City of Hamilton
Airport Employment Growth District - Phase 2

Subwatershed Study and Stormwater Master Plan

Final Report

June 2011

DILLON CONSULTING

Aquafor Beech Limited

Table of Contents

PART A – Phase 2 Subwatershed Study

General

The Airport Employment Growth District (AEGD) encompasses approximately 2,800 hectares of land (excluding the Greenbelt) located in the west end of Glanbrook, extending between Garner Road / Twenty Road West in the north and Carluke Road East / White Church Road in the south, Fiddler's Green Road in the west and Upper James Street in the east. The first stage of development in the urban area expansion comprises 660 net hectares of land. The Airport Employment Growth District is guided by this Secondary Plan and has been designed to provide for a major business park development which effectively integrates with and complements the existing John C. Munro Hamilton International Airport, effectively integrates with the residential development abutting Garner Road / Twenty Road, recognizes and allows for certain existing land uses to continue until such time that they are redeveloped, as well as respects and enhances the prominent natural areas throughout the Secondary Plan area.

The Airport Employment Growth District is intended to offer a range of employment and employment-related land uses in the context of an eco-industrial park. In general, this eco-industrial park concept provides for prestige business park (PBP), airport related business (ARB), light industrial (IND) and airside industrial (AI) development which has an environmental footprint that is managed through a range of urban design and sustainable design techniques. It also allows for the land use and character of surrounding lands to be protected.

The Airport Employment Growth District provides the opportunity to create a new employment node which improves live-work ratios in the City and helps meet provincial employment targets. It supports the airport as important infrastructure and as an economic driver, supports long-term prosperity, and contributes to quality of life for Hamilton. Prestige business park uses are directed to the Secondary Plan's major transportation corridors where urban design approaches help support the transition between prestige business park uses and any nearby residential and agricultural/rural land uses. Light industrial uses are directed to interior lands where they can abut natural areas and prestige business park uses. Airside industrial uses, which require direct "airside" access to the airport, are located adjacent to the existing and future runway aprons of the John C. Munro Hamilton International Airport. Airport related businesses, which allow for businesses and services to travelers, are planned in close proximity to the airport. The plan protects natural features and provides for a limited range of employment-related commercial

uses that serves employees of the Secondary Plan area. Fundamental to this entire process, was the commitment to the development and implementation of an eco-industrial park concept that would result in a state of the art industrial-commercial development.

The overall planning for the AEGD project includes the development of an overall land use plan and individual component infrastructure studies covering transportation, water and wastewater and stormwater management/natural heritage systems planning. In part, the end products of this planning exercise are a framework for the development of the AEGD lands through 2031 that is consistent with municipal and provincial policy and a set of planning documents and urban design guidelines that outline how development and associated infrastructure will be constructed to meet the growth objectives, while protecting human and natural environmental values. In addition, the master plans and capital elements of the infrastructure study components were developed to satisfy the requirements of the Municipal Class Environmental Assessment process for master plans. While the land use planning and infrastructure studies comprehensively address planning, development and environmental protection within the Study Area and are sensitive to the future needs of the Airport and its future land requirements, these lands are excluded from the Growth Management Study.

The Municipal Class Environmental Assessment process has been followed for all of the AEGD Infrastructure Master Plan Studies. The study has been carried out according to the guidelines set out in A.2.7 Master Plans of the Municipal Engineers Association (MEA) Class Environmental Assessment.

Approach #2 of the Master Planning process from the Municipal Engineers Association (MEA) document was used as a guide for the AEGD Infrastructure Plan Studies. This approach involves the preparation of a Master Plan document at the conclusion of Phase 1 and 2 of the Municipal Class EA process. The Master plan would provide the basis for the future investigations for the specific Schedule C project indentified within it. The coordinated EA Approach #2 is accompanied by master plans for transportation, water and wastewater, and stormwater management. The simultaneous preparation of these planning documents can reduce the social, environmental and economical impacts of the preferred alternatives, as land use is not yet finalized. This was a well-suited planning approach for the overall AEGD Study.

The use of Approach #2 for the preparation of the AEGD Infrastructure Master Plans provides a broad context for need and justification. The assessment within the master plan satisfies Phases 1 and 2 of the Class EA process for Schedule B projects.

Phase 1 of this process provided a description of the existing conditions associated with each of the component studies as well as outlining the current planning framework in which the AEGD project has been developed. Phase 1 studies are reported in two separate documents:

- Phase 1 Land Use Planning Report
- Phase 1 Infrastructure Component Report

These are stand alone documents that are not included as part of these Phase 2 studies

PART A – Phase 2 Subwatershed Study

1.0 Overview / Introduction

This study is somewhat unique in terms of the planning process to come up with a recommended plan and infrastructure components. Where typically a Subwatershed Study would be prepared in advance of and separate from, the Growth Management Study or Secondary Planning Study, thus establishing the Natural Heritage system and stormwater/groundwater management framework within which the secondary plan would be developed (see **Figure 1.0**); in this case, the two studies have been completed in a fully integrated, yet iterative process, which has allowed for the concept of an eco-industrial park concept to be more fully explored, while at the same giving more consideration to subwatershed study components. This has also led to the development of a Stormwater Master Plan that is also more integrated between the environmental components of the subwatershed plan and the planning and infrastructure elements of the land use plan because of the need to utilize LID measures extensively in the overall plan.

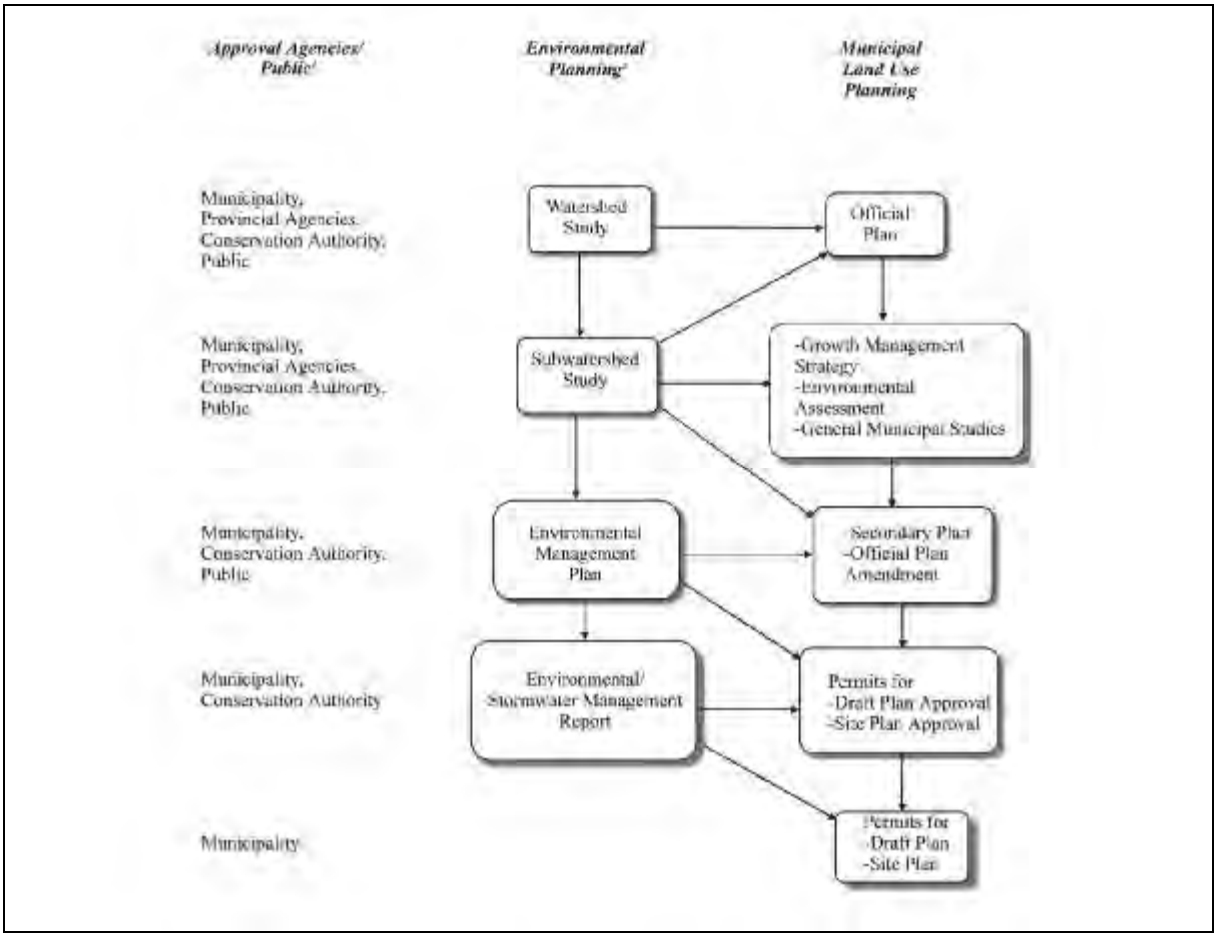

Figure 1.0: Municipal and Environmentally Planning Framework (from MOE 2003)

This fully integrated and iterative approach also provides for greater opportunity for public involvement, a key component of this project and is fully consistent with an adaptive environmental management approach.

Part A of the following report outlines the remaining phases of the Subwatershed Study and **Part B** addresses the Stormwater Master Plan Study. The Subwatershed Study outlines the environmental master plan for the study area, while the Stormwater Master Plan follows the Class EA process and describes the process leading up to the preferred alternative. In addition, the Stormwater Master Plan identifies the environmental criteria that need to be addressed in order for development to proceed.

Key findings/recommendations from the Phase 1 studies are as follows:

Natural Heritage System – Terrestrial

The Study Area Contains a Significant Terrestrial Natural Heritage System to be Protected and Enhanced:

- 434 ha (1072 acres) of Significant Natural Heritage Core Area both within and outside the Greenbelt Natural Heritage System.
- The Greenbelt Natural Heritage System extends in a north/south finger beyond the Core Areas.
- In all areas of the Greenbelt Natural Heritage System, significant policy restrictions are in place both in the Greenbelt Plan and the Rural OP including requirements for an EIS for adjacent land.
- Approximately 6.5% of the study area is forest cover.
- 20 patches that are at least 4 ha with the largest being 27 ha. These will be protected as part of the Core Areas, while the remainder are identified as linkages.
- Consideration should be given to identifying, preserving and enhancing wildlife linkages as well as final confirmation of the core natural heritage features in the study area.
- Significant Natural Heritage System can Provide a Parkway Setting

Natural Heritage System – Aquatic

The Area Contains Some Sensitive Aquatic Features:

- The study area is part of the headwaters of four watersheds.
- The drainage features appear to be intermittent. However, there are several features that may provide seasonal fish habitat.
- A range of warmwater fish species are likely typically present.
- At this time, cold/cool and warm water streams (critical and important fish habitat), as well as some intermittent or marginal habitat features have been identified as aquatic constraints that require protection in the form of fisheries buffers/setbacks as development proceeds.
- Some of these features may be allowed to be altered in terms of their location, although they still would be maintained as natural features.
- All Drainage Features are Sensitive to Water Quality and Sediment Impacts

- Enhanced or level 1 stormwater treatment from a water quality/fish habitat perspective is required for all tributaries.
- Both the Welland and Twenty Mile Creeks in the study area and immediately downstream are nutrient rich, moderately contaminated by bacteria and have elevated chloride levels.
- Airport and agricultural operations contribute to the elevated levels. Airport operations also contribute to elevated levels of glycol and other deicing compounds on a seasonal basis.

Groundwater

- The entire study area falls within the Source Protection Areas of the Hamilton, Grand River and Niagara Peninsula Conservation Authorities. There are both Significant Groundwater Recharge Areas and High Groundwater Susceptibility Areas within the Study Area as a result of the presence of aquifers supporting domestic water supplies, hydrologic connections to surface waters used as water supplies and local transport pathways that increase the potential for aquifer contamination. Multiagency committees have been established to prepare Source Water Protection Plans to provide policy, regulation and guidelines for activities within Source Protection Areas.
- Groundwater infiltration is generally low to moderate as a result of the relatively impermeable soil conditions (extensive veneer of glaciolacustrine silt and clay - Hydrologic C soils) found within the study area.
- Achieving pre-development water balance conditions will be a challenge due to the low to moderate permeability of the soils, and will require the application of a novel approach
- Groundwater does not have a major role in sustaining natural features such as wetlands and drainage features
- The majority of drainage features are intermittent and lack a significant baseflow from groundwater discharge

Stormwater Management

The following are general recommendations with respect to stormwater management within the study area:

- Generally there needs to be an emphasis on “lot level” and conveyance control measures, consistent with the industrial character of the lands and a predisposition to maintain a rural road cross section in most areas, as the headwater drainage features in the study area are too shallow to provide outlets for conventional stormwater management facilities.
- Due to the sensitivity of downstream areas to water quality impacts (fisheries, erosion susceptibility, ESA/wetland features, and Great Lakes Areas of Concern), all proposed development will require level 1 or enhanced stormwater treatment.
- Numerous headwater features exist within the study area and a preliminary mapping of features to be protected based on floodplain and fisheries requirements has been identified. A number of features have been classified as marginal fish habitat as they provide indirect or support habitat. Additional studies and site visits with Conservation Authority staff will be necessary to finalize whether these features require protection, or whether they may be replaced with components of the stormwater management system such as LID source and conveyance measures., consistent with replicating the flow conveyance/water quality attenuation functions of indirect habitat. It is important to note that most features, except those currently identified as warm or cool water streams (or important/critical fish habitat), may be altered in terms of their location, although they may still have to be maintained as natural features.
- From a stormwater management perspective, centralized facilities, where they are feasible, will require about 5% of the developable land area.
- Because the lands are gently undulating to flat, the floodplains tend to be very wide and shallow along the watercourses, and occupy a significant land area.
- A water budget approach is recommended to maintain the existing hydrologic cycle in new developed areas. Because much of the lands in the study area have a low potential for infiltration, innovative source and conveyance control measures will be necessary, perhaps even in combination with end-of-pipe measures. This is in keeping with the Eco-Industrial development concept being considered for these lands. This is also consistent with a “comprehensive urbanization approach” recommended in the City of Hamilton’s Stormwater Management Strategy (Aquafor Beech, 2007). Suitable stormwater management facilities may include:
    - rain barrels
    - rainwater harvesting
    - slab-on-grade development

- rain gardens
- biofilters
- soakaway pits
- pervious pavement
- perforated storm sewers
- grassed swales/ditches
- "end-of-pipe" controls for water quality control, erosion control, flood control and/or to promote infiltration:
  - stormwater management ponds
  - constructed wetlands
  - centralized infiltration facilities
  - erosion and sediment controls during construction.

- Other important measures for consideration include:
  - Revegetating riparian corridors along drainage features
  - Revegetating riparian areas around stormwater management facilities

2.0 Additional Baseline Studies

2.1 Stream Classification System

2.1.1 Stream Classification System

The surface drainage features within the study area make up the extreme headwaters of four watersheds within the jurisdiction of three Conservation Authorities: the Grand River Conservation Authority, the Hamilton Region Conservation Authority and the Niagara Peninsula Conservation Authority. The vast majority of these features exist as altered or improved agricultural drainage, vegetated swales through agricultural fields, roadside ditch features and natural drainage features in varying states of preservation.

As a component of the subwatershed study, a headwater tributary assessment was undertaken for the four (4) watersheds within the AEGD, namely Big Creek (GRCA), Sulphur Creek (HCA) and Twenty Mile Creek and Welland River (NPCA). Watercourses were surveyed at each road crossing within and immediately outside the AEGD study area limits to assess their current function within each watershed, physical characteristics, in stream and adjacent vegetation

types and to compile a photographic inventory of all features. Information gathered during the 3 day headwater tributary assessment included:

- General description of the feature - pool riffle, urban straightened, agricultural drain etc.
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The features have been subsequently divided generally into five (5) headwater feature types; permanent feature, small stream, urban feature (newly constructed), urban feature (older construction) and agricultural feature, examples which are provided **Figures 2.1 – 2.5. . These features were subsequently classified according to the MNR Fish Habitat Classification system and also according to the DFO classification system (as direct or indirect fish habitat) (see Section 2.1.2)**

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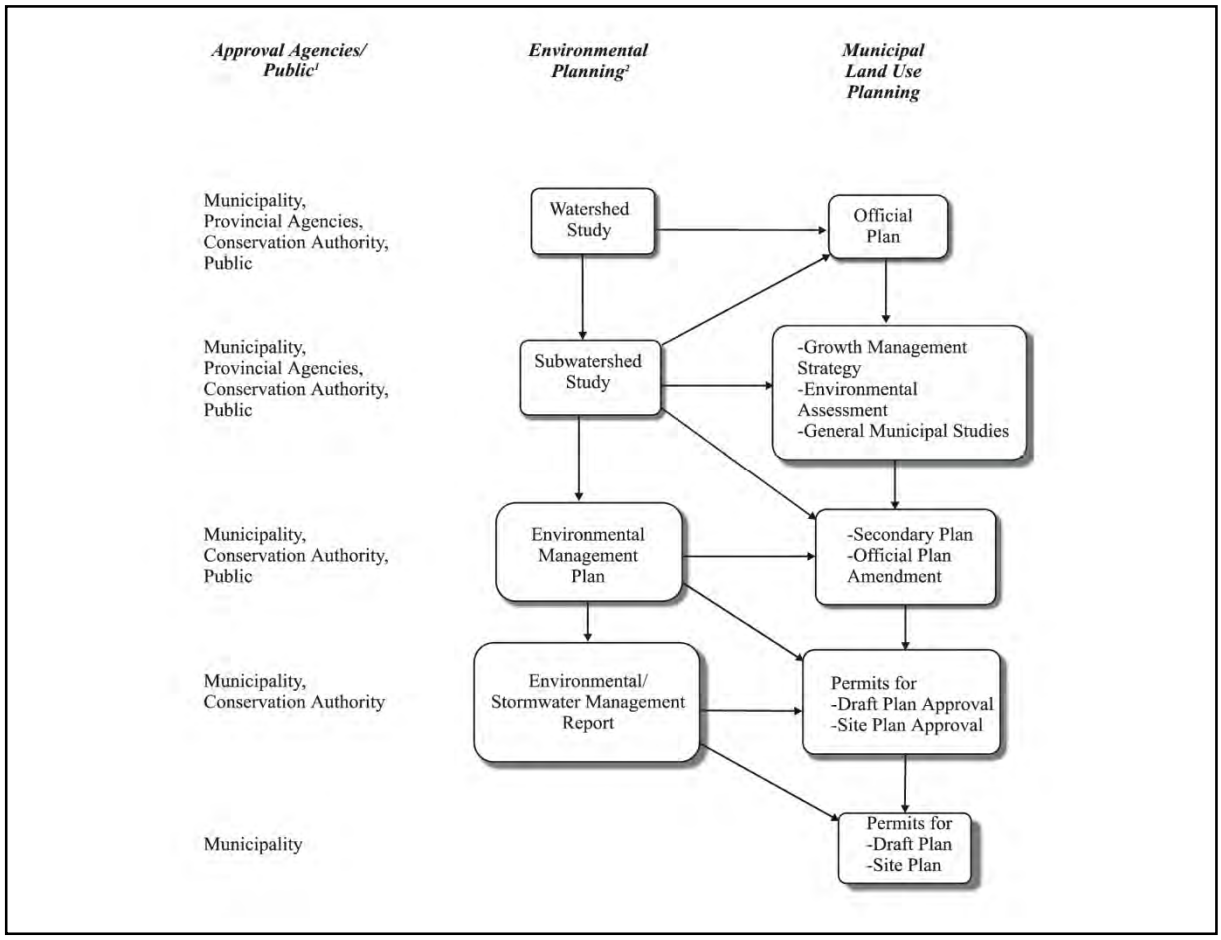

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The features have been subsequently divided generally into five (5) headwater feature types; permanent feature, small stream, urban feature (newly constructed), urban feature (older construction) and agricultural feature, examples which are provided **Figures 2.1 – 2.5. . These features were subsequently classified according to the MNR Fish Habitat Classification system and also according to the DFO classification system (as direct or indirect fish habitat) (see Section 2.1.2)**

Figure 2.1 Hamilton AEGD- Headwater Tributary Assessment
Welland River

Permanent Feature

Watercourse	Location on Map	Channel Description	Flowing water (Y/N)	Flow Depth (m)	Water Temp (C)	Air Temp (C)	Bed Material / Channel Type	Banks - material, general shape, veg?	Vegetation - type	Estimated Channel Width (m)	Estimated Channel Depth (m)	Up-Stream Picture #			Downstream Picture #		
R11	At Whitechurch Rd	Pool riffle	Y (considerable flow)	0.3	19.8	23.5	Alluvial	Vegetation	Grasses & wooded	8 to 9	0.6	41	-	-	42	-	-

Figure 2.2 Hamilton AEGD- Headwater Tributary Assessment
Welland River

Small Stream

Watercourse	Location on Map	Channel Description	Flowing water (Y/N)	Flow Depth (m)	Water Temp (C)	Air Temp (C)	Bed Material / Channel Type	Banks - material, general shape, veg?	Vegetation - type	Estimated Channel Width (m)	Estimated Channel Depth (m)	Up-Stream Picture #			Downstream Picture #		
R4 #2	At Whitechurch crossing	Definitive flow and channel	Y	0.1-0.15	19	23.5	Alluvial, fine gravel	Long grasses, vegetation, some meandering	Long grasses	5	0.6	29	30	-	31	-	

Figure 2.3 Hamilton AEGD- Headwater Tributary Assessment
Welland River

Urban Feature (Newly constructed)

Watercourse	Location on Map	Channel Description	Flowing water (Y/N)	Flow Depth (m)	Water Temp (C)	Air Temp (C)	Bed Material / Channel Type	Banks - material, general shape, veg?	Vegetation - type	Estimated Channel Width (m)	Estimated Channel Depth (m)	Up-Stream Picture #			Downstream Picture #		
R 17c	At Hampton Beach crossing	Straightened, vegetation	Y	0.1	20	21	Bruch/veg	Grasees and backyard lawns	Grass	5 (low-flow 1m)	0.3m	16	-	-	17	-	-

Figure 2.4 Hamilton AEGD- Headwater Tributary Assessment
Twenty Mile Creek

Urban Feature (Older constructed)

Watercourse	Location on Map	Channel Description	Flowing water (Y/N)	Flow Depth (m)	Water Temp (C)	Air Temp (C)	Bed Material / Channel Type	Banks - material, general shape, veg?	Vegetation - type	Estimated Channel Width (m)	Estimated Channel Depth (m)	Up-Stream Picture #			Downstream Picture #		
T10	At end of Talbot Rd	Agricultural field u/s, d/s manicured grass channel	N	-	-	-	Agricultural u/s, grass d/s	Agricultural u/s (no definition), short grass d/s	-	n/a	0.20	124	126	-	125	127	134

Figure 2.5 Hamilton AEGD- Headwater Tributary Assessment
Big Creek

Agricultural Feature

Watercourse	Location on Map	Channel Description	Flowing water (Y/N)	Flow Depth (m)	Water Temp (C)	Air Temp (C)	Bed Material / Channel Type	Banks - material, general shape, veg?	Vegetation - type	Estimated Channel Width (m)	Estimated Channel Depth (m)	Up-Stream Picture #			Downstream Picture #		
B5	At Butter	Agricultural drain	N	-	-	-	Agricultural drain	-	-	-	-	66	-	-	67	-	-

2.1.2 Fish Habitat Classification

A preliminary fish community and habitat classification was completed in Phase 1, however further refinement was necessary in order to finalize the treatment of all headwater features in the study area. The emphasis here was on establishing the classification of streams in terms of DFO's delineation of fish habitat as direct or indirect fish habitat and MNR's classification of fish habitat as Cold, Cool, Warm (GRCA/HCA jurisdiction) or Critical, Important, Marginal (NPCA jurisdiction) for the purpose of defining setback/buffer requirements. **Figure 2.6** shows the results of this classification.

The information collected for the stream assessment survey and the piezometer results were instrumental in finalizing the fish community and habitat classification. Four fish communities were identified as follows:

- Cool: cool/coldwater fish community represented by species such as rainbow trout, sculpin
- Warm: warmwater fish community represented by species such as northern pike, largemouth bass, sunfish species, Johnny darter, creek chub, white sucker
- Seasonal: intermittent drainage features that may be occupied by warmwater species on a seasonal basis. While these features are predominantly sustained by runoff events, they may also be supported seasonally by groundwater discharge.
- Support/indirect fish habitat: drainage features that are not occupied by fish but may contribute to downstream fish communities in terms of flow conveyance, water quality attenuation, food supply and thermal regulation

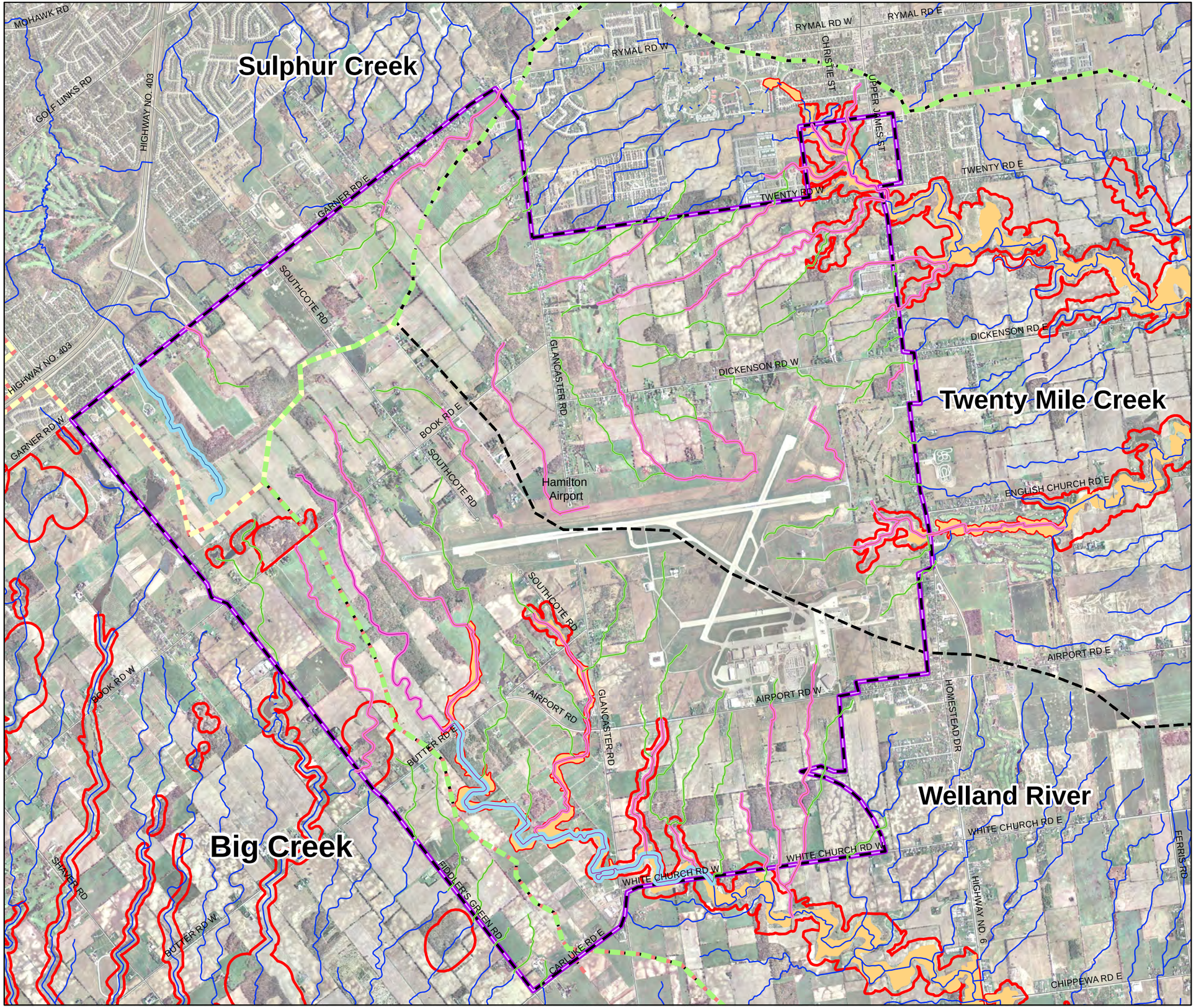
In addition, watercourses were also classified according to an MNR classification system used by NPCA. Fish habitat falls into 1 of 3 categories: Type 1, Type 2 or Type 3, which has been determined by the Ministry of Natural Resources (2000). Habitat type is based on the sensitivity and significance of current or potential habitats in a water body. Type 1 "critical" habitat is the most sensitive of the 3 types. As a result, it requires the highest level of protection. Examples of Type 1 habitat include critical spawning and rearing areas, migration routes, over-wintering

areas, productive feeding areas and habitats occupied by sensitive species. Type 2 “Important” habitat is less sensitive and requires a moderate level of protection. These areas are considered “ideal for enhancement or restoration projects” and include feeding areas for adult fish and unspecialized spawning habitat. The third habitat type is considered marginal or highly degraded and does not contribute directly to fish productivity. Examples of Type 3 “marginal” habitat include channelized streams and artificially created watercourses.

Table 2.0 was used to classify the drainage features according to broad fish community types. Based on this table, the existing communities can be classed as a tolerant coldwater fish community and a tolerant warmwater fish community. Downstream of the study area, however both Twenty Mile Creek and Welland River would be considered to support a moderately tolerant to diverse warmwater fish community type.

Hamilton AEGD Study Subwatershed Plan

AQUATIC RESOURCES
Figure 2.6



Legend

Fish Community Type
- Cool/Cold
- Seasonal
- Support/Indirect Fish Habitat
- Warm

Fish Habitat Buffer

Buffer
- Support/Indirect Fish Habitat/Marginal Habitat (30m)*
- Seasonal/Warmwater Watercourse/Important/Marginal Habitat (30m)
- Coldwater Watercourse/Critical Habitat (60m)
- Study Area
- Grand River Conservation Authority
- Hamilton Conservation Authority
- Niagara Peninsula Conservation Authority
- Floodplain
- Generic Regulation Lines**

NOTE:
***if watercourse is retained as an enhanced feature.**
****Generic regulations include a 30 m buffer on all watercourses.**

N

Meters

0 295 590 1,180 1,770

Map Created By: AS
Map Checked By: BH
Date Created: December 15, 2009
Date Modified:
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Only one watercourse (in Sulphur Creek) was classified as coldwater (**Figure 2.6**); the majority of the drainage features were classed in the other three classifications. Setbacks or exclusion buffers adjacent to each of these community classifications were then established as follows:

- Support/Indirect Fish Habitat / Marginal habitat: both the City's Official Plan and CA guidelines recommend a 15 m buffer set back from each side of the bankfull channel width. This represents the recommended protected corridor width for these features should they be retained, however they may be incorporated into the stormwater infrastructure of the site provided that their water quantity/quality function is maintained to support downstream fish communities

- Seasonal/Warmwater Watercourse / Important/Marginal Fish Habitat: a 15 m buffer set back from each side of the bankfull channel was established, representing the minimum protected corridor width for these features which are to be protected within the framework of future development

- Cool/Coldwater Watercourse / Critical Fish Habitat: a 30 m buffer set back from each side of the bankfull channel was established, representing the minimum protected corridor width for these features which are to be protected within the framework of development

Current limitations to fish habitat based on the stream assessment work are as follows:

- Lack of base flow and thermal cooling from groundwater and/or stream shading

- Lack of woody, riparian vegetation

- High sediment loads from agricultural activities

- Poor stream morphology (lack of well developed pool and riffle habitats) and low diversity of instream substrates due to naturally low stream gradients, channel modifications and excessive sediment deposition

Table 2.0: Representative Fish Community Types

FISH COMMUNITY				
Type I Tolerant Coldwater Community	Type II Diverse Warmwater Community	Type III Moderately Tolerant Warmwater Community	Type IV Tolerant Warmwater Community	Type Va Highly Tolerant Warmwater Community
Minimum of one of the following fish species: · rainbow trout · chinook/coho salmon · brown trout	Minimum of 14 fish species, including at least 4 of the following: · northern hog sucker · pike · smallmouth bass · lowa darter · redside dace · yellow perch · walleye · intolerant minnows[1] · stonecat	Minimum of 10 fish species, including at least 2 of the following: · rock bass · largemouth bass · rainbow darter · fantail darter · redhorses · central stoneroller · insectivorous minnows[2]	Minimum of 4 fish species, including at least 1 of the following: · pumpkinseed/bluegill · black crappie · white sucker · gizzard shad · johnny darter · omnivorous minnows[3]	Minimum of 1 of the following fish species: · carp · goldfish · brown bullhead · brook stickleback · central mudminnow
				Type Vb No Aquatic Community
				No fish present
BENTHIC INVERTEBRATE COMMUNITY				
Type I Stable Coldwater Community	Type II Stable Warmwater Community	Type III Unstable Warmwater Community	Type IV Impaired Warmwater Community	Type V Severely Impaired Community
WQI >13 EPT ³15 At least four of the following: · *Amphinemura* · *Leuctra* · *Haploperla* · *Ectopria* ·*Heterotrissocladius* · *Eukiefferiella* · *Rhyacophila*	WQI >12 EPT ³10 At least five of the following: · *Acroneuria* · *Isoperla* · *Taeniopteryx* · *Paraleptophlebia* · *Serratella* · *Chimarra* · *Rhyacophila* · *Diamesa* · *Lumbriculus* · Turbellaria · *Eukiefferiella*	WQI 7 EPT ³5 At least six of the following: · Turbellaria · *Baetis* · *Caenis* · *Stenacron* · *Tricoythrodes* · *Cheumatopsyche* · *Hydropsyche* · *Neophylax* · *Optioservus* · *Stenelmis* · *Micropsectra* · Simulidae	WQI 5 EPT 3 At least four of the following: · *Sialis* · *Berosus* · *Cheumatopsyche* · *Hydropsyche* · *Dubiraphia* · *Probezzia* · *Cryptochironomus* · *Paratanytarsus* · *Rheotanytarsus* · *Chaetocladius* · *Hemerodromia* · *Helobdella*	WQI £5 EPT £3 At least five of the following: · *Nais* · *Limnodrilus* · *L. claparedianus* · *Tubifex tubifex* · *Sparganophilus* · *Berosus* · *Probezzia* · *Chironomus* · *Physella*

[1] Blacknose shiner, sand shiner, rosyface shiner, river chub.
[2] Hornyhead chub, emerald shiner, common shiner, blacknose shiner, striped shiner, spottail shiner, rosyface shiner, spotfin shiner, sand shiner, redfin shiner, blacknose dace, longnose dace, mimic shiner.
[3] Fathead minnow, northern redbelly, bluntnose minnow, goldfish, creek chub, brassy minnow, golden shiner.

2.2 Surface Water Drainage Patterns

The surface drainage features within the study area are comprised of part of the headwaters of four different Watersheds which are governed by three different Conservation Authorities:

- Big Creek – Grand River Conservation Authority
- Sulphur Creek – Hamilton Region Conservation Authority
- Twenty Mile Creek – Niagara Peninsula Conservation Authority
- Welland River - Niagara Peninsula Conservation Authority

2.2.1 Big Creek

Big Creek drains from Ancaster to the Grand River. The watershed is mainly rural, and will see approximately 5% of its area developed with urban land uses, including a business park near Hamilton Airport in Additional Study Area (post 2031).

Approximately 330ha (330.2ha) of the study area (entirely within the Additional Study Areas) are located within the headwaters of tributaries to Big Creek watershed; with the exception of approximately 12ha at the corner of Garner Rd East and Fiddlers Green Rd – see Section 5.5 the Council Directed Additional Lands.

Half a dozen small tributaries of Big Creek originate within the study area and flow westerly away (downstream) from the study area and into the Grand River downstream of the study area and ultimately to Lake Erie.

2.2.2 Sulphur Creek

Sulphur Creek drains from the Escarpment northward into Spencer Creek and eventually to Cootes Paradise. A significant portion of the watershed is already developed in the Ancaster Area. This area will see continued urban growth, the majority of which is associated with the development of a business part adjacent to the Hamilton Airport.

Approximately 350ha (355.0ha) of the study area are located within the headwaters of Sulphur Creek watershed. Two dominant headwater tributaries drain from the headwater portion of

Sulphur Creek. These tributaries flow northerly away (downstream) from the airport on agricultural lands within the study area, on residential lands downstream of the study area and into the Dundas Valley Conservation Area. The Dundas Valley Conservation Area then drains to Lake Ontario via Hamilton Harbor (Cootes Paradise). This tributary is considered part of the Hamilton Harbor Remedial Action Plan (RAP).

2.2.3 Twenty Mile Creek

Twenty Mile Creek drains from the Glanbrook area towards Lake Ontario. Existing land uses are primarily rural, however, this watershed will see future urban development in approximately 21% of the watershed area.

Approximately 1100ha (1131.5ha) of the study area are located within the headwaters of Twenty Mile Creek watershed. The east portion of John C Munro Hamilton International Airport is located within this portion of the study area. Numerous headwater tributaries drain the airport lands and lands directly adjacent to the airport. These tributaries flow southerly away (downstream) from the airport to the confluence with Twenty Mile Creek which then drains to Lake Ontario (at Jordan harbor) downstream of the study area.

2.2.4 Welland River

The Welland River drains from above the Escarpment near the Hamilton Airport to the Niagara River. Existing land uses are primarily rural, however, the watershed will see development with urban land uses in approximately 13% of the watershed area, most of which is associated with the development of a business park next to the Hamilton Airport.

Approximately 1300ha (1295.3ha) of the study area are located within the headwaters of Welland River Watershed. The majority of John C Munro Hamilton International Airport is located within this portion of the study area. A dozen or so small headwater tributaries drain the airport lands and lands directly adjacent to the airport. All of these tributaries flow southwesterly away (downstream) from the airport to the confluence with the Welland River which then drains to the Niagara River downstream of the study area. The Welland River is part of the Niagara River RAP.

2.2.5 General Description of Surface Water Features

The majority of the headwater drainage features within the study area have been altered/improved for agricultural drainage or crop cultivation purposes and exist as agricultural drains, swales through cultivated fields, roadside ditches and natural drainage features (where they have been variously preserved by woodlot/wetland features or unproductive soils). The majority of these features have drainage areas less than 50 ha and all have drainage areas less than 125 ha.

In addition to these drainage features, there are numerous man-made ponds, created on agricultural, golf course and rural residential lands within the study area.

Essentially there are no engineered stormwater drainage systems within the AEGD as the majority of the lands are rural. The exceptions to this are the Hamilton International Airport lands, and the Highway 6/403 interchange. The Airport has a stormwater management system internal to the airport lands that also discharges via a number of stormwater management facilities/swales into adjacent headwater tributaries of Twenty Mile Creek and the Welland River; Highway 6 provides stormwater treatment at several discharge points along its length where it crosses headwater features of Sulphur Creek and Big Creek.

The existing road network is a rural system with roadside ditches, including the village of Mount Hope. Urban curb and gutter road systems, stormwater facilities and support infrastructure exist in communities adjacent to the study area on the north side along Garner Road and Twenty Road (i.e. St. Elizabeth Village SWM Ponds). At present the existing stormwater management facilities are under private management.

2.2.6 Drainage Mosaic

The pattern of the movement of surface runoff (overland flows) within the Hamilton Airport Employment Growth District is illustrated for each study area on **Figure 2.7**. These exhibits illustrate distinct parcels of land (catchments) each draining to a watercourse.

The drainage mosaic consists of 10 catchments within the Sulphur Creek Watershed Area, 11 catchments within the Welland River Watershed Area and 13 catchments within the Twenty Mile

Creek Watershed Area. This drainage mosaic was used for the hydrologic modeling work to determine hydrologic characteristics on a catchment basis.

NOTE: Big Creek was not partitioned into catchments, nor set up for HSPF modeling since the majority of the lands, approximately 330ha (330.2ha), are entirely within the Additional Study Area (post 2031). The exception to this is the approximately 12ha at the corner of Garner Rd East and Fiddlers Green Rd – see Section 5.5 the Council Directed Additional Lands. Development on these Council Directed Additional Lands within the Big Creek subwatershed will be subject to site-specific (lot level) controls and SWM criterion established based on the modeling results obtained from the other watersheds (these SWM criteria can be applied based on dominant soil types). Prior to Development in the remainder of the Big Creek Subwatershed, modeling should be undertaken and this study revisited given the time lapse anticipated between completion of the subwatershed study and Stormwater Master Plan and potential future development (post 2031).

2.2.7 Catchment Characteristics for Existing Conditions

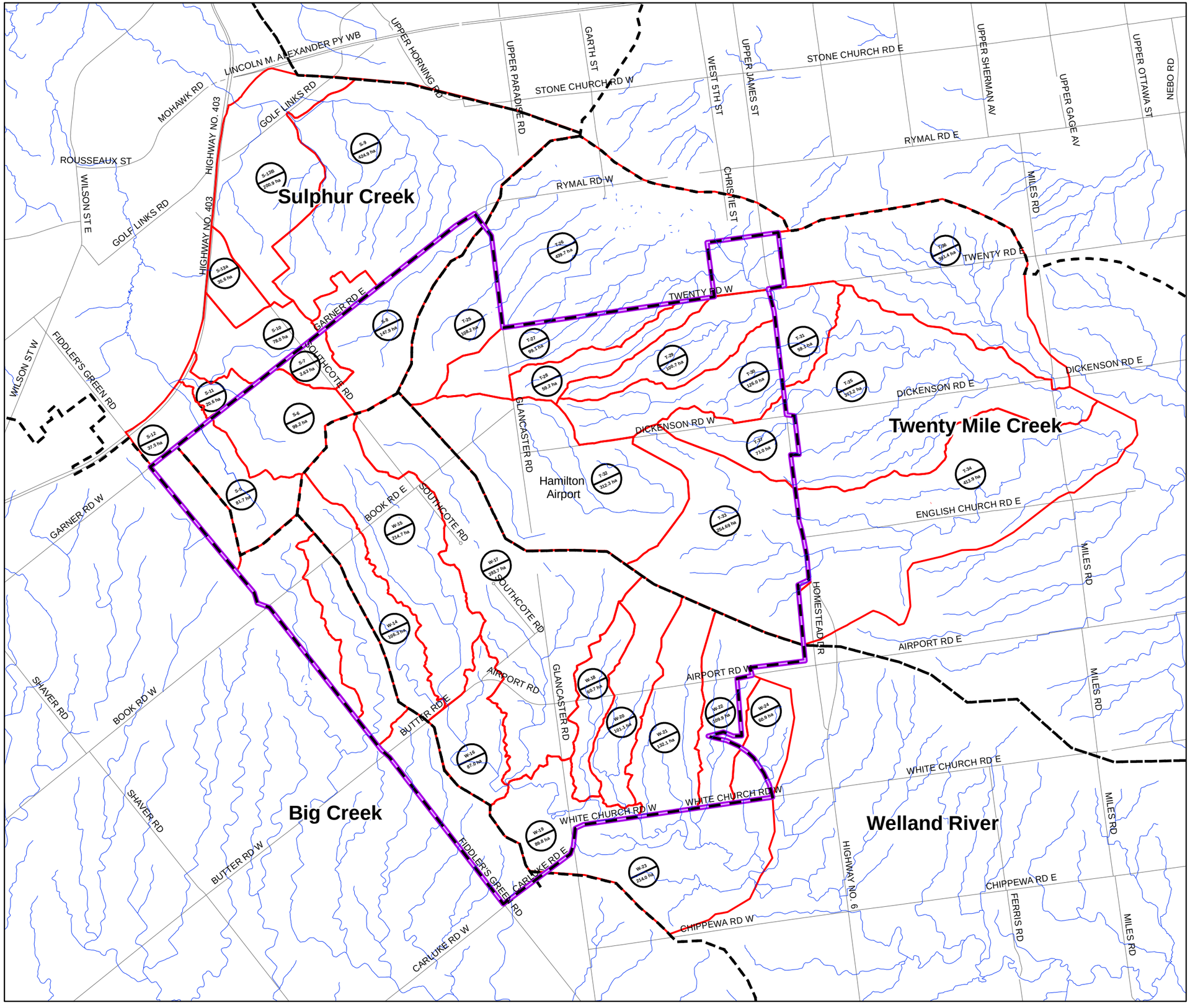
The study area catchments range in size from 26.2 ha to 439.7 ha, and are characterized by gently rolling topography with average catchment land slopes ranging from 0.1% to 0.8%. The average percent of the existing conditions land uses within each of the three watersheds is illustrated in **Table 2.1**

Table 2.1: Existing Conditions Land Use Distribution Reported as Percent of Total Area

Watershed	Area (ha)	Existing Conditions Land Use Distribution (%)							
		Woodlot	Row Crop	Pasture	Residential	Commercial	Roads and other impervious	Total Pervious	Total Impervious
*For the catchments located with the study area (as illustrated in **Figure 2.7**)*									
Sulphur Creek	*355.0*	*8*	*67*		*14*	*8*	*4*	*85*	*15*
Welland River	*1,295.3*	*16*	*52*	*13*	*13*	*2*	*3*	*88*	*12*
Twenty Mile Creek	*1,131.5*	*13*	*49*	*26*	*8*	*1*	*2*	*92*	*8*
Total Area of Hydrologic Modeling (Study Area and downstream area included in assessment)									
Sulphur Creek	*1,152.5*	*10*	*41*	*4*	*26*	*8*	*11*	*71*	*29*
Welland River	*1,570.2*	*17*	*56*	*11*	*14*	*2*	*3*	*89*	*11*
Twenty Mile Creek	*2,718.8*	*14*	*53*	*14*	*16*	*2*	*4*	*87*	*13*

Hamilton AEGD Study Subwatershed Plan

HYDROLOGICAL SUBCATCHMENTS
Figure 2.7



Legend

- Study Area
- Hydrologic Catchments

Meters

0 355 710 1,420 2,130

Map Created By: AS
Map Checked By: BH
Date Created: October 5, 2009
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2.3 Water Quality

2.3.1 General

As part of the Airport Employment Growth District Report – Phase 2, a more detailed water quality monitoring program was conducted to quantify the contaminant loading occurring at various site-specific locations throughout the study area. This section presents a summary of the sampling locations, sampling timing, constituents tested and results.

Full water quality results, laboratory certificates of performance, flow records and field data can be found in the John C. Monroe Hamilton International Airport (HIA) – Water Quality Monitoring Final Report, Aquafor Beech Ltd. (July 28, 2010); a concurrent, but separate, comprehensive 12 month water quality study which investigated surface discharges related to the Hamilton International Airport (HIA) for a variety of water quality parameters including BOD_5, TSS, Oil and Grease, TKN, Nitrate Nitrogen, Nitrite Nitrogen, TP, Metals (Cu, Pb, and Zn), Chloride, Propylene Glycol, Petroleum Hydrocarbons, Phenols, Benzene, Toluene, Ethylbenzene, Total Xylenes, Tolytriazole, pH, temperature, DO and Conductivity.

Summaries of water quality monitoring results by season for BOD_5, TSS, TKN, Nitrate Nitrogen, Nitrite Nitrogen, TP, Metals (Cu, Pb, and Zn), and Chloride are provided in Appendix J (Tables J1 – J4). MOE Effluent limits and PWQOs for all related contaminates are presented in Appendix J, Table J5.

2.3.2 Sampling Locations

Water quality monitoring was conducted to quantify runoff constituent concentrations at various site-specific locations throughout the study area. Eight (8) site locations were selected, including two (2) sites previously sampled by the NPCA (monthly grab samples) since 2002, one (1) reference site, and several additional locations downstream of proposed discharge locations. Of the eight sites implemented, sites 1 through 7 were located within the Welland Creek watershed, while site 8 was located in the Twenty Mile Creek watershed (Refer to **Figure 2.14** for monitoring site locations). The following provides a general description of the eight (8) site locations:

- Site 1 – Bridge crossing on Ferris Rd. between Chippewa Rd. West and Leeming Rd.
- Site 2 – Farmers Field South of Airport Rd., 500m east of the 447 Club site location.

- Site 3 – 447 Club ditch draining the south side of the HIA, upstream of Airport Rd.
- Site 4 – South of Whitechurch Rd. W. directly downstream of 447 Club ditch.
- Site 5 – Located downstream of an Airport Rd. culvert, directly east of the intersection of Airport Rd. and Glancaster Rd.
- Site 6 – Located upstream of a Butter Rd. culvert, at the junction of Southcote Rd. and Butter Rd.
- Site 7 – Located south of Butter Rd. between Fiddler's Green Rd. and Highway 6 extension (Reference Site)
- Site 8 – Located at the pumping station on Upper James St., upstream of the Willow Valley Golf Club

2.3.3 Sampling Frequency and Timing

Upon completing the monitoring program, nine (9) sampling events were conducted over the course of a twelve (12) month period. The nine (9) sampling events were conducted seasonally, under various flow conditions. A minimum of two (2) sampling events were collected during the following conditions:

- Two (2) during high spring flows;
- Two (2) during the summer period (quiescent (<10mm storm);
- Two (2) during fall period (dry, non storm events or precipitation events <10mm); and
- Two (2) during winter period (melt events).

Seasonal periods were assumed to correspond with the following schedule:

- Spring: March, April, & May
- Summer: June, July, & August
- Fall: September, October, & November
- Winter: December, January, & February

Table 2.2 presents the completed schedule for the surface water quality monitoring program.

Table 2.2: Sampling Schedule for the HIA Monitoring Program 2009-2010

Sample Run	Sampling Date	Seasonal Period	Seasonal Conditions
Run 1	August 14, 2009	Summer	Dry
Run 2	September 22, 2009	Fall	Wet
Run 3	November 24, 2009	Fall	Wet
Run 4	January 15, 2010	Winter	Melt/Wet
Run 5	January 25, 2010	Winter	Melt
Run 6	March 5, 2010	Spring	Melt
Run 7	March 8, 2010	Spring	Melt
Run 8	April 23, 2010	Spring	Dry
Run 9	June 7, 2010	Summer	Wet

2.3.4 Sampling Results Summary and Outcomes

Temperature

Temperature measurements were taken during field sampling for the duration of the monitoring program. Temperature ranged from 26°C – 1°C. **Figure 2.8** provide complete temperature measurement results collected as part of the field measurement program during grab sample collection.

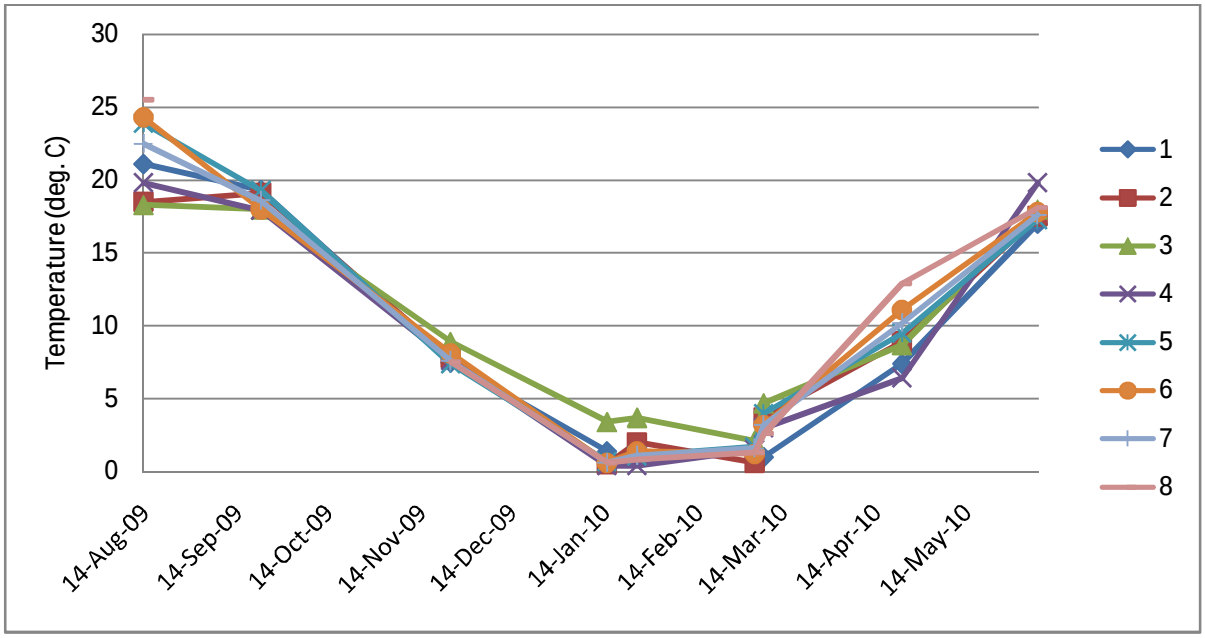


Figure 2.8 – Temperature Levels (°C) recorded during the monitoring program for Sites 1-8

pH

pH measurements were taken during field sampling for the duration of the monitoring program. pH levels ranged between 6.27 and 7.96 (**Figure 2.9**). One measurement obtained from site 7

on January 25, 2010 was recorded at 3.63 and is considered an outlier and is likely due to anthropogenic or instrument malfunction. The PWQO and MOE effluent limits for pH must be maintained between 6.5 and 8.5 to protect aquatic life and for the protection of surface waters for recreational uses.

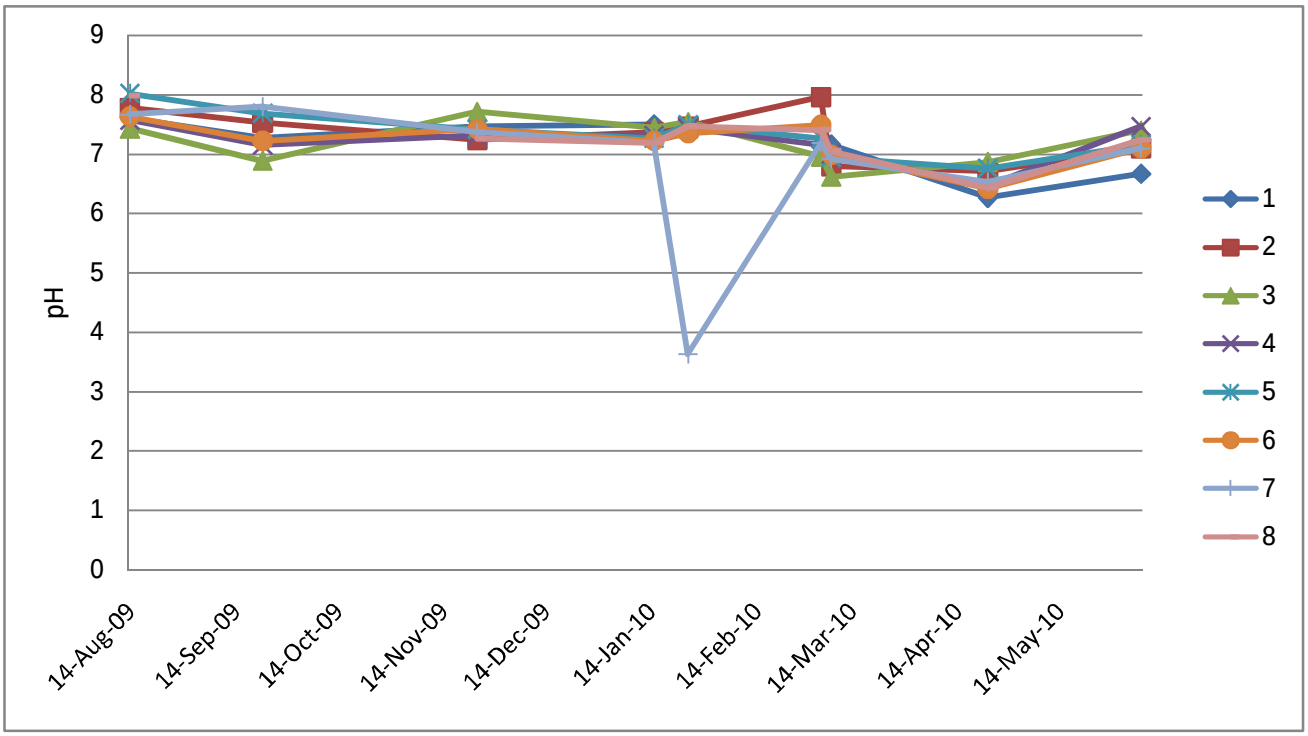


Figure 2.9 –pH Levels recorded during the monitoring program for Sites 1-8

Conductivity

Generally, conductivity for the majority of the site locations was recorded below 1000µS/cm. Sites 2, 3, and 4) exceeded 1000µS/cm numerous times throughout the monitoring program (**Figure 2.10**). During a single melt event on January 15, 2010, site 3 measured a conductivity value of 17.53mS/cm, almost three times the next highest recorded value (also recorded at the site 3). Elevated conductivity levels correspond with the high chloride levels observed during the month of January (see Figure 2.13:

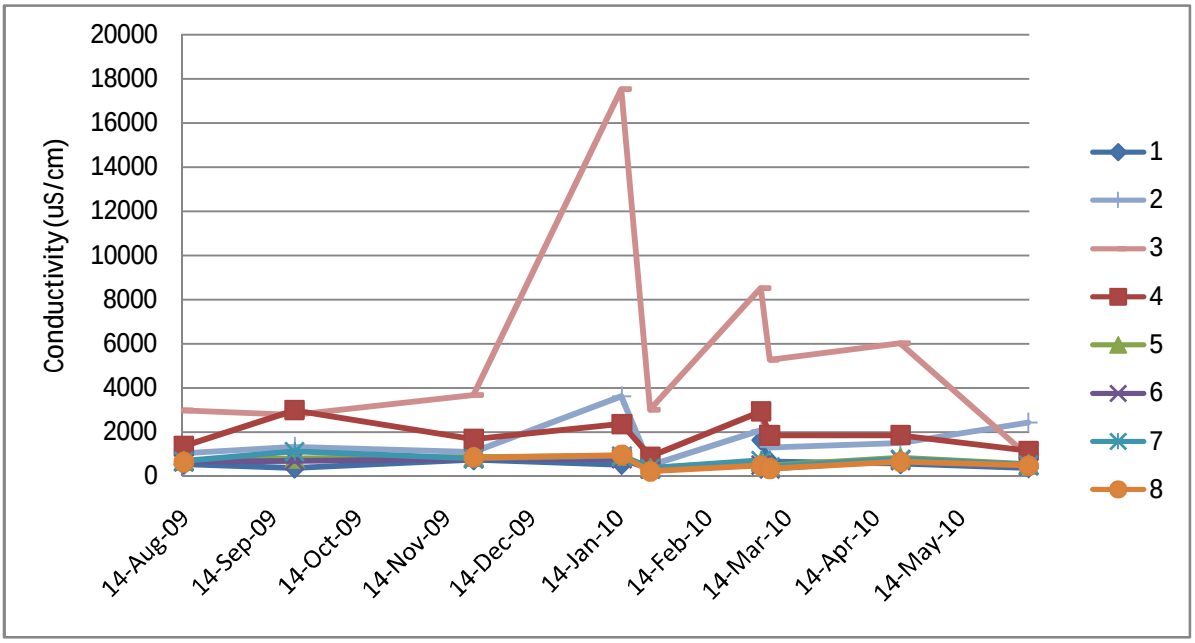


Figure 2.10 – Conductivity (µS/cm) Levels recorded during the monitoring program for Sites 1-8

Dissolved Oxygen

Generally Dissolved Oxygen (DO) concentrations remained between 60 – 100% saturation (**Figure 2.11**). Concentrations in the September sampling event at stations 3 and 4 dropped to 40% saturation or less suggesting more stressful conditions for aquatic organisms. This may be the result of an extended dry period or a localized increase in oxygen consumption, for example from decaying organic material on the streambed.

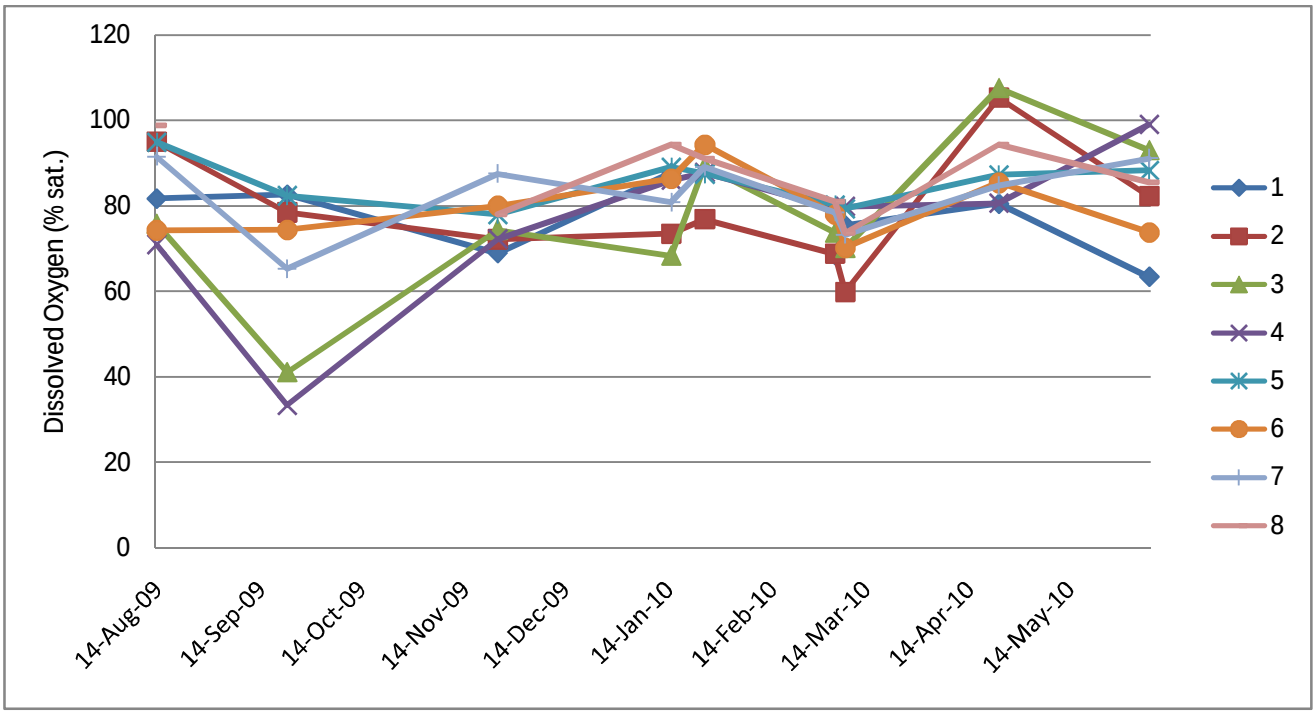


Figure 2.11 – Dissolved Oxygen (% sat.) Levels recorded during the monitoring program for Sites 1-8

Chloride

Chloride concentrations are significantly elevated within the study area with 5 of the 8 sites displaying continually elevate chloride concentrations (see **Figure 2.12**). Elevated chloride levels were particularly evident during winter melt and spring events, suggesting that road deicing compounds are a contributing source to elevated chloride concentrations. These concentrations exceed guidelines and represent a stress to aquatic life. Complete tabular results are provided in Appendix J.

Trace Metals

According to the Airport Employment Growth District Report – Phase 1, general water quality results as collected by the NPCA (2002 -2007) for five (5) of the eight (8) sampling sites demonstrated that levels of trace metals, such as copper, lead and zinc were below provincial guidelines. Results from the 2009-2010 sampling program data indicate that lead and copper levels, for the majority of sites, were below the provincial standards; however, during the wet events the majority of the sampled sites exceeded the provincial guidelines for copper.

Generally, there is evidence to suggest that zinc concentrations are generally elevated in the AEGD study area as zinc concentrations were consistently high and observed at nearly all sampled sites including the reference site (site 7) on two occasions (see **Figure 2.13**). Complete tabular results are provided in **Appendix J.**

In addition several sites exhibited elevated copper concentrations at various times throughout the sampling program (see **Appendix J**).

Nutrients

While nutrient levels were generally within typical background concentrations for an area dominated by agricultural land use practices, there were occasional high concentrations of nitrogen compounds, including nitrite and ammonia, suggesting that conditions may periodically be stressful to aquatic life (see **Figures 2.14** and **2.15**).

General Results

There was no evidence of the airport-related de-icing compounds, BTEX, Propylene or Polypropylene Glycol and Tolytriazole in any of the water samples collected during the monitoring program presented in the John C. Monroe Hamilton International Airport (HIA) – Water Quality Monitoring Final Report, Aquafor Beech Ltd. (July 28, 2010)

Summaries of water quality monitoring results by season for BOD_5, TSS, TKN, Nitrate Nitrogen, Nitrite Nitrogen, TP, Metals (Cu, Pb, and Zn), and Chloride are provided in **Appendix J** (**Tables J1 – J4**). MOE Effluent limits and PWQOs for all related contaminates are presented in **Table 2.2.1**.

Table 2.2.1 – MOE Effluent Limits and Provincial Water Quality Objectives (PWQOs)

<table>
<tr><th>Parameter</th><th>Provincial Water Quality Objectives (PWQOs)</th><th>MOE Effluent Limits</th></tr>
<tr><td>BOD_5</td><td>n/a</td><td>20.0 mg/L</td></tr>
<tr><td>Total Suspended Solids</td><td>n/a</td><td>15.0 mg/L</td></tr>
<tr><td>Oil and Grease</td><td>PWQO:
Oil or petrochemicals should not be present in concentrations that:
• can be detected as a visible film, sheen, or discolouration on the surface;
• can be detected by odour;
• can cause tainting of edible aquatic organisms;
• can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or are deleterious to resident aquatic organisms.</td><td>15.0 mg/L</td></tr>
<tr><td>Propylene Glycol
Propylene Glycol, 1,2-
Propylene Glycol, 1,3-</td><td>44000µg/L (Interim PWQO)
10000µg/L (Interim PWQO)</td><td>44.0 mg/L</td></tr>
<tr><td>Total Kjeldahl Nitrogen</td><td>n/a</td><td></td></tr>
<tr><td>Nitrate Nitrogen</td><td>n/a</td><td>2.97 mg/L</td></tr>
<tr><td>Nitrite Nitrogen</td><td>n/a</td><td></td></tr>
<tr><td>Ammonia Nitrogen (Un-ionised)</td><td></td><td>0.1 mg/L</td></tr>
<tr><td>Copper</td><td>5µg/L (PWQO)[1]</td><td>5 µg/L</td></tr>
<tr><td>Lead</td><td>
<table>
<tr><th>Alkalinity as $CaCC^3$ (mg/L)</th><th>PWQO (µg/L)</th></tr>
<tr><td><30</td><td>5</td></tr>
<tr><td>20 to 40</td><td>10</td></tr>
<tr><td>40 to 80</td><td>20</td></tr>
<tr><td>>80</td><td>25</td></tr>
</table>
<table>
<tr><th colspan="2">Interim PWQO</th></tr>
<tr><th>Hardness as $CaCC^3$ (mg/L)</th><th>PWQO (µg/L)</th></tr>
<tr><td><30</td><td>1</td></tr>
<tr><td>30 to 80</td><td>3</td></tr>
<tr><td>>80</td><td>5</td></tr>
</table>
</td><td></td></tr>
<tr><td>Zinc</td><td>30µg/L (PWQO)
20µg/L (Interim PWQO)</td><td>30 µg/L</td></tr>
<tr><td>Volatile Organic Carbons</td><td>n/a</td><td></td></tr>
<tr><td>Phenols</td><td>1µg/L (PWQO)[1]</td><td></td></tr>
</table>

<table>
<tr><td>Benzene</td><td>100µg/L (Interim PWQO</td><td>100.0 µg/L</td></tr>
<tr><td>Toluene</td><td>0.8µg/L (Interim PWQO)</td><td>0.8 µg/L</td></tr>
<tr><td>Ethylbenzene</td><td>8µg/L (Interim PWQO)</td><td>8.0 µg/L</td></tr>
<tr><td>Total Xylenes
Xylene, m-
Xylene, o-
Xylene, p-</td><td>2µg/L (Interim PWQO)
40µg/L (Interim PWQO)
30µg/L (Interim PWQO)</td><td>70 µg/L</td></tr>
<tr><td>Tolytriazole</td><td>3µg/L (Interim PWQO)</td><td></td></tr>
<tr><td>Chloride</td><td>n/a</td><td>100 mg/L</td></tr>
<tr><td>Total Phosphorus</td><td>Interim PWQO:
Current scientific evidence is insufficient to develop a firm Objective at this time. Accordingly, the following phosphorus concentrations should be considered as general guidelines which should be supplemented by site-specific studies:
To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20µg/L;
A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10µg/L or less. This should apply to all lakes naturally below this value;
Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30µg/L.</td><td></td></tr>
<tr><td>pH</td><td>PWQO: The pH should be maintained within the range of 6.5 - 8.5
to protect aquatic life; and
both alkaline and acid waters may cause irritation to anyone using the water for recreational purposes</td><td>6.5 – 8.5</td></tr>
<tr><td>Temperature</td><td>General
The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed</td><td></td></tr>
<tr><td>Conductivity</td><td>n/a</td><td></td></tr>
<tr><td>Dissolved Oxygen</td><td>PWQO: Dissolved oxygen concentrations should not be less than the values specified below for cold water biota (e.g. salmonid fish communities) and warm water biota (e.g. centrarchid fish communities):
<table>
<tr><td colspan="5">Dissolved Oxygen Concentration</td></tr>
<tr><td>Temperature</td><td colspan="2">Cold Water Biota</td><td colspan="2">Warm Water Biota</td></tr>
<tr><td>°C</td><td>% Saturation</td><td>mg/L</td><td>% Saturation</td><td>mg/L</td></tr>
<tr><td>0</td><td>54</td><td>8</td><td>47</td><td>7</td></tr>
<tr><td>5</td><td>54</td><td>7</td><td>47</td><td>6</td></tr>
</table></td><td></td></tr>
</table>

10	54	6	47	5
15	54	6	47	5
20	57	5	47	4
25	63	5	48	4

In waters inhabited by sensitive biological communities, or in situations where additional physical or chemical stressors are operating, more stringent criteria may be required. For example, a sensitive species such as lake trout may require more specific water quality objectives.

In some hypolimnetic waters, dissolved oxygen is naturally lower than the concentrations specified in the above table. Such a condition should not be altered by adding oxygen-demanding materials causing a depletion of oxygen.

2.3.5 Contaminant Loadings

Based on the flow measurements taken at time of sampling as part of the water quality sampling program, estimates of the total potential loading of key contaminants in the respective surface features was determined. **Table 2.2** summarizes the event mass loading estimates for dry, wet and melt events for each surface feature (sites 1-8) based on the water quality analysis results and respective flow estimates for the sampling dates.

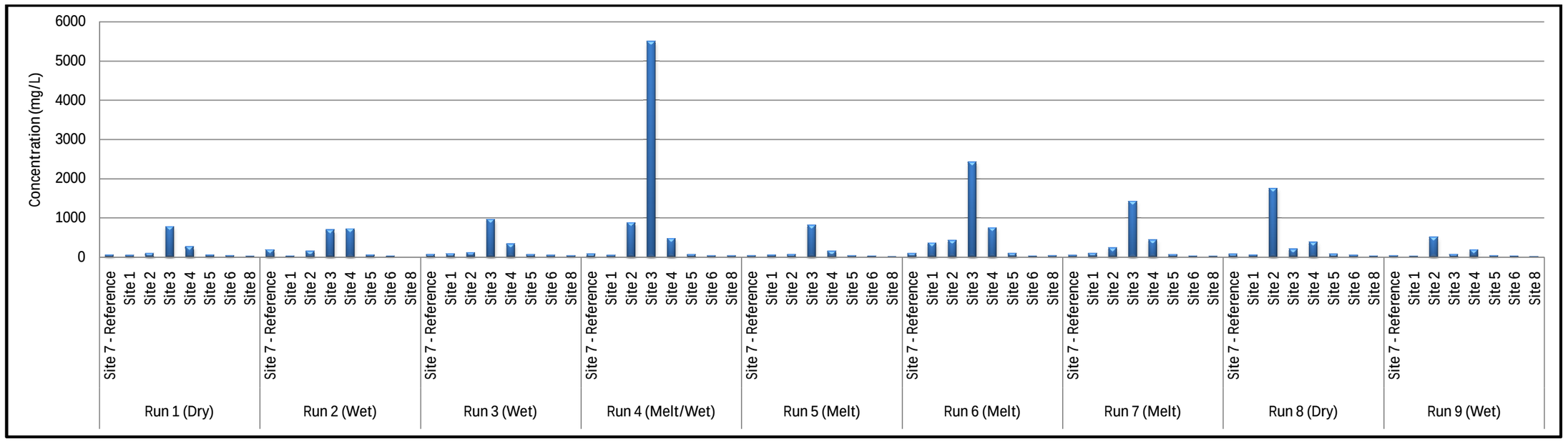


Figure 2.12 - Chloride Concentrations (mg/L) for Sampling Runs 1 - 9

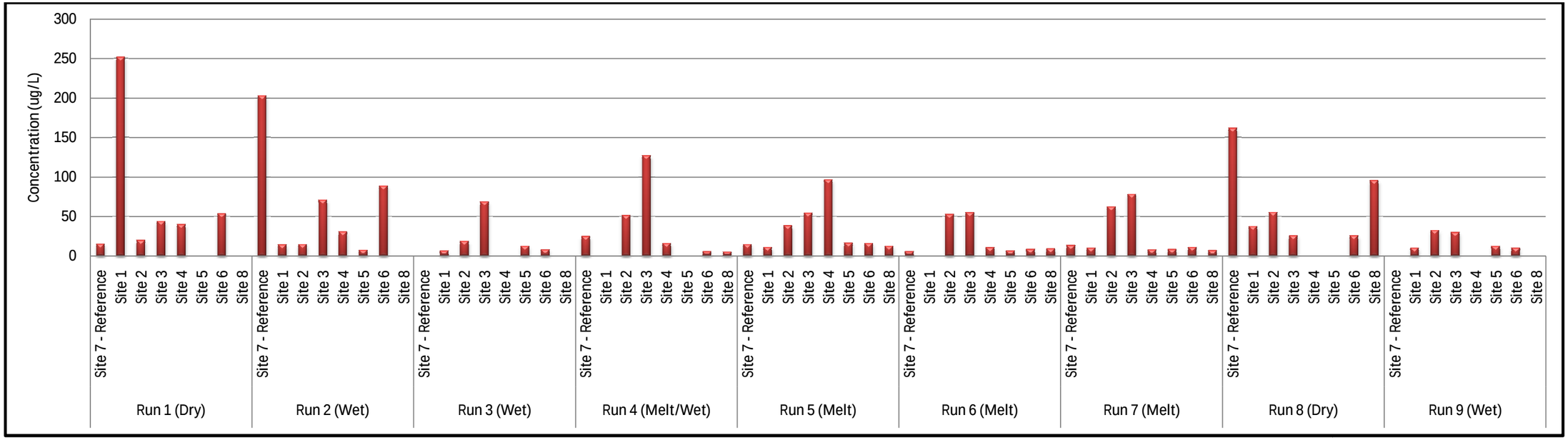


Figure 2.13 - Zinc Concentrations (µg/L) for Sampling Runs 1 - 9

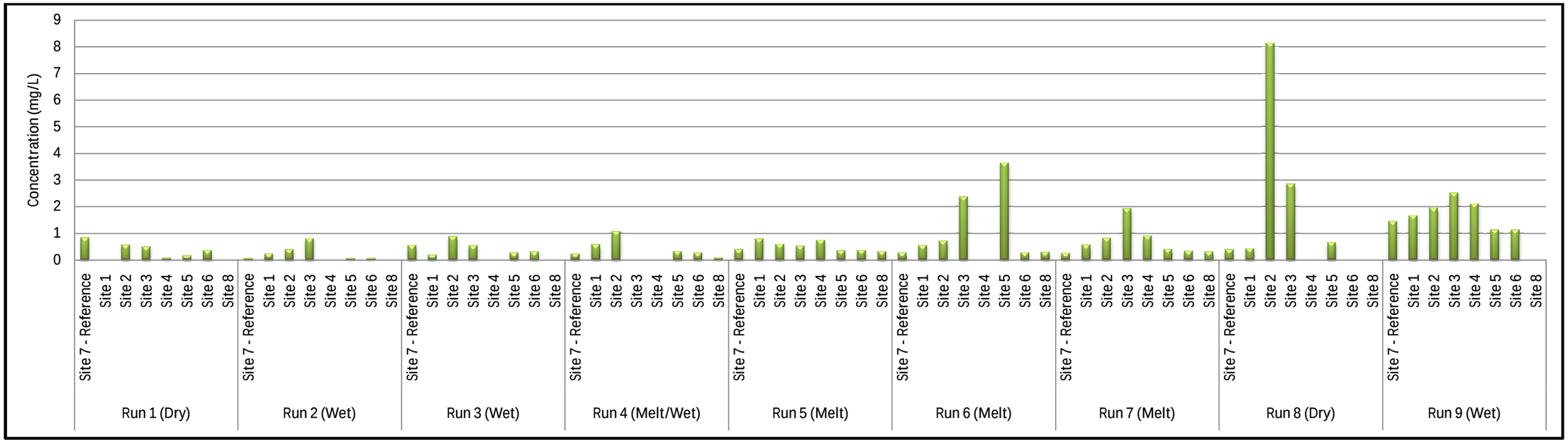


Figure 2.14 - Nitrate Concentrations (mg/L) for Sampling Runs 1 - 9

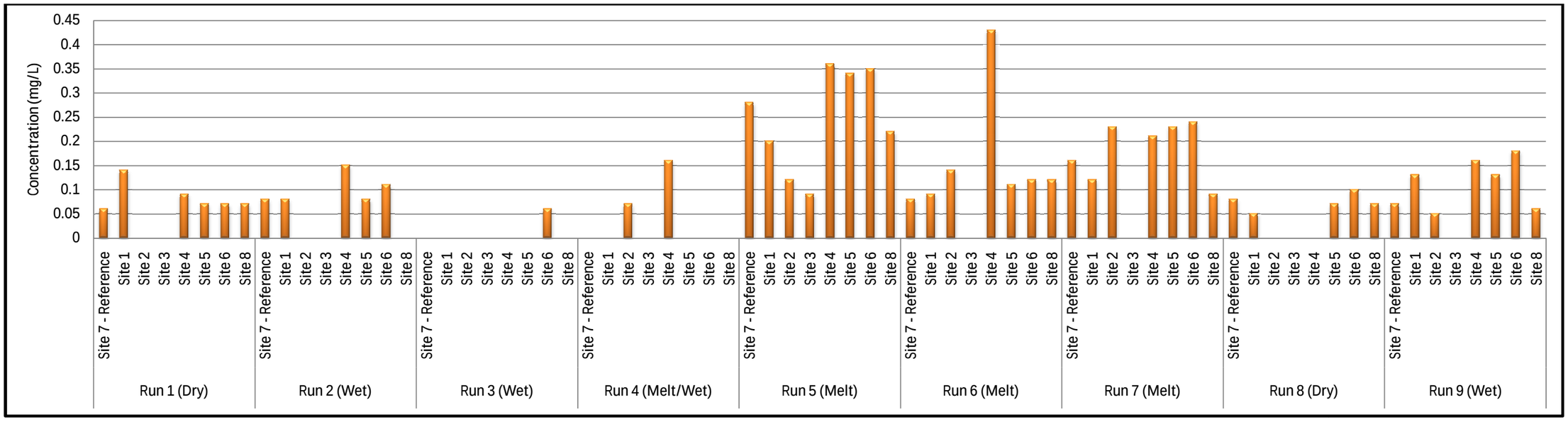


Figure 2.15 - Total Phosphorous Concentrations (mg/L) for Sampling Runs 1 - 9

Table 2.3 – Instantaneous Wet, Dry and Melt Event Mass Loadings (g/event type or mg/event type) for the Various Compounds Sampled as Part of the Water Quality Program

	Site 1				Site 2				Site 3				Site 4				Site 5				Site 6				Site 7				Site 8			
	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total	Dry	Wet	Melt	Total
BOD_5 (g)	0	0	0	0	0	0	6.13	6.13	0	0.021	0.015	0.036	0	0	1.085	1.085	0	0	0.23	0.23	0	0	0.07	0.07	0	0	0.97	0.97	0	0	5.50	5.50
Total Suspended Solids (g)	0	172.2	50.29	222	0	0.04	1.549	1.59	0.02	0.03	0.020	0.07	0.07	0	0	0.07	0.29	1.58	10.68	12.54	0	0.50	11.10	11.60	0	0.53	11.73	12.26	0.96	0	0	0.96
Nitrate Nitrogen (g)	0.02	6.86	1.46	8.34	0.14	0.01	0.06	0.21	0.01	0.01	0.033	0.047	0	0.02	0.016	0.033	0.009	0.065	0.362	0.437	0.002	0.016	0.219	0.238	0.003	0.019	0.305	0.327	0	0	0.181	0.181
Nitrite Nitrogen (g)	0	0.18	0	0.18	0	0.004	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0	0	0.004	0	0.004	0	0.003	0	0.003	0	0.002	0	0.002
Total Phosphorus (g)	0.02	0.54	0.26	0.83	0.00	0	0.012	0.012	0	0	0	0	0	0	0.072	0.073	0	0.01	0.04	0.05	0.002	0.003	0.043	0.05	0	0	0.05	0.05	0	0	0.03	0.03
Ammonia as N (g)	0	0.01	2.71	2.72	0	0	0.48	0.48	0	0	0.03	0.03	0	0	0.16	0.16	0	0	0.10	0.10	0	0	0.11	0.11	0	0	0.10	0.10	0	0	0.17	0.17
Total Kjeldahl Nitrogen (g)	0.17	4.79	5.06	10.01	0.01	0	2.99	3.01	0	0.01	0.06	0.07	0.02	0.01	0.32	0.35	0.02	0.03	0.56	0.61	0.01	0.02	0.53	0.56	0	0.02	0.39	0.42	0	0.01	0.87	0.88
Metals																																
Copper (mg)	0.16	12.03	6.23	18.43	0.04	0.01	0.61	0.66	0.01	0.03	0.07	0.10	0.08	0.01	0.65	0.74	0.03	0.17	1.37	1.57	0.02	0.05	1.26	1.32	0.01	0.06	1.65	1.72	0.12	0.02	4.79	4.93
Lead (mg)	0	2.54	0.81	3.35	0	0	0.12	0.12	0	0	0.01	0.01	0.004	0	0	0.004	0.02	0	0	0.37	0	0.03	0.43	0.46	0	0.03	0.27	0.30	0	0	0	0
Zinc (mg)	41.24	43.91	13.50	98.65	1.02	0.14	4.59	5.74	0.12	0.45	1.01	1.57	0.24	0	1.90	2.14	0	0.85	1.64	2.49	0.60	1.01	5.34	6.95	1.23	4.16	28.55	33.95	6.93	0	10.20	17.13
Chloride (g)	9.78	133.38	133.65	276.81	29.38	1.56	37.55	68.49	1.62	4.81	40.61	47.04	23.42	1.49	127.26	152.18	1.37	3.47	54.83	59.67	0.86	0.98	31.28	33.13	0.57	4.66	96.79	102.02	2.98	0.50	47.93	51.41

2.3.6 Benthic Macroinvertebrate Sampling

As part of the water quality monitoring program, benthic sampling was conducted at all eight (8) sites (**Figure 2.14)** on May 26, 2010. Results obtained help in identifying possible impacts to in-stream water quality. The ultimate goal of benthic invertebrate monitoring was to identify relationships between species composition and water chemistry and determine if results reflected impaired conditions. Complete benthic monitoring results are provided in **Appendix I.**

Benthic sampling was completed by taking three replicate samples in one reach from a riffle-pool-riffle sequence using a Surber sampler and combined these three replicates into one sample for each site location. The organisms were collected then sorted from the samples and preserved in the field using 10% buffered formalin. Sub-sampling was completed using the "bucket and ladle" method until approximately 100 organisms were sub-sampled for each sample (invertebrate counts were limited by their availability during collection). Organisms were identified in the laboratory down to the Family level other than Hirundinea, Oligochaeta and Nematoda.

Sites 2,3 and 7 correspond to the West Creek, East Creek and Reference Creek that are monitored regularly by NPCA (2006- 2009). The NPCA biomonitoring work consistently shows that the reference site has higher densities, high Water Quality Index values, a more diverse assemblage of organisms and more sensitive organisms (as represented by mayflies, caddisflies and stoneflies) that the other two sites. The East Creek Site, in particular, was the most impaired, however both creeks were more impaired than the reference site. The NPCA monitoring reports conclude that airport activities are causing water quality impairment of these watercourses from stormwater runoff and perhaps releases of propylene glycol (which was detected by its odour as noted by the NPCA).

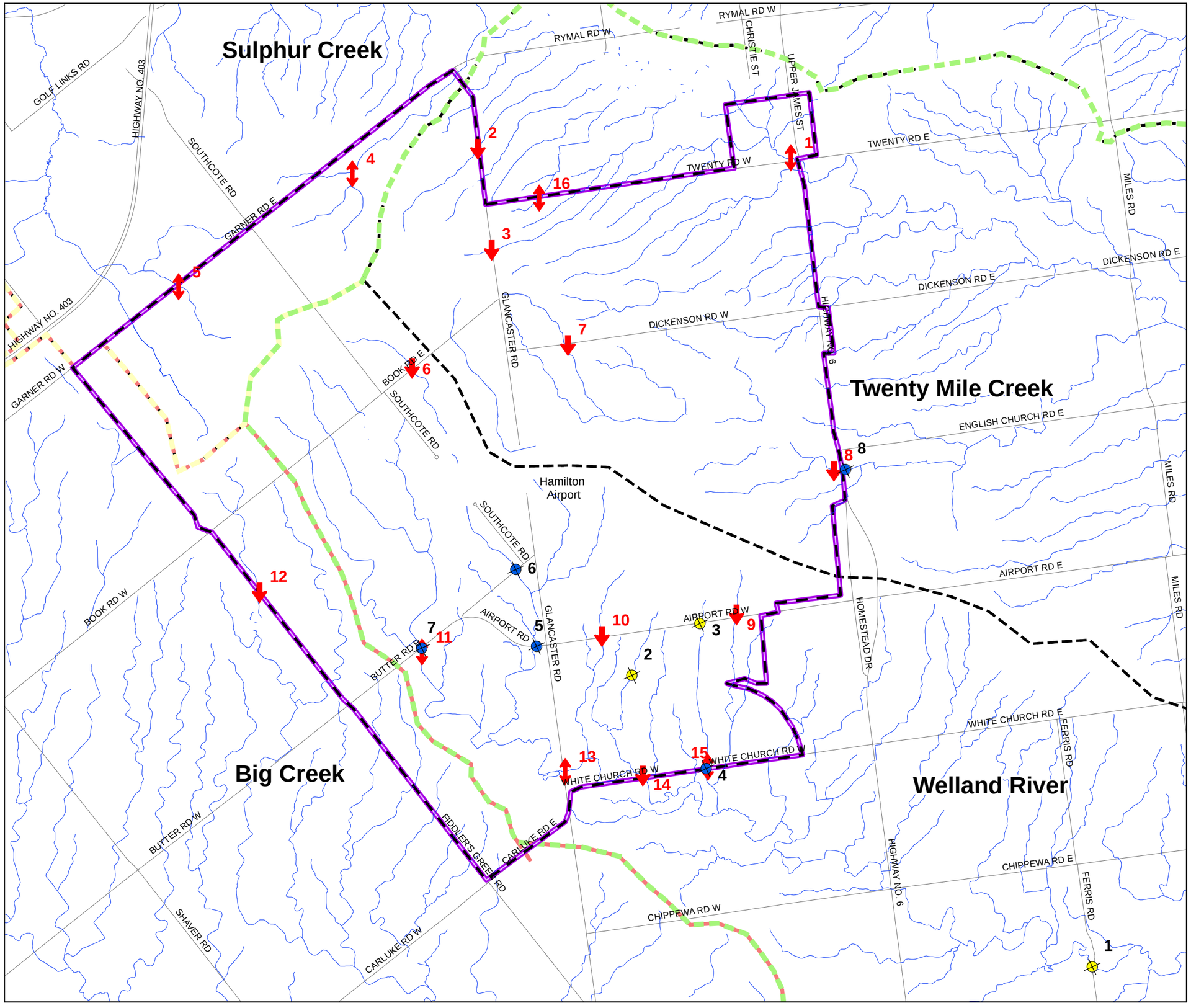
Spring results at sites 2, 3 and 7 are generally consistent with those from the NPCA studies, however densities at East Creek were somewhat higher than NPCA results and similar to West Creek, but both sites were considerably lower than densities at the reference site. In general, benthic invertebrate community at all sites receiving airport drainage is dominated by Chironomids, aquatic worms (nematodes and oligochaetes) and blackflies. Mayflies and

caddisflies were found at several stations and amphipods were found at all stations except station 3. Densities at all sites receiving airport drainage had lower densities than the reference site. All stations are considered to be moderately impaired, with the least impacted site (based on density and diversity of organisms) being the reference site (station 7) and station 5, followed by sites 1 and 6, then stations 3 and 4, and finally sites 2 and 8 being the most impacted.

Comparing the benthic results to the chemistry results, it would appear that levels of zinc, nutrients (nitrates) and chloride may be largely responsible for the observed water quality impairment. No propylene glycol releases were detected during the sampling program.

Hamilton AEGD Study Subwatershed Plan

MONITORING LOCATIONS
Figure 2.14



Legend

Surface Water Monitoring Locations

- Water Quality & Quantity Monitoring Station
- Water Quality Monitoring Station

Groundwater Monitoring Location

- Downward Gradient
- Upward Gradient
- Varies

- Study Area
- Grand River Conservation Authority
- Hamilton Conservation Authority
- Niagara Peninsula Conservation Authority

Meters

0 290 580 1,160 1,740

Map Created By: AS
Map Checked By: BH
Date Created: October 5, 2009
Date Modified:
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BUILDING A STRONG FOUNDATION HAMILTON

Hamilton
Planning & Economic Development Department

2.4 Terrestrial Studies

Limited additional field work was completed for Phase 2, however the terrestrial features mapping was updated to include other natural features identified, but not classified in Phase 1 and site visits and photographic records were obtained for all of the core wetland and forested features within the study area. All significant features including 2 Provincially Significant Wetlands/Environmentally Significant Areas, all significant woodlots and all identified wetlands are included in the Areas for Protection or Core Natural Areas identified in **Figure 2.15**. These areas also include a 30 m adjacent lands buffer. In addition, the features identified within the Greenbelt area are also considered part of the Areas for Protection/Core Natural Areas, however no adjacent lands buffer is identified with these features.

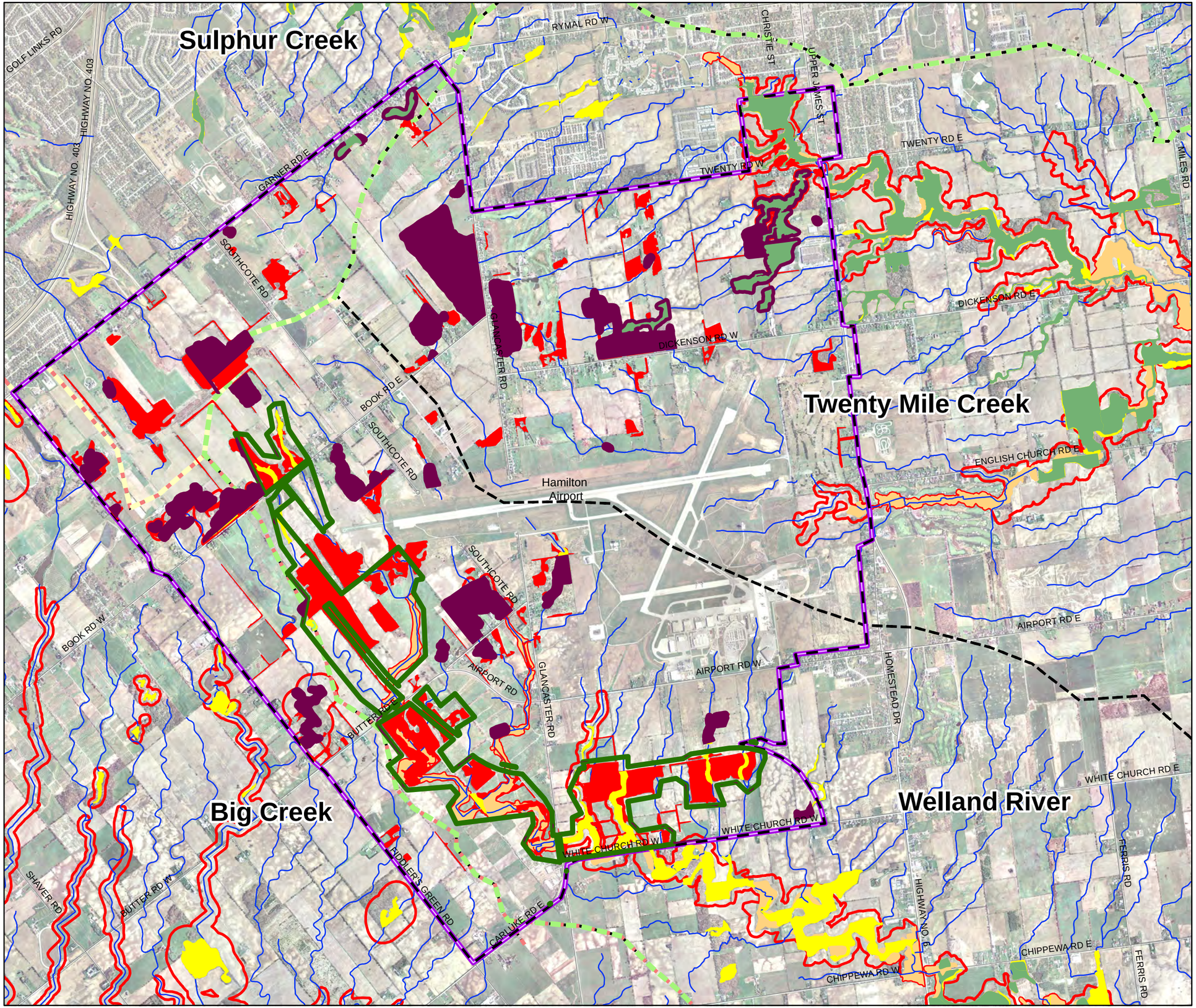
There are also numerous woodlots within the study area that do not meet the City's criteria for significant woodlots, yet may contain special status species and/or provide habitat for these species. These features will require further assessment as development proceeds and gave been identified as linkages, consistent with the City's OP.

A key element of a Natural Heritage System is the provision or identification of linkages or corridors that improve connectivity among the natural features within the study area and larger features surrounding it. In this regard, the Welland River and Twenty Mile Creek valleys downstream of the study area represent the largest complex of natural features nearby and the Greenbelt lands provide the most logical connecting corridor. In addition, there are several large woodlots on the north side of the airport that may be connected to Twenty Mile Creek along some of the headwater drainage features. Otherwise linkage opportunities to Twenty Mile Creek are limited unless an opportunity can be created within the development planning framework adjacent to or in combination with the recreational trail system network.

Based on the groundwater studies, groundwater plays a relatively minor role in supporting water-related functions wetlands. The majority of wetlands are supported by surface runoff either through connections to drainage swales or as a result of local flooding events, which can be extensive as a result of the relatively flat topography.

Hamilton AEGD Study Subwatershed Plan

TERRESTRIAL RESOURCES
Figure 2.15



Legend

- Study Area
- Grand River Conservation Authority
- Hamilton Conservation Authority
- Niagara Peninsula Conservation Authority

Core Areas

- Greenbelt Areas
- Provincially Significant Wetlands
- Significant Woodlots
- Local Wetlands

Linkage Areas

- Other Woodlots
- Floodplain
- Generic Regulation Lines*

***Generic regulations include a 30 m buffer on all watercourses.**

N

Meters

0 300 600 1,200 1,800

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2.5 Groundwater Studies

2.5.1 Geology and Soils

The Quaternary deposits in the Hamilton AEGD are between 20 and 35 metres thick (Vos, 1969) underlain by brown dolostones of the Guelph Formation (Liberty, 1975). The overburden consists of stratified clay and silt with a surface veneer of silt and sand. The silt, sand and clay were deposited by glacial Lake Warren on Halton Till. At the northwest corner of the AEGD (near Southcote), the sand deposit may be up to 6 metres thick, forming a scarp along the south margin.

The Halton Till is composed of silty clay, exposed in some of the incised headwater streams within the AEGD. The crest of the Fort Erie Moraine, with a core of Halton Till, crosses the Hamilton AEGD is a NW-SE direction.

The soil developed on these Quaternary deposits is predominantly silty clay loam and silt loam assigned to the Brantford, Beverley and Toledo Series. The former two series are imperfectly drained whereas the Toledo Series soils are poorly-drained, relatively impermeable soils with a thick organic rich “A” horizon, indicating these soils are susceptible to periodic inundation (Presant and others, 1965).

The northwest portion of the study area has a considerable thickness of Springvale sandy loam, developed on Lake Warren sand, the south boundary of which is marked by a depositional scarp and occasional gravel pits. This soil is characterized by a low water-holding capability and is very well-drained.

The slopes in the Hamilton AEGD are complex ranging from <2% on the tablelands to >10% where the soils are incised by tributaries to the Welland River and 20 Mile Creek.

2.5.2 Groundwater Resources

The Groundwater Resources Characterization study (SNC Lavalin 2004) shows that domestic water wells within the AEGD tap both overburden and bedrock aquifers. Most water wells along the east boundary of the study area (along Highway 6) tap the bedrock aquifer.

Most water wells extending from Renforth through Southcote to Garners Corners tap an overburden aquifer, consisting of sand and gravel layers within, or near the base of, the Halton Till.

The AEGD lies within the boundaries of all three of the City's (and the CA's) Source Protection Areas that includes areas designated as Significant Recharge Areas (see Figure 6.1) and High Groundwater Susceptibility Areas (see Figure 6.2). These areas are classified based on climate, soils, water table and local aquifer characteristics, as well as local domestic water wells and potential groundwater use for domestic purposes. Source protection guidelines, including land use screening and the development of contaminant management plans are recommended for these areas. This is discussed in more detail in section 6.0 as part of the groundwater management component of the subwatershed plan.

2.5.3 Groundwater Recharge and Discharge

Groundwater recharge within the AEGD study area is generally in the order of 50 – 60 mm annually due to the presence of an aquitard of glaciolacustrine silt and clay, some of which may be up to 10 metres thick (Feenstra, 1975).

Shallow groundwater gradients were examined by installing sixteen (16) drive-point piezometers in watercourses across the AEGD. Gradients were measured five times (September 3, October 1 and November 19, 2009, May 12, 2010, and July 15, 2010).

With rare exceptions, the gradients were even or slightly downward, confirming that watercourses are not gaining and few are "losing" (i.e. there is no significant groundwater discharge or recharge through the stream bed) **(Figure 2.14).**

Table 2.4 below summarizes the results of the groundwater gradient analysis using (16) drive-point piezometers.

Table 2.4 Summary of AEGD groundwater gradient analysis using (16) drive-point piezometers

		September 3, 2009				October 1, 2009				November 19, 2009				May 12, 2010				July 15, 2010				
Piezometer #	Stickup[1.]	Water Level In	Water Level Out	Relative Diff.	Gradient	Water Level In	Water Level Out	Relative Diff.	Gradient	Water Level In	Water Level Out	Relative Diff.	Gradient	Water Level In	Water Level Out	Relative Diff.	Gradient	Water Level In	Water Level Out	Relative Diff.	Gradient	**Overall**
P1	0.98	1.53	0.55	0.98	Down	0.82	0.59	0.23	Down	0.56	0.57	-0.01	Level**	-	-	-	-	-	-	-	-	**Down**
P2	0.60	1.62	0.55	1.07	Down	1.39	0.56	0.83	Down	1.14	0.56	0.68	Down	0.48	0.64	-0.16	Up	0.46	0.62	-0.16	Up	**Varies**
P3	0.79	1.49	0.72	0.77	Down	1.31	0.75	0.56	Down	1.12	0.72	0.40	Down	0.88	0.76	0.12	Down	0.84	>0.79 (dry)	-	-	**Down**
P4	0.81	1.51 (dry)	0.70	<0.81	Down	0.96	0.73	0.23	Down	0.56	0.70	-0.14	Up	0.42	0.72	-0.30***	Up	0.39	0.76	-0.37***	Up	**Varies**
P5	0.89	0.86	0.87	-0.01	Level	0.98	>0.89 (dry)	>0.09	n/a	1.04	>0.89 (dry)	>0.15	Level*	0.88	0.93	-0.05	Up	0.97	>0.89 (dry)	-	Up	**Varies**
P6	0.66	1.45	0.60	0.85	Down	0.68	0.61	0.07	Down	0.60	0.60	0	Level	0.61	0.66	-0.05	Up	0.61	0.61	0	Level	**Down**
P7	0.78	1.51 (dry)	0.72	<0.79	Down	1.30	0.79	0.51	Down	1.04	0.74	0.30	Down	0.72	0.74	-0.02	Level**	0.72	>0.78 (dry)	>-0.06	Up	**Down**
P8	1.00	1.42	0.80	0.62	Down	1.34	0.83	0.51	Down	1.26	0.76	0.50	Down	1.09	0.76	0.33	Down	1.04	0.91	0.13	Down	**Varies**
P9	0.80	1.56	0.70	0.86	Down	0.96	0.70	0.26	Down	0.64	0.63	0.01	Level	0.61	0.69	-0.08	Up	-	-	-	-	**Varies**
P10	0.73	1.60	0.67	0.93	Down	1.46	0.68	0.93	Down	1.33	0.62	0.71	Down	1.10	0.68	0.42	Down	1.03	>0.73 (dry)	-	-	**Down**
P11	0.90	0.82	0.80	0.02	Down	0.81	0.84	-0.03	Up	0.74	0.75	-0.01	Level**	0.76	0.80	-0.04	Up	0.92	0.92	0	Level	**Varies**
P12	0.85	1.60	0.77	0.83	Down	1.47	0.78	0.69	Down	1.47	0.78	0.69	Down	0.93	0.75	0.18	Down	0.90	>0.85 (dry)	-	-	**Down**
P13	1.05	1.05	0.62	0.43	Down	0.78	0.70	0.08	Down	0.62	0.66	-0.04	Up	0.53	0.61	-0.08	Level [2.]	0.73	0.78	-0.05	Up	**Varies**
P14	1.11	1.30	0.84	0.46	Down	0.93	0.90	0.03	Down	0.76	0.77	-0.01	Level**	0.81	0.88	-0.07***	Up	0.91	1.02	-0.11***	Up	**Varies**
P15	0.89	1.43	0.85	0.58	Down	0.83	0.85	-0.02	Up	0.80	0.80	0	Level	0.77	0.84	-0.07	Up	0.82	>0.89 (dry)	>-0.07	Up	**Varies**
P16	0.83	-	-	-	-	1.47	>0.83 (dry)	>0.64	Down	1.27	0.80	0.47	Down	0.92	0.82	0.10	Down	0.90	>0.83 (dry)	-	-	**Varies**

[1.] – Refers to measurement above stream bed

[2.]- piezometer tube was leaning – straightened before measurement – gradient should be level

* - visual projection of adjacent surface water level to piezometer indicates a level gradient

** - levels inside the piezometer higher than the surface water by about 1cm is caused by displacement of water due to the base of the probe entering the water before the sensor

*** - cap missing

- no reading – piezometer missing or damaged

2.5.4 Infiltration Potential

Infiltration potential in near-surface soils is low to moderate due to extensive veneer of glaciolacustrine silt and clay across the AEGD. However, the SNC Lavalin study (2004, s. 3.4.5 and Figure 3.11B) reports considerable thicknesses of sand and gravel along Glancaster Road, locally reaching thicknesses of 15 metres between Dickenson and 20th Road West.

It should be noted that the "sand and gravel" represents a grouping of consecutive sand and gravel layers with an interlayer aquitard of less than 1 metre to form the "parent" unit. The SNC Lavalin study considered that a "parent unit" of sand and gravel was significant if its aggregate thickness was >2 metres. The depth at which these sand and gravel deposits occur is not readily apparent from the SNC Lavalin study.

2.5.5 Source Water Protection Areas

The following information is taken largely from the following Source Protection documents, including the material reproduced in Section 6.0, Figures 6.1 and 6.2:

- Groundwater Vulnerability Analysis. Niagara Peninsula Source Protection Area. NPCA 2009.

- Significant Groundwater Recharge Area Delineation. Niagara Source Protection Area. NPCA and AquaResource Inc. 2009

2.5.5.1 Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (See Section 6.0, Figure 6.1) were determined through consultation with MNR and is based on the Draft 2007 Guidance Module – Water Budget and Water Quantity Risk Assessment and the Assessment Report Technical Rules (MOE 2009), Regulation 287/07 and Technical Bulletin methodology descriptions (MNR, MOE 2009). For this area, the key rule that defines a Significant Groundwater Recharge Area is as follows;

- The area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more, and the area has a hydrologic connection to a surface water body or aquifer that is a source of drinking water for a drinking water system (which includes domestic wells).

For the all of the Source Protection Areas within the Study Area, the annual rate of recharge was calculated based essentially on the entire area, since infiltration rate does not vary greatly by phyisography (predominantly the Haldimand Clay plain and Lake Iroquois Shoreline which make up 96% of the NPSP area, for example), and all areas drain to Lakes Ontario, Erie or the Niagara River. In addition, the four aquifer units, the basal granular and bedrock aquifer, the Guelph/Lockport formation, the Onondaga/Bois Blanc Formation, and the Fonthill Kame – Delta Moraine, are considered to be largely interconnected. The infiltration rate was therefore determined to be 46 mm, so with the the application factor it becomes 53 mm. Thus the Significant Groundwater Recharge Areas shown in Figure 6.1 include all areas with annual infiltration rates greater than 53 mm. While in some areas (for example along Great Lake shorelines) the SGRA's were reduced in area where municipal water serviced areas were located, the serviced and future serviced area in the Study Area was not excluded because there are down-gradient domestic water users (private wells).

2.5.5.2 Groundwater Susceptibility Areas

The Study Area was classified, into High, Medium and Low Groundwater Susceptibility (GwiSI) areas (See Section 6.0 ,Figure 6.2), based on the Assessment Report Technical Rules (MOE 2009). The primary aquifer systems that are water supply aquifers in the Study Area include:

- The Guelph Lockport formation
- The "contact zone" which is an overburden aquifer consisting of granular overburden and fractured bedrock overlain by clay (generally about 5 m in the Study Area)

The vulnerability of these groundwater features was assessed using a combination of a AVI analysis and a GwISI analysis, which produced comparable results. Generally areas of high groundwater susceptibility occur:

- In the presence of highly permeable overburden units with little, or no, low conductivity layers overlying the aquifer (these systems are generally not found in the Study Area)
- Where bedrock outcrops or where it is overlain by thin (< 5 m) deposits (this can include deposits of clayey or silty till and glaciolacustrine deposits that may contain hairline fractures that increase the hydraulic conductivity of the overburden by several orders of magnitude). These systems are generally found in the study area.

The second component of establishing groundwater susceptibility is to identify transport pathways for contaminants that would increase vulnerability including:

- Private water wells (including abandoned wells)
- "unknown" status oil and gas wells
- Aggregate operations

In the study area, private wells and abandoned wells have the potential to increase groundwater susceptibility and change medium and low susceptibility to high. As such, with the assumption that the entire AEGD will be developed under full municipal services (both water and sanitary sewage), existing wells (either private or on municipally-owned lands) will require appropriate decommissioning under O.Reg. 903 as the properties are either abandoned or redeveloped and are in a position to be serviced by municipal water and sanitary sewer. Partial servicing (condition where municipal water, but not municipal sewage service is available) is not typically be expected in the AEGD as development proceeds and is only permitted only subject to the conditions within Provincial Policy Statement (2005) under section 1.6.4.5.

The areas in **Figure 6.2** shown as high Groundwater Susceptibility areas, represent areas where water supply aquifers generally have a low degree of protection from the land surface because of they are in areas of exposed bedrock or shallow (<5 m) overburden and are highly susceptible to contamination because of domestic wells that act as transport pathways. Areas identified as highly vulnerable/ susceptible (**Figure 6.2)** will require additional Hydrogeological investigations prior to development.

2.5.6 Conclusions

- The AEGD lies within the boundaries of all three of the City's (and the CA's) Source Protection Areas that includes areas designated as Significant Recharge Areas (see Figure 6.1) and High Groundwater Susceptibility Areas (see Figure 6.2). These areas are classified based on climate, soils, water table and local aquifer characteristics, as well as local domestic water wells and potential groundwater use for domestic purposes. Source protection guidelines, including land use screening and the development of contaminant management plans are recommended for these areas. This is discussed in more detail in section 6.0 as part of the subwatershed groundwater management plan.

- Groundwater recharge and discharge functions are not identified as significant in the AEGD from a hydrologic and ecological perspective, however maintenance of existing water balance characteristics is required to maintain existing functions;

- Groundwater is not a significant component of surface geomorphology, stream habitat and the function of wetlands. These features are dominated by runoff; and

- Annual cycles of chloride and nitrate are consistent with high expected runoff from agricultural fertilizers and de-icing salts;

- Generally, the following recommendations are put forward to reduce the potential to increase groundwater susceptibility and to be consistent with the current initiatives under the Source Protection Program:

    - The City should undertake a review of all wells in the study area to determine their current location and status (in use or abandoned) and that any wells remain after servicing is available, that these be properly decommissioned as noted above.

    - Any existing abandoned or unused wells that can be identified now should be decommissioned as soon as possible.

    - Wells should be abandoned as directed under O.Reg. 903 as both municipal water and municipal sewage become available concurrently and as development proceeds.

- Areas identified as highly vulnerable/ susceptible (**Figure 6.2)** will require additional Hydrogeological investigations prior to proceeding with development.

3.0 Issues, Opportunities and Constraints

There are a number of issues, opportunities and constraints associated with the study area from a natural environment and water management perspective, as follows:

- Headwaters of 4 different watersheds with flat topography and relatively low to moderate permeability soils
- The AEGD lies within the boundaries of all three of the City's (and the CA's) Source Protection Areas that includes areas designated as Significant Recharge Areas and High Groundwater Susceptibility Areas. These areas are classified based on climate, soils, water table and local aquifer characteristics, as well as local domestic water wells and potential groundwater use for domestic purposes.
- Airport restrictions on open water and bird populations make wet ponds for stormwater management infeasible
- Generally low permeability soils present a challenge for implementing groundwater infiltration techniques in end-of-pipe applications. However, the use of dispersed/decentralized source and conveyance controls (provided they are properly sized and engineered) largely removes permeability limitations and may provide an opportunity to better manage pre-development hydrology and water balance criteria.
- Flat terrain and small headwater features create large floodplains and result in nuisance flooding conditions
- Small drainage features are very susceptible to impacts of increased runoff and may be too shallow to provide outlets for stormwater management facilities
- Eco-industrial park concept is well suited to a LID SWM approach
- Groundwater functions are generally not as significant as in other areas in supporting wetlands and watercourses
- Fish habitats are generally seasonal or warmwater and lack permanent baseflow, riparian vegetation, receive excessive sediment loads and have poor instream habitat conditions
- Wetlands are generally absent within the study area, but large wetland features exist downstream on Twenty Mile Creek and Welland River
- The Greenbelt lands provide for a significant area of natural features and agricultural lands to be preserved which provides an opportunity to have a significant terrestrial linkage from the Welland River valley to nearby significant woodlots
- Existing stormwater facilities in communities adjacent to the study area on the north side along Garner Road and Twenty Road accept surface flows from within the study area and are presently managed privately without the City possessing legal access for inspection, maintenance or upgrade (See Part B- Section 5.1.1).

4.0 Subwatershed Goals and Objectives

As part of the land use planning framework for the AEGD, a vision and principles for the underlying eco-industrial concept for future growth of the area were developed. The overall vision and the natural environment principles are as follows:

- VISION: The Airport Employment Growth District is vibrant and visually appealing and the natural and cultural heritage resources in the area have been preserved and used to establish a distinct character for the area. It is a working community that attracts a range of airport related and other businesses providing both conventional and knowledge-based services**.** The environmental footprint of the area has been managed through a range of sustainable design techniques and the character of the surrounding land uses have been protected through appropriate land use transitions and transportation planning.

- PRINCIPLES: Through sustainable design and appropriate development the employment district protects and enhances the natural environment. The intent is to:
    - Develop in a manner that is sensitive to the natural environment.
    - Use innovative, sustainable storm and wastewater infrastructure to protect water quality.
    - Protect and integrate provincially and municipally significant natural features, such as streams, wetlands, mature trees and forests into the employment district's development, implement provincial policy and meet municipal policy.
    - Respect and incorporate natural topography.
    - Use sustainable design to limit the emissions, water and energy consumption of buildings within the employment district.
    - Connect the employment district's open space system to surrounding natural areas to allow employees to enjoy and explore the region's natural heritage.

This vision and principles were reviewed and compared to the watershed goals and objectives developed for the Twenty Mile Creek Watershed Plan to develop a set of subwatershed goals and objectives:

4.1 Goals

- To protect the natural environments of the AEGD watershed ecosystem, within the context of a sustainable eco-industrial land use planning framework, for the benefit of humans and other terrestrial and aquatic life.
- To promote environmentally sound water management practices that recognize the interdependencies between the headwater features and the natural water balance of the area and their hydrologic contributions downstream.

4.2 Objectives

4.2.1 Communication & Education

- Demonstrate and promote awareness of the linkages between clean water, healthy lifestyles, and the economic viability of rural and urban land use
- Promote the use of surface and ground water having regard to human, agricultural, and ecological needs
- Promote environmental stewardship of aquatic and terrestrial habitats

4.2.2 Water Quantity

- Manage flooding and erosion risks to human life and property to within acceptable limits
- Maintain, enhance or restore stream processes to support human uses, agricultural needs and natural habitats
- Manage flows to reduce erosion and sediment impacts on habitats and property
- Protect groundwater water resources in order to support ecological and human use functions

4.2.3 Water Quality

- Maintain or improve surface/groundwater water quality in order to support ecological and human use functions
- Reduce or eliminate objectionable deposits, nuisance algae growth, turbidity and odour to improve aesthetics of the area's surface waters

4.2.4 Aquatic Communities and Habitats

§ Protect, enhance or restore populations of native aquatic species and their habitats

4.2.5 Terrestrial Communities

§ Protect, enhance or restore the habitats that support terrestrial species and communities

5.0 Future Land Uses and Potential Impacts

The development of land use options for the Airport Employment Growth District was completed and represented the first part of the planning process for the Phase 2 Secondary Plan. These options were the first step in evaluating alternative approaches to place employment and other related uses in the AEGD area. Three land use options were drafted and evaluated: Light Industrial Business Park, Prestige Business Park and Hybrid Business Park/Light Industrial, with the Hybrid Business Park being selected as the preferred option for development.

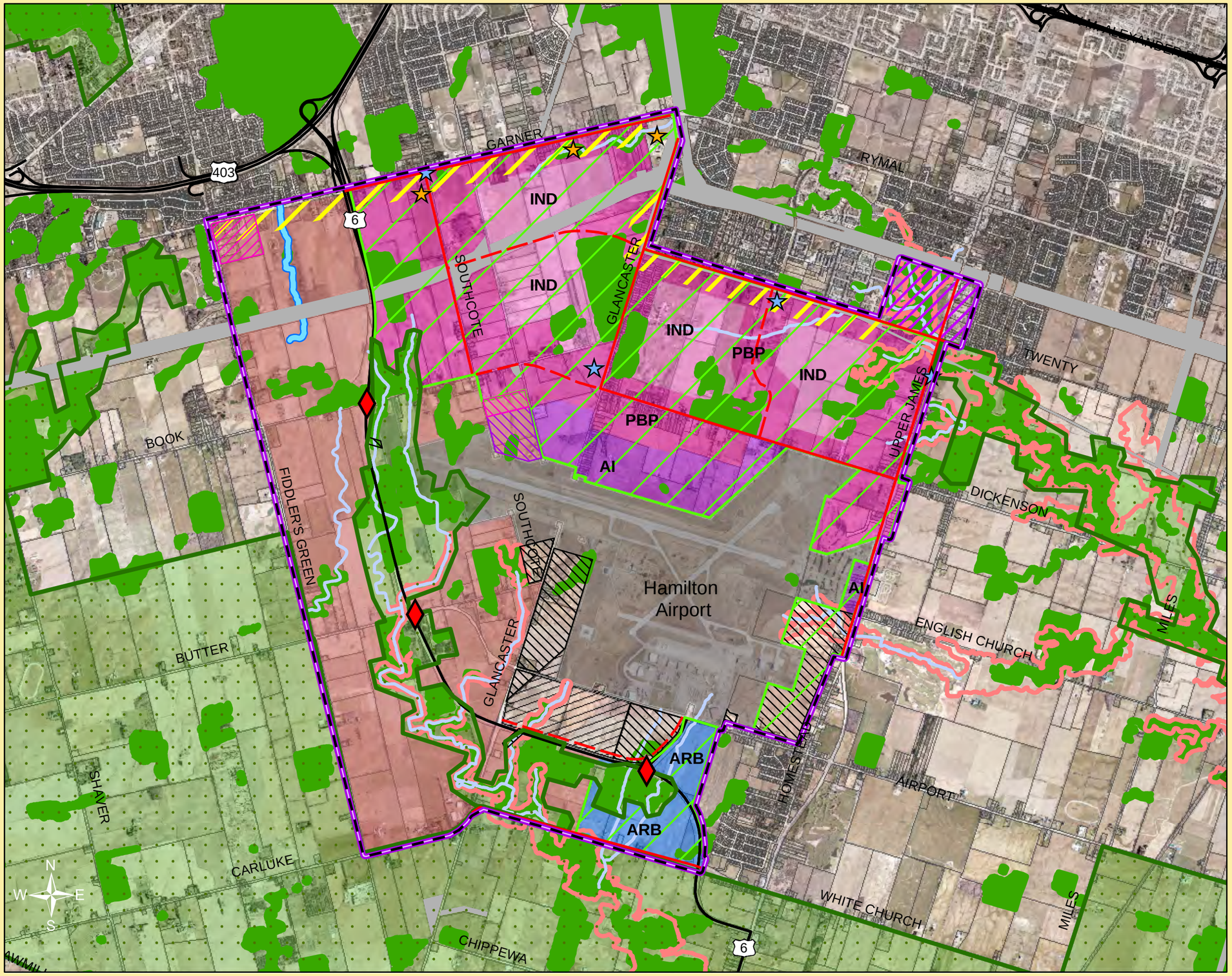
In Phase 2, the preferred alternative was refined and has become the basis for completing the Phase 2 infrastructure reports, including the integrated Subwatershed/Stormwater Master Plan. The preferred plan provides a growth strategy for development around the airport that includes planning to the year 2031 (Secondary Plan Area) to meet provincial growth management objectives, as well as providing an additional employment reserve area for potential growth beyond 2031 (Additional Study Area). **Figures 5.0 and 5.1** illustrate the preferred plan and the staging, respectively.

The Secondary Plan Area land use plan was further broken down into two phases as follows:

- Phase 1: growth that can occur without additional expansion of water and wastewater infrastructure
- Phase 2: growth that will require new water and wastewater infrastructure

The following provides an overview of the four employment land use categories:

1. Airport Related Business (ARB);
2. Airside Industrial (AI);
3. Light Industrial (IND); and
4. Prestige Business Park (PBP)



Hamilton

Hamilton AEGD Study

Figure 5: Secondary Plan Area

Legend

- Secondary Plan Area
- Additional Study Area
- Existing Airport Holdings
- Airport Expansion Area*
- Future Airport Land Requirements
- AI: Airside Industrial
- ARB: Airport-Related Business
- IND: Light Industrial
- PBP: Prestige Business Park
- Ancaster Chrisitian Reform Church Property - Prestige Business Park
- Smith Farm Property - Prestige Business Park
- Smith Farm Property - Airside Industrial
- Transitional Employment Zone
- Utilities
- Greenbelt Plan Area
- Core Natural Features Areas**
- Floodplain
- 60m Cool Water Stream Setback
- 30m Aquatic Setback
- Parcel
- Airport Employment Growth District Boundary
- Lands Proposed to be Removed from Employment Area
- Proposed Interchange
- Provincial Highway
- Arterial (Major/Minor)
- Proposed Arterial (Potential Alignment)
- Employment Supportive Centres
- Existing Institutional

*Airport Expansion Lands approved by Council

**Core Areas provided by the City of Hamilton (Hamilton Offical Plan Schedule B Natural Heritage System)
Areas are generally made up of environmentally sensitive areas, ANSI, wetlands, significant woodlots, significant wildlife, Niagara Escarpment Natural Areas, hazard lands and Rare Species.

Base data provided by the City of Hamilton

1 : 36,000 (NTS)

0 400 800 1,600 2,400m

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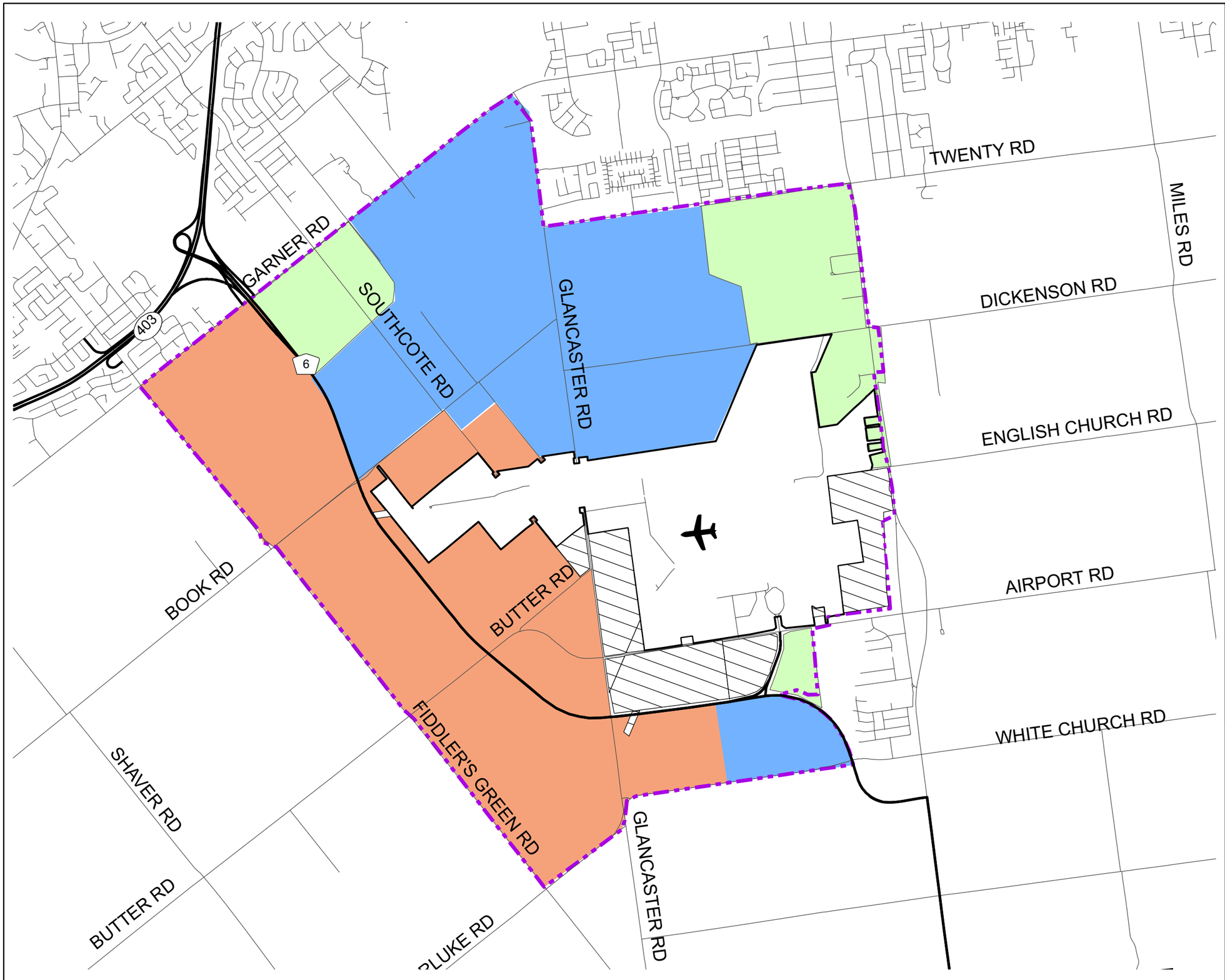
Map Created By: SFG
Map Checked By: EC
Date Created: December 20, 2007
Date Modified: January 13, 2011
File Path: I:\GIS\081276 - Hamilton AEGD Project\Mapping\TMP 2011\Figure 5 Preferred Land Use Option.mxd


TWENTY RD
MILES RD
DICKENSON RD
ENGLISH CHURCH RD
AIRPORT RD
WHITE CHURCH RD
GARNER RD
SOUTHCOTE RD
GLANCASTER RD
403
6
BUTTER RD
FIDDLER'S GREEN RD
BOOK RD
SHAVER RD
BUTTER RD
GLANCASTER RD
Legend
Secondary Plan Area - Servicing Phase 1
Secondary Plan Area - Servicing Phase 2
Additional Study Area
Airport Reserve
Airport Employment Growth District Secondary Plan Boundary
John C. Munro Hamilton International Airport
Airport Employment Growth District Secondary Plan
Figure 5.1
Phasing Plan
N
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Hamilton
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May, 2010
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5.1 Airport Related Business (ARB)

The ARB lands, located adjacent to the HIA, will have direct access to the airside and will be focused for businesses that require airside access, such as freight-forwarders, regional integrator operations (i.e. FedEx, UPS) and on-site customs brokers. This designation allows a broad range of employment uses, including light industry, warehousing, wholesale trade, distribution, outdoor storage, office, transportation, communication and utilities, among other uses. All will need to demonstrate the need for airside access to locate on these properties. This designation will have minimum standards for urban design (relative to the prestige areas) and will require a high level of sustainable design. In addition, this designation allows Employment Support uses that primarily support industry, businesses and employees within the employment area, such as commercial schools, amenities (e.g. health services, recreational facilities, open spaces, offices, entertainment, convenience commercial, gym and restaurants), financial establishments, personal services and labour association halls. It also allows accessory uses, such as smaller offices and retail.

5.2 Light Industrial (IND)

The IND designation allows a broad range of employment uses, including light industry, warehousing, repair service, wholesale trade, office, distribution, transportation, communication and utilities, among others. This designation will have minimum standards for urban design (relative to the prestige areas) and will require a high level of sustainable design. In addition, it allows Employment Support uses that primarily support industry, businesses and employees within the employment area, such as Employment Support to the primary use, commercial schools, amenities (e.g. health

services, and recreational facilities, open spaces, offices, entertainment, convenience commercial and gyms), financial establishments, restaurants, commercial rental establishments, personal services and labour association halls. It also allows accessory uses, such as smaller offices and retail. Controlled outdoor storage is permitted within this area.

5.3 Airside Industrial (AI)

AI designation will be focused on clustering accommodation; food and catering services; convention centres; research & development; offices; business/financial services; automobile rental; taxi terminals; and, Employment Support and supporting services, among other uses. These areas are set to have high quality urban design standards, sustainable development standards and the incorporation of amenities supporting employment (i.e. retail, offices, gym, services and restaurants). No light industry, warehousing, distribution, or outdoor storage is permitted.

5.4 Prestige Business Park (PBP)

Areas designated as PBP are set to have a high quality urban design and sustainable development standards. Businesses in PBP areas will integrate the natural sensitive features into their landscaping while providing all employees with opportunities for recreation and active transportation. The focus of the PBP designation is on business/financial services, research and development, offices, prestige/light industrial, warehousing, wholesale trade, transportation, communication and government services, among other uses. Outdoor storage is only permitted within this area subject to strict design

guidelines. In addition, this designation allows Employment Support uses that primarily support industry, businesses and employees within the employment area, such as commercial schools; amenities (i.e. health services, recreational facilities, open spaces, offices, entertainment, convenience commercial, gym and restaurants); financial establishments; personal services; and, labour association halls. It also allows accessory uses, such as offices and retail.

5.5 Council Directed Additional Lands

The Council Directed Additional Lands (CDAL), as the name suggests, were added by Hamilton City council at the request of the property owners and the public and as such are not part of the Secondary Plan Area. These lands were however part of the AEGD study area and were included in the subwatershed study analysis and mapping. The Recommended Subwatershed Plan detailed in Section 6.0, applies to the Council Directed Additional Lands (CDAL).

The CDAL lands are comprised of the following properties (**Figure 5**); each designated a land use as per the four employment land use categories detailed above:

1. The Ancaster Christian Reform Church (15.8ha): designated as Prestige Business Park (PBP), see **Section 5.4**.

2. The Smith Farm (approx. 22ha)
    - Smith Farm (North Portion – 6.4ha): designated as Prestige Business Park (PBP), see **Section 5.4**.
    - Smith Farm (South Portion – 15.4ha): designated as Airside Industrial (AI), see **Section 5.3**.

5.6 Future Land Uses and Potential Impacts: Conclusions

A number of potential opportunities and constraints from the development of this land use plan were addressed through the iterative planning process in addressing natural heritage and water resources systems as the land use plan was being developed including:

- A natural heritage system was identified by protecting significant woodlots and other significant features, as input to the development of the land use plan. This included protecting 30 m buffers around these core features

- The presence of a large Greenbelt Area within the study area was recognized and planning of land uses around this area in part provided a logical separation between Phase 1 and Phase 2 development
- The eco-industrial park concept is ideally suited to the implementation of LID Stormwater Management approaches and measures, which are also the SWM approach of choice because of airport restrictions on open waters.

At the completion of the integrative planning and adaptive management process, a number of potential impacts remain to be addressed:

- A number of smaller woodlots remain on the landscape as linkages that were not protected as part of the core areas
- The relatively high density and potential to create large impervious areas within the development areas has potential to impair or eliminate many of the numerous headwater drainage features and the need to develop a protected system of stream corridors, important in sustaining hydrology, water quality, flood management and fish habitats both within and downstream of the study area.

These issues are discussed in more detail in the following section.

6.0 Recommended Subwatershed Plan

6.1 Subwatershed Planning Guidelines

An integral component of the development of the land use plan for the AEGD is the preparation of a subwatershed plan for the watersheds within the study area. Lands within the AEGD are uniquely situated within the headwaters of four watersheds, Sulphur Creek (Cootes Paradise), Twenty Mile Creek (Lake Ontario), Welland River (Niagara River) and `1 (Grand River). The myriad of small headwater features, combined with restrictions on open water/wetland features imposed by the airport, present a unique challenge in terms of protection of stream corridors and natural heritage features, and stormwater management design that require state of art technologies consistent with Low Impact Development design. While the Airport and its future

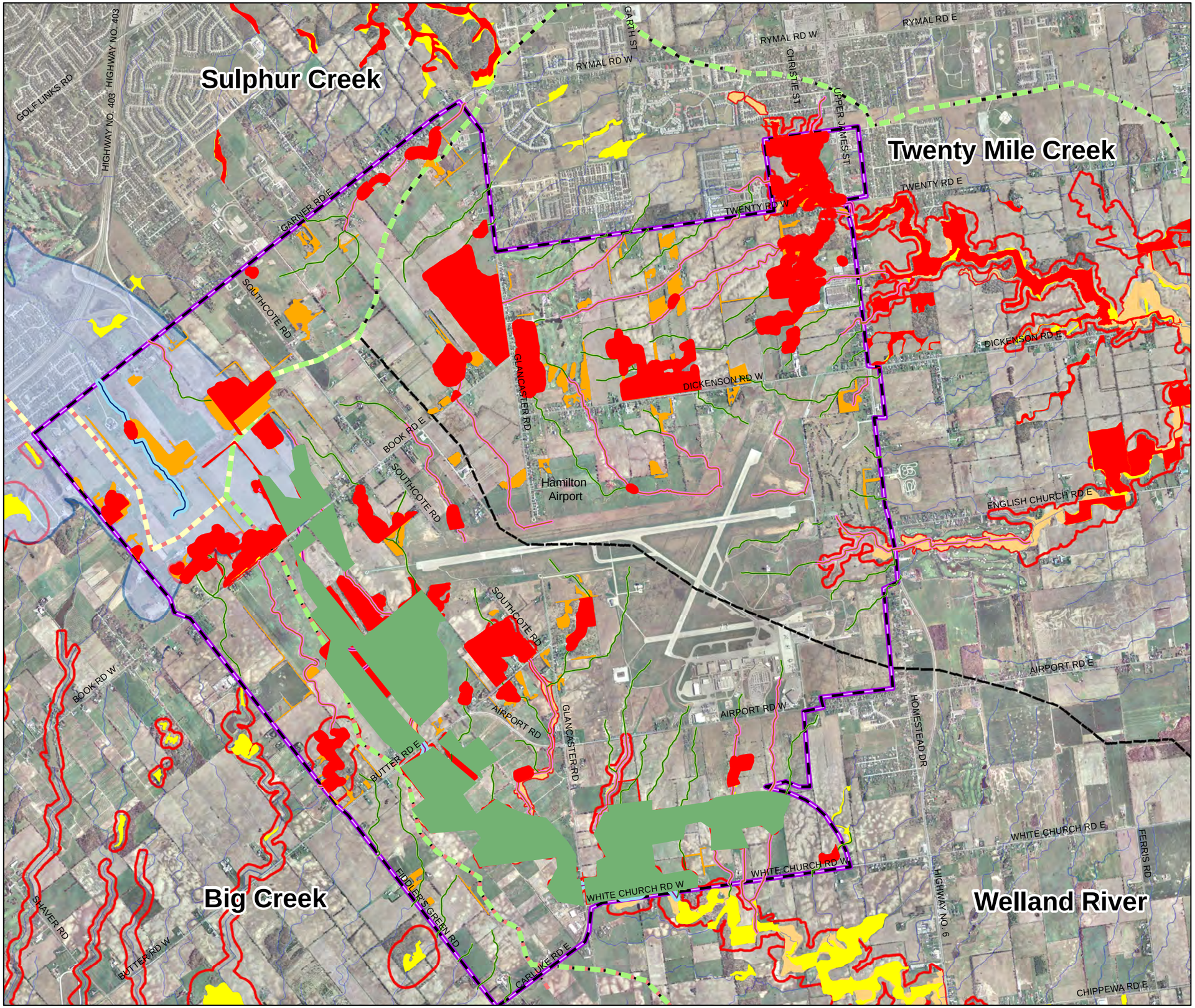
land requirements are not explicitly included in the study, many of the recommendations have relevance to these lands.

The AEGD Subwatershed Plan consists of three components:

- A Natural Heritage System component (**Figure 6.0**): this plan identifies core and support features (wetlands, forests, stream corridors) that are to be protected within the proposed land use plan, as well as providing guidance for the preparation of Environmental Impact Statements for lands adjacent to the NHS and for additional features within the study area;
- A Groundwater Management component **(Figures 6.1 and 6.2**): this plan identifies important groundwater features, such as recharge and discharge areas, defines the water balance criteria that need to be maintained as development proceeds and identifies requirements for protection of existing private and public wells in the study area.
- A Surface Water Management component (Part B Figure 3.3): this plan identifies stream corridors that require protection in order to address flood/erosion control and fish habitat requirements, as well as defining stormwater management guidelines to prevent increases in flooding and erosion, enhance water quality and maintain the existing conditions water balance.

Hamilton AEGD Study Subwatershed Plan

RECOMENDED NATURAL HERITAGE SYSTEM
Figure 6.0



Legend

- Study Area
- Grand River Conservation Authority
- Hamilton Conservation Authority
- Niagara Peninsula Conservation Authority

Areas for Protection

- Greenbelt Areas
- Floodplain
- Core Areas
- Local Wetlands

Fish Community Type

- Cool
- Seasonal
- Support/Indirect Fish Habitat
- Warm

MNR Fish Habitat Buffers

- Seasonal/Warmwater Watercourse/Important/Marginal Habitat (30m)
- Cool/Coldwater Watercourse/Critical Habitat (60m)

Potential Enhancement Areas*

- Linkages - Other Woodlots
- Indirect/Support Fish Habitat/Marginal Habitat (30m)**
- High Recharge potential
- Generic Regulation Lines***

NOTES:

*Subject to detailed EIS study
**if watercourse is retained as an enhanced feature.
***Generic regulations include a 30 m buffer on all watercourses.

Meters
0 262.5 525 1,050 1,575

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BUILDING A STRONG FOUNDATION HAMILTON

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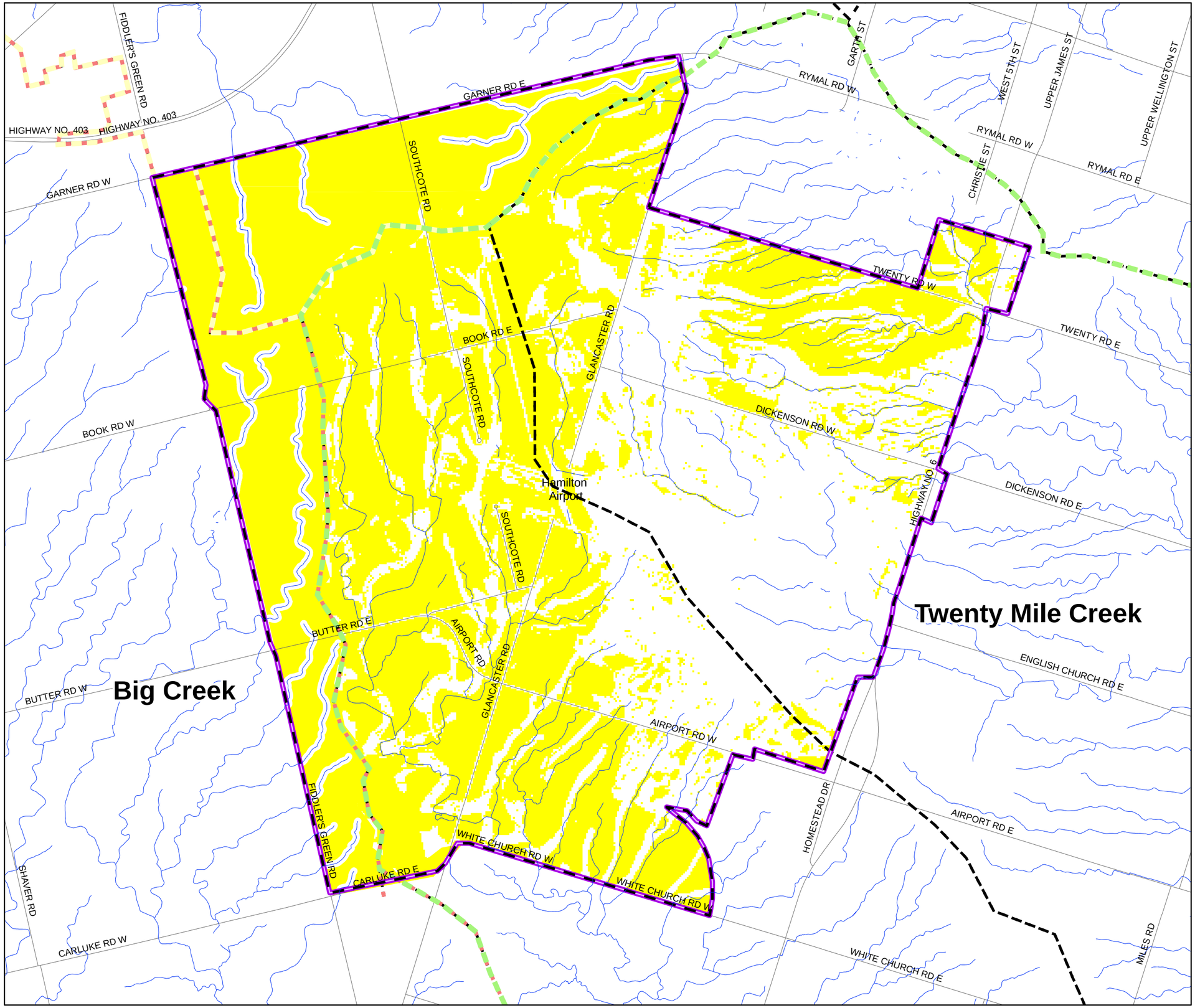
Planning & Economic Development Department

Hamilton AEGD Study Subwatershed Plan

SIGNIFICANT GROUNDWATER RECHARGE AREAS
Figure 6.1



Legend

- Study Area
- Grand River Conservation Authority
- Hamilton Conservation Authority
- Niagara Peninsula Conservation Authority
- Significant Groundwater Recharge Areas*

***Significant Groundwater Recharge Areas are based on MOE Rule 44(1) and 44(2).**
The Significant Groundwater Recharge Areas within Grand River Conservation Authority and Hamilton Conservation

Meters
0 255 510 1,020 1,530

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BUILDING A STRONG FOUNDATION HAMILTON

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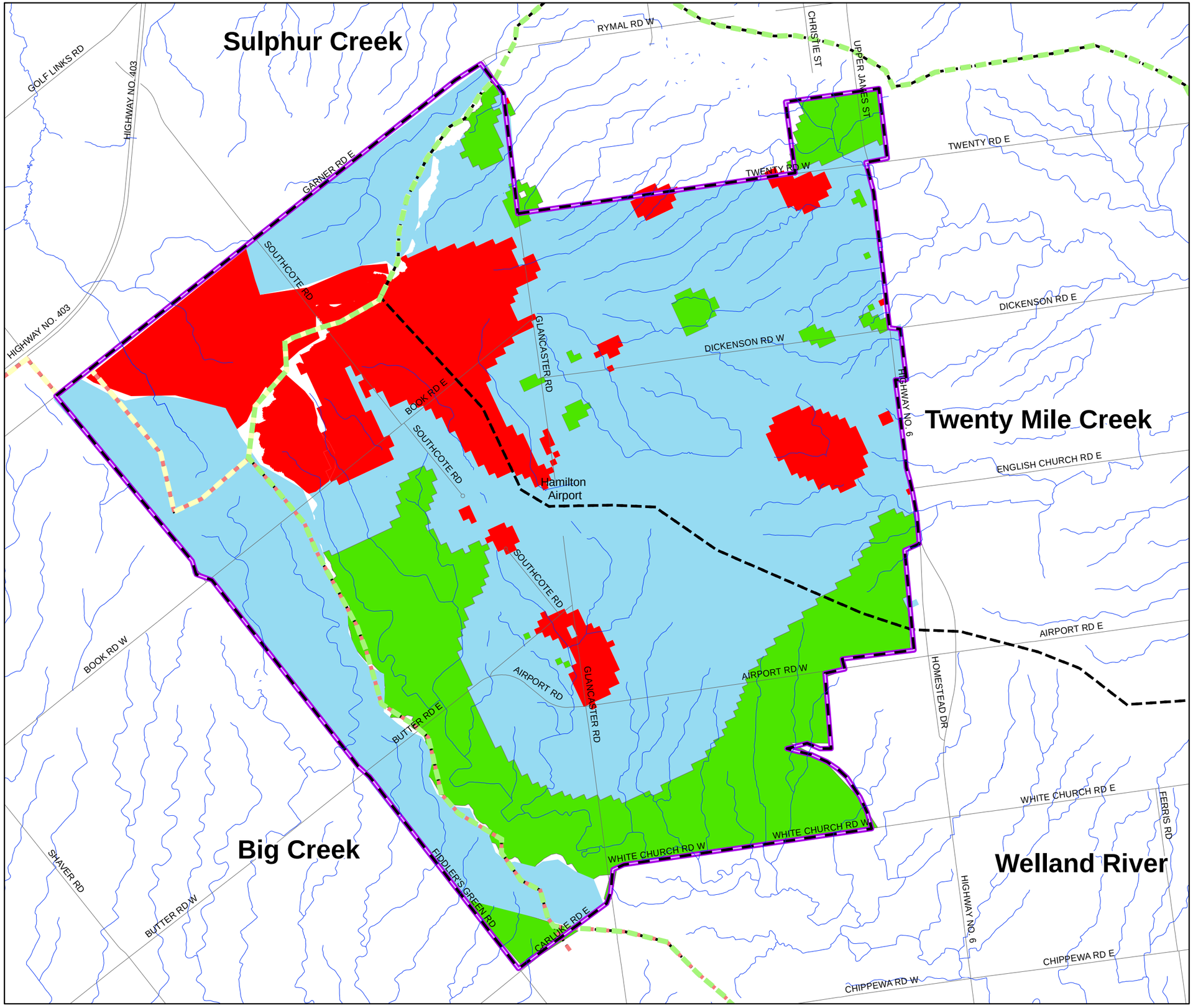
Planning & Economic Development Department

Hamilton AEGD Study
Subwatershed Plan

GROUNDWATER VULNERABILITY ANALYSIS
Figure 6.2



Legend

- Study Area
- Grand River Conservation Authority
- Hamilton Conservation Authority
- Niagara Peninsula Conservation Authority

Groundwater Suseptibility (GwiSI)*

- High
- Low
- Medium

***The groundwater suseptibility within Grand River Conservation Authority and Hamilton Conservation Authority jurisdiction are approximate.**

Meters
0 260 520 1,040 1,560

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6.2 Natural Heritage Plan

The Natural Heritage System is shown on **Figure 6.0** and consists of the following:

- Areas for Protection, including:
    - Natural features within the Greenbelt Lands
    - Core Areas, including:
        - Special status habitats – PSW's, ESA's, significant forests, wetlands
    - Floodplains – no additional floodplain mapping is required for the AEGD study area.
    - MNR fish habitat buffers
        - Seasonal/Warmwater Watercourses / Important/marginal Fish Habitat – The corridor width is defined as a 15 m setback from each side of the bankfull channel width
        - Cool/Coldwater Watercourses / Critical Habitat – the corridor width is defined as a 30 m setback from each side of the bankfull channel width
- Potential Enhancement Areas – may be protected subject to additional studies (for example a Scoped EIS):
    - Linkages - Other woodlots (assessed through a Scoped EIS)
    - 30 m Buffers Around Core Areas (included on **Figure 6.0** within the boundaries of the Core Areas) (assessed through a Scoped EIS)
    - Natural features overlying areas of high recharge (assessed through a Scoped EIS)
    - Features classified as providing support/indirect fish habitat – the corridor width is defined as a 15 m setback from each side of the bankfull channel width
    - CA Generic Regulations (Regulation of Development, Interference With Wetlands and Alterations to Shorelines and Watercourses) - the regulations are CA specific (GRCA – Reg 150/06; HCA – 161/06; NPCA – 155/06) and include setbacks/adjacent land areas abutting valleys, watercourses, wetlands ranging from 30 – 120 m. The final width of this setback would be determined based on a Scoped EIS, Geotechnical Assessment, a Feature-Specific Water Budget Assessment, etc.

In addition to the above, there are a number of management actions that are recommended to enhance the Natural Heritage System:

- Cool/Coldwater Watercourses / Critical Fish Habitat: undertake a native, woody, riparian vegetation planting program to establish 75% of the stream corridor length in woody vegetation with the remainder as meadow or riparian wetland as appropriate
- Seasonal/Warmwater Watercourses / Important/Marginal Fish Habitat: undertake a native, woody, riparian vegetation planting program to establish 75% of the stream corridor length in woody vegetation with the remainder as meadow or riparian wetland as appropriate
- Coldwater and Warmwater Fish Habitat: these features should be protected in their current location and existing functions should be protected or enhanced. Enhancement could include improving morphology (pool/riffle), reducing overland sediment inputs and improving instream habitats
- Seasonal Fish Habitat: these drainage features may be modified and relocated as necessary to facilitate development provided that their natural form and function is enhanced, subject to CA approval
- Indirect/Support Fish Habitat / Marginal Fish Habitat: based on a preliminary assessment of these features, they may be replaced by Stormwater Infrastructure, including LID and end-of-pipe facilities to replicate their water quantity and quality function. Alternatively, they may be enhanced and protected within a corridor width of up to 30 m (plus the bankfull channel width). Their location may also be modified and relocated provided that their water quality and quantity functions are maintained and subject to CA approval.

6.3 Groundwater Management Plan

The Groundwater Management Plan is taken from current efforts by the three conservation authorities and the City to address the need for groundwater protection and management within the three Source Protection Areas within the Study area, as follows:

- Halton – Hamilton Source Protection Region (the Sulphur Creek drainage area)
- Lake Erie Source Protection Region (the Big Creek drainage area)
- Niagara Peninsula Source Protection Region (the Welland and Twenty Mile Creek drainage areas)

The following information is taken largely from the following Source Protection documents, including the material reproduced in Section 2.0:

- Groundwater Vulnerability Analysis. Niagara Peninsula Source Protection Area. NPCA 2009.
- Significant Groundwater Recharge Area Delineation. Niagara Source Protection Area. NPCA and AquaResource Inc. 2009
- Ogilvie, Ogilvie and Company, Anthony Usher Planning Consultants. 2005. Watershed Planning from Recommendations to Municipal Policies: A Guidance Document. A report prepared for the Conservation Authorities Moraine Coalition

Two figures are produced that identify important groundwater resources within these three Source Protection Regions:

- **Figure 6.1**: Significant Groundwater Recharge Areas
- **Figure 6.2**: Groundwater Vulnerability Analysis

Groundwater Areas provide the focus for groundwater protection strategies in source protection areas. The following section describes the key recommendations for addressing development associated with these areas.

6.3.1 Provincial Policy Statement

Significant groundwater recharge areas are also to be protected under the Provincial Policy Statement (PPS) (Ontario Ministry of Municipal Affairs and Housing, 2005). However, the PPS refers to SGRAs as "sensitive groundwater features". Under the PPS, City of Hamilton, as a planning authority is required to:

"protect, improve or restore the quality and quantity of water by:
…d) implementing necessary restrictions on development and site alteration to:
…2). protect, improve or restore…sensitive groundwater features, and their hydrologic functions";

The PPS goes on to state that:
"*Development and site alteration shall be restricted in or near…sensitive groundwater features such that these features and their related hydrologic functions will be protected, improved or restored. Mitigative measures and/or alternative development approaches may be required…"*

6.3.2 Significant Groundwater Recharge Areas

It is recommended that improvement in the amount of groundwater recharge be a goal for the Source Water Protection Plan and Provincial Policy Statement implementation in the Niagara Peninsula Source Protection Area. Consideration should be given to two levels of significance; SGRAs by Rules 44(1) and 44(2).

To increase and/or maintain the amount of groundwater recharge, it is recommended the Source Water Protection Plans include requirements for infiltration-based lot level and conveyance controls in SGRAs. These are to achieve no decrease in groundwater recharge. Infiltration-based controls can mitigate the impacts that urbanization normally has, i.e. reducing groundwater recharge. Controls can maintain groundwater recharge and reduce the potential for flooding and erosion, and hence, the size and cost of stormwater infrastructure (MOE, 2003). This may however require a paradigm shift for stormwater designs to consider recharge (e.g. pre-post development water balances), as well as flood control. A further challenge may be maintenance and ownership of stormwater management systems by developers, municipalities and the public.

Examples of controls include:

- Grassed swales
- Reduced grading to allow greater ponding of stormwater and natural infiltration
- Directing roof leaders to rear yard ponding areas, soakaway pits and cisterns
- Use of permeable pavers
- Limiting traditional sump-pump and tile-drainage installation below the water-table

6.3.2.1 Contaminant Management

Recognizing the vulnerability of SGRAs, requirements for contaminant management plans are also recommended. As defined in guidance prepared for the Conservation Authorities Moraine Coalition (CAMC) (Ogilvie, Ogilvie & Company and Anthony Usher Planning Consultant, 2005):

> ***A contaminant management plan****: A nutrient management strategy or plan if and as required by the Nutrient Management Act, 2002 or a municipal nutrient management bylaw, or a comparable management and contingency plan for the management of contaminants stored on or discharge from the subject lands and that are not nutrients as*

defined by the Nutrient Management Act, 2002. A contaminant management plan is binding on successive owners of the subject lands.

The document recommended, under development approvals, contaminant management plans for SGRAs and:

- High and moderate threat land uses and/or contaminant storage. Their examples included but were not limited to sewage lagoons, petroleum fuels, road salt and golf courses. This could include site-specific management such as double-walled fuel storage tanks with a monitoring program; and
- New or expanded agricultural uses greater than 5 nutrient units of manure per year, e.g. more than 3 milking Holstein cows.

6.3.3 High Groundwater Susceptibility Areas

6.3.3.1 Potential Source Protection Plan Concepts

Consideration should be given to multi-agency policy development, monitoring and approvals. This is to address the complex nature of groundwater protection, supply and legislation. The following are some identified agencies and the areas of their mandate pertaining to groundwater.

- Public Health – communal and private water supplies;
- Public Works – Part 8 Building Code sewage system approvals;
- Municipal Building Officials – Geothermal approvals and some Part 8 Building Code sewage system approvals;
- Niagara Region District Office Ministry of the Environment – Wells regulation, as well as permits to take water, certificates of approval, permits to discharge and waste disposal; and
- Conservation Authority – Hydrogeologic study reviews, mapping of significant and vulnerable groundwater areas.

To protect, improve and restore groundwater supplies, it is also recommended the Source Water Protection Plan include requirements for groundwater protection. Some possible approaches include:

- A multi-agency well construction improvement program. This could include for the government and the public:

    - Targeted educational programs, e.g. flush-mounted monitoring wells and flowing wells are not allowed;
    - Construction bonds with government approvals, e.g. funds secured for well decommissioning prior to construction; and
    - Active well status commenting in reporting, e.g. party commitment to annual monitoring.
- Water use surveys (e.g. private well types and/or cisterns) in highly vulnerable aquifers;
- Tertiary sewage treatment system requirements, rather than conventional systems, of highly vulnerable aquifers. This could help reduce groundwater contaminants such as nitrate.
- Analytical wellhead protection area mapping for communal water supply systems;
- Requirements for licensed drilling contractors in construction of closed loop geothermal installations; and
- Pit and quarry rehabilitation plans that meet, improve or protect pre-development groundwater vulnerability in up-gradient areas.

Some programs to reduce groundwater vulnerability for consideration include:

- Locating and confirming “unknown” status well locations;
- Water supply well-upgrade incentive funding program; and
- NPCA aquifer system hydrogeologic mapping program.

6.3.3.2 Contaminant Management

Recognizing the vulnerability of Highly Vulnerable Aquifers, requirements for contaminant management plans are also recommended. Contaminant management plans were recommended for Highly Vulnerable Aquifers in guidance prepared for the Conservation Authorities Moraine Coalition (CAMC) (Ogilvie, Ogilvie & Company and Anthony Usher Planning Consultant, 2005). The CAMC document recommended, under development approvals, contaminant management plans for Highly Vulnerable Aquifers and:

- High and moderate threat land uses and/or contaminant storage. Their examples of high threat land uses included but were not limited to waste management facilities, airports, lagoons for sewage treatment, and auto wrecking and salvage yards. This could include

site-specific management such as double-walled fuel storage tanks with a monitoring program; and

- New or expanded agricultural uses greater than 5 nutrient units of manure per year, e.g. more than 3 milking Holstein cows.

6.3.3.3 Emerging Challenges

Future challenges to the protection of highly vulnerable aquifers include increased transport pathways that reduce natural protection and may increase groundwater vulnerability. Examples include:

- Priority aggregate extraction areas considered "to be important in ensuring an adequate resource base for the future", i.e. for possible resource development, and "represent*ing* areas in which a major resource is known to exist" (Ontario Geological Survey, 1985). These include considerable areas of "select bedrock resource" in the municipalities of Grimsby, Lincoln, City of Hamilton, West Lincoln, Wainfleet, Port Colborne and Fort Erie. As well as additional areas of "primary significance for sand and gravel" extraction in the municipality of Pelham.
- Earth Energy Systems, or more commonly known as geothermal systems, may have negative implications for groundwater protection. For example, closed loop installations do not require installation by a trained licensed drilling contractor

In Significant Recharge Areas and High Groundwater Suseptibility Areas, these uses are not precluded, and may be permitted provided that a contaminant management plan is prepared.

In addition, a number of groundwater protection measures are recommended to deal with development pressures:

- The partitioning of the water surplus between relatively high runoff and low infiltration will be exacerbated by increased imperviousness associated with commercial and industrial development unless measures are taken to promote infiltration of clean water (e.g. rooftops)

and rainwater harvesting (e.g. for landscaping and agriculture) which should be incorporated as part of a Low Impact Development SWM strategy.

- Maintaining the water balance is also important to prevent downstream erosion and disruption of the integrity of wetlands.
- Proposed future land uses should be screened to protect potable groundwater aquifers tapped by domestic wells screened in overburden.
- Greenbelt lands should be set aside to retain natural features, functions and agricultural or pastoral land uses.

6.3.3.4 Additional Recommendations

The following measures to ensure protection of groundwater are recommended:

- Generally, the following recommendations are put forward to reduce the potential to increase groundwater susceptibility and to be consistent with the current initiatives under the Source Protection Program:

    - The City should undertake a review of all wells in the study area to determine their current location and status (in use or abandoned) and that any wells remain after servicing is available, that these be properly decommissioned as noted above.

    - Any existing abandoned or unused wells that can be identified now should be decommissioned as soon as possible.

    - Wells should be abandoned as directed under O.Reg. 903 as both municipal water and municipal sewage become available concurrently and as development proceeds.

- Areas identified as highly vulnerable/ susceptible (**Figure 6.2)** will require additional Hydrogeological investigations prior to proceeding with development and implementation of infrastructure

- The protection of greenbelt lands and the proposed natural heritage system **(Figure 6.0)** should be recognized as providing a significant role in protecting water balance and sustaining local groundwater recharge.
- Contaminant management plans should be prepared for all high risk land uses
- An EMS system and groundwater monitoring program is recommended for the Airport to reduce potential groundwater contamination impacts
- The monitoring program for the existing groundwater monitoring well should be reviewed to ensure that the data collected reflects the future needs of the area with respect to future growth. This may include additional baseline water quality monitoring and the implementation of additional short term wells established as part of hydrogeological studies for proposed development.

6.4 Surface Water Management Plan

The Surface Water Management Plan is shown in Part B Figure 3.3. Part B of this document addresses, in detail, the Surface Water Management component of the Subwatershed Plan.

Management of water resources within the study area will address flooding; erosion, sedimentation and stream morphology; and water quality. The naturally low gradient, channelized, headwater drainage network that dominates the surface drainage of the study area currently results in regular nuisance flooding conditions. Lack of riparian cover and high sediment delivery to these features, results in localized sedimentation and leads to a reduction in substrate diversity (instream habitat) and an increase in nutrient enrichment. Generally these features are not erosion prone, because of their low stream power and the high sediment load they receive. Other factors affecting water quality include both agricultural and airport runoff. A number of management actions are recommended to address surface water problems:

- Develop a comprehensive Stormwater Master Plan and guidelines to address impacts of future land uses as they pertain to the four (4) watersheds of the study area (see **Part B**)
- Implement a stewardship program targeting existing agricultural operations to reduce sediment transport and delivery to watercourses through a combination of programs including:

  - Implementing nutrient management plans on farm operations
  - Utilizing sediment control practices such as conservation tillage and cover cropping practices
  - Encouraging the planting of buffer strips along drainage features to reduce sediment delivery to these features
- Continue to support initiatives by the airport to reduce water quality and quantity impacts by:
  - Monitoring offsite water quality to identify problem areas
  - Implement an EMS program on Airport lands to manage potential sources of surface water contamination
  - Identify opportunities to mitigate the effects of uncontrolled airport runoff on receiving waters

- Encourage the adoption of a similar approach to stormwater management within the airport and areas required to meet its future land requirements

6.5 Monitoring requirements

Monitoring Programs are generally separated into two types:

- **Environmental Monitoring** - designed to assess the environmental health of a watershed or subwatershed (measured based on a range of environmental indicators), in response to land use change.
- **Performance Monitoring** - designed to evaluate whether a measure is implemented properly (compliance monitoring) and how well it performs, based on a range of performance indicators or targets (effectiveness monitoring). Typically performance monitoring is completed for a Stormwater Master Plan
  - Compliance Monitoring
  - Effectiveness Monitoring

The monitoring approach for the Subwatershed Plan and the Stormwater Master Plan utilize an adaptive environmental management approach (see figure below), which considers the following:

- Promotes flexible decision making
- Monitoring advances scientific understanding and helps policy decisions
- Acknowledges natural variability in contributing to ecological resilience and productivity
- Not 'trial and error' – it is learning while doing

The objective of the environmental monitoring program is: to provide a means of updating the environmental database to reflect temporal changes; to provide a means of determining whether the measures proposed in the study are adequate to meet the goals, objectives and targets; and to establish a contingency plan in cases where the targets are exceeded. The monitoring program will form an integrated component of implementing an adaptive

management approach to subwatershed plan implementation. A monitoring program would include the following:

- network of integrated sampling stations for streamflow, groundwater, water quality, fish and benthic invertebrates, aquatic habitat and fluvial geomorphic conditions;
- a monitoring plan for assessing the condition of terrestrial features over the long term;
- sources of funding and reporting requirements; and
- assessment of monitoring results against implementation progress, appropriate enforcement and follow-up activities.

Further discussion pertaining to environmental monitoring is provided in the AEGD SWMP Implementation Document (under separate cover), See AEGD Section

7.0 Future Studies

Before development can proceed:

- Existing stormwater facilities in communities adjacent to the study area on the north side along Garner Road and Twenty Road accept surface flows from within the study area and are presently managed privately without the City possessing legal access for inspection, maintenance or upgrade (See Part B- Section 5.1.1).

- Areas identified as highly vulnerable/ susceptible (**Figure 6.2)** will require additional Hydrogeological investigations prior to proceeding with development.

- EIS studies will be completed adjacent to all areas identified in the Natural Heritage Plan **(Figure 6.0)**

- Stormwater Management Plans will be completed consistent with the recommendation of the Stormwater Master Plan, including addressing the treatment of watercourses, addressing water budget requirement through effective implementation of LID measures and the finalization of the Class EA related to end of pipe dry ponds. This will include meeting the CA's regulations with respect to watercourses.

Next steps/ studies that may need to be completed:

- Generally, the following recommendations are put forward to reduce the potential to increase groundwater susceptibility and to be consistent with the current initiatives under the Source Protection Program:

    - The City should undertake a review of all wells in the study area to determine their current location and status (in use or abandoned) and that any wells remain after servicing is available, that these be properly decommissioned as noted above.

    - Any existing abandoned or unused wells that can be identified now should be decommissioned as soon as possible.

    - Wells should be abandoned as directed under O.Reg. 903 as both municipal water and municipal sewage become available concurrently and as development proceeds.

- Areas identified as highly vulnerable/ susceptible (**Figure 6.2)** will require additional Hydrogeological investigations prior to proceeding with development and implementation of infrastructure
- The protection of greenbelt lands and the proposed natural heritage system should be recognized as providing a significant role in protecting water balance and sustaining local groundwater recharge.
- Contaminant management plans should be prepared for all high risk land uses
- An EMS system and groundwater monitoring program is recommended for the Airport to reduce potential groundwater contamination impacts
- The monitoring program for the existing groundwater monitoring well should be reviewed to ensure that the data collected reflects the future needs of the area with respect to future growth. This may include additional baseline water quality monitoring and the

implementation of additional short term wells established as part of hydrogeological studies for proposed development.

8.0 AEGD Implementation Document

Unique to the AEGD Subwatershed/Stormwater Master Plan is the development of the AEGD Subwatershed/Stormwater Master Plan Implementation Document (2010) (under separate cover). This document is designed to provide guidance with respect to selection, planning and design as well as the relevant stormwater targets for flooding, erosion, water quality, infiltration and natural features.