habitat only. - *None*.
	See flow pathway			
	See placement of material or structures in water pathway			
	See industrial equipment pathway			
Organic debris management	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in habitat structure and cover.	- not applicable.	- not applicable.	- not applicable.
	Change in food supply	- not applicable.	- not applicable.	- not applicable.
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in sediment concentrations	- not applicable.	- not applicable.	- not applicable.
	See industrial equipment pathway			
Wastewater management		- not applicable.	- not applicable.	- not applicable.
Addition or removal of aquatic vegetation	Change in food supply	- no aquatic vegetation is present. - not applicable.	- no aquatic vegetation is present. - not applicable.	- no aquatic vegetation is present. - not applicable.
	Change in habitat structure and cover.	- not applicable.	- not applicable.	- not applicable.
	Change in sediment concentration	- not applicable.	- not applicable.	- not applicable.
	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in water temperature	- not applicable.	- not applicable.	- not applicable.
	Change in dissolved oxygen	- not applicable.	- not applicable.	- not applicable.

Table 5.7.4: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, -NE-2A-2, downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
[1]Flow Management (altered frequency, amplitude, duration, timing and rate of change of flow)	Change in bioenergetics	- not fish habitat. - not applicable.	- not fish habitat. - not applicable.	- no fish. Contributing habitat only. - not applicable.
	Change in habitat structure and cover	- not applicable.	- not applicable.	- not applicable.
	Change in food supply	- not applicable.	- not applicable.	- if duration of flow is increased, production of aquatic invertebrates may occur or be increased. *- Potential increase in food supply.*
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in sediment concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in total gas pressure	- not applicable.	- not applicable.	- not applicable.
	Change in migration/access to habitats	- not applicable.	- not applicable.	- not applicable.
	Displacement or stranding of fish	- not applicable.	- not applicable.	- not applicable.
	Change in water temperature	- not applicable.	- not applicable.	- if duration of flow is increased, water temperatures may be affected. *- Potential decrease in water temperature.*
	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in salinity	- not applicable.	- not applicable.	- not applicable.
	See fish passage pathway			
Fish passage issues	Incidental entrainment, impingement or mortality of resident species	- not fish habitat. - not applicable.	- not fish habitat. - not applicable.	- no fish. - not applicable.
	Change in access to habitats.	- not applicable.	- not applicable.	- not applicable.
	Changes in total gas pressure	- not applicable.	- not applicable.	- not applicable.

Table 5.7.4: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Not fish habitat. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A	Not fish habitat. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. SWS-2-A-1, -NE-2A-2, downstream portion of SWS-2-C, SE-2-D-1
	Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Changes in thermal clues or temperature barriers	- not applicable.	- not applicable.	- not applicable.
	Changes in salinity	- not applicable.	- not applicable.	- not applicable.
	Interbasin transfer of species.	- not applicable.	- not applicable.	- not applicable.
Structure removal	Change in food supply.	- not applicable.	- not applicable.	- not applicable.
	Change in habitat structure and cover.	- not applicable.	- not applicable.	- not applicable.
	Change in sediment concentrations.	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	Change in contaminant concentrations.	- not applicable.	- not applicable.	- not applicable.
	See flow management pathway			
	See fish passage pathway			

[1]Modified from "Change in timing duration and frequency of flow" according to Clarke *et al* (2008).

Table 5.7.5: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Placement of material or structures in water	Change in habitat structure and cover.	- no fish. Contributing habitat only. - intermittent or ephemeral flow. - any culvert or bridge may result in an associated pool, of either extended or permanent duration. - *Minor improvement.*	- no fish. Contributing habitat only. - intermittent or ephemeral flow. - any culvert or bridge may result in an associated pool, of either extended or permanent duration. - *Minor improvement.*	- intermittent flow. - any culvert or bridge may result in an associated pool, of either extended or permanent duration, that may provide refugia for fish to occupy. - *Improvement.*
	Change in sediment concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in food supply	- water potentially retained under bridges or in culverts may provide a small amount of aquatic production. - *Insignificant*.	- water potentially retained under bridges or in culverts will provide some amount of aquatic production. - *Insignificant*.	- water potentially retained under bridges or in culverts may provide some amount of aquatic production. - *Potential improvement in watercourse productivity*.
	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	See fish passage pathway			
	See flow pathway			
Dredging	Change in food supply	- temporary effect during construction and until vegetation regenerates. - little change in flow regime, or substrate or vegetation type anticipated. - *Insignificant.*	- temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - *Minor temporary negative impact if channel realigned.*	- temporary effect during construction and until habitat naturalizes and aquatic and hydrophilic vegetation regenerates. - *Temporary negative impact if channel realigned.*
	Change in habitat structure and cover.	- very poor instream habitat at present. - no fish. Contributing habitat only. - *Insignificant*.	- simple instream habitat at present. - no fish. Contributing habitat only. - *Insignificant*.	- simple to moderately complex instream habitat at present. - *Minor negative impact.*
	Change in sediment concentrations	- if channel is realigned, a temporary effect during construction and until vegetation regenerates. - sediment control plan. - *Insignificant.*	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Insignificant.*	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Insignificant.*
	Change in nutrient concentrations	- if channel is realigned, a temporary effect during construction and until vegetation regenerates. - sediment control plan. - *Insignificant.*	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Insignificant.*	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Insignificant.*
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	See fish passage pathway			
	See placement of material or structures in water pathway			

Table 5.7.5: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Water extraction	Direct mortality of fish.	- no fish. Contributing habitat only. - *None*.	- no fish. Contributing habitat only. - *None*.	- Screens to prevent entrainment of fishes into water intakes - *Insignificant*.
	See flow pathway			
	See placement of material or structures in water pathway			
	See industrial equipment pathway			
Organic debris management	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in habitat structure and cover.	- not applicable.	- not applicable.	- not applicable.
	Change in food supply	- not applicable.	- not applicable.	- not applicable.
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in sediment concentrations	- not applicable.	- not applicable.	- not applicable.
	See industrial equipment pathway			
Wastewater management		- not applicable.	- not applicable.	- not applicable.
Addition or removal of aquatic vegetation	Change in food supply	- no strictly aquatic vegetation is present. - not applicable.	- may have simple community of hydrophilic and emergent aquatic plants at some locations. - if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - *Minor temporary negative impact if channel realigned.*	- may have simple community of hydrophilic and emergent aquatic plants at some locations. - if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - *Minor temporary negative impact if channel realigned.*
	Change in habitat structure and cover.	- not applicable.	- no fish. Contributing habitat only. - not applicable.	- no effect on watercourse retained in place. - simple fish community in isolated pools at culverts during dry period. - if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - *Minor temporary negative impact.*
	Change in sediment concentration	- not applicable.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Insignificant*.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Insignificant*.

Table 5.7.5: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in nutrient concentrations	- not applicable.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Minor temporary negative impact if channel realigned*.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - sediment control plan. - *Minor temporary negative impact if channel realigned*.
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in water temperature	- not applicable.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates, though effect of these on temperature is minor. - *Insignificant.*	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates, though effect of these on temperature is minor. - *Insignificant.*
	Change in dissolved oxygen	- not applicable.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - minor contribution due to intermittent flow. - *Insignificant*.	- if channel is realigned, a temporary effect during construction and until aquatic and hydrophilic vegetation regenerates. - minor contribution due to intermittent flow. - *Insignificant*.
[1]Flow Management (altered frequency, amplitude, duration, timing and rate of change of flow)	Change in bioenergetics	- no fish. Contributing habitat only. - not applicable.	- no fish. Contributing habitat only. - not applicable.	- no anticipated significant alterations to flow, except potential for increased duration or establishment of baseflow. - *Potential positive impact*.
	Change in habitat structure and cover	- not applicable.	- not applicable.	- if baseflow is established, the entire watercourse will become permanent fish habitat, rather than only isolated pools in culverts. - *Potential significant positive impact.*
	Change in food supply	- if duration of flow is increased, production of aquatic invertebrates may occur. - *Potential increase in food supply.*	- if duration of flow is increased, production of aquatic invertebrates may occur or be increased. - *Potential increase in food supply.*	- extension of flow duration may result in greater diversity of invertebrates and fish, and greater productivity. - *Positive effect.*
	Change in contaminant concentrations	- not applicable.	- not applicable.	- not applicable.

Table 5.7.5: Pathways of Effects, in-Water Activities				
	Watercourse reaches	Simple contributing habitat. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
	Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in sediment concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in total gas pressure	- not applicable.	- not applicable.	- not applicable.
	Change in migration/access to habitats	- not applicable.	- not applicable.	- if flow duration is increased, access will be improved. - *Positive effect*.
	Displacement or stranding of fish	- not applicable.	- not applicable.	- not applicable.
	Change in water temperature	- if duration of flow is increased, water temperatures may be affected. - *Potential decrease in water temperature.*	- if duration of flow is increased, water temperatures may be affected. - *Potential decrease in water temperature.*	- if duration of flow is increased, water temperatures may be affected. - *Potential decrease in water temperature.*
	Change in nutrient concentrations	- not applicable.	- not applicable.	- not applicable.
	Change in salinity	- not applicable.	- not applicable.	- not applicable.
	See fish passage pathway			
Fish passage issues	Incidental entrainment, impingement or mortality of resident species	- not fish habitat. - not applicable.	- no fish. Contributing habitat only. - not applicable.	- not applicable.
	Change in access to habitats.	- not applicable.	- not applicable.	- transportation or other infrastructure crossings will be designed to not create barriers to fish migration. - *None*.
	Changes in total gas pressure	- not applicable.	- not applicable.	- not applicable.
	Changes in thermal clues or temperature barriers	- not applicable.	- not applicable.	- not applicable.
	Changes in salinity	- not applicable.	- not applicable.	- not applicable.
	Interbasin transfer of species.	- not applicable.	- not applicable.	- not applicable.
Structure removal	Change in food supply.	- no fish. - ephemeral flow. - structure is generally very sparse and very poorly developed, severely limiting any food production that may occur and be washed downstream to fish. - *Insignificant*	- no fish. - ephemeral/intermittent flow. - structure is generally sparse and poorly developed, limiting any food production that may occur and be washed downstream to fish. - *Insignificant or minor temporary negative impact if channel realigned.*	- intermittent flow. - structure is generally sparse, limiting any food production that may occur. - *Minor temporary negative impact if channel realigned.*
	Change in habitat structure and cover.	- no fish. Contributing habitat only. - not applicable.	- no fish. Contributing habitat only. - not applicable.	- structure is generally sparse. - *Negative impact if channel realigned.*
	Change in sediment concentrations.	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	Change in contaminant concentrations.	- not applicable.	- not applicable.	- not applicable.
	See flow management pathway			
	See fish passage pathway			

[1]Modified from "Change in timing duration and frequency of flow" according to Clarke *et al* (2008).

Table 5.7.6: Pathways of Effects, in-Water Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
Placement of material or structures in water	Change in habitat structure and cover.	- permanent flow. - any culvert or bridge may result in an associated pool that is deeper than surrounding habitats, that may provide unique fish habitat. - *May provide deeper habitats for fish to occupy. Potential improvement.*	- permanent flow. - one clear-span bridge has already been added under a separate authorization. No additional culverts or bridges are anticipated. - *No further changes anticipated.*
	Change in sediment concentrations	- not applicable.	- not applicable.
	Change in food supply	- will likely have little effect on food supply. - *Insignificant*.	- will likely have little effect on food supply. - *Insignificant*.
	Change in nutrient concentrations	- not applicable.	- not applicable.
	See fish passage pathway		
	See flow pathway		
Dredging	Change in food supply	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations when appropriate. - *Insignificant change to food supply*.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations when appropriate. - *Insignificant change to food supply*.
	Change in habitat structure and cover.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations when appropriate. - restored habitats will naturalize over time. - *Potential for minor habitat change*.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations when appropriate. - restored habitats will naturalize over time. - *Potential for minor habitat change*.
	Change in sediment concentrations	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	Change in nutrient concentrations	- sediment control plan. - *Insignificant.*	- sediment control plan. - *Insignificant.*
	Change in contaminant concentrations	- not applicable.	- not applicable.
	See fish passage pathway		
	See placement of material or structures in water pathway		
Water extraction	Direct mortality of fish.	- Screens to prevent entrainment of fishes into water intakes - *Insignificant*.	- not applicable.
	See flow pathway		
	See placement of material or structures in water pathway		
	See industrial equipment pathway		
Organic debris management	Change in nutrient concentrations	- not applicable.	- not applicable.

Table 5.7.6: Pathways of Effects, in-Water Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in habitat structure and cover.	- not applicable.	- not applicable.
	Change in food supply	- not applicable.	- not applicable.
	Change in contaminant concentrations	- not applicable.	- not applicable.
	Change in sediment concentrations	- not applicable.	- not applicable.
	See industrial equipment pathway		
Wastewater management		- not applicable.	- not applicable.
Addition or removal of aquatic vegetation	Change in food supply	- may have a simple to complex community of hydrophilic and aquatic plants at some locations. - watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - *Insignificant.*	- may have a simple to complex community of hydrophilic and aquatic plants at some locations. - watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - *Insignificant.*
	Change in habitat structure and cover.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - *Insignificant.*	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - *Insignificant.*
	Change in sediment concentration	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - sediment control plan. - *Insignificant*.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - sediment control plan. - *Insignificant*.
	Change in nutrient concentrations	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - sediment control plan. - *Insignificant*.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - sediment control plan. - *Insignificant*.
	Change in contaminant concentrations	- not applicable.	- not applicable.

Table 5.7.6: Pathways of Effects, in-Water Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in water temperature	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - effect of aquatic and hydrophilic vegetation on temperature is minor. - *Insignificant.*	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - effect of aquatic and hydrophilic vegetation on temperature is minor. - *Insignificant.*
	Change in dissolved oxygen	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - *Insignificant*.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at appropriate locations, so disturbance of aquatic vegetation will not occur or will be minor. - *Insignificant*.
[1]Flow Management (altered frequency, amplitude, duration, timing and rate of change of flow)	Change in bioenergetics	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential positive impact*.	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential positive impact*.
	Change in habitat structure and cover	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential positive impact*.	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential positive impact*.
	Change in food supply	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential positive impact*.	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential positive impact*.
	Change in contaminant concentrations	- not applicable.	- not applicable.
	Change in sediment concentrations	- not applicable.	- not applicable.
	Change in total gas pressure	- not applicable.	- not applicable.
	Change in migration/access to habitats	- no anticipated significant alterations to flow, except potential for increased baseflow which may improve access. - *Potential positive impact*.	- no anticipated significant alterations to flow, except potential for increased baseflow which may improve access. - *Potential positive impact*.
	Displacement or stranding of fish	- not applicable.	- not applicable.
	Change in water temperature	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential, but likely insignificant decrease in water temperature.*	- no anticipated significant alterations to flow, except potential for increased baseflow. - *Potential, but likely insignificant decrease in water temperature.*
	Change in nutrient concentrations	- not applicable.	- not applicable.

Table 5.7.6: Pathways of Effects, in-Water Activities			
	Watercourse reaches	Permanent habitat, Protection 2. BP-4-C	Permanent habitat, Protection 1. 2-II
	Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. Realignment is not currently recommended, to avoid a *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Pathway of Effect	**Effects**	**Habitat considerations, Mitigation, and *Residual Effects***	**Habitat considerations, Mitigation, and *Residual Effects***
	Change in salinity	- not applicable.	- not applicable.
	See fish passage pathway		
Fish passage issues	Incidental entrainment, impingement or mortality of resident species	- not applicable.	- not applicable.
	Change in access to habitats.	- transportation or other infrastructure crossings will be designed to not create barriers to fish migration. - *None*.	- not applicable.
	Changes in total gas pressure	- not applicable.	- not applicable.
	Changes in thermal clues or temperature barriers	- not applicable.	- not applicable.
	Changes in salinity	- not applicable.	- not applicable.
	Interbasin transfer of species.	- not applicable.	- not applicable.
Structure removal	Change in food supply.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations where appropriate, so removal of structure will be none or minor, and the effect will be temporary. - *Insignificant.*	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations where appropriate, so removal of structure will be none or minor, and the effect will be temporary. - *Insignificant.*
	Change in habitat structure and cover.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations where appropriate, so removal of structure will be none or minor, and the effect will be temporary. - *Insignificant.*	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations where appropriate, so removal of structure will be none or minor, and the effect will be temporary. - *Insignificant.*
	Change in sediment concentrations.	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations where appropriate, so removal of structure will be none or minor, and the effect will be temporary. - sediment control plan. - *Insignificant.*	- watercourse will stay in current location and form, but may be enhanced/restored using natural channel design principles at discrete locations where appropriate, so removal of structure will be none or minor, and the effect will be temporary. - sediment control plan. - *Insignificant.*
	Change in contaminant concentrations.	- not applicable.	- not applicable.
	See flow management pathway		
	See fish passage pathway		

[1]Modified from "Change in timing duration and frequency of flow" according to Clarke *et al* (2008).

Risk Assessment

The Risk Assessment phase focuses on categorizing the level of risk of the residual effects, as determined by the PoE analysis. In this case the residual effects range from insignificant or absent, through to moderate, as indicated in Tables 55.7.1 to 5.7.6.

The attributes typically considered in evaluating the scale or magnitude of residual effects are:

- *Geographic extent* - The geographical extent of the proposed works varies between watercourse classifications. At one extreme, some watercourses will be completely reconstructed along their entire length, while at the other extreme the watercourse will be completely protected in its same form and location.

- *Duration* – For the watercourses that will be eliminated or relocated, this will be a permanent condition. For those watercourses being impacted by certain activities but retained in place, the duration of impact upon habitat will range from very short to moderate, depending upon the rate of regeneration and naturalization.

- *Intensity (degree of change in habitat)* - The degree of habitat change varies between watercourses. Watercourses presently having high-quality habitat will be protected in place, while those with increasingly poorer-quality habitats may be subjected to a commensurate degree of relocation, enhancement, and reconstruction, using natural channel design principles.

The attributes typically considered in evaluating the sensitivity of fish and fish habitats are:

- *Species sensitivity* - As expected, the sensitivity of fish species present in this area are appropriate to the watercourse classification and habitat quality in which they are found. There are no highly sensitive species within any of the affected watercourses, other than the Main Branch of Sixteen Mile Creek, which is classed as permanent, Protection 1.

- *Species dependence on habitat* – None of the fish species present within the watercourses being impacted (watercourses other than Reaches 2-II and BP-4-C) require unique or rare habitats for any specific life history function.

- *Rarity* – None of the habitats within this area are rare. None of the fish species within the affected habitats are rare or considered at-risk, however, the silver shiner (*Notropis photogenis*) occurs more than 3.5 km downstream of the watercourses from the east portion of the Boyne Survey area, within the East Branch of Sixteen Mile Creek. The silver shiner is listed in Schedule 3 of the Federal Species At Risk Act, and as Special Concern in the Ontario Endangered Species Act.

- *Habitat resiliency* – All aquatic habitats in the Boyne Survey area can recover easily from any construction related impact, except for the Main Branch of Sixteen Mile Creek.

The evaluation of these attributes for the watercourse reaches of the Boyne Survey Secondary Plan Area are provided in Tables 5.7.7, 5.7.8, and 5.7.9. To assess risk the Scale of Negative Effects and the Sensitivity of Fish and Fish Habitat are determined for these residual effects, for the vertical and horizontal axes, respectively, in Figure 5.1.

Table 5.7.7: Risk Assessment.			
Watercourse reaches	Not fish habitat. Ellipse A in Figure 5.1. I-NE-2A-5, I-NE-2A-6, I-NE-2A-7, SWS-4-A, SWS-1-A-2, SWS-1-B, SWS-3-A, SWS-2-B, upstream portion of SWS-2-C, SWS-5-B, SE-2-A, SE-2-B, SE-2-D-2, SE-3-B-1, SE-4-A, SE-3-A, SE-3-C, upstream portion of SE-5-A.	Not fish habitat. Ellipse B in Figure 5.1. I-NE-2A-4, I-NE-1B-2	Simple contributing habitat. Ellipse C in Figure 5.1. SWS-2-A-1, I-NE-2A-2, downstream portion of SWS-2-C, SE-2-D-1
Potential treatment	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.	Watercourse to remain open. Realignment may be acceptable.	Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Scale of Negative Effects			
Geographic extent	- broad extent, in that entire reaches affected.	- broad extent, in that entire reaches affected.	- broad extent, in that entire reaches affected.
Duration	- no duration if retained in place. - if retained as open but relocated, or if not retained as open, the resulting change will be permanent.	- no duration if retained in place. - if retained as open but relocated, the resulting change will be permanent.	- no duration if retained in place. - if retained as open but relocated, or if not retained as open, the resulting change will be permanent.
Intensity (degree of change in habitat)	- if retained in place, the change in habitat will be minor. - if retained as open, but relocated, the change in habitat will be major. - if not retained as open, the change in habitat will be major. - overall drainage density will be maintained and would provide similar ecological function.	- if retained in place, the change in habitat will be minor. - if relocated, the change in habitat will be major. - ecological function will be maintained.	- if retained in place, the change in habitat will be minor. - if retained as open, but relocated, habitat change will be major. - if not retained as open, the change in habitat will be major. - overall drainage density will be maintained and would provide similar ecological function.
Sensitivity of Fish and Fish Habitat			
Species sensitivity	- no fish.	- no fish.	- no fish.
Species dependence on habitat	- not fish habitat - no fish	- not fish habitat - no fish	- no fish.
Rarity	- habitat is common with a simple functional relationship to downstream habitats	- habitat is common with a simple functional relationship to downstream habitats	- habitat is common with a simple functional relationship to downstream habitats
Habitat resiliency	- highly resilient to impacts. - will largely retain its functional relationship to downstream habitats, regardless of whether watercourse is retained as open or not. - drainage density targets will be met, ensuring that an appropriate length of open channel, providing the same ecological function, will continue within the landscape.	- highly resilient to impacts. - will retain its functional relationship to downstream habitats.	- highly resilient to impacts. - will largely retain its functional relationship to downstream habitats, regardless of whether watercourse is retained as open or not. - drainage density targets will be met, ensuring that an appropriate length of open channel, providing the same ecological function, will continue within the landscape.

Note: The Risk Assessment phase focuses on categorizing the level of risk of the residual effects, as determined by the PoE analysis undertaken in Tables 5.7.1 and 5.7.4. The Scale of Negative Effects and the Sensitivity of Fish and Fish Habitat are determined for these residual effects, for the vertical and horizontal axes, respectively, in Figure 5.1.

Table 5.7.8: Risk Assessment			
Watercourse reaches	Simple contributing habitat. Ellipse D in Figure 5.1. I-NE-2A-3, I-NE-2A-1	Complex contributing habitat. Ellipse E in Figure 5.1. upstream portion of I-NE-2A, SWS-5-A, downstream portion of SE-5-A, SE-3-G	Seasonal habitat. Ellipse F in Figure 5.1. downstream portion of I-NE-2A, I-NE-1B-1, SWS-1-A, SWS-2-A, SE-3-B
Potential treatment	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.	Watercourse to remain open. Realignment may be acceptable.
Scale of Negative Effects			
Geographic extent	- broad extent, in that entire reaches affected.	- broad extent, in that entire reaches affected.	- broad extent, in that entire reaches affected.
Duration	- no duration if retained in place. - if relocated, the resulting change will be permanent.	- no duration if retained in place. - if relocated, the resulting change will be permanent.	- no duration if retained in place. - if relocated, the resulting change will be permanent.
Intensity (degree of change in habitat)	- if retained in place, the change in habitat will be minor. - if relocated, the change in habitat will be major. - ecological function will be maintained.	- if retained in place, the change in habitat will be minor. - if relocated, the change in habitat will be major. - watercourses will be retained with required setbacks within a riparian corridor. - ecological function will be maintained.	- if retained in place, the change in habitat will be minor. - if relocated, the change in habitat will be major. - watercourses will be retained with required setbacks within a riparian corridor. - ecological function will be maintained.
Sensitivity of Fish and Fish Habitat			
Species sensitivity	- no fish.	- no fish.	- simple fish community at isolated locations representing a small proportion of watercourse during dry periods.
Species dependence on habitat	- no fish.	- no fish.	- common, resilient species.
Rarity	- habitat is common with a simple functional relationship to downstream habitats	- habitat is common with a simple functional relationship to downstream habitats	- generally common habitats with a simple functional relationship to downstream habitats. - some habitats of limited extent may exist that provide spawning locations for migratory fishes.
Habitat resiliency	- highly resilient to impacts. - its functional relationship to downstream habitats will be retained.	- highly resilient to impacts. - its functional relationship to downstream habitats will be retained.	- common habitats are highly resilient to impacts. - habitats of limited extent that provide spawning locations for migratory fishes may be less resilient to impacts.

Note: The Risk Assessment phase focuses on categorizing the level of risk of the residual effects, as determined by the PoE analysis undertaken in Tables 5.7.2 and 5.7.5. The Scale of Negative Effects and the Sensitivity of Fish and Fish Habitat are determined for these residual effects, for the vertical and horizontal axes, respectively, in Figure 5.1.

Table 5.7.9: Risk Assessment		
Watercourse reaches	Permanent habitat, Protection 2. Ellipse G in Figure 5.1. BP-4-C	Permanent habitat, Protection 1. Ellipse H in Figure 5.1. 2-II
Potential treatment	Watercourse to remain open. Realignment may be acceptable if present condition is degraded and no significant hydrogeologic features are present. However, it is recommended that this watercourse be treated as Permanent habitat, Protection 1, and be protected/enhanced in current form and location to avoid a potential *Fisheries Act* Authorization.	Watercourse to be protected/enhanced in current form and location.
Scale of Negative Effects		
Geographic extent	- watercourse will be retained in same location and form. No extent.	- watercourse will be retained in same location and form. No extent.
Duration	- no duration if protected in place.	- no duration if protected in place.
Intensity (degree of change in habitat)	- watercourses will be retained with required setbacks within a riparian corridor.	- watercourses will be retained with required setbacks within a riparian corridor.
Sensitivity of Fish and Fish Habitat		
Species sensitivity	- simple to moderately complex fish communities.	- moderately complex to complex fish communities.
Species dependence on habitat	- generally common, resilient species.	- generally common, resilient species, but there may be some sensitive species.
Rarity	- generally common habitats with a functional relationship to downstream habitats. - some habitats of limited extent may exist that provide spawning locations for migratory fishes.	- generally common but good quality habitats with a functional relationship to downstream habitats. - some habitats of limited extent may exist that provide spawning locations for migratory fishes.
Habitat resiliency	- common habitats are resilient to impacts. - habitats of limited extent that provide spawning locations for migratory fishes may be less resilient to impacts.	- common habitats are moderately resilient to impacts. - habitats of limited extent that provide spawning locations for migratory fishes may be less resilient to impacts.

Note: The Risk Assessment phase focuses on categorizing the level of risk of the residual effects, as determined by the PoE analysis undertaken in Tables 5.7.3 and 5.7.6. The Scale of Negative Effects and the Sensitivity of Fish and Fish Habitat are determined for these residual effects, for the vertical and horizontal axes, respectively, in Figure 5.1.

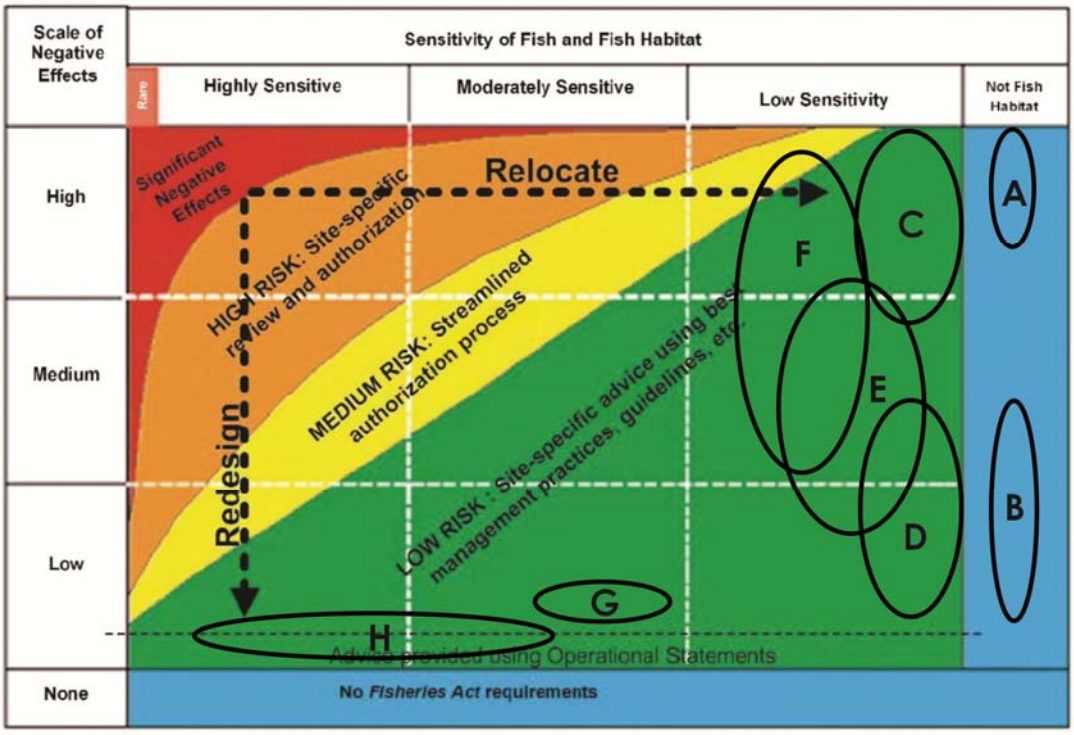

Figure 5.1: DFO Risk Management Framework. Each ellipse illustrates the risk assessment for a combination of habitat type and proposed treatment of habitat. The shape of each ellipse signifies the degree of uncertainty involved, and/or the breadth of habitat quality being considered.

The positions of the ellipses in Figure 5.1 are logical. Ellipse A and Ellipse B represent watercourses that are not fish habitat, and are therefore located on the far right side of the chart. Ellipse A habitats may be eliminated and their function replicated through the use of rear-lot swales, etc., as determined by the "drainage density" calculations. Therefore, Ellipse A is designated as High on the Scale of Negative Effects, while Ellipse B, which are retained habitats, is designated Low/Medium on the Scale of Negative Effects.

Ellipses C and D represent the simplest of contributing fish habitats, which are of very low sensitivity, and which primarily function to provide ephemeral flow, nutrients, and organic matter to downstream habitats. Ellipse C are those simple contributing habitats that may be eliminated and their function replicated through the use of rear-lot swales, etc., as determined by the "drainage density" calculations, and so, before compensation measures are taken into account, impacts to these watercourses are considered High on the Scale of Negative Effects. Ellipse D are those simple contributing habitats that may be moved but retained open, thereby preserving most of their ecological function, and so, before compensation measures are taken into account, impacts to these watercourses are considered Low to Medium on the Scale of Negative Effects.

Ellipse E represents somewhat more complex contributing habitats, due to ephemeral/ intermittent flow that results in some aquatic habitats which persist long enough to maintain hydrophilic vegetation and potentially some hydrophilic/aquatic invertebrates. These watercourses are considered Low with regard to the Sensitivity of Fish and Fish Habitat, and

much of their ecological function, which primarily is to provide ephemeral flow, nutrients, and organic matter to downstream habitats, is preserved if these watercourses are moved but retained open. Therefore, before compensation measures are taken into account, impacts to the Ellipse E watercourses are considered Low to High on the Scale of Negative Effects.

Ellipse F represents seasonal habitats, that due to their intermittent flows, generally simple habitat features, a simple fish community that persists in low numbers in isolated locations, and the apparent lack of migratory fishes that enter these watercourses to spawn, are considered Low with regard to Sensitivity of Fish and Fish Habitat. Therefore, though the Ellipse F watercourses provide direct fish habitat, a significant portion of their ecological function is the provision of intermittent flow, nutrients, organic matter, and food to downstream habitats, which remains the case if these watercourses are relocated. Based upon these considerations, and before compensation measures are taken into account, impacts to the Ellipse F watercourses are considered Medium to High on the Scale of Negative Effects.

Ellipse G represents potentially complex and moderately sensitive habitats that have been degraded by historical land use, and which may be relocated wherever rehabilitation is appropriate. However, at present, the one watercourse (Reach BP-4-C) that falls into this category has been evaluated as being protected in its current form and location to avoid triggering a *Fisheries Act* Authorization. Given the changes to the *Fisheries Act* that were scheduled to take effect January 1, 2013, future discussions with the Department of Fisheries and Oceans may indeed indicate that this watercourse may be realigned and rehabilitated without constituting a HADD and triggering a *Fisheries Act* Authorization. Considering the above, Ellipse G has a very narrow range of Low Negative Effects.

Ellipse H are high quality diverse habitats with a range of habitat sensitivities, but which are being protected in their current form and location. Therefore, these have a very narrow range of Low Negative Effects.

When these results are considered within the Department of Fisheries and Oceans (DFO) Risk Management Framework (DFO, 2006), it is clear that the proposed works should be characterized primarily as Low Risk (Figure 5.1), and can be dealt with through advice with respect to best management practices and guidelines. Through the mitigation and enhancement works discussed throughout this report, such as the use of natural channel design, the rehabilitation of historically degraded watercourse sections, and the establishment of naturally vegetated riparian corridors, the risks associated with the proposed works are further reduced.

6. MONITORING OF NET IMPACTS ON FISH AND FISH HABITAT

The Environmental Monitoring Plan for the Town of Milton Phase 3 urban expansion area, known as the Boyne Survey area, will be comprised of two parts: a holistic monitoring plan that involves parts of the Sixteen Mile Creek Area 2 and Area 7, and Indian Creek subwatersheds, and local monitoring plans that would cover each of the individual Subwatershed Impact Study (SIS) areas (ref FSEMS Report, Appendix M).

The Holistic Program is intended to assess the overall impacts of development/urbanization of the entire Boyne Survey area on the subject and surrounding watersheds. The Holistic Program is structured so as to monitor on a subwatershed basis, covering the broader area surrounding the proposed development. The program will use several environmental parameters as tools for detecting temporal and spatial changes to the ecosystem.

The SIS or Local Program focuses on the site specific monitoring of the impacts of development/urbanization on local resources. As part of the FSEMS, the Boyne Survey lands have been divided into seven logical units, using topography, drainage areas, watercourses and natural resource features as the basis for the division. All of the local plans will fit within the bounds of the Holistic Program, and once completed, are proposed to provide a composite "picture" of the impacts of the development.

The Terms of Reference for the Local monitoring program are provided in the FSEMS for the Boyne Survey Area and are to be further refined as part of the requirements of the Subwatershed Impact Studies. The proponents of each individual SIS will be responsible for developing a local monitoring plan to the satisfaction of the Town and Agencies.

It is proposed that the Team engaged to complete the Boyne Environmental Monitoring Plan will be responsible for both the Holistic Program and the individual locally-based SIS monitoring activities. The purpose of this approach is to ensure consistent, streamlined interpretation of all information.

6.1 Need and Justification

Environmental compliance monitoring is required as outlined in the Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study Technical Appendix: Functional Stormwater and Environmental Management Strategy, Boyne Survey Secondary Planning Area (AMEC, 2013). This report describes the criteria which must be used in addressing stormwater and environmental management issues in support of the Boyne Survey Secondary Planning Area.

The monitoring plan is a combined requirement of both the Federal (Canadian Environmental Assessment Act) and the Provincial (Class Environmental Assessment process) regulatory agencies. The monitoring program needs to commence immediately, in advance of the start of the Boyne Survey construction.

It will be a condition of any Fisheries Act Authorization that any compensation works be monitored in order to verify their predicted performance detailed in the CFCP.

A schematic representation of the foregoing process is outlined in the following flow chart.

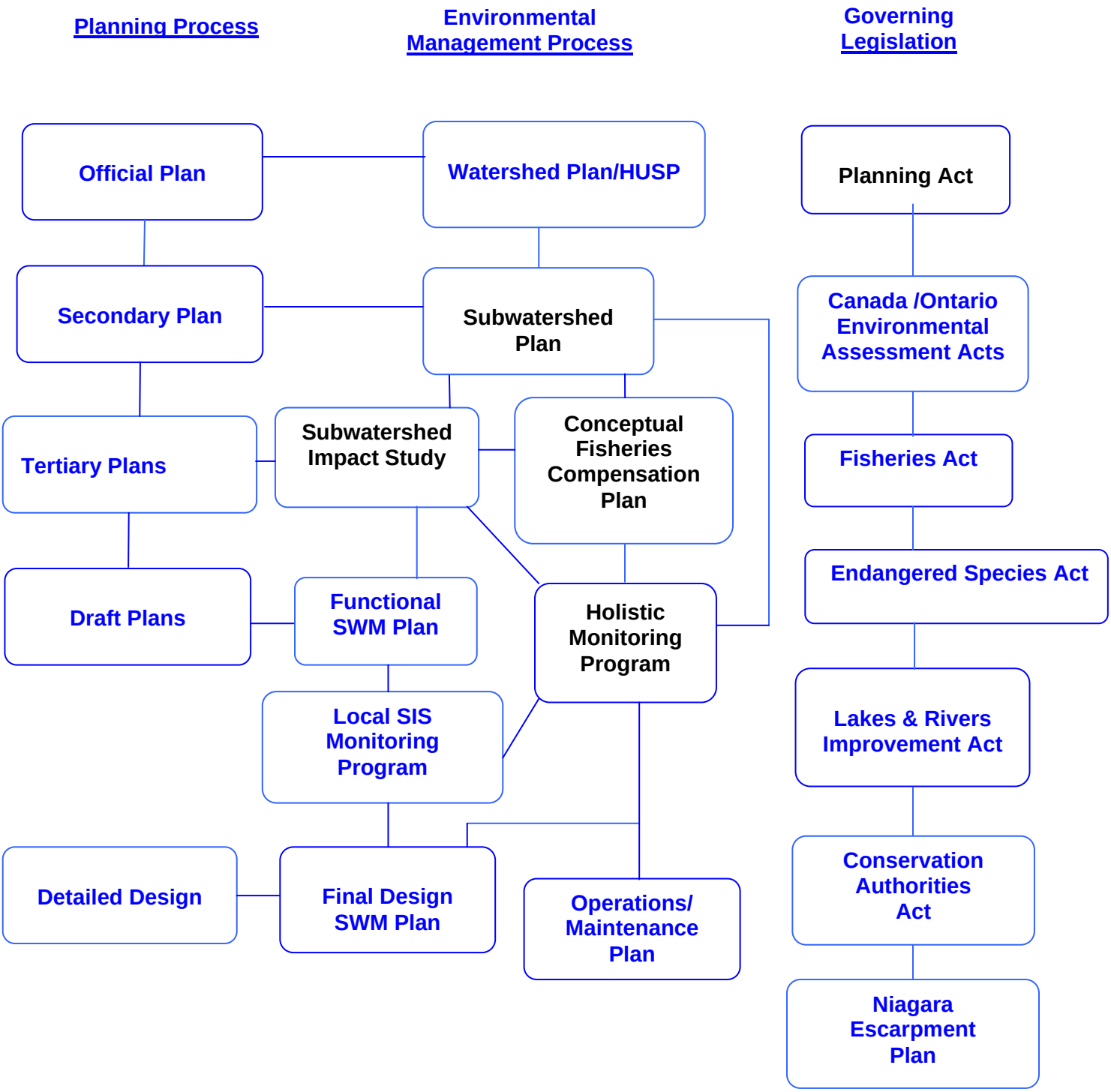

Figure 6.1: Integrated Watershed Management and Land Use Planning Process

6.2 Purpose

The purpose of the Environmental Monitoring Plan Holistic Program plus local SIS plans is to:

1. Evaluate the performance of the Stormwater and Environmental Management System (i.e. design and mitigation techniques).

2. Provide the necessary information to adjust and/or optimize the plan recommendations through a process of Adaptive Management.

It is not the purpose of the holistic plan/program to monitor an isolated stormwater management facility or isolated creek realignment (this would be covered by SIS monitoring), rather it is the intent to identify the impact associated with converting the Boyne Survey lands from rural to urban uses.

6.3 Background Information

Clearly, there is considerable background information which should be reviewed prior to the submission of a proposal. All of the following documents are available at the Town of Milton and can be reviewed at the Town or purchased:

1. Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study Technical Appendix: Functional Stormwater Environmental Management Strategy for the Boyne Survey Secondary Plan Area, AMEC, 2013.

2. Sixteen Mile Creek Areas 2 and 7, Subwatershed Update Study, AMEC, 2013.

3. Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (Philips Engineering Ltd., December 2004).

4. Sixteen Mile Creek Subwatershed Planning Study, Areas 2 and 7, Philips Planning and Engineering Ltd., 2000.

5. Sixteen Mile Creek Watershed Study, Gore and Storrie Ltd. and Ecoplans, 1996.

6.4 Holistic Monitoring Program Duration

In general, monitoring of the impacts associated with the development of the Boyne Survey area is proposed to continue until at least 80% of the area has been constructed. Given that this timeframe will be market driven, it is not fixed at this time.

The total duration of the monitoring program has been proposed to be a minimum of 10 years or 80% build-out, whichever is greater. The frequency of monitoring will vary depending on the component being monitored. The monitoring protocols and methods are discussed in Section 6.5.

The following table presents a draft framework for the different frequencies and durations of monitoring:

Table 6.4.1: Monitoring Framework

Component	Frequency	Monitoring Year	Minimum Duration
Streamflow	Continuous: April 1 – November 30	All	10 Years / 80 %
Rainfall	Continuous: April 1 – November 30	All	10 Years / 80 %
Temperature	Continuous: April 1 – November 30	All	10 Years / 80 %
Erosion / Stream Morphology	Annual	All	10 Years / 80 %
Benthics	Annual	All	10 Years / 80 %
Groundwater	Year One, then Bi-Annually	1,3,5,7,9	10 Years / 80 %
Vegetation	One session per year	1, 5, 10	10 Years / 80 %
Breeding Birds	At least two Sessions per year as per Breeding Bird Atlas, Forest Bird Monitoring Program, and Marsh Monitoring Protocol	1, 2, 5, 8, 10	10 Years / 80 %
Amphibians	Three sessions per year as per Marsh Monitoring Protocol	1, 2, 5, 8, 10	10 Years / 80 %
Fisheries Community	Spring/Fall	1, 3, 5,7, 9	10 Years / 80 %
Ecological Land Classification	Year One, then every 5 Years	1, 5, 10	10 Years / 80 %

6.5 Environmental Monitoring Program: Holistic Program

It should be noted that the following requirements should be considered a minimum; if any team wishes to propose alternate methods, techniques, approaches etc., as a minimum the following data must be collected. The merits/benefits of any additional data collection should be highlighted in the proposal.

6.5.1 Hydrometeorologic

Rainfall

Purpose

Rainfall drives all hydro-meteorological processes. As such, it is important to have a good understanding of the amount and temporal distribution of rainfall, in order to be able to assess all environmental processes.

Methodology

Recognizing the spatial and temporal distribution of rainfall during a single event, the rainfall gauge should be located within or in close proximity to the Boyne Survey Secondary Planning Area. The rainfall gauge must be designed, installed and monitored in accordance with recognized standards such as the Meteorological Services Canada national standards. The period of monitoring will be analogous to the streamflow monitoring (April through November). Downloading of data and processing is to occur on a 3 to 4 week interval, plus following major events. Additional rainfall data is to be obtained from AES, Conservation Halton and the Region, in order to validate/support local data collection efforts. The data is required to be collected in a minimum of 5 minute increments and be processed into a digital ASCII format.

The data will be combined and cross-referenced with an additional three continuous rainfall gauges, operated by Conservation Halton at the Hilton Falls Reservoir, Scotch Block Reservoir, and Hornby.

Stream Flow

Purpose

Managing flows is a key aspect of the Boyne Survey development, and monitoring the effectiveness of the measures which are implemented, is an important element of the plan. The effectiveness of the measures predicted to prolong flow is of particular interest from a fisheries perspective.

Methodology

Continuous flow monitoring on the five main tributaries within the Boyne Survey area, as well as along the Sixteen Mile Creek Centre Tributary and downstream of reach SE-2-D-1 in a manner that permits even small volumes to be detected, is proposed to be implemented in order to describe, as accurately as possible, the changes which occur following development.

The streamflow gauges must be installed, and the flow and water level measurements carried out, in accordance with recognized standards such as Water Survey Canada national standards (e.g. Environment Canada – Hydrometric Field Manual: Measurement of Streamflow, Measurement of Stage, etc. – contact: Robert Halt (613) 992-4015). For stream flow monitoring a continuous streamflow gauge and possibly a temporary small weir, subject to meeting fisheries passage criteria, will be required to assist in low flow measurement. All gauges will be operable from April, subject to meeting fisheries passage criteria through November 30; it is important to ensure no impacts on the riparian area, sediment transport and water quality. A field verified rating curve is to be established in a location intended to remain relatively stable and unaltered during the monitoring period.

Groundwater

Purpose

The groundwater monitoring program has been proposed to consider the potential impacts from a reduction in groundwater recharge and the potential for degraded stormwater infiltrating into the groundwater system. Water level trends correlated to rainfall are necessary to assess changes to the recharge resulting from development. Water quality trends relating to non-attenuated stormwater quality parameters such as road salt should be assessed.

Methodology

As major developments proceed or through the SIS studies, shallow piezometers would normally be installed to confirm the water table. A number of piezometers should remain in each major development area. These piezometers should be cased and locked for security. Water levels and water chemistry should be monitored at least on a five year schedule. The

actual schedule is dependent to a large degree on the pace of development. Chemical analysis should include inorganic parameters, nitrogen species, and metals. Water level trends correlated to rainfall are necessary to assess changes on the recharge resulting from development.

6.5.2 Fluvial Geomorphology Monitoring

Purpose

To measure and monitor the form and function of Sixteen Mile Creek, Indian Creek and their tributaries at previously established geomorphological field sites.

Methodology

Six geomorphological detailed field investigation sites have already been established at sites relevant to Boyne Survey lands (ref. Figure 6.1, Table 6.5.1). These sites are currently being monitoring as part of the Phase 2 Monitoring Program therefore existing monitoring data is available.

Table6.5.1: Established Monitoring Sites relevant to Boyne Survey Lands

Site	Established (Re-established)	Monitoring Data Available
SM4	1998 (Oct 24, 2008)	Oct 24, 2008, Dec 8, 2009, Oct 15 2010
R2-II	July 25, 2007	July 25, 2007, Oct 15 2010
SM5	1998 (Oct 24, 2008)	Oct 24, 2008, Dec 8, 2009, Oct 18, 2010
SWS-1-A-1	Dec 19, 2007	Dec 19, 2007, June 18-08, July 21-08, Oct 9-08, Dec 14-09
SWS-2-A-1*	Dec 20, 2007	Dec 20, 2007, June 18, 08, July 21-08, Oct 9-08, Dec 14-09, Oct 22, 2010
7-1X	Dec 6, 2007	Dec 6, 2007, June 18-08, July 21-08, Oct 9-08, Dec 14-09

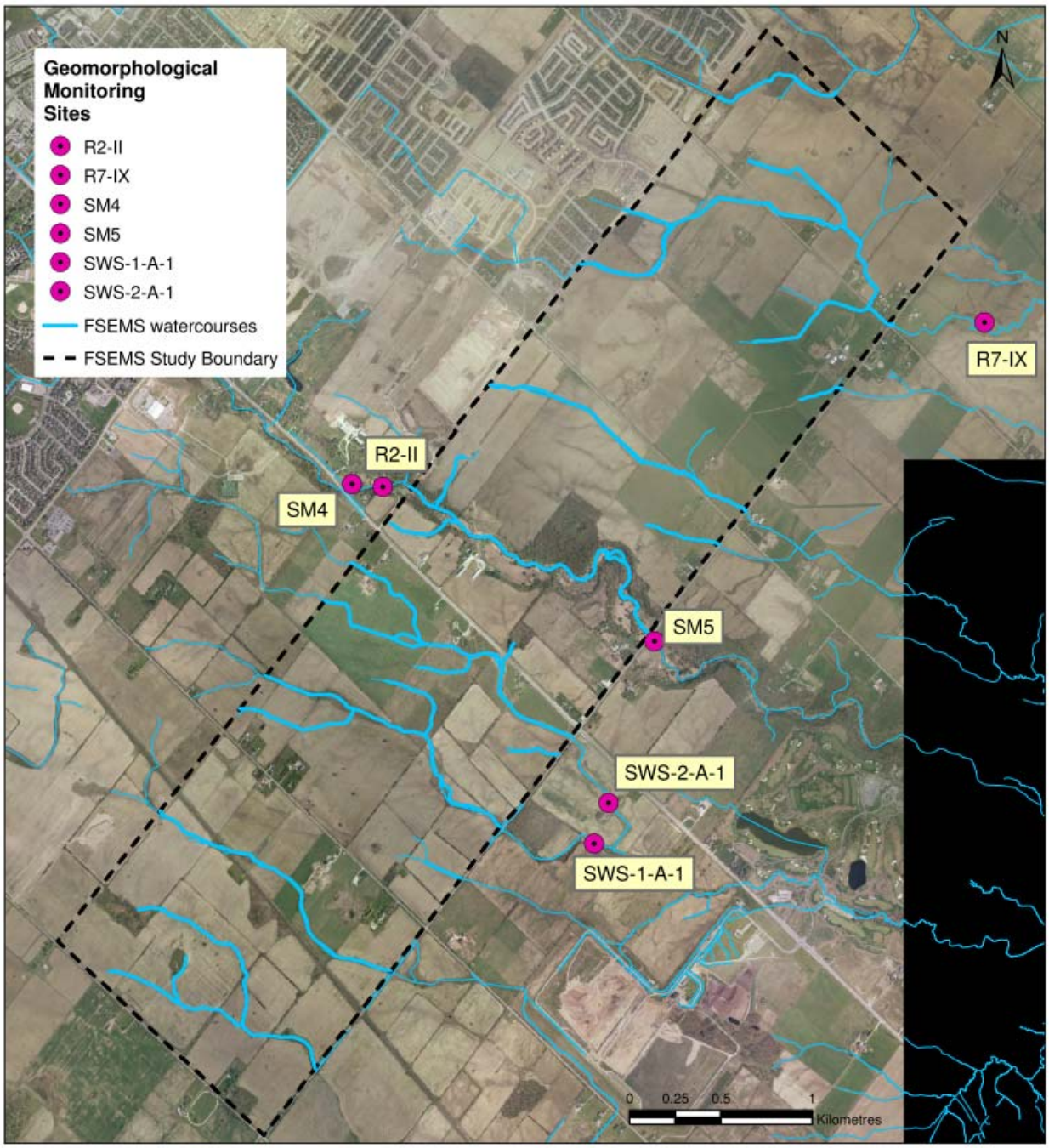

Figure 6.1: Location of Established Geomorphological Monitoring Sites

Monitoring of channel form and function in the study area will be repeated at each of these field sites. Measurements will include:

- Cross-section profile,
- Bed substrate characterization (min. 40 pebbles using Wolman's 1954 method),
- Bank characterization (e.g., height, angle, materials, rooting depth).
- Detailed longitudinal bed morphology survey to plot the top, crest, and toe of each riffle and the maximum depth of each pool. (Chainage will follow that used in previous

geomorphologic work where appropriate to allow for overlay of the bed profiles obtained from previous surveys).

- Photographs from fixed vantages to document channel change in the reach through time.

While erosion pins were initially established in 2004 by Trent University, it was not possible to relocate these pins, therefore there is no existing monitoring data. It is proposed that erosion pins be established at appropriate sites as part of the local monitoring protocol (see Section 8.5). Erosion pins were installed at sites SM4, SM5, 2-II and SWS-2-A in 2010 (five pins per site) as part of the Phase 2 monitoring program.

6.5.3 Water Quality

Benthic Invertebrates

Purpose

The purpose of the benthic invertebrate monitoring is to determine if the change in land use has affected aquatic ecosystems in the ultimate receiving watercourses, which is the Main Branch of Sixteen Mile Creek, the East Branch of Sixteen Mile Creek, and the main branch of Indian Creek. The biological communities could be affected if the quality or temperature of the treated storm water differs from that in the receiving waters. If no effects or positive effects are observed, this will indicate that the stormwater management strategies employed have been successful in mitigating any potential impacts.

The purpose of the benthic invertebrate monitoring is to determine if the treated stormwater is affecting water quality in a manner that alters benthic invertebrate abundance or species composition. Sampling must be initiated prior to development to determine baseline conditions. If systems are currently degraded, then it will be important to determine whether or not this existing condition changes with urbanization.

Methodology

Benthic invertebrate samples are to be collected in the spring and fall from habitats that are exposed to the water that runs off developed Boyne Survey lands and from reference habitats upstream of the confluence. The exposed and reference habitats will be as similar as possible in all other respects. Samples are to be collected using a technique that allows both abundance and community composition to be quantified. At a minimum, two benthic invertebrate samples are to be collected from each of five sites. Water velocity and substrate particle size distribution will be determined at each sampling location. The Ontario Benthic Biomonitoring Network Protocol (OBBN), MOE, EMAN, Environment Canada, will be followed.

Benthic invertebrates are to be identified to the lowest feasible taxonomic level by a qualified benthic taxonomist. All of the organisms in a sample should be identified unless the numbers are too high to make this practical. In that case, quantitative sub-sampling may be used, provided that a minimum of 25% of the sample is identified.

Reporting will include the raw data and, at a minimum, calculations of taxonomic richness, diversity, the Hilsenhoff Biotic Index, and other indices as appropriate.

Water Temperature

Purpose

Appropriate water temperature is critical for the survival of aquatic organisms. High water temperatures, which could result from latent heating of stormwater (either due to urbanization or retention in surface water ponds), can adversely affect the health and survival of fish and other aquatic organisms, particularly in cold water streams.

Methodology

Continuous temperature measurements are proposed to be taken at five water quality sampling locations. The probes shall be installed in the general vicinity of the continuous streamflow gauges.

Water Chemistry

Purpose

Water chemistry provides an indicator of the influence of urban development and stormwater management practices with respect to the viability of the aquatic system.

Methodology

Surface water chemistry would be monitored by obtaining grab samples at strategic locations within the Boyne Survey area in order to obtain instream water chemistry data. This sampling will be conducted separately from the streamflow and rainfall monitoring. The sites would be sampled during three wet weather events and three dry weather events for each year of the monitoring program. Ideally, the three sample dates would be one in May, one in August, and a third date to be added after a rainfall event having over 15 mm of precipitation (wet weather), however this would be contingent upon the precipitation patterns and frequency during the monitoring years.

6.5.4 Natural Heritage System

Purpose

Monitoring of the Natural Heritage System (NHS) at the subwatershed and SIS level shall ensure that basic measures of system integrity are assessed at regular intervals, using recognized standard methodologies capable of detecting integrity factors, and reported in a format consistent with ongoing implementation of the Subwatershed Planning Study.

Methodology

The monitoring program has been developed to detect temporal and spatial changes in the NHS at the both the subwatershed and SIS site scales. Monitoring at the subwatershed scale will consist of tracking changes in land cover and collecting vegetation and wildlife data from a network of permanent sample plots over a period of 10 years, depending on focus (ref. Table 6.4.1). Monitoring at the SIS scale will consist of documenting land cover changes and site-specific impacts at the natural-urban interface prior to development, immediately post development, and at five year intervals up to 10 years following development.

Ecological Land Classification

Aerial photo interpretation and field verification will be used to map and classify all components of the NHS (i.e., core areas, linkages, buffers and enhancement areas) to the level of Vegetation Type in accordance with Ecological Land Classification System for Southern Ontario (Lee et al., 1998). This will ensure that the Town has current mapping and description of its natural heritage resources. This information will be collected for the entire subwatershed and will facilitate detection of changes in the type and extent of cover over time.

Biological Diversity

Prior to development, a network of permanent vegetation and wildlife monitoring stations will be identified across the subwatershed including the respective SIS areas. Monitoring plot locations should be established within the NHS components so as to capture representative vegetation types and habitats. Permanent (10 m x 10 m) vegetation monitoring plots should be installed and sampled according to the methods outlined in Chambers and Lee (1992).

Wildlife monitoring will focus on changes in species diversity and abundance. Point counts are to be used based on the Marsh Monitoring Program, which monitors marsh birds and amphibians. Breeding bird studies shall be conducted in the vicinity of each community within the seasonal window for breeding as identified in the Ontario Breeding Bird Atlas (Cadman et. al., 2007). Changes in avifaunal composition and abundance will be monitored using Forest Bird Monitoring Program according to protocols (FBMP 2002). Changes in amphibian composition and abundance will be monitored according to the Marsh Monitoring Program (LPBO & Environment Can. 2009).

This information will facilitate the detection of changes in biological diversity at the subwatershed and SIS level.

6.5.5 Fisheries

Purpose

The purpose of the instream fish habitat and community monitoring is to determine if potential changes to water quality and quantity within the development areas, as a result of development, have resulted in changes to the fish community and fish habitat quantity and quality.

Methodology

The approach involves comparisons, over time, of the fish community and associated habitat at a permanent monitoring station within each SIS area. Sampling should be undertaken using the Ontario Stream Assessment Protocols (OSAP), and the most current methodology utilized by Conservation Halton.

Additional habitat monitoring at a minimum of one location in each surface watercourse will primarily consist of annual photographs (upstream and downstream) and flow characterization (i.e. permanent, intermittent, ephemeral), to provide a description of overall habitat change (quantity and quality) over time. The locations of all photographs and observations will be recorded using UTM coordinates (NAD83).

For each SIS area it is preferable that at least one monitoring period be completed prior to development, and then continue post-development for 10 years or 80 % build-out, whichever is greater. In order to carry out this work, it will be necessary to acquire a License to Collect Fish for Scientific Purposes from the Ministry of Natural Resources and to comply with all of the conditions of that permit, including the reporting requirements.

No specific monitoring plan will be used for the Holistic Monitoring program. This field monitoring program will occur in each SIS area as part of the Local Monitoring program, with the resulting information from all SIS areas compiled into a single Holistic Monitoring report.

6.6 Local Monitoring Programs

6.6.1 Purpose

Terms of reference for local monitoring programs are provided with the SIS Terms of Reference in Appendix ‘M’ of the Boyne Survey Area FSEMS. The local Terms of Reference should be considered a minimum and the requirements will differ from area to area based on site specific conditions.

6.7 Hydrologic Modelling Verification

Purpose

The design of stormwater management facilities, culverts and watercourses has been based on largely uncalibrated hydrologic modeling. As field data is collected, the hydrologic model can be fully calibrated and the designs validated accordingly.

Methodology

During the course of the Boyne Survey build-out, the hydrologic model would be systematically updated to reflect final land use conditions and detailed designs for stormwater management facilities. As additional rainfall and streamflow data is collected during the course of the field monitoring, the hydrologic model can be periodically 'tested' with respect to its ability to replicate (and predict) actual in-field conditions. Specific performance issues associated with low flow, erosion flow and flood flow conditions will be examined. Depending on the model integrity and performance, it may be necessary (through adaptive management procedures), to update the stormwater management requirements for the balance of the Boyne Survey development. The HSP-F hydrologic model should be verified through a standard calibration process at the end of this 10 year monitoring period. A minimum of 3 events per year exceeding 15 mm in volume shall be used for the calibration. The model should also be used to verify that the respective targets are being met by the proposed SWM system.

6.8 Reporting

Annual

At the end of each calendar year, a report shall be prepared summarizing the findings of each discipline monitoring effort. Five copies of the draft report along with digital files are to be provided to the Technical Steering Committee for review prior to March 1 in the year following the monitoring. Five copies of a final report are to be prepared incorporating any amendments offered by the Technical Steering Committee. Only limited data interpretation with respect to system performance and integrity is expected to be provided in the annual reports.

Milestone

At key milestones during the build-out of an SIS area (say 25, 50 and 75 % of build-out), a similar report is to be prepared summarizing the previous years' data collection efforts. In addition, the milestone reports are to comment on:

- System performance
- Trends
- Recommendations for repairs
- Modifications to subsequent monitoring activities
- Preliminary direction on Adaptive Management requirements and associated cost estimates for same.

As for the Annual Reports, five Draft and five Final Reports will be required for the Technical Steering Committee. It will be important to provide the digital database in a coherent and reusable format for use by the Town, Agencies and others in future study and assessment of the environmental management system.

The SIS data findings should also be integrated into the overall holistic monitoring.

6.9 Summary

The Holistic Program is intended to be combined with the local SIS monitoring, in order to provide the Town and Agencies with a comprehensive environmental monitoring plan for the Boyne Survey area.

Reporting

The reporting is also to be correlated with the local SIS monitoring, allowing for comprehensive and consistent review and assessment of the data.

Annual

At the end of each calendar year, a report shall be prepared summarizing the findings of each discipline monitoring effort. Five copies of the draft report along with digital files are to be provided to the Technical Steering Committee for review prior to March 1 in the year following the monitoring. Five copies of a final report are to be prepared incorporating any amendments offered by the Technical Steering Committee. Only limited data interpretation with respect to system performance and integrity is expected to be provided in the annual reports.

Milestone

At the end of 20%, 40%, 60%, and 80% build-out, a similar report is to be prepared summarizing the previous years' data collection efforts. These are also to integrate SIS information collected locally. In addition, the milestone reports are to comment on:

- System performance
- Trends
- Recommendations for repairs
- Modifications to subsequent monitoring activities
- Preliminary direction on Adaptive Management requirements and associated cost estimates for same.

As for the Annual Reports, five Draft and five Final Reports will be required for the Technical Steering Committee. It will be important to provide the digital database in a coherent and reusable format for use by the Town, Agencies and others in future study and assessment of the environmental management system.

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APPENDIX 'A'
DFO INFORMATION REQUIREMENTS/DOCUMENTS

APPENDIX 'B'
HYDROGEOLOGY

APPENDIX 'C'
TERRESTRIAL