4.0 Hydrogeology and Geology

4.0 Hydrogeology and Geology

4.1 Introduction

The Subject Property is approximately 75.1 ha in area, of which approximately 53.8 hectares is proposed for development. The ground at the Subject Property generally slopes from the northwest to the southeast from a topographic high of about 160 metres above sea level (masl) at the north boundary to approximately 142 masl in the main watercourse (FM1001/Reach 14W-12) where it passes under Dundas Street West. In general, the lands at the Subject Property are gently undulated, with elevation changes between the crests of the rises down to the watercourses of the order of 5 to 8 m.

The property is bordered by the following existing land uses as illustrated on Figure 4.1:

- Agricultural lands to the southwest, with Bronte Creek located approximately 1 km to the southwest of the western property line;
- Highway 407 and agricultural/forested lands to the northwest;
- An industrial facility (General Electric) and vacant/agricultural and forested lands to the northeast; and,
- Residential development to the southeast.

A quarry owned by Hanson Brick Ltd. is located approximately 1 km to the northwest of the Subject Property. The quarry is located to the north of Highway 407 and west of Tremaine Road.

Three subwatersheds cross the Subject Property, identified as subwatersheds FM1109, FM1001 and FM1102 in the NOCSS. Subwatershed FM1001 (also identified as the West Branch of Fourteen Mile Creek) drains the majority (approximately 81%) of the Subject Property (approximately 60.4 ha of the total 75.1 ha site area), contains three watercourse (Reach 14W-13, Reach 14W-14 and Reach 14W-16) and a small dug pond and Farm Pond (Reach 14W-14A), all of which eventually converge and exit the Subject Property at the southeast through a single main channel (Reach 14W-12).

Subwatershed FM1109 (Central Branch of Fourteen Mile Creek, Reach 14W-11 and Reach 14W-11A) drains about 10.0 ha of the Subject Property area along the eastern and north-eastern portions of the Subject Property, and the watercourse flows across the northeast corner of the property.

The smallest of the three subwatersheds, FM1102 drains about 4.7 ha of the total property area at the extreme southwest corner. There is no defined channel through the Subject Property within this subwatershed but two shallow “swales” were observed in a moist to standing water condition in early May 2009 and in a dry condition in April 2010. No evidence of flowing water was observed in this subwatershed during the course of our investigation. A small pond is located on a farm property that is not part of the Subject Property and water from this pond drains under Dundas Street West through a culvert located to the west.

The present land use over the tablelands on the Subject Property and adjoining lands is primarily agricultural. The farm in the past had been used to raise pigs but this use was discontinued more than 20 years ago. Within the watercourse valleys vegetation is generally comprised of tall grasses, weeds and shrubs.

The future development on the Subject Property will be fully serviced with municipal water and sewers. The development lands are designated for employment uses and will consist of industrial and commercial uses. Two SMW Facilities will be constructed on the Subject Property, which will treat, approximately 56% (Pond 3) and 26% (Pond 2) of the total property area following development. The remaining area is green space.

A hydrogeological evaluation of the Subject Property was carried out by WSP (formerly MMM Group) according to the Town ToR for EIR and FSS carried out in North Oakville. The stated purpose of the EIR is to characterize and analyze the natural heritage features and functions, and to determine and address the potential impacts of a proposed development application, including servicing requirements on the natural heritage system. The ToR further indicate that the EIR be carried out on a subwatershed basis and that only one EIR will be permitted per subwatershed even if multiple property owners (developers) were proposing development within the same subwatershed. The expectation was that investigative works were not only to be carried out directly on the Subject Property, but also within the subwatershed catchment as a whole to characterize the entire natural heritage system.

The hydrogeological evaluation included interpreting regional geology and site-specific geology and hydrogeology, based on fieldwork carried out by WSP at both on-site and off-site locations between May 2009 and April 2017. A detailed breakdown of fieldwork activities is provided in Section 4.1.2.

4.1.1 Subwatersheds

The Subject Property is located within three subwatershed catchments identified in the NOCSS (Figure 4.1). The upper reaches of all three subwatersheds are defined by the crest of the Trafalgar Moraine that forms the topographic high ground to the northwest of the Subject Property. In Table 4.1 below, it is clear that the majority of the Subject Property are currently drained by the central subwatershed (FM1001) and that the Subject Property contains about 15% of the total overall area of this subwatershed. Conversely, the Subject Property only comprises about 3% of subwatershed FM1109, and about 11% of subwatershed FM1102. With further regard to FM1102, the small proportion (4.7 ha) of the Subject Property contained within this subwatershed also makes up only a very small proportion of the total area of the future employment lands to the west of the Subject Property. This hydrogeological investigation; therefore; focuses on subwatershed FM1001 although some discussion of subwatersheds FM1109 and FM1102 is provided.

Table 4.1 – Subwatershed Areas

Subwatershed	Subwatershed Area (ha)	Subwatershed Area within Subject Property (ha)	Proportion of Subwatershed within Subject Property (%)	Proportion of Subject Property within the Subwatershed (%)
FM1102	43.9	4.7	11%	6%
FM1001	395.3	60.4	15%	81%
FM1109	365.0	10.0	3%	13%
Subject Property		**75.1**		**100%**

4.1.1.1 Subwatershed FM1001

As discussed above, Subwatershed FM1001 is the main subwatershed found at the Subject Property, draining approximately 81% of the Subject Property. This subwatershed is identified as the West Branch of Fourteen Mile Creek, and in the study, area is comprised of a main channel (Reach 14W-16 and Reach 14W-12) with two smaller watercourse (Reach 14W-14 and Reach 14W-13) that all join on the Subject Property. The topography within the overall subwatershed slopes from northwest to southeast from a topographic high of about 185 masl at Number Two Sideroad to approximately 142 masl where the watercourse crosses under Dundas Street West. The land cover of the subwatershed area is mostly open or agricultural (90%), with about 8% of the total subwatershed area covered in forest (Figure 4.2). The remaining 2% area is considered impervious, comprised mainly of the Highway 407 pavement and the existing extent of the Hanson Brick quarry, which will expand over time as operations continue.

4.1.1.2 Subwatershed FM1109

Subwatershed 1109 is located east of Subwatershed FM1001 and this subwatershed is known as the Central Branch of Fourteen Mile Creek. This subwatershed drains a small portion of the Subject Property, primarily via a defined channel at the northeast corner (Reach 14W-11 and Reach 14W-11A) and through a swale, which drains a portion of the Subject Property near its east property line (Figure 4.2). The topographic relief of this entire subwatershed ranges from approximately 190 masl along the crest of the moraine to the northwest to about 150 masl along Dundas Street West. Approximately 23% of the overall subwatershed area is presently forested, 74% is interpreted as agricultural/open ground cover, and the remaining 3% is considered impervious (Highway 407 and the GE facility make up most of this).

4.1.1.3 Subwatershed FM1102

Subwatershed FM1102 is located to the west of Subwatershed FM1001 and is the smallest of three subwatersheds passing through the Subject Property. No defined channels were observed in this subwatershed on-site, other than two wide, gentle swales affected by agricultural activities (e.g., furrowing through cropping). These swales were found to contain pockets of stagnant/ponded water at the times of all site visits beginning from May 2009. The topography of this small subwatershed ranges from about 170 masl at the western limit of the subwatershed to about 152 masl along Dundas Street West. The current land use of the area is predominantly agricultural (90%) and forested (9%) with only a minor percentage (1%) of imperviousness.

4.1.2 Work Program

The work program for the hydrogeological investigation was designed to address the requirements outlined in the ToR, including:

- Review of background information pertinent to the subwatersheds, including areas beyond the Subject Property limits;

- Field investigations, including:
    - Site visits, initial site inspection and quarterly visits;
    - Drilling boreholes and installing monitoring wells. Streambed mini-piezometers and staff gauges were also installed at on-site locations;
    - Soil sampling and grain size analyses of selected samples;
    - Quarterly groundwater level monitoring, including "continuous" monitoring using data loggers at selected monitoring wells located at both on-site and off-site locations;
    - Estimating watercourse flows at the time of the quarterly site visits;
    - Groundwater and surface water sampling; and,
    - Single well hydraulic conductivity testing and shallow percolation testing.

- Assessing site conditions, including:
    - Characterizing the local geologic and hydrogeologic conditions;
    - Identifying groundwater discharge areas and evaluating surface water base-flows;
    - Establishing surface water-groundwater interactions;
    - Preparing pre-development and post-development water balance analyses at the Subject Property and the overall subwatersheds;

- Analyzing and assessing the potential impacts of the development; and,

- Providing recommendations for the mitigation of any potential impacts.

4.2 Regional Physiography and Geological Setting

4.2.1 Regional Geology and Hydrostratigraphy

The Subject Property and surrounding area are situated in the South Slope physiographic region identified by Chapman and Putnam (1984). The Trafalgar Moraine, a subtle topographic ridge that was formed during the retreat of the Lake Ontario ice lobe 12-13,000 years ago, extends from western Mississauga across the northern part of Oakville and is found to the north and west of the property marking the boundary between the South Slope and the Peel Plain physiographic region to the north. The till plain on which the subject property lies is comprised of reddish coloured Clay-Silt Halton Till which is locally derived from the underlying bedrock.

The underlying bedrock in the area is Upper Ordovician red Shale and interbedded Limestone of the Queenston Formation. It is encountered at shallow depth and is reported in the MECP water well records as red shale with limestone, at depths between 3 to 27 metres below ground surface (mbgs). It is exposed at

surface along the steep valley walls of Bronte Creek to the west, and is exposed at surface at the lower reach of the central watercourse (Reach 14W-12) passing through the Subject Property alongside Dundas Street West. On a regional basis the bedrock surface is interpreted to be dipping from the northwest to southeast, generally following the regionally topographic slope, mapped with a surface elevation of approximately 165 to 170 masl in the vicinity of the Trafalgar Moraine to approximately 145 to 150 masl along Dundas Street (Ontario Department of Mines, 1964).

An infilled bedrock valley is identified through interpretation of the water well record logging at wells located east of the subject property, generally below the watercourse draining FM1109 (Reach 14W-11 and Reach 14W-11A, Central Branch of Fourteen Mile Creek, (Figure 4.2)). Bedrock elevations in this "valley" are interpreted between 120 to 130 masl to the east and south of the Subject Property and buried sand and gravel deposits are logged between the surficial tills and the bedrock in this section (water well records are found in Appendix 4-1). Farther north, by Burnhamthorpe Road, the valley bottom elevations are interpreted at about 140 to 145 masl, and low permeability till and/or clay deposits are logged from surface to rock.

Drawing 4.1 (appended to this report) presents the hydrogeological cross-sections A-A', B-B' and C-C' identified on Figure 4.2. These cross-sections were prepared from geological information recorded in the MECP water well records, supplemented with borehole data from WSP investigations in 2009 and data from the Hanson Brick Quarry studies.

Figure 4.3 presents the interpreted bedrock and shallow (till) based groundwater contours. The bedrock contours are based on both water well records and on and off-site borehole data, while the shallow contours are based primarily on borehole monitoring data. On this figure, groundwater in the bedrock is seen to generally flow from northwest to southeast with deflections created by the Bronte Creek valley to the west, and the infilled bedrock valley to the east, which leads to a west to east bedrock groundwater flow at the Subject Property. The regional horizontal gradient within the bedrock is approximately 0.009, increasing locally to 0.013 to 0.015 where the flow is being deflected towards the infilled bedrock valley.

The shallow groundwater system is controlled by the topography of the land declining from roughly 180 masl at the upper limits of Watershed FM1001 (at Number 2 Sideroad) down to approximately 145 masl at the point where the main FM1001 channel passes under Dundas Street West. On a watershed basis, the horizontal gradients in the shallow system are on the order of 0.01 to the southeast. Further discussion on groundwater levels is provided in Section 4.3.2.3.

The Halton Till and the Queenston Shale are poor aquifers due to their fine-grained nature and low permeability and are capable of providing only limited quantities of groundwater to water wells. In terms of existing groundwater usage, within the jurisdiction of the CH, approximately 75% of all wells are completed into the bedrock, which indicates that the surficial overburden deposits of Halton Till are not a significant source of groundwater in the area (Singer et al, 2003). Most wells in the study area are completed into the bedrock, except for wells in the bedrock valley. Wells drilled into the bedrock valley, south of Highway 407, are completed in the buried sand and gravel deposits above the shale bedrock.

The bedrock in the area is also described as a poor aquifer due to poor pore space interconnections in the shale. The Queenston Formation shale does not fracture easily or dissolve, which limits its effective porosity. The upper 3 to 5 m of the bedrock is weathered, and is where most of the available yield is observed. The reported geometric mean averages of the specific capacity and Transmissivity for this formation are 1.5

l/min/m and 2.7 m^2/day, respectively (Singer et al, 2003). The bedrock is therefore considered a poor aquifer with yield capacities barely enough to satisfy individual domestic water needs.

As reported in Singer et al (2003), 92% of all wells completed within the Queenston Shale (across Southern Ontario, not only Halton Region) are reported as providing "fresh" water. Salty water is reported at 5% of these wells and the remaining 3% of wells are reported with either mineralized or sulphurous water. Water quality from the shale is considered highly variable, ranging from good to poor. Water quality from 12 samples were presented in the Singer report, and indicated the water is hard (mean hardness of 472 mg/L), has high levels of sodium and chloride (averages of 88 and 123 mg/L respectively), and an average concentration for sulphate of 251 mg/L.

4.2.2 Topography and Drainage

The Subject Property and surrounding area has moderate relief (between 190 to 130 masl on a regional basis, 160 to 142 masl relief across the Subject Property) with the ground generally falling from the west-northwest to east-southeast. The area is referred to as part of the South Slope physiographic region by Chapman and Putnam (1984). The Trafalgar Moraine, a subtle topographic ridge that extends from western Mississauga across the northern part of Oakville, lies to the north and northwest of the property.

The local drainage network is generally oriented in a west-southwest to east-northeast direction The Subject Property is predominantly drained by subwatershed FM1001, which has four channels (Reach 14W-12, Reach 14W-16, Reach 14W-13 and Reach 14W-14). Subwatersheds FM1109 and FM1102 drain the eastern portion and the extreme south-western corner of the Subject Property, respectively. These three subwatersheds are located in what can be described as a bevelled till plain with local relief provided by creek valleys, which are locally incised in the order of 5 to 10 m. Significant watercourses, such as Bronte Creek to the west are incised deeply into the underlying bedrock (bedrock exposed), with steep side slopes and relief in the order of 20 to 30 m relative to the table lands.

4.3 Hydrogeological Evaluation

4.3.1 On-Site and Off-Site Investigations

WSP carried out hydrogeological field investigations across the Subject Property and at off-site locations to the north and west of the Subject Property commencing in the late spring of 2009. Off-site field work was also carried out within subwatershed FM1001, the focus of this EIR.

WSP's initial hydrogeological site visit took place on May 5, 2009. During this visit, hydrogeologists from WSP staked out 12 on-site borehole locations (MMM-09-1 to MMM-09-12), installed 7 mini-piezometers (MP-01 to MP-07) within two of the sub-watercourse systems that cross the Subject Property (FM1001 and FM1109) and measured water levels at three of four monitoring wells MW-1 to MW-3 (MW-4 was reported by the farmer on the Subject Property to have been destroyed) installed on the Subject Property by Trow Associates Inc. (Trow, see Section 4.3.1.3). Estimates of stream flows and field parameters such as pH, temperature, electric conductivity and concentration of total dissolved solids were measured in the watercourses at each of the mini-piezometer locations. Monitoring wells associated with the Hanson Brick Quarry site to the northwest of the Subject Property were observed following this site visit during a drive by of the local area.

A total of 16 boreholes were drilled at 12 locations within the Subject Property to depths of between 2.3 and 16.6 mbgs (metres below ground surface) in June 2009 (MMM-09-01 to MMM-09-12). Eleven (11) additional boreholes were drilled at eight off-site locations in November 2009 to depths ranging from 3.6 to 15.6 mbgs. Off-site property access was obtained from the Diocese of Hamilton (MMM-09-13 to MMM-09-15) and from the local municipalities and the Region of Halton (MMM-09-16 to MMM-09-20) for drilling within the road allowances. Borehole and monitoring well locations are presented on Figure 4.3 and Figure 4.4.

Soil samples from the overburden were collected using continuous sampling techniques. At selected intervals, split spoon samples were obtained from the upper portion of the continuous sample intervals. The sampling technique was changed to bedrock coring upon auger refusal at borehole locations where a greater depth was required. Water levels in the boreholes on the completion of drilling were recorded and monitoring wells were installed at each borehole.

The monitoring wells were constructed with 51 mm diameter Schedule 40 PVC screen and riser, equipped with O-rings at the threaded joints. Screens were between 0.5 to 3.0 m in length and a sand pack was installed around the screen, extending 0.3 m above the top of the screen. A bentonite seal was placed from the top of the sand pack to about 0.3 m below grade. A protective lockable steel casing and 0.3 m of concrete at surface completed the installations. Seven of these monitoring locations were constructed as nested wells with both a shallow and deeper monitoring well to ascertain vertical groundwater gradients.

Borehole logs for all boreholes, including stratigraphic descriptions, sampling intervals and monitoring well details, are contained in Appendix 4-2. Grain size analysis results from these boreholes are presented in Appendix 4-3.

4.3.1.1 Supplemental Farm Pond Investigation

Additional monitoring wells and mini-piezometers were installed around the periphery of the large human-made Farm Pond (Reach 14W-14A) in July 2011 as part of an investigation to confirm if this Farm Pond was receiving groundwater. WSP staff installed a staff gauge within the Farm Pond and three mini-piezometers (MP-21, MP-22, and MP-23) at the edges of the Farm Pond on July 4, 2011. Three new monitoring wells (50 mm diameter PVC riser and screen) were constructed in mid-July 2011 by EXP Services Inc. on behalf of WSP at two locations along the west side of the Farm Pond and identified as MMM11-21, MMM11-22 (nested). These wells are located to the west and southwest of the Farm Pond (borehole logs are included in Appendix 4-2). Data loggers were installed at the staff gauge in early July 2011 and at the three new monitoring wells in late July 2011. A data logger had been installed at monitoring well MMM09-02 (located to the east of the Farm Pond) in March 2011 in anticipation of this supplemental study.

A drive-point mini-piezometer nest (MP-24) was installed near the upstream limit of the Farm Pond on October 22, 2013 at a location agreed to with CH's hydrogeologist at a site meeting on October 10, 2013. This mini-piezometer nest is located to the northwest of a topographic rise that separates the Farm Pond from Reach 14W-12A, with the edge of the Farm Pond, as defined by the average Farm Pond water level elevation of 148.7 masl, situated approximately 65 m southeast of the mini-piezometer nest. Two mini-piezometers were installed, the shallower piezometer was screened between 0.31 and 0.44 mbgs, and the

deeper piezometer was screened between 1.19 and 1.28 mbgs. Data loggers were installed in both piezometers[1].

Additionally, four boreholes drilled by EXP Services Inc. along the main Reach channel (Reach 14W-12) for a slope stability investigation included piezometers (EXP report dated November 18, 2011 and entitled "*Slope Stability Analysis Report, 14 Mile Creek, Pigott Farm Land, Oakville, Ontario*") and these piezometers were also included in the monitoring for this study (the borehole logs are included in Appendix 4-2).

4.3.1.2 Quarterly Monitoring

Quarterly site visits were scheduled to monitor the Subject Property and off-site monitoring locations over spring, summer, fall and winter conditions. During such visits, manual water level readings were taken at the monitoring wells and mini-piezometers, data loggers were downloaded and when there was flowing water present (and not frozen), flow estimates were obtained in the watercourses at staked locations identified as FMP-1 to FMP-6. These site visits were ideally scheduled to follow periods of dry weather (greater than 3 to 5 days following a rain event), although this was not always possible. Flow measurements were supplemented with stream water levels at staff gauges locations SG-1 and SG-2.

Additional investigative work carried out by WSP at the time of the regularly scheduled monitoring visits included water quality sampling and hydraulic conductivity testing at selected monitors.

4.3.1.3 Investigations by Others

An earlier study was carried out on the Subject Property and additional lands to the north of Highway 407 in 2001, and three of the four monitoring wells installed from this program were still available for use from 2009 to present. This earlier field work was carried out on behalf of Beutel Goodman Real Estate Group and was undertaken at the property by Trow to document the geotechnical and environmental conditions at these lands. The report examined two parcels of land separated by Highway 407 and identified as Parcels A and B. Parcel A coincides with the Subject Property currently under consideration for development. Parcel B was located north of Highway 407 extending north to Burnhamthorpe Road, with an area of about 23 ha. No work was carried out by WSP for this work program on the lands identified as Parcel B in the 2001 Trow reports.

Trow's prior on-site investigations consisted of the following:

- Drilled forty-five (45) geotechnical boreholes (MW-1 through MW-4, and BH-1 through BH-41) to depths ranging between 1.6 to 6.1 m below grade. Four groundwater monitoring wells were installed at the locations identified as MW-1 to MW-4 (MW-4 could not be located in 2009 and was reported by the previous owner as destroyed years ago). Shale bedrock was reported at 16 of the 45 borehole locations, generally those boreholes located along the south and west portions of Parcel A (the Subject Property under current investigation);
- Excavated forty-eight (48) shallow test pits to depths ranging 1.0 to 2.3 m. None of these test pits was reported having encountered the shale bedrock;

[1] The data logger at MP-24S, a very shallow monitor (0.44 m deep), was removed for the winter on December 16, 2013 to prevent damage to the unit from freezing. The data logger was re-installed at MP-24S on April 30, 2014 for the spring to fall seasons.

- One aspect of the Trow work plan was to investigate the potential for contamination near three USTs (Underground Storage Tanks) that had contained pig manure and one UST used for fuel storage. Soil and groundwater samples from the boreholes, monitoring wells and private wells located on the property were submitted for analysis and all met the relevant criteria of the time for the proposed commercial/industrial land use with full municipal servicing.

Copies of the available borehole logs, test pit logs and location plan from the Trow report are also included in Appendix 4-2.

Several hydrogeological investigations were carried out by Golder Associates Ltd. (Golder) on behalf of Hanson Brick in support of their Tremaine Quarry, located to the northwest of the Subject Property. Information from these investigations relevant to the hydrogeological interpretation of the Subject Property was examined. Copies of these reports, including annual monitoring reports up to November 2009 were obtained from those on file at the Regional Municipality of Halton.

The off-site field investigation programs carried out for Hanson Brick by Golder since 2002 consisted of the following:

- Construction of 11 on-site monitoring well nests (MW-1 to MW-11), with a minimum of a shallow monitor completed in the overburden till, and a deep monitor screened deep within the shale bedrock. Six nest locations also include a monitor screened within the upper shale, and 4 nest locations include a monitor screened across the till/shale bedrock interface;

- Construction of three off-site 150 mm diameter drilled test wells, located within the road allowances for Number 1 Side Road/Burnhamthorpe Road West and Tremaine Road. These wells were drilled and tested as part of a Class Environmental Assessment to determine the feasibility of providing a source of water communal water supply system for local residents;

- Static water level monitoring collected on a quarterly basis between 2002 and 2008, and monthly thereafter. The 2008 water level monitoring program included 11 private wells and monitoring of the 11 on-site monitoring well nests and the 3 test wells located on the road allowances. Most of the on-site monitors and all of the 11 private wells were equipped with data-loggers;

- In-situ hydraulic conductivity testing of the overburden and bedrock was carried out at most of the monitors at the 11 monitoring well nests, with the exception of two of the shallow overburden wells;

- Groundwater sampling at the 11 on-site monitoring well nests and at 10 private wells.

WSP staff did not access nor monitor any of the Hanson Brick wells during this study and used the publicly accessible reported data for those wells.

4.3.2 Site Geology

WSP's drilling programs confirm the surficial soils encountered within the Subject Property and the EIR Sub-catchment Study Area (FM1001) are comprised of clay-rich Halton Till, underlain by Queenston Shale.

Topsoil generally ranged from 0.1 to 0.3 m thickness at most borehole locations. Thicker topsoil was noted at on-site boreholes MMM-09-4 and MMM-09-10, on the order of 0.5 to 0.6 m thickness. Both of these locations are near to existing watercourses (e.g., valley bottoms).

Generally, the soils at ground surface below the topsoil layer were classified as a brown to reddish brown stiff to very hard Clayey Silt Till, some sand, occasionally classified as Sandy Silt Till, with shale fragments. At six of the borehole locations[2], thin deposits of differing soils were logged between the topsoil and till. These deposits were generally similar in composition as the underlying till (e.g., Clayey Silt, to Silt with some sand and with till-like appearance, extending to depths between 0.5 to 1.4 m below grade) and are possibly representative of soils disturbed by farming activities. At MMM-09-4, located next to Reach 14W-11 in sub-watershed FM1109, a deposit of Silty Sand to Sandy Silt (to 1.4 m depth) overlays the till.

Fracturing within the till was evident at most boreholes, with the shallower depths being highly fractured and weathered, and with fracture frequency noted to decrease with depth. Fractures were observed up to extend downward to between 4 to 6 m depth from the logging of the soil samples. Fractures near surface were observed to have a greyish white infilling of a Silt-Clay composition, or were identifiable through rusty to black oxidation staining.

The till deposits were logged to the underlying shale bedrock at the boreholes where the bedrock, or weathered bedrock was encountered or assumed through auger refusal. At many of the boreholes, the transition from shale/weathered shale to till was quite gradual.

The geological stratigraphy at the off-site drilling locations (MMM-09-13 to MMM-09-20) was similar though as locations progressed northward and the ground elevation increased the shale bedrock was less likely to be encountered.

The shale bedrock was identified as red Queenston Shale, with zones of green banding or green inclusions visible within the cores. The upper surface of the bedrock was weathered, with the weathered depth of the shale bedrock at the on-site boreholes generally extending beyond the lower completion depths of the boreholes. At three locations, the weathered depth of shale was logged to between 0.6 to 1.7 m from the top of the bedrock surface[3]. At MMM-09-15D (off-site location) the shale bedrock was still identified as weathered to 12.3 m depth (bottom of hole), with a highly weathered zone at approximately 5 to 6 m depth reported at this location. The RQD (Rock Quality Designation) of the shale bedrock was generally found to range from 29% at (poor rock mass quality) to 89% (good rock mass quality).

At the Subject Property, the surface of the bedrock was noted to decline in elevation from the southwest to the north-northeast[4]. Bedrock along the western property line was encountered at approximately 150 masl

[2] MMM-09-2 to MMM-09-5 inclusive, MMM-09-9, and MMM-09-12

[3] MMM-09-1 (1.5 m), MMM-09-6 (1.7 m), and MMM-09-10 (0.6 m)

[4] This includes information from the borehole logs prepared by Trow in their 2001 work on the property.

elevation. Towards the southeast corner of the Subject Property, where the main watercourse exits the property and passes under Dundas Street West, the bedrock surface is encountered at around 145 masl, and is in fact exposed at surface within the main stream channel alongside Dundas Street. The shale bedrock is located close to the watercourse channel bottoms up to the west-central parts of the Subject Property, being identified within 0.8 m of the channel at MMM-09-10, and approximately 1.6 m from the channel bottom in the vicinity of MMM-09-9 and MP-07.

At the northeast corner of the Subject Property, the bedrock was not encountered at either MMM-09-4 (borehole terminated at 146.3 masl) or at MMM-09-5D (borehole terminated at 142.8 masl). These on-site boreholes are the ones located in closest proximity to the buried bedrock valley identified in mapping and water well records.

4.3.2.1 Grain Size Analyses

Following installation of MMM-09-1 to MMM-09-20 monitoring wells, ten soil samples were submitted to Thurber Engineering Ltd. (Thurber) for a grain size analyses. The results of these grain size analyses were reviewed and used to provide estimates of hydraulic conductivity and soil classification for use in the water balance analysis. The grain size curves are found in Appendix 4-3.

Table 4.2 presents the location and depth of soil samples that were tested for grain size distribution and the estimated hydraulic conductivity. The estimates of hydraulic conductivity presented in Table 4.2 were obtained based on grain size results using the Hazen approximation:

$$K = 0.01 \times C d_{10}^2 \text{ (m/sec)}$$

Where:

K = bulk hydraulic conductivity (m/sec);
d_{10} = grain size at which point 10% of the soil passes the sieve (mm); and
C = a constant generally set at 1 for these units.

Table 4.2 – Hazen Estimates of Hydraulic Conductivity

BH ID	Sample ID	Depth (mbgs)	Soil Description	d_{10} (mm)	Hazen $K \sim 0.01 \times d_{10}^2$ (m/sec)
MMM-09-01D	S2	1.5 – 1.7	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-05D	S3	2.7 – 2.8	Clayey Sandy Silt (TILL)	<0.001	$< 1.0X10^{-8}$
MMM-09-08	S1	0.9 – 1.1	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-09	S1	1.0 – 1.1	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-11	S1	1.0 – 1.2	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-12	S3	2.5 – 2.7	Clayey Silt (TILL), trace sand	<0.001	$< 1.0X10^{-8}$
MMM-09-13	S1	0 – 1.2	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-17	S4	5.5 – 5.6	Sandy Silt (TILL), some clay	<0.001	$< 1.0X10^{-8}$
MMM-09-18D	S1	0.9 – 1.2	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-19D	S4	3.7 – 3.9	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$

From Table 4.2, the Till deposits are estimated by the Hazen approximation to have hydraulic conductivities less than $1x10^{-8}$ m/sec[5]. These are reasonable estimates for unweathered till soils, but will underestimate the apparent (or bulk) permeability of the surficial zone for these soils. The bulk hydraulic conductivities for the shallow soils are expected to be greater as the preferential horizontal movement of water will be through the fractures found in the upper, weathered zones of these soils, and alongside creek valleys where erosion of the original deposit also provides some additional fracturing caused by stress relief.

Table 4.3 – Tri-Linear Soil Classification

BH/SA	Description	Percent			Soil Classification
		Sand	Silt	Clay	
MMM-09-01D	Clayey Silt (TILL), some sand	26	45	28	Clay Loam
MMM-09-05D	Clayey Sandy Silt (TILL)	29	42	28	Clay Loam
MMM-09-08	Clayey Silt (TILL), some sand	26	43	31	Clay Loam
MMM-09-09	Clayey Silt (TILL), some sand	22	52	26	Silty Loam
MMM-09-11	Clayey Silt (TILL), some sand	27	44	29	Clay Loam
MMM-09-12	Clayey Silt (TILL), trace sand	12	60	28	Silty Clay Loam
MMM-09-13	Clayey Silt (TILL), some sand	27	44	29	Clay Loam
MMM-09-17	Sandy Silt (TILL), some clay	28	52	20	Silty Loam
MMM-09-18D	Clayey Silt (TILL), some sand	24	45	31	Clay Loam
MMM-09-19D	Clayey Silt (TILL), some sand	29	47	23	Medium Loam

Note:
Percentages expressed in the table above are based on the proportions of Clay, Silt and Sand sized particles, excluding Gravel content

[5] Hazen estimates of hydraulic conductivity were not used to classify the soil type for use in the water balance calculations.

The tri-linear soil classifications obtained through the grain size analyses were used to derive the soil classification for estimating infiltration input into the water balance analysis (along with published soils mapping of the site (see Section 4.4.3.1). The percentage composition of soils was categorized as percentages of sand, silt, and clay and compared against classifications in a tri-linear soil classification chart. The results are presented on Table 4.3. The predominant soils found at shallow depth are Clayey Silt Till (and typically classified as Clay Loam). The tri-linear soil classifications range between Silty Clay to Medium Loams. On average, Clay Loam was considered representative of the soils found near surface for input into the water balance.

4.3.2.2 In-Situ Permeability Testing

Hydraulic conductivity testing was carried out at nine WSP monitoring well locations in December 2009, January 2010 and October 2010[6] to provide estimates of the in situ hydraulic conductivity of the deposits across the Subject Property and the FM1001 subwatershed. The monitoring well locations were selected on the basis of providing data from locations across the subwatershed, and for representative soil types, and at both shallow and deeper depths.

At six of the nine tested monitors, the hydraulic conductivity was anticipated to be quite low, and recovery was monitored using data loggers installed at those locations (see Section 4.3.2.3 for details of the loggers)[7]. Manual measurements were taken at MMM-09-9 and both wells at the two monitors at location MMM-09-10 as these wells recovered quickly (less than 10 minutes each).

The hydraulic conductivity testing was generally carried out by extracting a volume of water in the monitoring well using either a polyethylene bailer or dedicated *Watterra* tubing and foot-valves, In the case of testing carried out at MMM-09-10, a slug with a known volume was used to displace the water and a falling and rising head test was carried out. In all cases, the recovery of the water levels in the well was measured over time until they had recovered to within approximately 80% of the original water level.

The recovery data was analysed with Aquifer Test Pro (Version 4.2) using the Hvorslev (1951) approach and the results of the hydraulic conductivity testing are presented in Table 4.4[8]. These values are considered representative of horizontal hydraulic conductivity in the immediate vicinity of the well. It is anticipated that the vertical hydraulic conductivities with depth will be an order of magnitude lower than these values.

The measured hydraulic conductivities within the shallow zones of the Till deposits (i.e., 1.5 to 4.5 m depth) were generally one to two orders of magnitude greater than the conductivities estimated using the Hazen approximation from grain size analyses for the Till (see Section 4.3.2.1). The horizontal hydraulic

[6] MMM-09-04, MMM-09-09, MMM-09-15S, and MMM-09-17 (December 2009); MMM-09-19S, MMM-09-19D, and MMM-09-20 (January 2010); MMM-09-10S and MMM-09-10D (October 2010).

[7] Rising head recovery monitoring using data loggers at these locations indicated that recovery of the water levels in these wells over several hours (MMM-09-04, MMM-09-15S) to several days (MMM-09-17, MMM-09-19S, MMM-09-20). The recovery at monitor MMM-09-19D continued on the order of one month.

[8] The Hvorslev analyses are presented in Appendix 4-4.

conductivities in the weathered shale were measured on the order of 10^{-6} m/sec, and are expected to decrease with depth as the effects of weathering and fracturing becomes less pronounced[9].

Table 4.4 – In-Situ Permeability Testing Summary

Monitoring Well	Screen Interval (mbgs)	Description	Hydraulic Conductivity (m/sec)
MMM-09-09	1.8 – 2.3	Clayey Silt Till	9.0×10^{-6}
MMM-09-10S	1.6 – 2.1	Weathered Shale	6.4×10^{-6}
MMM-09-10D	6.2 – 7.7	Weathered Shale	4.4×10^{-6}
MMM-09-15S	1.5 – 4.4	Shaley Till to Weathered Shale	1.8×10^{-7}
MMM-09-04	3.0 – 6.0	Sandy Silt to Silty Sand Till, Clayey Silt Till and Sandy Silt Till	4.4×10^{-9}
MMM-09-17	2.9 – 5.9	Clayey Silt Till and Sandy Silt Till	3.9×10^{-9}
MMM-09-19S	3.2 – 5.9	Clayey Silt Till	4.8×10^{-10}
MMM-09-20	4.2 – 7.2	Clayey Silt Till	3.0×10^{-9}
MMM-09-19D	13.6 – 15.1	Clayey Silt Till	9.8×10^{-11}

Notes:

The calculated horizontal hydraulic conductivity may be underestimated due to effects such as smearing of the borehole wall during drilling. This can reduce the ability of water to be transmitted across the perimeter of the borehole and so may result an underestimate of the hydraulic conductivity.

The geometric mean horizontal hydraulic conductivity of the upper till/weathered shale is calculated at about 3×10^{-6} m/sec (using the first four results in the table above).

The geometric mean horizontal hydraulic conductivity for the deeper till deposits is calculated to range from 3.7×10^{-9} m/sec (MMM-09-04, MMM-09-17, and MMM-09-20) to 2.2×10^{-10} m/sec (data from MMM-09-19 nest only). Vertical hydraulic conductivity is further assumed to be $1/10^{th}$ the horizontal hydraulic conductivity.

4.3.2.2.1 Percolation Testing

Two percolation tests were performed at locations identified as PT-1 and PT-2 on October 18, 2010. Percolation Test PT-1 was located nearby to the monitoring well nest at MMM-09-10 and PT-2 was carried out in the vicinity to mini-piezometer location MP-04.

The percolation test holes were between 160 to 300 mm diameters and were dug out to a minimum depth of 0.2 m into the till below the base of the overlying topsoil. Each hole was pre-soaked by filling it with water and allowing the water to infiltrate completely prior to the start of the test. If necessary following pre-soaking, silt and sediment were removed from the bottom of the hole and the hole was cleaned to its original depth. Water was then poured into the hole until the water level was approximately 0.15 m above the base of the hole. A small board was placed across the top of the hole and a reference point was marked on the board over the center of the hole. All the measurements were taken from that reference point with a measuring tape. The distance from the top of the board to the surface of the water was measured and recorded at consistent time intervals.

[9] Hydraulic conductivity measurements from the Hanson Brick monitors (Golder Associates. November 2009) show the hydraulic conductivity (geometric means) of the shale bedrock decreasing with depth, from an order of magnitude of 10^{-7} m/sec at the overburden/bedrock interface to 10^{-9} m/sec at depths greater than 30 mbgs – see summary table and plot in Appendix 4-4.

Plotted results of the percolation tests at PT-1 and PT-2 are presented in Appendix 4-4. Percolation testing yielded T-times of 2 to 4.4 min/cm in the Clayey Silt Till at these two locations. These T-times correlate to hydraulic conductivities in the very upper weathered zone of the Till at locations PT-1 and PT-2 on the order of 10^{-3} to 10^{-5} m/sec, or to an infiltration rate equivalent (used in the MOE Storm Water Design Manual, 2003) of between 135 to 300 mm/hour. These results were not used in the water balance calculations[10].
These results, while higher than would be anticipated for a clay-rich Till, are considered useful however for illustrating the effect of weathering and fracturing on increasing the bulk hydraulic conductivity of these types of soils at very shallow depth. The bulk hydraulic conductivity of the clay-rich Till will decrease with depth as the soils become less exposed to the effects of surface weathering. We note that site grading activities will remove essentially all of this upper weathered zone of the Till soils in the developable land parcels, either through removal at cut areas, or from compaction of engineered fill in the low areas. The resulting exposed surficial soils after site grading will be low conductivity clay-rich soils that will not be conducive to mitigating infiltration.

4.3.2.3 Groundwater Level Monitoring

Groundwater level measurements at the monitoring wells and mini-piezometers have generally been carried out on a quarterly schedule since the installation of the on-site monitors in June 2009. On-site and off-site quarterly monitoring has been typically scheduled to occur roughly during the months of January, April, July and October[11]. The complete results of groundwater level monitoring at the Subject Property are tabulated on Tables SWL-1 through SWL-2 found in Appendix 4-5. This table also includes water levels from the previously installed Trow monitors MW-1, MW-2 and MW-3, which are included in the WSP monitoring program.

Groundwater levels were also continuously monitored at selected wells using pressure transducers (data loggers). WSP staff installed *Schlumberger* Mini-Diver DI501 data-loggers at on-site and off-site monitoring wells beginning in June 2009. Table 4.5 identifies the locations and date ranges over which time data loggers have been installed. A *Schlumberger* Mini Baro-Diver DI500 was also installed at the Subject Property to provide barometric compensation of the data. The loggers were suspended from the tops of the monitors by steel cables and were set to record water level fluctuations at hourly intervals.

The data from each data logger and the baro-logger were downloaded during the quarterly monitoring visits. Figures SWL-1 through SWL-20-2 in Appendix 4-5 present plots of the spot level and continuous water level measurements at all locations with data loggers[12]. The data logger plots for the monitoring wells (Figures SWL-7 through SWL-20-2 inclusive) include the spot water level measurements and generalized stratigraphy and well construction details at the boreholes, and where available nearby watercourse channel invert elevations and mini-piezometer spot data measurements. Farm Pond water levels are also shown for comparison to the groundwater elevations at the monitors closest to the Farm Pond (MMM-09-2, MMM-11-21 and MMM-11-22).

[10] Data from the tri-linear soil classifications and published soils mapping were used in the water balance calculations (see Section 4.3.2.1).

[11] Monitoring at the off-site locations was discontinued following the February 2011 event.

[12] The data loggers at the off-site wells north of Highway 407 were removed in February 2011. Two of these data loggers were then installed at MMM-09-02, and at MMM-09-06-D.

Table 4.5 – Data Logger Locations

Monitoring Well	Figure Reference	Start Date	End Date
MMM-09-1S	SWL-7	June 19, 2009	July 27, 2011
MMM09-1D	SWL-7	December 12, 2015	April 4, 2016
MMM-09-2	SWL-16	February 18, 2011	still installed
MMM-09-4	SWL-8	June 19, 2009 December 12, 2015	July 27, 2011 April 4, 2016
MMM-09-6S/D	SWL-15	February 18, 2011	still installed
MMM-09-9	SWL-9	June 19, 2009	July 27, 2011
MMM-09-10S/D	SWL-10	June 19, 2009	still installed
MMM-09-15S	SWL-11	November 11, 2009	February 17, 2011
MMM-09-17	SWL-12	November 18, 2009	February 17, 2011
MMM-09-19S/D	SWL-13	November 17, 2009	February 17, 2011
MMM-09-20	SWL-14	November 18, 2009	February 17, 2011
MMM-11-21	SWL-17	July 27, 2011	still installed
MMM11-22S/D	SWL-18	July 27, 2011	still installed
Farm Pond	SWL-19	July 5, 2011	November 28, 2012
		July 7, 2013	still installed
MP-24S/D	SWL-20-1, SWL-20-2	October 29, 2013	still installed

Notes:
The data loggers at MP-24D and MP-24S were intended to be removed from the mini-piezometers during the 2013-14 winter season to prevent damage to the units from freezing. In 2013, the logger at MP-24D could not be retrieved as it was already frozen in place but the logger at MP-24S was successfully removed for the winter season. Both of these loggers were removed over the winters of 2014-15 and 2015-16 but left in place over the winter of 2016-17. During the winter of 2014-15 both loggers were installed at MMM-09-10 to check their operation against the logger already installed at MMM-09-10 (both were fine). During the winter season, these two loggers were temporarily installed at MMM-09-1D and MMM-09-4.

Groundwater levels exhibit a seasonal pattern from the spring time highs of late March/early April to late season lows at the end of the growing season (late September/early October). On the basis of the quarterly spot measurements at all on-site monitors, the maximum recorded fluctuations in static water levels at the monitors varied from 0.4 to 2.6 m (average of 1.6 m) at monitors located some distance from the watercourses. This range was smaller at the monitors located in the low lying lands next to the watercourses, from about 0.3 to 1.7 m declines observed over the study period (average of about 1.0 m)[13]. The lower magnitude in seasonal fluctuations observed at monitors located next to the watercourses is expected as watercourse valleys act as boundaries to the shallow groundwater system. Figure 4.5 and Figure 4.6 present interpreted groundwater levels at the Subject Property for spring and summer conditions.

The range in seasonal groundwater fluctuations was also examined at most of the data-logger equipped wells[14]. The seasonal range at these wells, with their continuous data sets, when compared to the corresponding ranges obtained from spot measurements at these same wells, was found to be about 0.1 to 0.7 m higher at monitors close to the watercourse (average 0.4 m), and from 0.2 to 0.7 m at monitors located away from the creeks (average 0.5 m). It is therefore not considered unreasonable based on these

[13] On-site monitoring wells MMM-09-04, MMM-09-06S/D, MMM-09-07, MMM-09-09, MMM-09-10S/D, MMM-09-14, MMM-09-17, and EXP-1 to EXP-4 are located nearby to the watercourses. The remaining on-site wells were considered to be included in the other category described above.

[14] MMM-09-19D that experienced very slow recovery of water levels is excluded from this discussion.

observations to conclude that the seasonal groundwater level fluctuations observed from 2009 to 2017 can range in average from between approximately 1.4 and 2.1 m (low ground and higher ground).

Vertical gradients are available from the eight monitoring well nests. At six of the nests, all located some distance from the watercourses; consistent downward hydraulic gradients were recorded[15]. At monitoring well nest MMM-09-01 and MMM-11-22 downward gradients ranged respectively between 0.00 to 0.24 and 0.04 to 0.18 respectively. At MMM-09-01 the downward gradients were observed to increase above 0.10 when the shallow water levels at this location rose in response to rain or snow melt events. At the other five monitors, the measured downward gradients were more pronounced and ranged from 0.34 to 0.81 (MMM-09-18), up to 1.07 to 2.02 (MMM-09-05)[16].

Upward vertical gradients have been generally recorded at the well nest at MMM-09-10, ranging from 0.001 to 0.09[17] (refer Figure SWL-10 in Appendix 4-5). The vertical gradient at the well nest constructed at MMM-09-6 varies depending on the season. Downward gradients are generally observed during the spring season, and reverses to an upward gradient during the summer and fall (July to December typically) as the shallow groundwater levels in the till drain and decline below the groundwater level of the bedrock (refer to Figure SWL-15 in Appendix 4-5). These two nests are located on the Subject Property next to the central watercourse (Reach 14W-14) and the deeper monitors are screened in the shale bedrock. In addition, at monitoring well MMM-09-09 (also screened in the upper shale) which is located close to the main branch of the FM1009 watercourse, the groundwater levels are often recorded above the stream channel bed elevation at mini-piezometer MP-07 (located about 40 m away). The data logger plots for MMM-09-09 and the MMM-09-10 nest indicate the groundwater levels at these locations are above the stream bed elevation over much of the year, declining at or below the channel during the summer season in particular (refer to Figures SWL-9 and SWL-10 in Appendix 4-5).

These findings imply that minor groundwater discharge from the bedrock aquifer is occurring at the Subject Property across both the main channel (Reaches 14W-12, 14W-16) and the central watercourse channel (Reach 14W-14) over much of the year. The volume of bedrock groundwater discharge over Reach 14W-14 (central Reach to FM1001) is insufficient to maintain base flow during the summer months as witnessed by the dry channel conditions during the summer season. Similarly, bedrock discharge into the main channel system is also insufficient to maintain baseflows based on on-site observations of isolated pools of water in the lower reaches and no flows observed at the mid to upper reaches during summer seasons.

Data collected from groundwater monitors and mini-piezometers alongside the easternmost channel of FM1009 (Reach 14W-13) and the Reach to FM1109 at the eastern part of the Subject Property (Reach 14W-11 and Reach 14W-11A) do not indicate bedrock groundwater contributions into these channels, and the interpreted bedrock groundwater contours (see Figure 4.5 or Figure 4.6) are below the channel bed elevations (Reach 14W-13's channel bed declines from 153.9 to 149.0 masl, and Reach 14W-11A declines from 154.9 to 151.3 masl on the Subject Property). Reach 14W-11A is considered to be losing water into the ground over most of the year (refer to Figure SWL-8 in Appendix 4-5).

[15] Monitoring Well Nests MMM-09-01, MMM-09-05, MMM-09-15, MMM-09-18, MMM-09-19, and MMM-11-22.

[16] Early data at some of these monitors is not included in these summaries because the calculated vertical gradients were not accurate (as one or both of the nested wells were still recovering).

[17] A downward gradient of 0.05 was manually recorded at this location on one occasion, July 5, 2011.

The data logger plots also illustrate rapid rises in the shallow groundwater following notable precipitation events and snow-melts, followed by a decline towards pre-event water levels over a two to three week length of time. These observations are consistent with an environment comprised of generally low hydraulic conductivity materials (till and/or clayey silt soils in the overburden and shale in the bedrock). Weathering of the surficial zone (approximately the upper 3-5 m) results in an enhanced bulk permeability of these soils due to the presence of fractures and other openings. This allows the upper zone to more readily receive, and transmit water, with rapid increases in water level due to events such as snow melts (clearly visible in the data logger equipped wells (Figures SWL-7 to SWL-18 in Appendix 4-5), which is then followed by a lowering of the water table as the upper zone drains. With depth, the effects of weathering and the frequency of fractures decreases and the permeability of these till and clayey silt soils becomes lower.

4.3.2.4 Findings of the Supplemental Farm Pond Investigation

An investigation was carried out at the Farm Pond (Reach 14W-14A) to characterize groundwater interactions at the large human-made Farm Pond at the centre of the Subject Property. Aerial photography from 1935 shows no evidence of a Farm Pond at this location but rather the continuation of Reach 14W-14 passing through the present day Farm Pond location before joining with the main channel to the south. According to the farmer living on the property, the Farm Pond was constructed shortly before the Hurricane Hazel storm event in October 1954.

The supplemental Farm Pond investigation study commenced in February 2011 when the surface water elevation of the large Farm Pond at the centre of the Subject Property was surveyed by WSP surveyors (February 10, 2011) and with the installation of a data logger at monitoring well MMM-09-02 (February 18, 2011). As noted earlier, three monitoring wells were constructed at two locations to the southwest of the Farm Pond in mid-July 2011, and a staff gauge was installed in the existing Farm Pond along with three mini-piezometers that were installed along the periphery of the Farm Pond in early July 2011.

Data loggers were installed at the staff gauge in early July 2011 and at the three monitoring wells in late July 2011 (MMM-11-21 and MMM-11-22S/D). WSP hydrogeological staff carried out water level monitoring visits and data logger uploads at these monitors between July 2011 and mid-April 2017[18].

Plots of the water level fluctuations at each of the above monitors (and MP-24, see below) are provided in Appendix 4-5 on Figures SWL-16 to SWL-20-2[19] as are hydrogeological cross-sections plotted through the centre of the Farm Pond (see Figure 4.4, and Figures HG1 through HG3 which are provided in Appendix 4-

[18] WSP staff discovered that the Farm Pond staff gauge was missing in January 2012 (top of T-bar visible at ice surface) and that the data logger (direct read cable with interface at the shore) could not be uploaded (no connection/signal). It is suspected that the staff gauge was sheared off the T-Bar by ice-heave, and at time of a subsequent thaw event sank into the Farm Pond. An estimate of the ice level was made based on the height of the visible T-Bar above the ice. The data logger was recovered, the staff gauge was repaired, and the logger was reinstalled at this location on July 18, 2012. The data logger was found again to be at the bottom of the staff gauge in October 2012 (direct read cable was sheared) and recovered on November 28, 2012. A new Farm Pond gauge installation was set up nearby to MMM-11-21 in July 2013 and Farm Pond level monitoring reinitiated. This location was again found to have been damaged by ice action in the winter of 2013-14 and a fourth installation was made nearby to MMM-11-21 in April 2014.

[19] Data logger plots with 5 m vertical intervals are also provided in Appendix 4-5.

5). Farm Pond levels range between 1 to 2 m higher than the groundwater at the nearby wells during the summer and fall seasons, and from about 0.5 to 1.2 m higher during the winter and spring seasons[20].

The data collected up to the end of 2012 indicated the Farm Pond was losing water into the ground but there remained questions from CH about the potential for groundwater discharge into the Farm Pond at its upstream end where no monitors were immediately located. WSP staff met on-site with CH's Hydrogeologist in early October 2013 and it was agreed to construct a shallow drive-point mini-piezometer nest at the upper (west) end of the Farm Pond and install data loggers at these stations. The purpose for this new nest was to provide a data point location at the upstream end of the Farm Pond to monitor and confirm the previously reported conclusions about the groundwater input into the Farm Pond.

The two drive-point piezometers were installed towards the upstream (west) end of the Farm Pond on October 22, 2013 and the mini-piezometers were screened at depths of 1.19 and 1.28 m below grade (MP24-D), and 0.31 and 0.44 m below grade (MP-24S)[21]. Following the installations, WSP staff manually surveyed the elevations of the new piezometers and also re-surveyed the elevations of the pre-existing wells and mini-piezometers in the immediate vicinity of the Farm Pond[22] to ensure all elevations at these monitors were using a consistent datum.

Figures SWL-20-1 and SWL-20-2 (Appendix 4.5) graphically present the data logger plots of water level fluctuations at the two mini-piezometers with pond levels also shown for comparison. Table 4.6 below provides a summary of the observations seen in the data over the past 3.5 years broken out by dates.

Table 4.6 – Mini-Piezometer MP-24 Observations

Date Range	MP-24S	MP-24D
Oct. 22 - Nov. 24, 2013	Water level fluctuations similar to Farm Pond, but slightly lower.	Water level fluctuations do not behave similar to Farm Pond, remain slightly above grade, and above Farm Pond level.
Nov. 24 - Dec. 13, 2013		Recorded water levels behave oddly with some random spikes not seen at the pond. Data during the winter then generally mimicked what was observed at the Farm Pond, until March 18, 2014. Believed to be due to freezing of mini piezometer (see main discussion).
Dec, 13, 2013 - Mar. 18, 2014	Logger removed for winter.	
Mar. 18 - Apr. 30, 2014		Sudden change in response at the logger (believed to be from ice melting in the mini-piezometer), but response at the logger for the

[20] The narrowing of the difference between the Farm Pond and groundwater elevations during the winter and spring seasons is due to recharge of the shallow groundwater system. On average, the groundwater levels recorded at the Farm Pond monitors are between 1.1 and 1.6 m higher than the Farm Pond.

[21] As explained in Section 4.3.1.1, this mini-piezometer nest was installed just beyond the upper limit of the Farm Pond (as defined by its average water level) and to the northwest of a topographic high point in Reach 14W-12A.

[22] The top of pipe elevation of MMM-09-2 was used as a benchmark for this survey and elevations were then re-surveyed at MMM-11-21, MMM-11-22S/D, MMM-09-10S/D, the Farm Pond logger station and MP-21, MP-22, MP-23, and MP-24S/D. The elevations presented in Tables SWL-1 and SWL-2 reflects these resurveyed top of pipe elevations.

Date Range	MP-24S	MP-24D
Apr. 30 - Nov. 26, 2014	Water level fluctuations similar to Farm Pond but lower. Responses to rain events match those at the Farm Pond and declines afterward are similar to a point, and then decline at a faster rate.	remainder of the year was very abnormal, exhibiting delayed responses (see Figure SWL-20-1 in the appendices). Logger was thought to have been damaged.
Nov. 26, 2014 - Apr. 27, 2015	Logger removed and installed at MMM-09-10 for winter to confirm its operation against the logger installed at that well. Logger is operating normally.	Logger removed and installed at MMM-09-10 for winter to confirm its operation against the logger installed at that well. Logger is operating normally. Logger is not damaged as originally surmised.
Apr. 27 - Jul. 20, 2015	Water levels at both mini-piezometers nearly identical, and nearly identical to Farm Pond, at or slightly below Farm Pond levels.	
July 20 - Oct. 25, 2015	Water levels at the mini-piezometers decline below Farm Pond levels and then dry out.	
Oct. 25 - Dec. 23, 2015	Water levels at the mini-piezometers and the Farm Pond rise rapidly in response to a rainfall event and water levels at the mini-piezometers then are nearly identical and closely mimic those at the pond, generally at or slightly below the pond levels, although they show greater immediate responses to rainfall events than recorded at the Farm Pond.	
Dec. 23, 2015 - Apr. 4, 2016	Logger removed for winter and temporarily installed at MMM-09-1D.	Logger removed for winter and temporarily installed at MMM-09-4.
Apr. 4 - Apr. 14, 2016	Water levels at both mini-piezometers nearly identical and at or slightly below the Farm Pond levels, with similar responses to precipitation events.	
Apr. 14 - Jun. 8, 2016	Water levels at both mini-piezometers are near identical and their responses are similar to those observed at the Farm Pond, but are lower, on the order of 0.1 to 0.2 m lower.	
Jun. 8 - Nov. 4, 2016	Water levels at both mini-piezometers are near identical and they decline and then become dry over the summer. Two short term responses to rainfall events were seen between Sep. 27 - Oct. 9 and Oct. 27-28 that were not seen at the Farm Pond location (likely because Farm Pond location was dry during the same period).	Water levels at both mini-piezometers are near identical and they decline and then become dry over the summer. Logger stopped recording on Aug. 26, 2016 and was returned to the office on Oct.14 in order to upload its data.
Nov. 4 - Nov. 24, 2016	Water levels at the mini-piezometers are near identical, exhibiting a peak response to a rainfall event followed by a decline (MP-24S becomes dry). There is no response observed at the Farm Pond, likely as the Farm Pond station is dry (above the Farm Pond water level) and thus changes in water level at the Farm Pond are not recorded.	Logger reinstalled on Nov. 4. Water levels at the mini-piezometers are near identical, exhibiting a peak response to a rainfall event followed by a decline (MP-24S becomes dry). There is no response observed at the Farm Pond, likely as the Farm Pond station is dry (above the Farm Pond water level) and thus changes in water level at the Farm Pond are not recorded.
Nov. 24 - Dec. 26, 2016	Water levels at the mini-piezometers are nearly identical, and recorded well above the Farm Pond level, which begins to show response (gradual increase) beginning Dec. 2, until a precipitation event on about Dec. 26 where both Farm Pond levels and mini-piezometer levels show a marked increase.	
Dec. 26, 2016 - Apr. 18, 2017	Water levels at the mini-piezometers are nearly identical, and nearly identical to Farm Pond, at or slightly above Farm Pond levels.	

4.3.2.4.1 Atypical Responses of Data Logger at MP-24D (November 18, 2014 to November 26, 2014)

The readings collected from the logger at MP24-D over the first year of monitoring exhibited odd behaviour as can be seen on Figure SWL-20-1. The upper part of the mini-piezometer was found to be solidly frozen on December 16, 2013 and the logger could not be removed for uploading data, and the unit was left in place through the winter[23]. The data recorded by this unit between roughly November 23, 2013 and March 18, 2014 exhibited a number of large and sudden spikes in recorded water levels that do not correlate with changes in water levels at the Farm Pond (see Figure SWL-20-1), although for much of the winter season the water levels recorded at MP-24D mimicked the Farm Pond levels[24]. The data during this 4 month period also shows significantly more variability (i.e., noise) than the data before or after this time frame. A sudden 61 cm decline in water pressure was recorded over a 1-hour period on March 18, 2014 after which the data displayed a more stable looking trend, which matched up with the manual measurement taken on April 30, 2014. We therefore do not consider the data collected at MP-24D during this 4 month winter period to be reliable given the strange behaviour observed. The sudden spikes in pressure readings at the MP-24D data logger appear to correlate to air temperature changes that fall below freezing, particularly in the earlier part of the winter season, and we are of the opinion that the behaviour is related to pressure build-up within the mini-piezometer due to surface freezing and expansion of ice within the pipe.

For the remainder of 2014, the data provided by the data logger installed at MP24-D continued to show odd behaviour in the water level fluctuations at the mini-piezometer. The recorded water level fluctuations at the mini-piezometer did not follow the pattern observed at MP24-S, where water level fluctuations were seen to quickly respond to rainfall events in a like manner to the responses at the Farm pond. Instead, the water level responses recorded by the MP24-D data logger appeared to be delayed and highly averaged.

The data logger was thought to have been possibly damaged from having been left installed over the winter of 2013-2014 and it was removed on November 26, 2016 and installed for the winter season at MMM-09-10 so that a comparison in its response could be made against that well's data logger. A review of the winter data collected at MMM-09-10 indicated that the MP24-D logger was operating correctly and it was re-installed at the mini-piezometer on April 27, 2015. All subsequent data collected at MP-24D by this data logger indicates near identical water level fluctuations to MP24-S in a pattern that resembles those seen at other monitoring wells across the property.

4.3.2.4.2 Discussion of MP-24 Results

Over the roughly 3.5 year period of study at location MP-24 (MP-24D discussions exclude data from the 1 year period discussed in the preceding section), the groundwater levels at the 2 mini-piezometers have generally been closely matched to the water level fluctuations observed at the Farm Pond and are therefore considered to be controlled by precipitation and the water level fluctuations at the Farm Pond and adjacent channel. The average difference between the water level at MP-24S has it at 1 mm (-0.001 m) below the

[23] It had also been intended to remove this unit from the mini-piezometer over the winter months but this could not be done because of the frozen condition.

[24] The Farm Pond levels were frequently higher than the ground elevation at the mini-piezometer suggesting the area was also inundated with surface water following precipitation events.

Farm Pond level (range of -0.32 to +0.71 m[25]) and at MP24-D, water levels at the mini-piezometer were on average 4mm below Farm Pond level (-0.004 m) with a range of -0.84 to +0.69 m. Water levels at the mini-piezometers have been recorded above grade only at times when the Farm Pond level has also been recorded above the grade at the MP-24 monitoring station (grade is approx. 148.8 masl).

We also wish to note that, as the Farm Pond levels decline during the summer season, the Farm Pond edge also recedes to the southeast, moving further away from the mini-piezometer station and therefore; comparisons between water elevations at the mini-piezometer and the Farm Pond as an indicator of groundwater seepage potential relative to the Farm Pond levels become less significant.

The data collected to date at MP-24D indicates that the gradients at this location vary between upward (towards the Farm Pond/channel) and downward (from the Farm Pond/channel into the ground) with an average gradient calculated at +0.001 (downward). This is not unexpected as this monitor is sited in the area where groundwater gradients by the water course system were predicted to change from upward (i.e., to the northwest such as observed at MMM-09-10) to downward (as seen at all the monitors around the Farm Pond to the southeast).

Figure HG-4 (Appendix 4.5) shows the interpreted limits of the potential for seepage towards the upstream (west) end of the Farm Pond. The seepage limits are based on where the interpreted groundwater contours (from April 30, 2014 data) intercept the topographic contours and extends approximately 35 m further east of Station MP-24. This potential seepage area is generally located beyond the proposed limits of Farm Pond construction highlighted by the yellow line shown on the figure, and based on topographic contours, is also located below the topographic rise between the channel and the Farm Pond (see Figure HG-4) that indicates seepage is directed into the channel and will not reach the Farm Pond except under short-term conditions when there is flow from the channel into the Farm Pond (e.g., after rain events).

The data collected since 2011 at the data loggers at the monitoring wells have shown the Farm Pond levels are always higher than the static water levels at the groundwater monitors surrounding the Farm Pond itself, and downward gradients were generally recorded at the mini-piezometers[26] along the edges of the Farm Pond. The monitoring data from MP-24 indicates there is potential for a very small amount groundwater input beyond the upstream end of the Farm Pond entering Reach 14W-12A. Between October 22 and November 22, 2013 the groundwater elevations recorded at MP24-D (see Figures SWL-20-1 and SWL-20-2) ranged from 17 cm below the Farm Pond level (following a surface runoff event into the pond) to 12 cm higher than the Farm Pond water elevation (October 29), and from April 27, 2015 to April 17, 2017 have ranged from between 82 cm below Farm Pond levels to 69 cm above the Farm Pond levels[27]. To date the maximum upward gradient at this location relative to the Farm Pond (excluding data between November 23, 2013 and November 26, 2014) has been measured at about -0.215[28], with an overall average of +0.001, a very slight

[25] The peak high difference at both mini-piezometers occurred on October 25, 2015 over a 2 hour period when water levels at the mini-piezometers and the Farm Pond rose dramatically over a short period of time in response to a rain event. This large difference quickly declined as Farm Pond levels recorded at the Farm Pond logger station continued to rise.

[26] At site visits when the mini-piezometer and/or Farm Pond were not dry or frozen. Mini-piezometers MP-22 and MP-23 were identified as plugged by accumulated silt and cleaned out in early September 2013.

[27] As identified earlier, the data collected after November 23, 2013 through the winter of 2013-2014 and up to November 26, 2014 at the mini-piezometer exhibited strange behaviour and was not considered reliable.

[28] Upward gradients are expressed as negative values, downward gradients as positive values.

downward gradient[29]. In contrast, downward gradients are present at the monitoring wells located around the perimeter of the main area of the Farm Pond where groundwater has always been measured at lower elevation than the water in the Farm Pond (on average at the monitors, between 1.1 and 1.7 m below the water level in the Farm Pond, or downward gradients from the Farm Pond towards the monitors on the order of +0.042 to +0.118).

Given the larger surface area of the eastern part of the Farm Pond, and the larger outward gradients identified in that area, losses of water from the Farm Pond back into the ground will be significantly greater than any potential groundwater inflows originating near the upstream end of the Farm Pond, which as noted earlier, are to the northwest of the Farm Pond alongside Reach 14W-12A, and would discharge into this reach and not into the Farm Pond itself. As the hydraulic conductivity of the clay/silt soils found across the site and at the Farm Pond is on the order of 10^{-7} to 10^{-8} m/sec (very low), the quantity of groundwater entering into Reach 14W-12A and/or the Farm Pond will be low. The new monitoring station data therefore refines but does not change the understanding of the function of the Farm Pond, which is that it is maintained by surface water inflows and not by groundwater contributions.

In conclusion, surface water level data from the Farm Pond as well as groundwater data from surrounding monitors indicate that the Farm Pond does not receive groundwater inputs in sufficient quantities to affect the water level of the Farm Pond, nor to lead to appreciable discharges into the adjacent channel at the top end of the Farm Pond. Flows from the Farm Pond is associated with surface water inputs that fill the Farm Pond following rain events, and then drains back out to the watercourse network afterward. Groundwater elevations at the surrounding monitoring wells showed the water level at the Farm Pond is consistently on the order of 1 to 2 m higher elevation than the groundwater, and therefore; the Farm Pond loses water into the ground rather than receiving groundwater inputs[30]. The very minor groundwater discharge potential that is present near the upstream end of the Farm Pond (calculated at 110 m^3/year, see Section 4.4.4.7) and that enters Reach 14W-12A is far outweighed by the losses back into the ground over the much larger area of the Farm Pond to the east, where the greater downward head differences are recorded.

4.3.2.5 Stream Base Flow Measurements

Estimates of the flows within the watercourses traversing the Subject Property were carried out by WSP staff during site visits between May 2009 and February 2011. Measurements were taken at consistent locations at each Reach, generally at the mini-piezometers and flow monitoring points (MP-1 to MP-7 and FMP-1 to FMP-4, refer to Figure 4.4 for these locations[31]). The flow estimates were generally carried out, if possible,

[29] The gradients presented above have been calculated using the lateral and vertical distances from the edge of the Farm Pond (average Farm Pond water elevation 148.7 masl) or edge of watercourse (e.g., MMM-09-10) to the centroid of the well screen.

[30] Groundwater elevations at a monitoring well nest located approximately 100 m upstream of the Farm Pond inlet (MMM-09-10 alongside Reach 14W-14) indicate groundwater elevations at that location to range between about 0.5 and 1.0 m higher than the surface water levels in the Farm pond located downstream of this station (further note that during the summer season, groundwater elevations at these monitors would typically decline the base of the channel, so inputs to the channel are not year-round). The data from this monitoring well nest and the wells around the Farm Pond indicated that the area where the potential for groundwater inputs changed to surface water losses would be located near the upstream end of the Farm Pond. The data collected at MP-24D supports this as the groundwater levels have been recorded close to ground surface at this location.

[31] FMP-3 is located at the central Reach of the FM1001 watercourse at the southeast corner of Tremaine Road and Number 1 Sideroad.

following 5 days of dry weather, with some exceptions when precipitation events conflicted with staff scheduling.

The measurements were carried out by visually identifying a consistent length of channel and measuring the time for a small floating object to travel from the upstream end to downstream end of the measured length of this reach. A minimum of five to six timed runs were obtained (using the stop-watch function on a GPS) and an average flow velocity was calculated. Runs where the floating object were caught on an obstruction or otherwise prevented from travelling down channel unhindered were ignored and the run was repeated. Saturated channel cross-sectional areas were obtained at the upstream and downstream ends of the length under consideration and an average area was calculated. This allowed for an estimate of total flow at the watercourse. Frictional losses along the channel sidewalls and along the substrate were ignored and thus the calculated flow volumes are recognized to be potentially over-estimated.

Stream flow measurements pertinent to each watercourse are summarized in Table 4.7 below. Flow estimate calculations are also provided in Appendix 4-5. Table 4.7 also presents estimated base flow contributions from groundwater based upon the monthly water balances carried out for this study[32].

The watercourses within the Subject Property and EIR Sub-catchment Study Area were generally observed in flowing conditions during the late fall through to the late spring, although wintertime observations often found the watercourses as completely frozen, or frozen with some flow observed below the ice. In the summer months, the watercourses, particularly the central and eastern watercourse to FM1001 (Reach 14W-13 and Reach 14W-14) and the watercourse for FM1109 (Reach 14W-11 and Reach 14W-11A) are observed to be non-flowing. The main channel for FM1001 (Reach 14W-12 and Reach 14W-16) was observed on the Subject Property during the summer and late summer months with little to no flow, and pooled or standing water. These summertime pockets of water along the lower stretches of the watercourse are likely from a combination of minor groundwater discharge from the bedrock system, and remnants of storm flows collected in depressions along the stream channel.

It is also noted that, based on interpretation of aerial photography, that ditching along both sides of Highway 407 appears to be conveyed directly into the watercourses passing through the Subject Property, without benefit of SWM facilities. One other source of water within Reach 14W-12 and Reach 14W-16 (FM1001) is from quarry discharge at the Hanson Brick operation to the north of Highway 407.

Groundwater and precipitation entering the quarry is reported to be intermittently pumped into a settling pond and discharged into this watercourse. In 2008, a total volume of approximately 44,500,000 litres was pumped from the quarry into this watercourse, at an average rate of 1,078 litres/minute. This is equivalent to an average of about 13 hours discharge per week into this watercourse, which would not be noticeable during fall to spring conditions, but which would lead to additional water to this stream during the summer period when the watercourses are intermittent.

[32] The monthly water balance methodology and pre-development infiltration estimates are presented beginning in Section 4.4.2 of this report.

Table 4.7 – Summary of Stream Flow Observations

Table 4.7: Summary of Stream Flow Observations

Monitoring Location	Easting	Northing	5-May-09	29-May-09	19-Jun-09	24-Sep-09	9-Nov-09	18-Nov-09 and 20-Nov-09
5-Day Preceding Weather Description			20 to 25 mm rainfall recorded at Pearson and Oakville Weather Stations on April 30, and additional 1 mm combined over May 1 and 2. May 2 to 5 no precipitation.	Wet weather. May 27-28, 30 mm combined recorded at Pearson, 15 mm combined recorded at Oakville. An additional 3 - 4 mm of rain recoded at both stations on May 29	Rain Event June 16, 12 to 15 mm recorded at Pearson and Oakville over June 16 to 17, bulk falling on the 16th.	3 to 4 mm rain recorded at Pearson and Oakville combined on September 21 and 23 (Pearson only). Previous to these minor events, there was no precipitation recorded after August 28-29 at either station.	3 to 4 mm precipitation recorded at each weather station over November 4 and 5.	Zero precipitation recorded at Pearson or Oakville from November 4-5. Significant Precipitation Event beginning approx. 0500 hours at Oakville/Pearson on the morning of November 19, precipitation ending at 0300 hours on the 20th - 14 mm at Pearson
Subwatershed FM1001	Est'd Base Flow Rates from Water Balance -->		**1,127 to 457 LPM (April and May)**	**457 to 27 LPM (May and June)**	**27 LPM (June)**	**0 to 52 LPM (Sept and Oct)**	**52 to 184 LPM (Oct and Nov)**	**184 LPM (Nov)**
Easternmost Tributary (14W-13)								
FMP-4	597523	4809561				Downstream of FMP-4 standing water in pockets - no flow	Standing water in channel, no flow	
Central Tributary (14W-14)								
FMP-3 (Corner of Burnhamthorpe and Tremaine)								No defined channel - water observed flowing in rivulets from concrete bridge/culvert. Water was bright green with algae Some flow from west through culvert that crosses Tremaine Road
MP-06	597348	4809417.944	Mini-piezometer is situated in water but area is spread out with Reed Canary Grass, flow is present but spread out over wide area - no flow estimate possible. Temperature = 14.8C (Air Temp = 22.5C @ 2:00 PM) Conductivity = 873 uS, pH = 7.81					
MP-03/FMP-5	597808	4809266.198	Watercourse flowing. Flow estimated at approx.**365 LPM**	Flow estimated at **43 LPM**		Channel dry		
Main (Westernmost) Tributary (14W-16/14W-12)								
MP-07	597541	4809149.703	Watercourse flowing but no suitable location for flow estimate found during first visit. Temperature = 16.9C (Air Temp = 16.0C @ 2:20 PM) Conductivity = 1,050 uS, pH = 7.95	Watercourse flowing. Flow estimated at **445 LPM**.				
FMP-1 (upstream of SG-1)	597618	4809131						
Staff Gauge #1 (Upstream of small (West) Pond)	597677	4809113.09	Flow estimate downstream of MP-07 immediately upstream of small pond outlet (flowing) into main channel (roughly where SG-1 was later installed). Flow estimated at approx **450 LPM.** Temperature = 20.1C (@ 2:40 PM) Conductivity = 404 uS, pH = 8.5ℓ			No flow, standing water observed. Temperature = 20.0C (Air Temp = 26.2C) Conductivity = 862 uS, pH = 7.05	Flow estimated at **106 LPM**	
MP-04/FMP-06	597972	4809088.192	Watercourse flowing. No suitable reach for flow estimate Temperature = 14.3C (Air Temp = 16.0C @ 10:55 AM) Conductivity = 710 uS, pH = 8.78	Water flowing, flow estimated at **268 LPM**.	Water flowing, flow estimated at **645 LPM** - precipitation event recorded 2-3 days prior	Channel dry at MP-04. At farm bridge downstream of MP-04, no flow also observed in channel, standing water only in pools.		
Staff Gauge #2 (by Dundas Street)	598345	4809063.452	Flow in Main Channel by Dundas Street - channel is in bedrock so no opportunity to install mini-piezometer. Flow estimated at approx. **1,020 LPM** - same order of magnitude as water balance estimate. Temperature = 18.9C (time approx. 3:00 PM) Conductivity = 853 uS, pH = 8.45			Standing water - no discernible flow		Nov. 18 - Ponded water observed in main channel with no discernible flow. Nov. 20 - Flow measured in channel, estimated at approximately **1,635 LPM** (after rainfall)
Subwatershed FM1109 (14W-11A/14W-11)	Est'd Base Flow Rates from Water Balance -->		**107 to 44 LPM (April and May)**	**44 to 3 LPM (May and June)**	**3 LPM (June)**	**0 to 5 LPM (Sept and Oct)**	**5 to 18 LPM (Oct and Nov)**	**18 LPM (Nov)**
MP-01	597409	4809839.704	Watercourse flowing. Not an ideal location for an estimate but estimated flow rate was approx.**220 LPM** - same order of magnitude as water balance estimate Temperature = 15.8C (@ 1:05 PM) Conductivity = 700 uS, pH = 8.1ℓ	Flow estimated at **128 LPM**.		Channel dry at mini-piezometer - standing water observed in low spots - no flow. Temperature = 20.1C (Air Temp = 26.1C) Conductivity = 2987 uS, pH = 6.07	No flow, pooled water in places	
FMP-2 (located between MP-01 and MP-02)	597608	4809788					Channel approximately 1.0m wide intermittent damp to wet areas approx. 0.02m depth. No measureable flow.	
MP-02	597769	4809665.798	Minor/slow/diffuse flow observed - could not be estimated. Temperature = 19.2C (Air Temp = 18.2C @ 12:30 PM) Conductivity = 745 uS, pH = 8.04	Watercourse flowing. Flow estimated at **247 LPM**.		Channel dry	No flow, pooled water in places	
Subwatershed FM1102								
Tributary FM1102 (Tributary passing through SW part of Site)	597989	4808801	No defined channel (ploughed field) and no culvert passing under farm lane to direct flows. Stagnant/ponded water in furrows. Temperature = 21.4C Conductivity = 460 uS, pH = 7.97					
Other Water Features								
Large Pond (21 m to the west of MMM-09-2)			Temperature = 18.9C Conductivity = 630 uS, pH = 8.11					
MP-05 (Small ponded area on hill-top)	597514	4809671.167	Ponded area on crest of hill. Temperature = 21.4C (@ 1:30 PM) Conductivity = 185 uS, pH = 7.98			Dry	Channel dry at mini-piezometer - standing water observed in low spots - no flow. Pooled water 2.5 m west of MP location	
Comments regarding FM1001/FM1109			Flow estimates at the downstream end of FM1001 (14W-12) by SG-2 (1,020 LPM) is of the same order of magnitude order of magnitude estimated by water balance (between 430 to 1,060 LPM). Flow estimates at MP-01 (FM1109/14W-11A) are also the same order of magnitude (though a bit higher) as estimated by the water balance	Measurements obtained at the end of the month, so flow as would be predicted by the water balance is anticipated somewhere between the average rate for May and June. Estimated flows within FM1001 are of the same order of magnitude but higher than the average for May and June. At FM1109, at least an order of magnitude higher than predicted. Weather was wet however so measured flows should be higher than predicted by water balance.	Flows measured at FM1001 an order of magnitude higher than would be predicted by water balance, but measurement was obtained about three days after rain event. These higher flows may also coincide with a discharge event at the Hanson Brick Quarry located upstream of the site.	Both FM1001 and FM1109 were dry or pooled with no flow which is in line with September estimates of the water balance which predicts no flow.	FM1001 (14W-16) entering site flow estimated at 106 LPM, on the same order of magnitude as predicted by the water balance. FM1109 - no discernible flows, pooled water, but water balance estimates low flows of 5 to 17 LPM	At downstream end of FM1001 (by Dundas Street), no discernible flow was observed on Nov. 18, but two days later after approximately 1-day rainfall event, flow at the same station was estimated at 1,635 LPM.

Notes:
5-day Preceding Weather observations, focussed on precipitation are presented at the top of the table for Oakville and Pearson Airport weather stations. The Pearson data is complete, the Oakville data, while closer to the site does have missing data.
The 5-day weather observations are also colour coded (shaded) per the following:

Stream flow estimates were made by measuring the time for a floating object to traverse a measured length of watercourse, of generally consistent cross-sectional profile and straight alignment. An average time was calculated using between 3 to 6 measurements. As flow velocity was thus obtained.
The area of this typical cross-sectional saturated profile (or a weighted average of multiple profiles along the length of run) was calculated and this, combined with the flow velocity were used to arrive at an estimated flow rate in the channel.
The calculated flow is considered an overestimation as it does not account for lower flows due to friction along the water/channel bed interfaces.

For the purposes of checking the water balance model against estimated stream flows (described above), the monthly water balance volumes of groundwater infiltration was assumed to be converted fully stream base flow.
Estimates (presented in LPM) for the entire subwatershed FM1001, and a portion of the tributary to FM1109 that passes through the northeast corner of the site area from the water balance calculations are identifie**d bold blue** text.
Where estimates were obtained towards the beginning or end of a month, a range of the calculated average monthly base flows is presented. Measurements made towards the middle of the month are correlated against the estimated base flow calculated for the month.
The water balance calculations are based on long-term averages and variations in actual precipitation from these averages will affect results. Furthermore a portion of infiltrating water will be directed to the deeper system, though this is estimated at less than 10%.
Most of the infiltrating groundwater is anticipated to flow horizontally through the upper weathered/fractured zone, discharging as this layer drains into watercourses within a 1 to 2 month timeframe.

Considered dry preceding 5-days and suitable for base flow estimates | Precipitation recorded within 5 days | Significant precipitation on the day of or within 1 to 2 days before visit

Table 4.7: Summary of Stream Flow Observations

Monitoring Location	Easting	Northing	18-Dec-09	21-Jan-10	13-Apr-10	5-Aug-10	18-Oct-10 and 19-Oct-10	17-Feb-11 and 18-Feb-11
5-Day Preceding Weather Description			4.5 mm of precipitation recorded at Pearson over December 13 to 16. 2.5 mm of this on December 14. Incomplete data at Oakville.	0.2 mm precipitation at Pearson on January 19, zero at Oakville over preceding 5-days.	32 mm precipitation at Pearson Over April 6 to 8 (5-7 days prior), and at Oakville, 12 mm between the 4th to the 6th, 25 mm on the 7th, and 5 mm on the 8th. No precipitation at either station April 9 to 13.	0.2 mm recorded at Pearson (July 31) and 1 mm recorded at Oakville (July 31) otherwise no precipitation at either station in the previous 5 days.	Oakville Data incomplete over 5-day interval. Pearson Airport data indicates 12.4 mm rainfall Oct 14 (and 4.2 mm Oct. 13). MMM staffer visited site late afternoon Oct. 14 to view conditions at main tributary following rain event - main channels were in flood. Quarterly site visit was 4-5 days later with no additional precipitation recorded. Flows observed over Oct 18-19 were continuing to decline from Oct. 14 rates	Minor precipitation recorded at Pearson Airport (1.4 mm) or Oakville (2.6 mm) in preceding 5 days. However, temperatures were generally above 0C in the preceding 5 days with snow cover melting. The maximum daily temperatures on the two days on-site at both weather stations were recorded between 10 and 11C.
Subwatershed FM1001	Est'd Base Flow Rates from Water Balance -->		**359 LPM (Dec)**	**550 (Jan)**	**1,127 LPM (April)**	**0 LPM (July and August)**	**52 LPM (Oct)**	**1,156 LPM (Feb)**
Easternmost Tributary (14W-13)								
FMP-4	597523	4809561		Watercourse was frozen, no visible flow	Flow estimated at **88 LPM**.	Dry	No flow estimates made	
Central Tributary (14W-14)								
FMP-3 (Corner of Burnhamthorpe and Tremaine)				(Jan 22) Frozen, ice clear with pockets of trapped air. No flow observed.	Flow estimated at **235 LPM**.		No suitable location to measure flow was available this visit, some flow was observed.	
MP-06	597348	4809417.944		Frozen.		Dry	No flow estimates made	
MP-03/FMP-5	597808	4809266.198		Frozen. No flow observed	Flow estimated at **183 LPM**.	Dry	Flow estimated at **83 LPM**	
Main (Westernmost) Tributary (14W-16/14W-12)								
MP-07	597541	4809149.703		Frozen, no flow observed. Clear ice.		Dry	No flow estimates made	
FMP-1 (upstream of SG-1)	597618	4809131	Flow estimated at **592 LPM**	Frozen, crunchy ice over a denser ice. No flow observed.	Flow estimated at **381 LPM**.	Dry	No flow estimates made	
Staff Gauge #1 (Upstream of small (West) Pond)	597677	4809113.09		Frozen. Crunchy ice over a clear denser ice. Flow observed downstream at culvert crossing.		No flow, some pooled water.	No flow estimates made	
MP-04/FMP-06	597972	4809088.192	At farm bridge downstream of MP-04, flow observed in channel - ice along edges.	Some flow observed north of concrete farm bridge, but frozen at bridge and to the south. MP-04 has been destroyed by ice. Flow estimated at **63 LPM**	Flow estimated at **871 LPM**.	Dry	No flow estimates made	
Staff Gauge #2 (by Dundas Street)	598345	4809063.452		Frozen, some flow under ice.	Flow observed.	No flow, some pooled water.	No flow estimates made	
Subwatershed FM1109 (14W-11A/14W-11)	Est'd Base Flow Rates from Water Balance -->		**36 LPM (Dec)**	**496 (Jan)**	**107 LPM (April)**	**0 LPM (July and August)**	**5 LPM (Oct)**	**99 LPM (Feb)**
MP-01	597409	4809839.704		Frozen. No flow observed.		Dry		
FMP-2 (located between MP-01 and MP-02)	597608	4809788	Frozen - water flowing under ice. Ice at least 2 cm thick. Clear and dense ice.	Frozen, dense ice covered with snow	Flow estimated at **100 LPM**	Dry	Flow estimated at **32 LPM**	
MP-02	597769	4809665.798	Frozen. Broke through ice - about 0.1 m of water. No measureable flow.	Frozen. Surface water in area frozen. Wet under ice.		Dry		
Subwatershed FM1102								
Tributary FM1102 (Tributary passing through SW part of Site)	597989	4808801						
Other Water Features								
Large Pond (21 m to the west of MMM-09-2)								
MP-05 (Small ponded area on hill-top)	597514	4809671.167		Frozen. Surface water in area frozen.				
Comments regarding FM1001/FM1109			Flow in FM1001 (14W-16) at same order of magnitude (but higher) than predicted by the water balance but also within about 3 days of a rainfall event. At FM1109, low flows are predicted by the water balance, and low flows seen but channels also ice-covered frozen.	All watercourses frozen at time of visit - water balance infiltration estimates suggest flow potential but very little opportunity to measure flow - one measurement obtained at FM1001 is an order of magnitude lower than predicted).	FM1001, flows estimated at about 870 LPM just upstream of Dundas Street, which is in line with water balance estimate of 1,060 LPM. FM1109 estimates of flow at 100 LPM, vs. 102 LPM estimated by water balance.	All watercourses dry (or pooled water in low areas) which agrees with water balance estimate (no flow)	Flows where measured are a bit higher than (but same order of magnitude) as flows predicted by water balance. Rates were noted to be declining still following a significant rain event on Oct 13-14.	Channels were in flood and flow measurements were not attempted by field staff.

Notes:
5-day Preceding Weather observations, focussed on precipitation are presented at the top of the table for Oakville and Pearson Airport weather stations. The Pearson data is complete, the Oakville data, while closer to the site does have missing data.
The 5-day weather observations are also colour coded (shaded) per the following:

Stream flow estimates were made by measuring the time for a floating object to traverse a measured length of watercourse, of generally consistent cross-sectional profile and straight alignment. An average time was calculated using between 3 to 6 measurements. As flow velocity was thus obtained.
The area of this typical cross-sectional saturated profile (or a weighted average of multiple profiles along the length of run) was calculated and this, combined with the flow velocity were used to arrive at an estimated flow rate in the channel.
The calculated flow is considered an overestimation as it does not account for lower flows due to friction along the water/channel bed interfaces.

For the purposes of checking the water balance model against estimated stream flows (described above), the monthly water balance volumes of groundwater infiltration was assumed to be converted fully stream base flow.
Estimates (presented in LPM) for the entire subwatershed FM1001, and a portion of the tributary to FM1109 that passes through the northeast corner of the site area from the water balance calculations are identified in bold blue text.
Where estimates were obtained towards the beginning or end of a month, a range of the calculated average monthly base flows is presented. Measurements made towards the middle of the month are correlated against the estimated base flow calculated for the month.
The water balance calculations are based on long-term averages and variations in actual precipitation from these averages will affect results. Furthermore a portion of infiltrating water will be directed to the deeper system, though this is estimated at less than 10%.
Most of the infiltrating groundwater is anticipated to flow horizontally through the upper weathered/fractured zone, discharging as this layer drains into watercourses within a 1 to 2 month timeframe.

Considered dry preceding 5-days and suitable for base flow estimates | Precipitation recorded within 5 days | Significant precipitation on the day of or within 1 to 2 days before visit

4.3.2.6 Groundwater and Surface Water Quality

Groundwater samples were collected by WSP staff at selected locations on September 24, 2009 and January 21, 2010 for background general chemistry. The samples were obtained from nine monitoring wells (MMM-09-4, MMM-09-10S, MMM-09-10D, MMM-09-11, MMM-09-15S, MMM-09-15D, MMM-09-17, MMM-09-19S, and MMM-09-19 D (See Figure WQ-1 in Appendix 4-6 for the sampling locations)). One surface water sample was collected from a water stream, where a staff gauge SG-1 was installed (also shown on Figure WQ-1). Dedicated polyethylene bailers were used for the purging and sampling of the groundwater into laboratory prepared sample bottles. The samples were then placed in a cooler with ice and transported to the laboratory (*Maxxam Analytics*) under standard Chain of Custody procedures.

Water quality sample results are provided in Tables WQ-1 and WQ-2 found in Appendix 4-6. Selected inorganic and metal parameter concentrations are plotted in Figure WQ-2 to facilitate the water quality characterization discussion. A graphical representation of cation and anion water chemistry is depicted in a Piper/Trilinear diagram, as shown in Figure WQ-3 (Figures WQ-2 and WQ-3 are also presented in Appendix 4-6). Water quality results were compared to the Ontario Drinking Water Standards (ODWS) and the Provincial Water Quality Objectives (PWQO)[33]. For comparative purposes, the groundwater sample results were also grouped according to the geological unit in which the wells are screened. The groupings include monitoring well sample results screened in Halton Till, the till/bedrock interface, Queenston Shale (deep/shallow), and surface water.

As shown in Tables WQ-1 and WQ-2 and Figure WQ-2 several parameters exceed the ODWS, PWQO, or both comparative standards, from at least one location, including boron, cobalt, iron, manganese, silver, sodium, uranium, zinc, hardness, total dissolved solids (TDS), dissolved organic carbon (DOC), sulphate, chloride, and nitrate.

Water quality results were generally indicative of rural land uses, with no widespread evidence of inorganic parameter impacts at the Subject Property. Dissolved metals sample concentrations (cobalt, sulphate, magnesium, molybdenum, DOC and manganese), were higher in wells screened within the Halton Till as compared to samples collected from wells screened in the Queenston Shale. Samples collected from bedrock monitors indicated relatively higher boron concentrations as compared to collected till water quality samples.

Surface water quality samples indicate higher concentrations of conductivity, manganese and lower concentrations of DOC and sulphate as compared to the collected groundwater sample concentrations.

With the exception of MMM-09-15S, there is no marked variance in water chemistry between wells screened within the same geological unit. MMM-09-15S exhibited elevated concentrations of conductivity, sodium, chloride, and iron in comparison to other bedrock wells, indicating it may be affected by road de-icing salt from Tremaine Road.

[33] ODWS are from Table 2 (Chemical Standards) and Table 4 (Chemical/Physical Objectives and Guidelines) of Technical Support Document for Ontario Drinking Water; Standards, Objectives and Guidelines (MOE), June 2003, revised June 2006.

PWQO are from Table 2 (Table of PWQOs and Interim PWQOs) of Water Management, Policies, Guidelines, Provincial Water Quality Objectives (MOE), July 1994, and revised February 1999.

The Piper/Trilinear diagram (Figure WQ-3) shows good segregation between the till, bedrock, and surface water samples, with each grouping occupying a close-knit area within the diagram. Therefore, water from the different aquifers have a unique 'geochemical fingerprint', and can be characterized within a defined area of the Piper diagram. It is apparent from these distinct groupings that there was limited groundwater - surface water mixing at the time of sampling.

4.3.3 Local Hydrogeological Setting

The following discussion of the local hydrogeology is based on the information gathered during this investigation and from previous studies conducted on the property and elsewhere within the watersheds.

The surficial fine-grained deposit of Halton Till found throughout the study area serves to limit infiltration to the groundwater system and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff. As will be demonstrated in the water balance discussion, average infiltration in this environment is approximately 69 mm/year. Of this 69 mm/year of infiltration, on the order of 0.3 to 5 mm/year is estimated to recharge the deeper bedrock system[34], with the majority of the groundwater inputs to the local watercourses considered to flow laterally through the upper, weathered zone of the till. Almost 100% of this contribution occurs primarily in the period of November to May when the entire shallow system, including upgradient reaches of the channel are saturated and contributing flow to the watercourses.

The upper weathered zone of the till is estimated to have a bulk horizontal hydraulic conductivity on the order of $3x10^{-6}$ m/sec. This enhanced permeability permit infiltrating groundwater to travel somewhat quickly through the shallow zone towards the watercourses. During the late fall to late spring seasons, the streams are generally observed to be in flow, which is predicted by the water balance (groundwater infiltration is predicted during these periods). The higher bulk conductivity in the shallow system can also be observed through the rapid rise and subsequent steady declines in shallow groundwater elevations following precipitation and snow melt events visible in the data logger plots (Appendix 4-5).

Because of this enhanced conductivity, most (approximately 90%) of the infiltrating groundwater moves horizontally through the shallow system, and provides a source of base flow to the local streams during the late fall to late spring. During the growing season groundwater infiltration ceases (there is a water deficit and plants are active and using up water), the shallow system drains, and the watercourses become dry. Figure 4.5 and Figure 4.6 illustrate this decline in the shallow groundwater levels that lead to the reduction in base flow contribution from the spring into the summer seasons.

Towards the lower (southern) reaches of watershed FM1001 the watercourse valleys approach the underlying Queenston Shale bedrock, which is exposed at surface at the extreme southern limits of FM1001 (at the southern end of Reach 14W-12), just before it passes under Dundas Street. Minor groundwater inputs from the bedrock discharging into the main watercourse (Reach 14W-12 and Reach 14W-16) and the central watercourse (Reach 14W-14) across the entire Subject Property is interpreted from the monitoring well data. Bedrock discharge into the main watercourse is anticipated to continue up to a point roughly where this

[34] These estimates are based upon an average downward vertical gradient through the till of approximately 0.4, and vertical hydraulic conductivity ranging between $3.8x10^{-10}$ to $2.2x10^{-11}$ m/sec (see notes from Table 4.4). The greater vertical recharge (approx. 5 mm/year) is considered the more representative value for this system.

watercourse passes under Highway 407, and in Reach 14W-14 up to a point somewhere between the Highway and Number 1 Sideroad (see Figure 4.3)[35]. The extent of the length of these reaches with potential bedrock discharge may become reduced somewhat by ongoing and future activities at the recently constructed Hanson Brick quarry, which is being excavated into the shale, and thus will lead to a localized lowering of the groundwater within the bedrock around the perimeter of the pit over time.

The seasonal groundwater elevation changes within the bedrock are not as highly variable as in the surficial tills, and thus its contribution of groundwater towards these two watercourse channels is considered to continue throughout the year. However, the volumetric rate of water moving towards these watercourses is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses, particularly in the reaches from about the mid-point of the Subject Property and to the north, where the channels have been observed in a dry state during the summer period. Over the lower reaches of the main channel there may be greater opportunity for groundwater to maintain pools in the channel as the bedrock is exposed in the channel and the watercourse is shaded somewhat by large trees.

4.4 Impacts of the Proposed Development

For the purposes of this study, the employment lands development for the Subject Property and adjacent lands to be developed was considered to be 90% future imperviousness[36] within the development limits. This is based on the maximum lot coverage requirement of 90% of the North Oakville Zoning By-Law, which anticipates more urban and intensive employment uses in North Oakville. Lands designated to remain in their natural state, or to be reconstructed in a natural state were assumed to be 100% pervious after development.

Under existing conditions, four watercourses currently enter the Subject Property from the west and northwest. The three reaches associated with watercourse FM1001 (Reach 14W-13, Reach 14W-14 and Reach 14W-16) converge into one main channel (Reach 14W-12) at about the middle of the Subject Property, and one watercourse (Reach 14W-11 and Reach 14W-11A) FM1109 cuts across the northeast corner of the Subject Property.

It is proposed to re-align the central and eastern reached (Reach 14W-14 and Reach 14W-13) of the main watercourse (FM1001) at the north boundary of the Subject Property, to the west and then southerly along the western property line via a new channel (Reach 14W-22) into Reach 14W-12A upstream of its confluence with Reach 14W-12. The watercourse to FM1109 that enters the property at the northeast (Reach 14W-11A) is also proposed for re-alignment (Reach 14W-23) along the northern and eastern property lines up to the point where it currently exits on the Subject Property (Reach 14W-11).

The main focus of the following impact assessment will be on the effects of the proposed development on the overall water balance, more specifically on changes to infiltration to the groundwater system. In addition to the water balance analysis, the potential impacts related to the proposed stream channel realignments will also be examined (Reach 14W-13, Reach 14W-14, and Reach 14W-11A).

[35] Note that across much of the identified channel reaches shown on Figure 4.3 with groundwater discharge potential from the bedrock, there are overlying Till sediments between the rock and the channels.

[36] Lots at 90% imperviousness. Road allowances with grassed boulevards are assumed as 70% impervious.

4.4.1 Water Balance Methodology

The MOE Stormwater Planning and Design Manual (2003) offers a method to estimate the infiltration on the site, based on a local infiltration factor "i", which is applied to the available water surplus to determine the groundwater recharge for a given area with pervious cover. The methodology considers factors such as the soil type, topography, and vegetation to arrive at the infiltration factor that is then applied against the water surplus to provide an estimate of the amount of water infiltrating into the ground. The remaining water surplus is considered runoff.

Under the post-development conditions the infiltration factor is recalculated to account for changes in soil types, vegetation and topography after development, and the infiltration and runoff at the pervious land areas are recalculated. As the land after development will have impervious surfaces that prevent infiltration, such as building footprints, roads and parking areas, the pervious area available for infiltration is reduced. Furthermore, there is limited opportunity for evapotranspiration on these impervious surfaces, other than evaporative losses from wetting and ponding of water in shallow depressions (estimated at 10% of total precipitation), and so total precipitation is applied to these surfaces instead of the water surplus.

The discussions that follow focus on subwatershed FM1001 only, which is the main system passing through the Subject Property and is the subwatershed for which this EIR is specifically addressing. The adjoining subwatersheds FM1102 and FM1109 will behave in a similar manner though the magnitude of change under post-development conditions will depend in part on the proportion of development area in North Oakville compared to the total subwatershed area in these other subwatersheds.

4.4.2 Climate and Water Surplus

The inputs used for the water balance calculations are based on information provided by Environment Canada using climate data from the Oakville Gerard meteorological station (43°26'-N 79°42'-W), for the period 1990 to 2006. This climate station is considered to be more representative of climatic conditions at the Subject Property than the Hamilton Royal Botanical Garden (HRBG) station used in the NOCSS. The Oakville Gerard station is located approximately 7 km southeast of the Subject Property, whereas HRBG is located about 17 km southwest from the Subject Property, along the edge of Hamilton Harbour. Furthermore, the Oakville Gerard station is also not located immediately adjacent to the lake (as is the case of the HRBG) and therefore will experience less climatic lake effect potential.

Environment Canada inputted their climate data into a computer model (Johnstone and Louie, 1983) to provide actual evapotranspiration and water surplus inputs for soils with different water holding capacities (WHCs). Under existing conditions, the WHC of the soils at the Subject Property and surrounding areas are estimated to be 200 and 400 mm (see Section 4.4.3.1). The Environment Canada data is presented in Appendix 4-7 and is also found on Table WB-1 within this same Appendix.

The Subject Property is located in an area of temperate climate with a mean annual temperature of 9.0 C and a mean annual precipitation of 819 mm. The potential evapotranspiration estimate that was provided by Environment Canada based on the Thornthwaite approach is 656 mm per year. The mean actual evapotranspiration in the vicinity of the Subject Property (pervious areas excluding existing imperviousness runoff contributions) is 607 and 644 mm respectively for soils with WHCs of 200 mm and 400 mm (see below) reflecting periods of soil moisture deficiency. The pre-development water surplus, the water available for

infiltration and runoff, is estimated to be 198 mm per year under existing conditions across the entire subwatershed (FM1001) and 209 mm per year on the portion of the Subject Property found within this subwatershed.

4.4.3 Inputs to Water Balance

Site specific inputs used in the water balance analysis are summarized in Table 4.8 and the inputs under the post-development case are explained below. The rationale for the pre-development and post-development inputs is discussed in Sections 4.4.3.1 and 4.4.3.2.

Table 4.8 – Watershed Specific Inputs Used in the Water Balance – FM1001

Infiltration Factor Based on Land Conditions	**Pre-Development**	**Post-Development**
Topography	0.11	0.11 to 0.13
Soils	0.12	0.12
Vegetation	0.11	0.11
Thicker Topsoil/Amendment within Development Areas	-	0.05
Sum	**0.34**	**0.34 to 0.41**
Water Holding Capacity of Soils (mm)	**Pre-Development**	**Post-Development**
	200 and 400	100, 200 and 400
Site Areas for Use in Calculations (ha) **Subject Property Only (within FM1001)**	**Pre-Development**	**Post-Development**
Pervious	60.4	20.7
Impervious	0.0	39.7
Total Area	**60.4**	**60.4**
Entire Subwatershed, including Subject Property	**Pre-Development**	**Post-Development**
Pervious	379.4	296.5
Impervious	15.9	98.8
Total Area	**395.3**	**395.3**

Notes:

The individual infiltration factors presented in this table are **weighted averages** across the entire subwatershed (bcIMC and other developer owned lands south of Highway 407 as well as the lands north of 407).

Post-development areas are based on the conceptual development plan which is subject to revision. Because site grading is expected to reduce slopes in developed lands to the order of 2%, the infiltration factor for topography increases from 0.11 to 0.13 within the developable lands only. This also includes an assumption pertaining to increased future imperviousness at the Hanson Brick Quarry lands as that operation expands.

A proposed mitigation measure is the tilling/scarifying and compost amendment of the sub-soils with placement of thicker topsoil, which is modelled to promote additional infiltration. An increase in the "cover" infiltration factor by 0.05 for the landscaped areas within the developable lots was incorporated into the water balance analyses with mitigation.

Water Holding Capacity of Soils is based values presented on Table 3 from the MOE Stormwater Management Manual (2003).

The infiltration factors and WHCs presented in Table 4.8 are considered to be the same across all subwatersheds for the purposes of this analysis. The increase in imperviousness across the entire subwatershed also includes increased imperviousness at developable lands owned by others in North Oakville as well as increased imperviousness at the Hanson Brick quarry north of Highway 407, which will expand over time.

4.4.3.1 Pre-Development Conditions

The surficial soils at the Subject Property and surrounding area within the subwatersheds, as described previously, are generally comprised of Clayey Silt Till, underlain by Shale Bedrock (exposed at surface in watercourses near to Dundas Street). As described in Section 4.3.2.1, the surficial soils are best classified as Clay Loam.

Soils mapping of the Subject Property presented on Figure 4W.6.1 in the NOCSS (included in Appendix 4-7) identifies most of the Subject Property as comprised of Oneida Clay Loam (Hydrologic Soil Group D (i_{soil} = 0.10), ref. Table 4W.6.2 from NOCSS), with Chinguacousy Clay Loam (Hydrologic Soil Group C (i_{soil} = 0.20)) mapped within the natural valley features at the site. The Chinguacousy Clay Loam comprises approximately 23.7 ha of the 109.7 ha area of Subwatershed FM1001 south of Highway 407, or about 21.6% of the total area. This results in a weighted average for the i_{soil} of 0.12 and this has further been assumed to be representative of the soil conditions across the three subwatersheds.

The existing vegetation at the Subject Property is predominantly agricultural with soy beans having been planted on site in 2013. Corn is also a major local crop grown within the subwatershed areas. The soil and vegetation conditions at the Subject Property lead to a soil water holding capacity of 200 mm and 400 mm as defined on Table 3 of the MOE Stormwater Planning and Design Manual.

The pre-development infiltration factor for the Subject Property and the main subwatershed (FM1001), "i", is calculated at 0.34 based on the following:

- Topography is considered to be hilly, i_{topo} = 0.11 (average slopes across the three subwatersheds is approximately 3.0%)
- Soils are considered to be a clay loam from grain size analysis, i_{soils} = 0.12
- Cover is predominantly cultivated land with some forest cover, i_{cover} = 0.11

The pervious surface area of the Subject Property within FM1001 under existing conditions is approximately 60.4 ha. Approximately 45.4 ha of this area is situated within future developable lands and will be changed following development; the remaining 15.0 ha will not be developed. Most of this 15.0 ha area (approximately 9.5 ha) will essentially remain untouched, other than from works such as road crossings and sewer outfalls. It is proposed to realign the watercourses entering the Subject Property along the north (Highway 407) property line. The central and eastern watercourses to FM1001 (Reaches 14W-14 and 14W-13) are proposed to be diverted to the west and then southerly along the property line with the Arch-Diocese lands (proposed Reach 14W-22) and into Reach 14W-12A upstream of where it joins the main channel (Reach 14W-16). Reach 14W-11A is proposed to be diverted easterly along the north property line and then to the south (proposed Reach 14W-23) to the point where it currently joins Reach 14W-11 before exiting the Subject

Property. The proposed channel realignments are shown on Figure 4.7. The approximate area of the FM1001 channel realignments (within FM1001) is 4.1 ha[37].

4.4.3.2 Post-Development Conditions

Future development of the Subject Property and adjacent development lands from agricultural to employment land use will change the evapotranspiration, runoff and infiltration conditions of these lands by adding hard surfaces such as roads, driveways, parking lots, sidewalks and roofs that are effectively impervious. For the purposes of the water balance analyses, the total area covered by impervious surfaces for this type of development is estimated at about 88%[38] over the 45.4 ha of developable area. This is equivalent to about 66% imperviousness over the full 60.4 ha of site area (within Subwatershed FM1001) with the 15.0 ha of "natural" area at 0% imperviousness included.
Post development conditions on lands northwest of Highway 407 are anticipated to remain essentially the same as the pre-development situation. These lands are currently designated Protected Countryside (Greenbelt Plan, 2005) and Agricultural in the local and Regional Official Plans. The post-development water balance on a subwatershed basis (FM1001) includes allowance for a minor increase in imperviousness in the lands northwest of the 407 that reflect a projected increase in size of the Hanson Brick Tremaine Quarry over time.

It is also noted however, that runoff from pervious areas surrounded by streets within the developed lands will eventually be directed to the stormwater management system, as it will drain onto the road network and from there into the storm sewer system. The exception would be the runoff from pervious areas abutting and draining to natural features or runoff conveyed to these features by means of mitigation such as infiltration swales.

Under the post development condition, the soil composition is expected to remain classified as a Clay Loam after site grading, as soils used for fill are expected to be obtained from the Subject Property, and the soils exposed by cutting activities are anticipated to be similar to the existing surficial soils. While compositionally the soils will remain unchanged at finished grades within the developable limits, the infiltrative benefits of weathering and fracturing will have been lost through the cut and fill activities. The vegetation following development is anticipated to be comprised predominantly of short-rooted vegetation such as grassed lawn in landscaped areas, with natural vegetation remaining as-is elsewhere where these areas are to remain undisturbed or with new plantings in areas to be created through the proposed channel realignments.

Based on Table 3 from the MOE Stormwater Management Manual (2003), Clay Loams with short rooted vegetation such as lawns are shown to have a WHC on the order of 100 mm. Therefore, under the post-development scenarios, the local climate data provided by Environment Canada for soils with a WHC of 100 mm was used to estimate the future water surplus for the developed areas of the Subject Property and surrounding development lands. With a WHC of 100 mm, the Actual ETR is reduced from 607 and 644 mm/year (pre-development conditions) to 536 mm/year at areas to be landscaped. The reduction in Actual ETR across pervious areas of the developed lands results in an estimated water surplus of about 229

[37] The 4.1 ha is the approximate area of the proposed channel where cuts below existing grade will be required, necessitating the removal of the upper weathered soils within this area.

[38] Based on 39.8 ha of developable lots and SWM's at 90% imperviousness, and 5.7 ha of internal roads and future transit way at 70% imperviousness.

mm/year compared to the pre-development surplus of 209 mm/year, over pervious areas of the property. These changes apply to the future landscaped grounds within the development lands only, or to about 5.7 ha of the total 45.4 ha of lands to be developed within the 60.4 ha total area within FM1001. On a subwatershed basis, the estimated water surplus (pervious area) rises from 198 mm/year to about 209 mm/year.

4.4.4 Water Balance

Water balance analyses were performed for the entire Subject Property area, and for the three subwatersheds that are partially located within the Subject Property. As noted earlier, discussions will be focussed upon subwatershed FM1001. Water balance analyses for the other two subwatersheds FM1109 and FM1102 are also presented in Appendix 4-7 for completeness. In addition, a pre-development water balance analysis was carried out for a portion of the FM1109 subwatershed that passes through the east corner of the Subject Property to compare observed watercourse base flows against predicted base flows from these analyses (identified on Figure 4.2). This is discussed in Section 4.4.4.1.1.

4.4.4.1 Pre-Development Water Balance

Under pre-development (existing) conditions the Subject Property is considered pervious over its full area (e.g., 60.4 ha within FM1001). The water surplus under these conditions was calculated as 209.4 mm/year (see Section 4.4.2) and the infiltration factor was calculated to be 0.33. Therefore, pre-development infiltration across the full property area and leading towards the watercourses of FM1001 is estimated at about 69.3 mm per year (41,902 m^3/year), which is consistent with the reported infiltration values for these types of soils. Most groundwater recharge occurs during the spring melt period when soil moisture content is high. The remaining 140.1 mm per year (84,670 m^3/year) would be available for surface run-off, most of which occurs during the spring melt period.

On a subwatershed basis, the predevelopment water balance indicates that FM1001 will receive 263,546 m^3/year of infiltration (66.7 mm/year equivalent) and 637,237 m^3/year (161.2 mm/year) of runoff. The subwatershed volumes reflect pre-existing imperviousness within the entire subwatershed (e.g., Highway 407, Hanson Brick quarry).

The major contribution of water to the subwatershed occurs, as expected, in the late winter and spring. Water surpluses during the majority of the growing season (June through October) are essentially zero as the ETR remains high and the soil moisture goes into a deficit. Soil moisture starts to become replenished in September/October.

The pre-development water balances for the Subject Property and the overall subwatershed are summarized on Table 4.9 and Table 4.10 (in Section 4.4.4.2); with the detailed, monthly water balance calculations presented in Appendix 4-7 on Table WB-2-FM1001.

4.4.4.1.1 Base Flow Comparisons to Pre-Development Water Balance

During the course of the site investigations, estimates of surface water flows were made at selected locations in the watercourses of FM1001 and FM1109 that passed through the Subject Property. No flow estimates were attempted at FM1102, as there was no defined channel or any measurable flow at this part of the Subject Property.

One of the requirements of the EIR and FSS TOR is to validate the pre-development water balance where possible. The water balance analyses provide monthly estimates of infiltration and runoff. For purposes of this comparison, we have assumed that monthly infiltration calculated by the water balance is representative of base flow conditions in the watercourses less 10% to allow for recharge of the deeper shale bedrock aquifer, leaving 90% of the infiltration calculated by the water balance available for base flow to the creeks.

Table 4.7 presents the watercourse base flow estimates against the water balance calculated infiltration volumes (90% as noted above), converted to equivalent flow rates at the downstream edges of the watercourses. For FM1001 (West Branch of Fourteen Mile Creek) this is at SG-2 by Dundas Street (bottom end of reach 14W-12). For FM1109, (Central Branch of Fourteen Mile Creek) only a portion of a contributing watercourse passes through the Subject Property (Reach 14W-11 and Reach 14W-11A). The upgradient portion of this Reach was identified on Figure 4.2 and a pre-development water balance analysis was carried out for this small portion of FM1109 (see Table WB-2-14W-11A in Appendix 4-7).

The water balance is based upon averages from a 16-year weather record and the calculated monthly average infiltration is being treated as a proxy for base flows to the watercourses. These monthly averages were then compared to measured estimates of channel flows (with inherent inaccuracies) that are a function of real (non long-term averaged) weather patterns. Notwithstanding the above, as can be seen from Table 4.7, the predicted stream flows and measured stream flows are in good agreement when measurements were possible without influence from rainfall or snow-melt events (e.g., February 17-18, 2011), and generally of the same order of magnitude. Thus it can be concluded that the water balance methodology used in this study is a simple, yet valid, model of the hydrogeological system in which the Subject Property is situated.

4.4.4.2 Post-Development Water Balances

In addition to the pre-development water balance, two post-development water balance scenarios were examined. The first of these scenarios examined the worst case situation with no mitigation measures applied at the Subject Property and the second scenario examined the improvements from the worst case scenario with mitigation measures employed. The post-development scenarios were compared against the pre-development case. The results for the water balance calculations are described below and summarized on Table 4.9 and Table 4.10. The detailed calculations are presented on Tables WB-2-FM1001 through WB-4-FM1001 located in Appendix 4-7.

The following assumptions have also been made to estimate the post-development water balance including recharge mitigation measures:

- Total imperviousness of the developable lots is assumed as 90%, which reflects the Town of Oakville's planned land use and maximum lot coverage requirements for more intensive employment development. Imperviousness of the road allowances with grassed boulevards is assumed at 70%, resulting in weighted imperviousness of 88%;

- There is no infiltration occurring on hard surface areas and evapotranspiration is significantly lower than that under pre-development conditions (10% as evaporation only), due to rapid runoff of precipitation;

- Runoff from the road network, as well as roof areas not directed to mitigation is discharged directly into the storm sewer network[39];

- The characteristics of the native soils and bedrock limit the choices of suitable measures to infiltrate water into the ground at both the Subject Property and the surrounding areas. The data collected over the course of this investigation indicates the upper, weathered zone of the till soils has enhanced (secondary) permeability from fracturing. The most promising locations for infiltration-promoting mitigation measures will therefore be within areas where the native soils are to be left undisturbed by construction activities;

- The imperviousness of the Subject Property after development is calculated at about 66% (39.7 ha) of the total 60.4 ha site area found within subwatershed FM1001. Of this 39.7 ha, roofs are assumed to account for approximately 40% of the total imperviousness or about 16.0 ha. Runoff from the roof areas may be suitable for use in mitigation measures depending upon the nature of the businesses that eventually are developed (e.g., businesses with zero to low emissions versus heavy industries with the potential to release particulate matter that collects on roofs). For the purpose of this analysis the runoff collected on the roofs has been considered usable for mitigation measures, though as noted above the opportunities to mitigate in this hydrogeological environment are limited;

- Landscaped areas within the developable areas and the newly created natural environment areas associated with the channel realignments will have the newly exposed sub-soils tilled/scarified/ripped to 500 mm depth and amended with compost (resulting in organic content of 8 to 15% by weight / 30 to 40% by volume) prior to placing approximately 0.25 m of topsoil. This increased thickness of organic soils with additional void space will retain a greater proportion of precipitation and/or runoff over these pervious areas and therefore promote additional infiltration. Within the developable lots, this activity would be deferred to the time of individual lot development once the proposed layout of buildings and paved areas within the individual lots are known;

- Infiltration works such as infiltration swales constructed along the periphery of areas retained in their natural state are considered viable (see Figure 4.7). By carefully constructing these measures within the undisturbed natural environment areas, they are anticipated to be capable of recharging a portion of the relatively clean roof runoff that can be directed to these swales, provided the existing surficial fractured and weathered zone of the native till soils remains intact. This will require using specified construction techniques to minimize smearing of the walls and bases of these swales, which would dramatically reduce the potential effectiveness of these measures. Constructing infiltration swales within portions of the Subject Property with engineered fill or deep cuts into unweathered and relatively unfractured soils will not be as effective for mitigating infiltration, but, if connected to infiltration swales along the perimeter of the natural features, will provide temperature moderation to the roof runoff;

- Construction of small off-line open water wetlands within the proposed valley realignment (Reach 14W-22) that will convey the central and eastern reaches (Reach 14-W-14 and Reach14W-13) into Reach 14W-12A and will be recharged by flood events will provide for some measure of additional

[39] A portion of the runoff from roofs at the central part of the Subject Property will be diverted to the small channel (14W-12A) located to the northwest of the central SWMP to maintain flows across that section of channel (see Section 7.4).

infiltration, though this will be limited somewhat by the fact that such ponds will be constructed alongside the realigned channels at lower elevations where groundwater discharge from the underlying bedrock is anticipated; and,

- Additional mitigation measures, such as vegetative swales at parking areas, landscaped infiltration ponds/wetlands, green roofs, cistern systems for grey-water use and/or landscape irrigation, etc. are specific to lot configurations, intended use, building design and so forth and should be examined during later stages of detailed design or at the time of building permit applications. For example, construction of landscaped ponds/wetlands would not appear feasible on a lot with a large warehousing facility and extensive parking facilities, but may be feasible at a lot housing a corporate headquarters facility. As such specific measures on a lot by lot basis are not identified at this time and they have not been included in the post-development water balances.

4.4.4.3 Post-Development Water Balance with No Mitigation

This first scenario, examines the worst-case condition, where there will be no mitigation measures incorporated. This assumes that all impervious area runoff (less impervious surface losses to evaporation), including roof runoff, is conveyed directly into the stormwater management system. This scenario considers that groundwater infiltration is supplied only by precipitation that falls upon pervious areas. The potential maximum loss of infiltration from the proposed development was calculated to provide a worst-case estimate of the potential impacts on infiltration due to the introduction of hard surfaces. Detailed monthly water balance calculations may be found on Table WB-3-1001 in Appendix 4-7.

As indicated in Table 4.9 under this worst-case scenario, the water balance method estimates a 62% reduction in groundwater infiltration from the Subject Property falling within subwatershed FM1001 while on a total subwatershed basis the reduction in infiltration is estimated at about 21%[40]. On-site runoff contribution to the watercourse system is calculated to increase about 283%, or by 79% on a subwatershed basis. The change to the local groundwater recharge function assumes that all runoff from hard surfaces is conveyed to the storm sewer network. Some additional loss of groundwater flow may occur due to foundation drains and permeable backfill surrounding services, however, most of recharge loss is anticipated to be due to rapid runoff from impervious surfaces.

[40] The overall subwatershed calculations includes, in addition, to the effects identified at the Subject Property, effects from development on lands owned by others, and from the proposed expansion of the Hanson Brick Quarry lands to the north of Highway 407.

Table 4.9 – Pre and Post Development Water Balance – No Mitigation

Parameters	Pre-Development		Post-Development		Change	
	mm/year	m^3/year	mm/year	m^3/year	m^3/year	%
Subject Property Only (within FM1001)						
Precipitation	819.0	495,004	819.0	495,004	0	0.0%
Total AET	607.5	367,167	201.2	121,584	-245,583	-66.9%
Evaporative Losses at 10% Precipitation	0.0	0	53.9	32,552	32,552	N/A
Infiltration (MOE Methodology)	69.3	41,902	26.4	15,969	-25,932	-61.9%
Runoff (MOE Methodology)	140.1	84,670	536.8	324,428	239,757	283.2%
Entire Subwatershed, incl. Subject Property						
Precipitation	819.0	3,237,507	819.0	3,237,507	0	0.0%
Total AET	585.4	2,314,021	455.8	1,801,628	-512,393	-22.1%
Evaporative Losses at 10% Precipitation	3.3	13,022	20.5	80,923	67,901	521.4%
Infiltration (MOE Methodology)	66.7	263,546	53.0	209,312	-54,235	-20.6%
Runoff (MOE Methodology)	161.2	637,237	287.8	1,137,703	500,466	78.5%

Notes:
Evaporative losses are losses of precipitation though simple evaporation on impervious surfaces (such as from ponding at puddles).

4.4.4.4 Post-Development Water Balance with Mitigation

A post-development water balance analysis was carried out with mitigation measures. The choice of mitigation measures was constrained by site conditions (e.g., site soils, location and orientation of natural features) and design constraints (e.g., site grading, requirements for connections to adjacent future developments). The locations of the proposed mitigation measures examined under this scenario are shown on the conceptual plan of development presented on Figure 4.7.

The improvements to recharge and runoff contributions of the following mitigation measures were examined:

- A portion of the roof runoff is collected and directed into infiltration swales located at the rear of the lots at the edge of the buffers to the NHS. Locating these swales immediately adjacent to the NHS will ensure that the functionality of these swales will not be compromised because of site grading activities on the Subject Property. These swales are also proposed alongside the "natural" areas that are to be created because of the proposed watercourse diversions. The surficial soils in those areas are expected to be deeper, less fractured soils exposed by cutting the grades, and the

proposed tilling/scarifying and addition of compost amendments and topsoil within these newly created areas will provide additional infiltration potential. The locations of infiltration swales will need to be confirmed at detailed design as other factors such as final site grades must be considered in the siting of these facilities. Figure 4.8 presents the conceptual design of the proposed infiltration swales. As these swales are not designed for stormwater management purposes, they do not have to adhere strictly to the criteria specified by the MOE Stormwater Planning and Design Manual (2003) in particular a requirement that they drain in 24 to 48 hours.

- Published research studies by Toronto and Region Conservation Authority (Young, et al, 2013) and Credit Valley Conservation (2014) of infiltration trenches and galleries constructed in low permeability glacial tills within the Greater Toronto Area indicate that these LIDS can be effective at infiltrating water into the ground. Our review of these studies indicates that infiltration rates on average of the order of 3 mm/hour (equivalent to a percolation rate T-Time of 200 minutes/cm) have been measured at trenches and galleries constructed at sites located in Richmond Hill, Bolton, Brampton and Mississauga (2 sites). The grain size distributions of the till at these sites where reported are similar in nature to the till found at the Subject Property. The water balance calculations with respect to the infiltration swales are therefore based on this 3 mm/hour rate;

- Landscaped areas within the development lands and the newly created natural environment areas will include thicker topsoil and 0.5 m of tilling/scarifying/ripping of the sub-soils with compost amendments to promote additional infiltration. To model this effect in the water balance, an increase in the "cover" infiltration factor by 0.05 (from 0.10 to 0.15) for the landscaped areas was considered appropriate, putting this value mid-way between the factors for cultivated lands (0.10) and forested areas (0.20);

Small off-line open water wetlands are proposed within the valley of the westernmost of the two proposed channel realignments (Reach 14W-22) to address removal of wetlands in Reach 14W-13 and Reach 14W-14, as well as, the wetland and open water function of the Farm Pond (Reach 14W-14A). These wetlands would be maintained through storm flood events (surface flows) and while they have the potential to provide the additional infiltration to the shallow system, the post-development water balance does not account for any infiltration benefits from these off-line wetlands as the static water level within the underlying bedrock ranges from about 155 to 150 masl along the proposed channel realignment, and the invert of the realigned channel profile will range from about 152 to 149 masl. In order for there to be potential for vertical infiltration through the bottom of these off-line wetlands, the design water levels in these ponds would need to be higher than that of the groundwater in the bedrock.

Notwithstanding the above, these wetlands can be expected to provide some level of infiltration enhancements during the drier summer season when shallow groundwater levels in the valleys have declined somewhat due to the effects of evapotranspiration. Contributions to groundwater infiltration from these measures are not however included in the water balance calculations as a conservative assumption and the potential volumes of infiltration will also be relative to the final design sizing of these features.

Additional enhancements to the post-development infiltration at these development lands may be realized through the promotion of additional infiltration measures within the development such as wet (landscaped) ponds, bio-retention facilities, vegetated swales, etc. The feasibility of such measures is; however, a function of the individual lot configurations, proposed lot uses and site design opportunities. The infiltration contributions from these potential opportunities are anticipated to be minor because these features will likely

be constructed within the limited available pervious areas. Infiltration from these undetermined mitigation measures are therefore not accounted for in the water balance calculations.

Table 4.10 summarizes the results of the water balance assessment for the Subject Property including pre-development and the post-development conditions with the implementation of mitigation measures described above. The detailed calculations are found on Table WB-4-FM1001 in Appendix 4-7.

With the proposed mitigation, the water balance method estimates the post-development groundwater infiltration at the Subject Property within FM1001 will be balanced, which is a significant improvement from the 62% loss calculated under the worst-case scenario and in consideration of the low permeability soils and proposed lot coverage at the Subject Property. This balancing of the post-development infiltration with the pre-development level exceeds the expectations of NOCSS (Sections 5.5.2, 7.4.4.2). The increase in post-development runoff generated at the Subject Property for the mitigated scenari**o** is reduced from about 283% to 252%. Volumetrically, approximately 25,955 m^3/year of potential runoff is redirected into infiltration through these proposed mitigation opportunities compared to the unmitigated scenario.

Table 4.10 – Pre and Post Development Water Balance – With Mitigation

Parameters	Pre-Development		Post-Development		Change	
	mm/year	m^3/year	mm/year	m^3/year	m^3/year	%
Subject Property Only (within FM1001)						
Precipitation	819.0	495,004	819.0	495,004	0	0.0%
Total AET	607.5	367,167	201.2	121,584	-245,583	-66.9%
Evaporative Losses at 10% Precipitation	0.0	0	53.9	32,552	32,552	N/A
Infiltration (MOE Methodology)	69.3	41,902	69.5	41,923	21	0.1%
Runoff (MOE Methodology)	140.1	84,670	493.7	298,474	213,804	252.5%
Entire Subwatershed, incl. Subject Property						
Precipitation	819.0	3,237,507	819.0	3,237,507	0	0.0%
Total AET	585.4	2,314,021	455.8	1,801,628	-512,393	-22.1%
Evaporative Losses at 10% Precipitation	3.3	13,022	20.5	80,923	67,901	521.4%
Infiltration (MOE Methodology)	66.7	263,546	63.7	251,708	-11,839	-4.5%
Runoff (MOE Methodology)	161.2	637,237	277.1	1,095,307	458,070	71.9%

Notes:
Evaporative losses are losses of precipitation though simple evaporation on impervious surfaces (such as from ponding at puddles).

On a total subwatershed basis (FM1001 only), and where opportunities are present, using similar mitigation measures on development lands owned by others, about 42,395 m^3/year of runoff may be redirected into the ground as infiltration. Mitigation at the Subject Property and development lands owned by others to the west is calculated to reduce overall infiltration losses by about 4.5% of the unmitigated totals[41].

4.4.4.5 Discussion of Water Balance Results

The preceding tables and discussion present the potential impacts and results of mitigation measures on the post-development water balance for the Subject Property within subwatershed FM1001. From the tables it can be seen that with the proposed mitigation measures it can be anticipated that impacts to recharge across the Subject Property can be fully mitigated, meeting one of the stated goals of NOCSS (to protect groundwater quantity, Section 7.4.4.2), even with the Subject Property situated within a setting where the predominant surficial soil is low permeability clayey silt till (confirming the soil conditions expected by NOCSS, Section 4W.3.2.2, Section 5.5.1, Section 5.5.2). Clayey silt till is not considered an ideal soil for constructing infiltration measures, and with an infiltration rate of 3 mm/hour as demonstrated from local conservation authority pilot projects, this balance is achieved on-site through an extensive infiltration swale network, totaling about 2.6 km in length[42]. We caution that construction activities at the Subject Property as well as placement of compacted earth fill will serve to reduce the native infiltration capacities of this clayey silt till soil and that care during construction must be taken in the immediate area of the proposed mitigation measures to prevent this from occurring.

The infiltration swales must be constructed along the edges of the watercourse valleys where weathering and stress relief of the low permeability deposits has resulted in a highly fractured upper soil zone conducive to recharge and are considered to be the most opportune locations for installing mitigation measures for infiltration. These areas will not be greatly affected by site grading which would lead to scraping and compaction and which would degrade or remove the ability of these low permeability soils to transmit water through the weathered zone (e.g., fractures)[43]. As noted above, specific construction limitations will also be required for these measures to be successful. Heavy equipment must not be permitted to travel across the areas proposed for these devices. Construction of the swales can only be done in dry weather to avoid remoulding the soil that would effectively line the swale sides and base with an impervious smeared layer. Manual scraping and removal of smeared soils from the sidewalls and base of the swales to expose the natural fracturing should be contemplated.

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[41] On a subwatershed basis, the total infiltration reduction across the development lands south of the 407 is calculated at approximately 47,300 m^3/year without any mitigation and with mitigation, at about 4,900 m^3/year on lands owned by others to the west of the Site (increasing the in the width of the infiltration swales in these lands from 1.1 m to about 1.5 m is one possible way to lead to a calculated balance for these lands). This is a 90% improvement in the total calculated infiltration losses from the redevelopment of these future employment lands (Subject Property and lands owned by others). The above stated volumes exclude infiltration reductions assumed and accounted for in the water balance from the future expansion of the Hanson Brick Quarry lands to the northwest (calculated reduction of about 6,900 m^3/year at the Hanson Brick site).

[42] 1,680 m length on the Subject Property, 950 m length on the lands owned by others to the west, within subwatershed FM1001 only.

[43] Excluding the proposed re-alignments that are to be constructed within unweathered till soils exposed through cuts. The exposed sub-soils within these areas are recommended to be tilled/scarified/ripped to a depth of 0.5 m and amended with compost to their improve infiltration capacity. Placement of 0.25 m of topsoil in addition to this will further provide additional moisture retention.

The potential for effective mitigation measures elsewhere across the Subject Property is affected by the proposed site coverage where a conservative 90% imperviousness ratio has been assumed on the development lots of the Subject Property. This constraint leads to reduced lot level perviousness and reduced infiltration potential as there is simply much less available area in which to infiltrate large volumes of water. Reducing lot coverage, which would result in more pervious area and therefore higher infiltration potential, is however in conflict with the Town's planned land use and maximum lot coverage requirements (more intensive employment development).

4.4.4.6 Discussion of the Potential for Base Flow Reductions to Watercourses

The surficial soils across the entire watershed system are comprised of low permeability Halton Till and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff with the balance derived from groundwater (based on the water balance and validated by stream flow measurements made at the Subject Property). The majority of the groundwater inputs to these watercourses is derived from the shallow till zone, and almost 100% of this contribution occurs primarily in the period of November to May when the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams. The NOCSS recognizes that minimizing changes (reductions) in infiltration will be difficult given the low permeability of the surficial soils found in North Oakville, estimated in the NOCCS as up to a 60% reduction in infiltration without mitigation within development limits (ref. Section 5.2.2 of the NOCCS).

The proposed mitigation measures are concentrated along the perimeter of the natural environment areas, which focuses this infiltration towards the watercourses where it will emerge from the embankments and mimic shallow groundwater discharge. In order to allow a uniform and sustained level of baseflow to be maintained in the Reach 14W-12A channel, a Redside Dace identified watercourse, additional mitigation measures will be incorporated. During Interim Development Phase 1B, flows from rooftops of the proposed buildings (2.56 ha) together with runoff from the part of the existing area (7.68 ha) will bypass the proposed SWM Pond 3 and be diverted directly to Reach 14W-12A by a storm sewer system. Under Interim Phase 2 and the Ultimate Development Conditions, flows from rooftops of the proposed buildings (5.12 ha) will be diverted to Reach 14W-12A directly in order to allow a uniform and sustained level of baseflow to be maintained in the subject receiving watercourse. Please refer to Section 7.4 (Development of GAWSER Hydrological Model) and Section 7.6 (Hydrologic Flow Regimes Analysis) for more details.

The development, with the incorporation of mitigation measures described above will result in a balance in infiltration across the Subject Property area for FM1001. This infiltration balance is calculated for the Subject Property as a whole over the year. As illustrated on Figure 4.9, the predicted monthly distribution of the infiltration at the Subject Property leads to potential for base flow increases to the three watercourses after development (Reach 14W-12, Reach 14W-22 (realigned) and Reach 14W-16) over a 7-month period (June to December, by between 18 to 48 litres/minute) along with potential for base flow reductions at the during a 3-month period (February to April[44]). The daily base flow reduction over this 3-month time period is calculated to range from 67 to 128 litres/minute[45] across the combined three watercourse at the Subject Property. These are considered minor reductions as:

[44] Calculated infiltration is approximately balanced in January (97%) and May (96%) at the Subject Property.

[45] This is based on daily averages calculated by the monthly water balance for each of the 3 months.

- The watercourses will continue to receive contributions from the upgradient areas (north of Highway 407), which are not planned for urban development and are not expected to undergo major land use changes, with the exception of the expansion of quarrying at the Hanson Brick property to the northwest. These upgradient areas are on the order of 2.6 times the catchment area of the future development lands south of Highway 407[46] and therefore these reductions will be small compared to the overall flow received from upgradient land areas. These are calculated by the monthly water balance to range between 800 and 1,200 litres/minute of upstream base flow during the same February to April timeframe. The calculated base flow reductions at the Subject Property also occur over the part of the year where the natural system is fully saturated and thus upgradient flow contributions will be at their greatest during the year; and,

- Baseflow at the lower reaches will also be further augmented at watercourse channel 14W-12A from runoff from about 5.12 ha of rooftop area under the ultimate built out condition. This water will enter the watercourse system to the north of the central SWM Facility (via Reach 14W-12A).

Figures 4.9 and 4.10 graphically presents the monthly and cumulative infiltration calculated using the water balance methodology for the pre-development and post-development with mitigation scenarios across the FM1001 within the Subject Property (Figure 4.9) and for the overall subwatershed (Figure 4.10). As discussed in Section 4.3.3 of this report, approximately 90% of the infiltration is considered to flow laterally towards the watercourses providing base flow, the balance recharging the shale bedrock. Figure 4.9 shows that the calculated monthly infiltration under post-development conditions at the Subject Property ranges between 53 to 64% of the pre-development values between February and April and for the overall subwatershed during this same time interval, from 83 to 86%. Infiltration both on the Subject Property and for the overall subwatershed over the period between June and December is calculated to be higher than the pre-development conditions and may lead to a slight lengthening of the period when baseflow contributions to the watercourses do occur at the Subject Property. The net effect is that overall balance is achieved and that additional infiltration will be directed towards the on-site watercourses during the summer and fall months when the channels have little to no baseflow than currently is the case. During the wetter late-winter and early-spring periods, although the calculated post-development infiltration is reduced from the existing condition, this also occurs during the time of the year when the area is expected to be fully saturated from snowmelt and other runoff. The net effect to the lower reaches of FM1001 is considered positive given the potential for additional water during the summer and fall months.

FM1109 Reach 14W-11 and Reach 14W-11A that traverses the Subject Property at the northeast corner is interpreted to lose water to the ground over much of the year, because of the nearby influence of a buried bedrock valley located to the east. Nonetheless, the water balance predicts an overall calculated increase in infiltration at the Subject Property within this subwatershed of approximately 45% (refer to Tables WB-2-1109 and WB-4-1109 in Appendix 4.7). During the period between February and April, the potential reductions in shallow base flow contributions to this reach are calculated between 4 to 13 litres/minute. We note that this is an overestimate as data collected at the site indicate this stream generally loses water into the ground.

[46] Future development lands to the south of Highway 407 total approximately 109.7 ha (28%) of the total FM1001 subwatershed area.

As identified earlier in this report, the existing channel reaches for the main and central watercourses of FM1001 (Reach 14W-16, Reach 14W-14, and Reach 14W-12) are below the interpreted bedrock groundwater levels and so there is minor upward flow of groundwater from the underlying bedrock and intervening till soils towards these channels. These bedrock contributions are small and are insufficient to maintain flow in this watercourse during the summer months (watercourses were observed in dry to pooled conditions during both the 2009 and 2010 summer seasons). The bedrock contributions are; however, expected to remain consistent after development.

The proposed realignment of Reach 14W-13 and Reach 14W-14 into a combined Reach 14W-22 alongside the western property line of the Subject property will not result in reduced groundwater inputs from the bedrock into this watercourse system. Under existing conditions, Reach 14W-13 is not interpreted to receive groundwater inputs from the bedrock except at its point of convergence with Reach 14W-14 as its' channel inverts decline from approximately 154 to 149 masl while the interpreted bedrock groundwater elevations (spring conditions, see Figure 4.5) decline from roughly 153 to 148 masl. Reach 14W-14 on the other hand is interpreted to receive bedrock groundwater inputs over its entire on-site length down to the point where it joins with Reach 14W-12A. The channel invert declines from about 154 masl at the northwest corner of the Subject property to about 148.5 masl where it joins up with Reach 14W-12A, while the interpreted bedrock groundwater drops from 155 to 148 masl over this same distance. On average, the groundwater levels at the bedrock are interpreted at between 0.5 and 1.0 m above this Reach's channel bottom during the spring condition. Reach 14W-14's total channel length (existing) is approximately 801 m (see Table 6.24).

Under post-development conditions, the proposed Reach 14W-22 channel inverts will decline from approximately 153.8 masl at the northwest corner of the Subject Property down to about 149.3 masl where it converges with Reach 14W-12A upstream of that reach's confluence with Reach 14W-12. The interpreted bedrock groundwater levels along the proposed channel alignment drops from about 155 to 149 masl. This places the spring bedrock groundwater level, or from between 0.4 m below to about 1.9 m above the proposed channel invert, at an average of about 1.1 m above the channel. The total length of channel interpreted to be below the bedrock groundwater is 1,143 m, which includes 157 m length of Reach 14W-14 that is to remain undisturbed at the upstream end, a 206 m length of proposed Reach 14W-21 (western portion) that diverts upstream flows from Reach 14W-13 into this channel, and the 780 m length of proposed Reach 14W-22 (see Table 6.24).

Therefore, considering the length of proposed channel below the bedrock water table (1,143 m) is about 43% longer than the existing length at Reach 14W-14 (780 m), and the upward head differential is also greater at the proposed channel (-0.4 to +1.9 m, +1.1 m average) compared to +0.5 to +1.0 m, bedrock groundwater contributions into the proposed channel realignment should exceed the existing condition. This is in addition to the calculated infiltration balance in the shallow system with the use of infiltration swales.

As described elsewhere, Reach 14W-11 and Reach 14W-11A, located in watershed FM1109, loses water into the ground. The existing channel bottom is also located between approximately 5 and 7 m above the interpreted bedrock groundwater levels and therefore does not receive any bedrock inputs from within the Subject Property. The proposed realignment (Reach 14W-23) along the north and east property lines will not alter these conditions and therefore no change is expected in the bedrock contributions to this reach after the realignment.

4.4.4.7 Potential Groundwater Seepage Area Near Upper End of the Farm Pond

As discussed in Section 4.3.2.4, there is potential for minor groundwater inputs beyond the upstream end of the Farm Pond in the vicinity of monitor MP-24 as our interpretation of the data indicates this seepage enters Reach 14W-12A to the northwest of the Farm Pond and the topographic channel high between MP-24 and the Farm Pond, meaning that this seepage does not flow to the Farm Pond except during runoff events when the channel flows temporarily raise the Farm Pond levels. The data collected to date at this monitoring nest indicates that the groundwater levels at the two mini-piezometers are closely matched to the surface water level fluctuations of the Farm Pond and are considered to be influenced by precipitation and the changes in surface water levels at the Farm Pond that are induced by these precipitation events. The gradients at this location vary between upward and downward with the water levels at the mini-piezometers being on average, 0.001 and 0.004 m lower than the water levels recorded at the Farm Pond (MP-24S and MP-24D respectively). The upstream end of the Farm Pond therefore is located nearby to an area where groundwater gradients to the water course system are predicted to change from upward (i.e., to the northwest towards MMM-09-10) to downward (the monitors around the Farm Pond to the southeast). The top end of the central SWMP is to be constructed near this area (see Figure HG-4, Appendix 4.5), and the limits of the Farm Pond work is located beyond the predicted extent of the minor seepage area which extends about 35 m east of MP-24.

While these temporal groundwater inputs are predicted to be quite small, should they be impacted by the construction of the SWM facility, they will be replicated in the post-construction condition. A 40 m length of infiltration swale is proposed to the north of the central SWM facility and is expected to easily make up for any losses of minor groundwater discharge presently found at the upstream end of the Farm Pond in the vicinity of MP-24. Infiltration input from this length of trench is calculated at 620 m^3/year of water[47].

An estimate of the groundwater discharges to the edge of the watercourse (Reach 14-12A) within the SWM facility Block[48] was made using a simple Darcy calculation:

$$Q = kiA \ (m^3/year)$$

Where:

K = bulk hydraulic conductivity (m/year) = 94.6 m/year ($3x10^{-6}$ m/sec, Section 4.3.3);

i = hydraulic gradient (dimensionless, m/m) = 0.0332 (average of all upward gradients relative to the Farm Pond recorded to date at MP-24D, excludes all negative (downward) gradients in the calculation);

A = Area of seepage face (m^2) = 70 m^2 (assumed 70 m total length with 1 m seepage face along banks of Farm Pond and channel); and,

It is assumed that upward seepage potential is present over a 6 month time period

[47] Pro-rated based on annual calculated infiltration of 25,129 m^3/year over 1,620 m total proposed length of trenches (Table WB-4-1001).

[48] The area to the west is designated as NHS and will not be disturbed and thus is not considered in the calculation. As described in Section 4.4.4.6, groundwater base flow contributions from the removal of Reach 14W- 14 is predicted to be increased by the creation of Reach 14W-22 which will be constructed deeper into the bedrock water table, and results in a longer length of channel that intercepts the bedrock groundwater table.

For these calculations we have assumed a 1 m seepage face over 70 m length of shoreline (35 m either side of Farm Pond/channel to the east of MP-24), an area that could be affected by the construction of the central SWM facility. Monitoring station MP-24, as noted, has gradients that vary between inward and outward, and therefore seepage potential to the east of this monitor is expected to be even less as the lands transition to the those with a downward gradient. We have also only considered the time when upward seepage potential may exist (assumed 6 months) and have applied the average of all upward gradients recorded to date (0.00 to 0.215, average 0.0332) over a 6 month period. The hydraulic conductivity for the soils used in the equation is 94.6 m/year, equivalent to $3x10^{-6}$ m/sec obtained from field testing as reported earlier in this report.

Based on the above stated factors, an upper limit of seepage potential in this area that may be lost due to construction of the Farm Pond is calculated at 110 m^3/year. This is not an unreasonable figure given the nature of the native soils (clays and silts with a low hydraulic conductivity) and limited area in which such seepage may occur. The calculated infiltration at the 40 m infiltration swale of 620 m^3/year will make up for this potential loss by a factor of about 5.6 times[49]. Additionally, baseflow at the Reach 14W-12A located in this same area will be further augmented with controlled rooftop runoff measures described earlier in this report.

4.4.4.8 Dewatering Potential

Extensive construction dewatering is not anticipated across the majority of the Subject Property other than for removal of minor seepage into excavations. Dewatering related to building construction will be in large part a function of the proposed building designs. Minimal dewatering would be expected for buildings with slab-on-grade foundations whereas buildings constructed with basements and/or underground parking may require more extensive groundwater removal.

The excavations of the SWM facilities will be mainly within the Clayey Silt Till found at surface across the entire subwatershed, but are also anticipated to be partially completed into the underlying Shale Bedrock. As noted in Section 4.2.1, the Shale is weathered in the upper 3 to 5 m, and is considered the local aquifer, albeit a poor aquifer with low yields. Because the SWM facilities are expected to be constructed fully within low permeability till deposits and in places into the upper weathered zone of the bedrock, some dewatering during construction is anticipated. Groundwater entering the SWM facilities excavations through localized sand seams within the till or from the upper weathered zone of the shale are expected to be managed through passive drainage and pumping through filtered sump pumps. Clay liners will be necessary where the SWM facilities intercept the Shale Bedrock and at localized sand seams within the Till, and the native soils are likely suitable for this purpose[50]. Additional geotechnical drilling investigations should be considered at the proposed SWM facilities to better characterize the expected conditions and dewatering potential during detailed design.

[49] The 620 m^3/year of water to be provided by the infiltration trench could conceivably offset a loss of seepage across a total seepage face length of 175 m, or seepage along the shoreline of the watercourse/Farm Pond extending about one quarter of the Farm Pond length to the east. However, as noted elsewhere in this report, the extent of this potential seepage area is limited to the immediate vicinity of monitoring station MP-24, as strong downward gradients from the Farm Pond into the underlying clay/silt soils are present at monitoring wells to the east.

[50] Subject to confirmation by a geotechnical engineer.

The development will be serviced with municipal water and sewers. The sewer services are expected to be mainly located in the till soils and as such, no dewatering other than local sump pumping for construction of sewer services, is anticipated. Granular pipe bedding backfill material used for buried services may become a preferential flow path for percolated surface water and groundwater. Anti-seepage collars should be installed at regular intervals to prevent continuous groundwater flow along the backfill. The frequency of collar installation will depend on final grade elevation, slope of services and thickness of granular pipe bedding.

Based on the proposed concept plan (refer to Figure 4.7) three watercourse crossings, with buried services (e.g., water, sewer) are proposed within FM1001, with two of these crossings located on the Subject Property. It is understood that the crossings will be carried out using trenchless techniques that will preclude the need for trenching across the existing watercourses. Access pits would need to be constructed at each side of the watercourse and removal of minor groundwater seepage from these pits may be required.

Scheduling excavations for the late summer, if practical, will further serve to reduce groundwater seepage into excavations as this is the time of year when groundwater levels are typically at their lowest. In particular, scheduling the channel crossing works for the late summer when these channels are observed in dry condition is recommended, as this will minimize potential for localized impacts to aquatic life. It is further recommended that the service crossing of the proposed realigned channel be completed at the time of construction of the new channel. In this one location, simple trenching can be used, provided the work is carried out before the realigned channel becomes operational.

Dewatering volumes are not anticipated to exceed 50,000 litres/day. However, dewatering potential is dependent upon a number of factors such as the proposed depth and size of excavations, the time of year and groundwater elevation. It may be later determined that a Permit to Take Water (PTTW) or Environmental Activity and Sector Registry (EASR) from the Ministry of Environment and Climate Change will be required. The need for this permit would be identified at detailed design. The application requirements for a PTTW or EASR requires the applicant to address how much water will be withdrawn, over what time period, where it will be discharged to, the water quality discharge parameters that are to be met, the expected zones of influence and effects on natural features and other users, among other things. Monitoring and mitigation measures would also be required and would be identified in the application. PTTW and EASR applications are submitted after detailed design and in advance of the construction works.

4.5 Conclusions and Recommendations

The Subject Property and the three subwatersheds that traverse the property are located in a hydrogeological environment that is not particularly favourable towards mitigation of infiltration losses (ref. NOCCS Sections 5.5.2 page 5-11, 7.4.4.2, page 7-22). The surficial fine-grained deposits of Halton Till found throughout the study area serves to limit infiltration to the groundwater system (69 mm/year) and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff (141 mm/year). Almost all of the groundwater base flow into the watercourses occurs over the period of November to May, when the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams. The watercourses are observed in a dry to ponded condition during the summer months as predicted by the water balance, and the comparisons of measured stream flows to estimates from the water balance methodology are reasonable.

The lower reaches of the FM1001 watercourses (generally to the south of Highway 407) are interpreted as receiving minor groundwater contributions from the Queenston Shale bedrock based on water level monitoring carried out at the Subject Property. However, the rate of influx of bedrock groundwater is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses, observed in the summer months as dry to pooled condition. Groundwater inputs from the bedrock in the realigned watercourses after development are however expected to increase compared with the pre-development levels. Over the lower reaches of the main channel there may be greater opportunity for bedrock-based groundwater to maintain pools in the stream channel as the bedrock is exposed in the channel and the watercourse is shaded somewhat by large trees.

The channel section of the FM1109 (Reach 14W-11 and Reach 14W-11A) passing through the northeast corner of the Subject Property is interpreted from collected site data to be losing water to the ground, due to the nearby influence of a buried bedrock valley to the east. The large Farm Pond at the central portion of the Subject Property is also shown to be maintained almost entirely by surface water inflow rather than from groundwater contributions on the basis of the comparison of the measured surface water levels at the pond against the groundwater elevations at monitoring wells constructed around the Farm Pond.

Both upward and downward gradients have been recorded at the mini-piezometer nest (MP-24) located near the upstream end of the Farm Pond. Therefore, some minor groundwater contribution to adjacent channel (Reach 14W-12A) may be occurring at times of the year, but the limits of the seepage area is interpreted to be to the northwest of the upper end of the Farm Pond (see Section 4.3.1.1, and Figure HG-4, Appendix 4.5). Even should this seepage make its way towards the Farm Pond, given the larger surface area of the eastern part of the Farm Pond, and the larger outward gradients identified in that area, losses from the Farm Pond will be significantly greater than the potential groundwater inflows from near the upstream end of the Farm Pond.

The 40 m length of infiltration swale proposed to the north of the central SWMP is expected to make up for the potential minor losses of groundwater discharge presently found at the upstream end of the Farm Pond by MP-24. Additionally, baseflow at the lower reaches will also be further augmented at Reach 14W-12A from runoff from about 5.12 ha of rooftop area under the ultimate built out condition. This water will enter the watercourse system to the north of the central SWM facility (via Reach 14W-12A).

The upper weathered zone of the till, with an estimated bulk horizontal hydraulic conductivity on the order of $3x10^{-6}$ m/sec therefore provides the bulk of the groundwater inputs to the local watercourses, but on a seasonal basis over about seven months of the year. The enhanced permeability of this upper zone permits infiltrating groundwater to travel somewhat rapidly through the shallow zone towards the watercourses and it is these conditions that provide the most promising potential mitigation opportunities at this site.

However, these opportunities are of limited extent as:

- The Town of Oakville's land use policies and maximum lot coverage requirements for more intensive employment development dictate 90% of the lots proposed for actual development are assumed to be covered with impervious surfaces, either asphalt/concrete or building envelope, leaving very little pervious area within the developable portion of the Subject Property;

- Significant site grading is proposed within the developable lands, where the tops of the gentle ridges at the Subject Property will be removed by cut and these materials will be placed and compacted in the lower lying lands to raise grades. This will lead to most of the surficial soils within the developable zone consisting of deeper unweathered deposits and reworked and compacted layers of the clayey silt till. These soils will therefore have significantly less transmissive ability to convey large quantities of water at any mitigation devices proposed within the developable lands. This can be improved by tilling/scarifying/ripping the sub-soils (0.5 m depth) and amending them with compost prior to placing topsoil (0.25 m).

Therefore, the most promising opportunity for mitigating against infiltration losses at the Subject Property is along the edges of the existing valley lands where the naturally weathered and fractured surficial till soils will remain undisturbed by construction and will retain their ability to convey water laterally towards the watercourses. It is along these lands that infiltration swales receiving primarily clean roof runoff are proposed, and such infiltration measures are calculated to reduce the on-site infiltration deficit from approximately 62% with no mitigation, to a balance with the pre-existing conditions with the use of the infiltration swales. The balancing of the post development infiltration with existing conditions exceeds the expectation of NOCSS. Post-development base flow during the period between June and December is predicted to be at or above the existing base flow contributions, which includes the dry summer season, where a slight increase in infiltration is provided to the groundwater system from the proposed mitigation measures.

The following recommendations are provided:

- Construct infiltration swales along the edges of the NHS and direct clean roof runoff into these swales and allow it to infiltrate into the ground. These will consist of narrow swales filled with clear stone and amended soils constructed at the rear of developable lots (see Figure 4.8). Clean surface runoff from landscaped areas can be directed towards these swales via vegetated filter strips. No runoff from roads and parking areas are to be directed into the infiltration swales;

- Construction of the swales should only be done in dry weather to avoid remoulding the soil and effectively lining the swale sides and base with an impervious smeared layer. Manual scraping and removal of smeared soils from the sidewalls and base of the swales to expose the natural fracturing should be contemplated;

- Additional investigative techniques such as percolation testing at the proposed infiltration swale locations should be carried out during detailed design to confirm the infiltration rates of the surficial soils along the alignment of the proposed swales, and this information be used in refining the sizing of the swales. It is further recommended that a short length of swale be installed during the detailed design stage and tested to confirm its suitability for its intended purpose;

- Grading at the Subject Property should be, if possible, designed to moderate runoff and enhance recharge characteristics subject to the Town's standards for lot grading;

- Grade the rear/side landscaped grounds on lots adjacent to the natural features (reach valleys) towards these features. This recommendation is also applicable to the SWM facility blocks, where as much of the block area as feasible should be graded towards the valleys rather than back into the SWM facilities;

- Steps to minimize post-development reduction in the infiltrative capacity of the low permeability till soils should be implemented where feasible. These steps are more pertinent to the parts of the Subject Property where minimal site grading is anticipated and they include:

    - Scheduling site grading and heavy construction activities during the drier summer months to reduce the potential of lowering the permeability of these materials while they are in a wet state;

    - Where possible, designating areas that should see a minimum of construction traffic. In particular heavy construction equipment must be kept away from the crests of the slopes by the valley lands (along the rear lot lines of the abutting lots), where infiltration swales are proposed;

- Scarify and till the upper 0.5 m of soil within the proposed channel realignments to amend these soils with organic matter and/or placement of thicker topsoil cover (0.25 m) to provide for water storage. This should also be done at the landscaped areas within the development lands. There will be a substantial volume of topsoil at the property after grading and this material can be re-used at the site:

    - However, within the future development lots, it is recommended to defer this mitigation measure to the time when each lot is individually developed and the landscaped areas are known;

- Additional mitigation measures, such as vegetative swales at parking areas, landscaped infiltration ponds/wetlands, green roofs, cistern systems for grey-water use and/or landscape irrigation, etc. are specific to lot configurations, intended use, building design and so forth and should be examined during later stages of detailed design or at the time of building permit applications. For example, construction of landscaped ponds/wetlands would not appear feasible on a lot with a large warehousing facility and extensive parking facilities, but may be feasible at a lot housing a corporate headquarters facility;

- Construct trench plugs at intervals along sewers and buried service trenches to prevent high permeability conduits from intercepting and redirecting groundwater away from discharge areas across the Subject Property;

- Construction of the watercourse crossings should be scheduled if possible during late summer to take advantage of the typically lower groundwater elevations during this season, and will reduce groundwater seepage into the pit excavations required for the trenchless techniques envisioned. The watercourses at the Subject Property have been observed to be in a generally dry condition during the summer and scheduling this work at this time will minimize potential for localized impacts to aquatic life and would potentially limit dewatering during construction;

- The service crossing proposed at the realigned channel should be completed at the time of construction of the new channel (before it comes into service) and in such case can be constructed using standard trenching methods;

- Dewatering volumes are not anticipated to exceed 50,000 litres/day. However, dewatering potential is dependent upon a number of factors such as the proposed depth and size of excavations, the time of year and groundwater elevation. It may be later determined that a Permit to Take Water (PTTW) or an Environmental Activity and Sector Registry (EASR) from the Ministry of Environment and Climate Change will be required;

- The SWM facilities may be excavated into the Shale Bedrock, and where bedrock or sand seams within the Till are encountered, a clay liner will be required. Additional geotechnical drilling investigations should be considered at the proposed SWM facilities to better characterize the expected conditions and dewatering potential during detailed design;

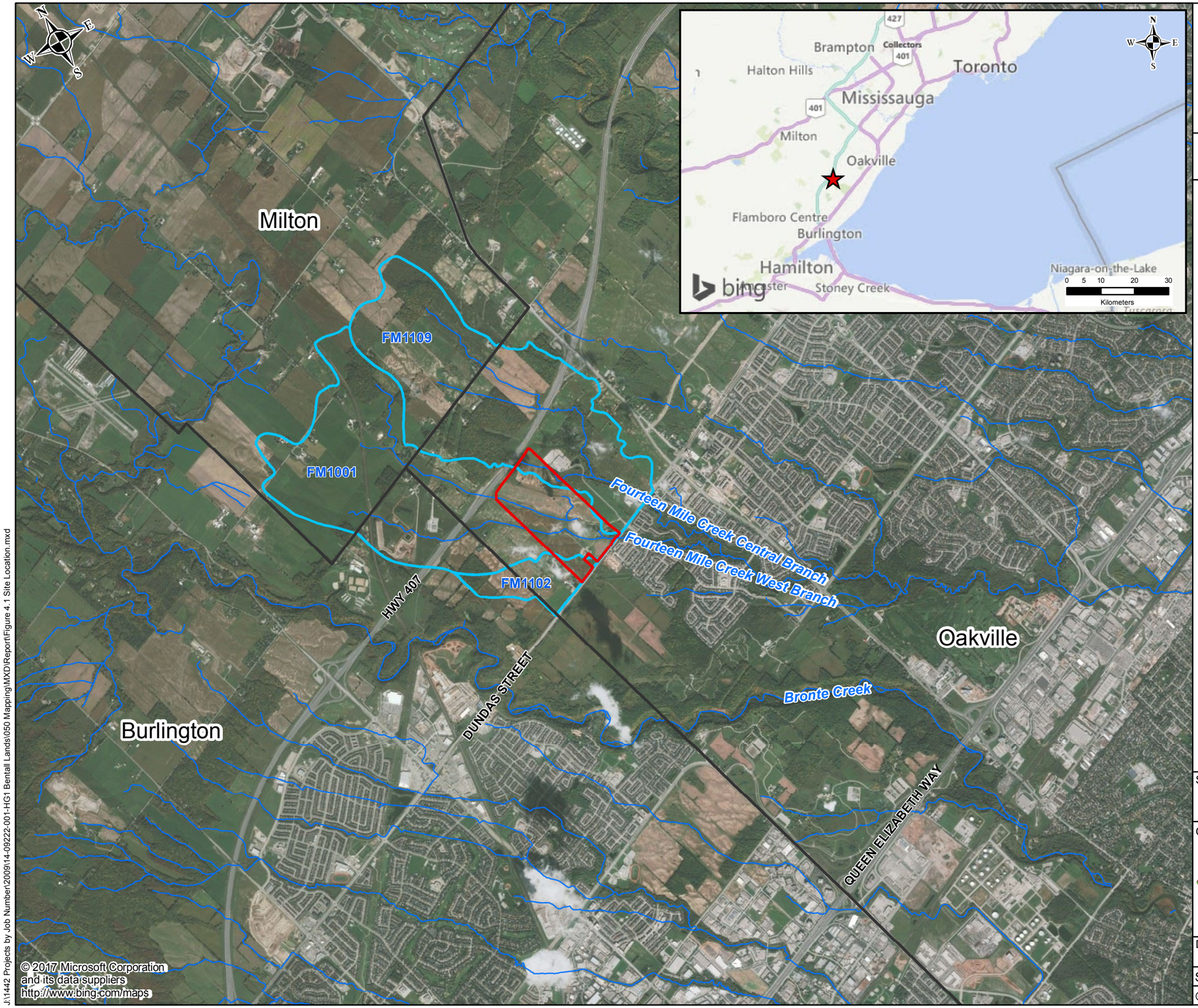
- Off-site monitoring wells alongside the road allowances are recommended for decommissioning (well locations MMM-09-16 to MMM-09-20 inclusive). These monitors will need to be decommissioned as per the requirements of O.Reg. 903 (as amended);

- Continued baseline monitoring of water levels at the on-site wells is recommended. Monitors presently constructed on the bcIMC property and other adjacent developer owned lands are recommended to remain in place for future monitoring in support of these developments until such time as they are no longer needed, in which case they will also need to be decommissioned as per the requirements of O.Reg. 903 (as amended). Monitors completed to shallow depth that will be completely removed by site grading will not require decommissioning since following site grading there will be no potential contaminant pathway left in place at such locations; and,

- Groundwater monitors presently constructed within natural environment areas should be retained for long-term, post development monitoring. Additional monitors may be required to replace existing monitors to be removed by development.

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Site Location



Legend

- Municipal Boundaries
- Subject Property
- Subcatchment Areas
- Watercourse

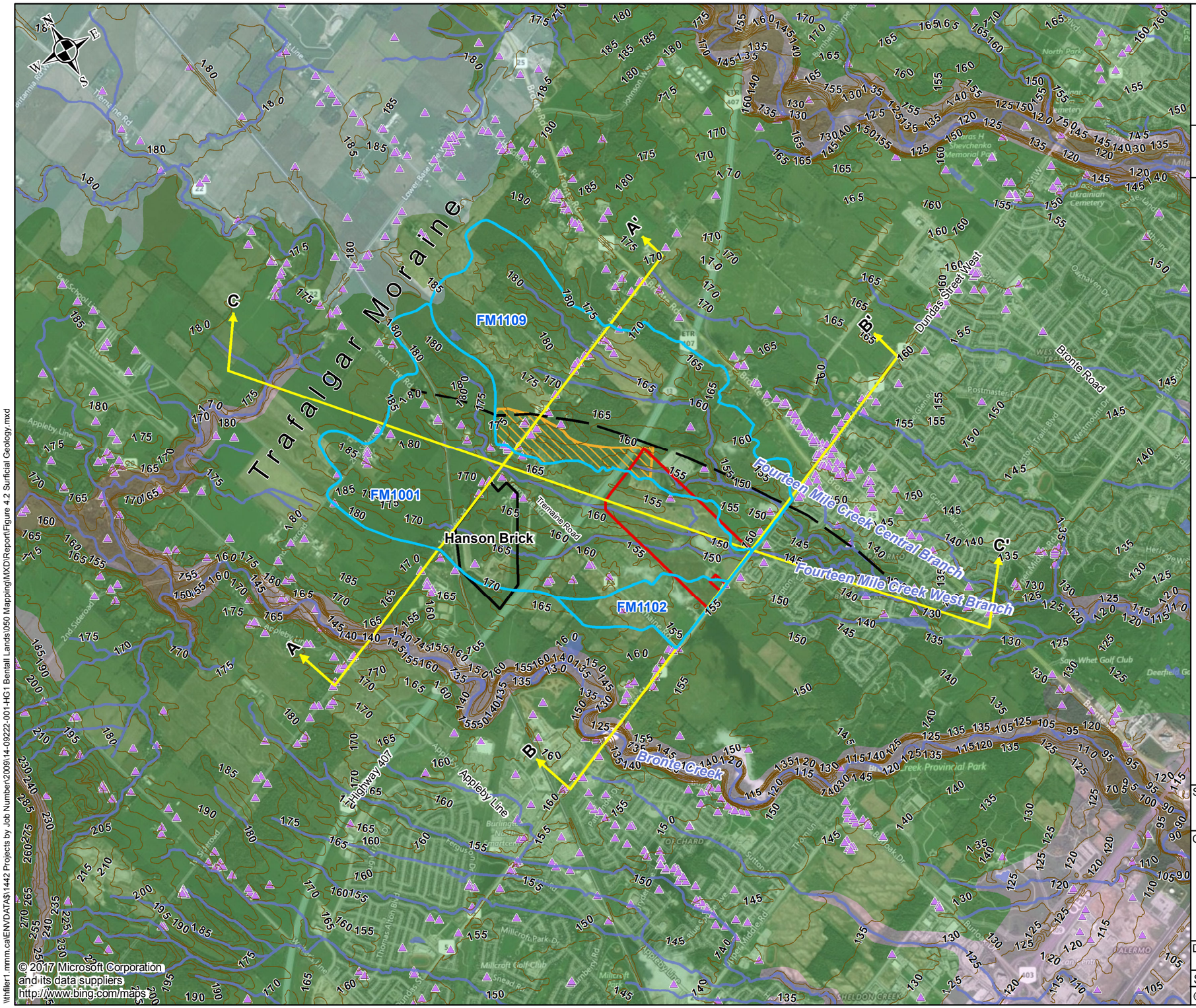
Scale
0 0.5 1 2 3
Kilometers

Client: QuadReal	Prepared By: WSP
Date: May 2019	Project No.: 09M-00013-01
Scale as Shown	**Figure: 4.1**
© Queen's Printer for Ontario	

J:\11442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.1 Site Location.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Surficial Geology



Legend

- Buried Bedrock Valley (Inferred from Water Well Records)
- Approximate Extent of Hanson Brick Tremaine Quarry Lands
- Subject Property
- Watercourse
- Waterbody
- Cross-Section
- Topographic Contour (5m Interval) (Source: Ontario Base Map / OBM)
- MECP Water Well Locations
- Subcatchment Areas
- (See text in section 4.4.4.1.1 of the report for explanation)

Surficial Geology

- Queenston Formation (Shale Limestone)
- Halton Till
- Peel Pond Glaciolacustrine Silt and Clay Deposits
- Modern Alluvial Deposits

Scale: 0 0.5 1 2 Kilometers

Client: QuadReal

Prepared By: WSP

Date: May 2019

Project No.: 09M-00013-01

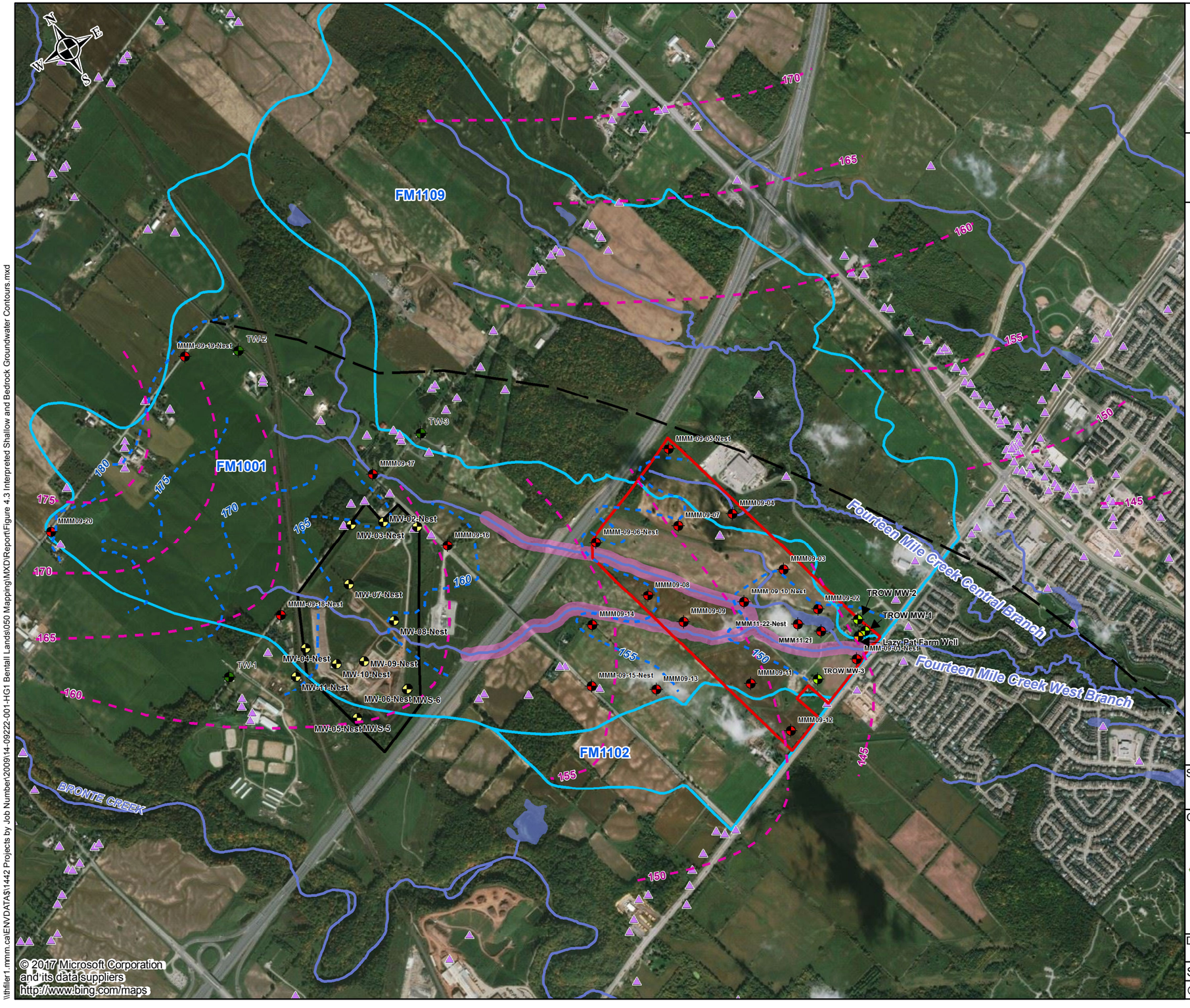
Scale as Shown

Figure: 4.2

\\thfiler1.mmm.ca\ENVDATA$\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.2 Surficial Geology.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Interpreted Shallow and Bedrock Groundwater Contours



Legend

- Interpreted Shallow Groundwater Contours
- Interpreted Bedrock Static Water Levels

Monitoring Locations

- MMM Monitoring Well
- TROW Monitoring Well
- Lazy Pat Farm Well
- Potential Areas with Groundwater Discharge from the Bedrock
- Buried Bedrock Valley
- Subject Property
- MECP Water Well Locations
- Watercourse
- Waterbody
- Subcatchment Areas
- Approximate Extent of Hanson Brick Tremaine Quarry Lands

Locations Not Monitored by MMM

- Hanson Brick Monitoring Well
- Hanson Brick Test Wells

Note: Interpreted bedrock groundwater contours are based on the MOE water well record data along with upper levels from MMM and Hanson Brick monitors.

Scale
0 0.25 0.5 1 1.5
Kilometers

Client	Prepared By
QuadReal	WSP
Date: May 2019	Project No.: 09M-00013-01
Scale as Shown	**Figure: 4.3**
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\\tfnfiler1.mmm.ca\ENVDATA$\11442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.3 Interpreted Shallow and Bedrock Groundwater Contours.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

On-site Monitoring Locations

Legend

- Pond Logger (July 2013 - Present)
- Pond Logger (July 2011 - November 2012)
- Lost / Destroyed Mini-Piezometers
- EXP Monitoring Well (2011)
- MMM Monitoring Well (2009/2011)
- Mini-Piezometer
- TROW Monitoring Well (2001)
- Lazy Pat Farm Well
- Flow Monitoring Points
- Staff Gauge
- Surface Water Sampling Location at SG-01
- Supplemental Pond Study Cross Section
- Watercourse

Topographic Contours

- 5 m Interval
- 1 m Interval
- Subject Property

Note: FMP-3 is located offsite at the southeast corner of Tremaine Road and Number 1 Sideroad

Scale 0 100 200 400 Metres

Client: QuadReal

Prepared By: wsp

Date: May 2019

Project No.: 09M-00013-01

Scale as Shown

Figure: 4.4

J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.4 On-site Monitoring Locations.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Static Water Levels - Spring

Legend

Monitoring Locations

- MMM Monitoring Well
- Mini-Piezometer
- TROW Monitoring Well
- Lazy Pat Farm Well
- Interpreted Shallow Groundwater Contours
- Interpreted Bedrock Groundwater Contours
- Interpreted Zone For Potential Bedrock Groundwater Contribution to Watercourses
- Watercourse

Topographic Contours

- 5 m Interval
- 1 m Interval
- Subject Property

For the nested wells: The upper value represents the shallow monitor and the lower value represents the deep monitor. The value in brackets represents the vertical gradient at the nest. Positive (+) values indicate downward flow, negative (-) values indicate upward flow.

Based on April 2010 levels. Data for MMM 09-15D is based upon Jan. 2010 levels as April 2010 values were depressed and not fully recovered from groundwater sampling in Feb. 2010.

Scale 0 100 200 400 Metres

Client: QuadReal

Prepared By: WSP

Date: May 2019

Project No.: 09M-00013-01

Scale as Shown

Figure: 4.5

J:\11442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.5 Static Water Levels - Spring.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Static Water Levels - Summer

Legend

Monitoring Locations

- MMM Monitoring Well
- Mini-Piezometer
- TROW Monitoring Well
- Lazy Pat Farm Well
- Interpreted Shallow Groundwater Contours
- Interpreted Bedrock Groundwater Contours
- Interpreted Zone For Potential Bedrock Groundwater Contribution to Watercourses
- Watercourse

Topographic Contours

- 5 m Interval
- 1 m Interval
- Subject Property

Notes:

CNL - Could Not Locate

For the nested wells: The upper value represents the shallow monitor and the lower value represents the deep monitor.
The value in brackets represents the vertical gradient at the nest.
Positive (+) values indicate downward flow, negative (-) values indicate upward flow based on August 2010 levels.

Scale 0 100 200 400 Metres

Client: QuadReal

Prepared By: WSP

Date: May 2019

Project No.: 09M-00013-01

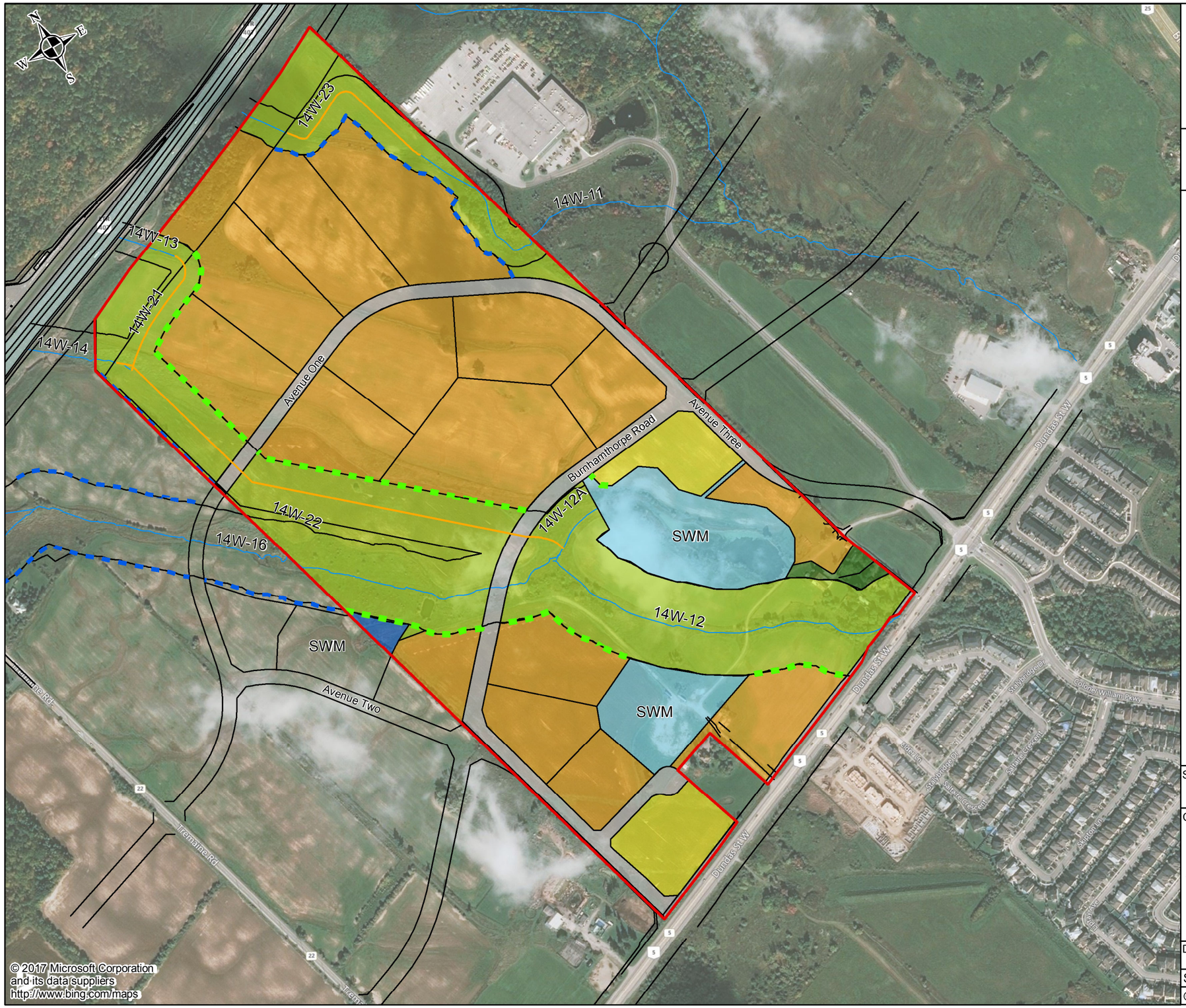
Scale as Shown

Figure: 4.6

J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.6 Static Water Levels - Summer.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Proposed Concept Plan



Legend

- Existing Watercourse
- 1.1m Infiltration Swale
- 1.5m Infiltration Swale
- Subject Property
- Development Plan
- Proposed Channel Diversions

Proposed Land Uses

- ROAD / ROAD WIDENING
- NATURAL HERITAGE - OPEN SPACE
- PARK
- RESERVED FOR FUTURE USE
- STORMWATER MANAGEMENT
- EMPLOYMENT
- SERVICE EMPLOYMENT
- RESERVES

Scale 0 100 200 400 Metres

Client: QuadReal

Prepared By: wsp

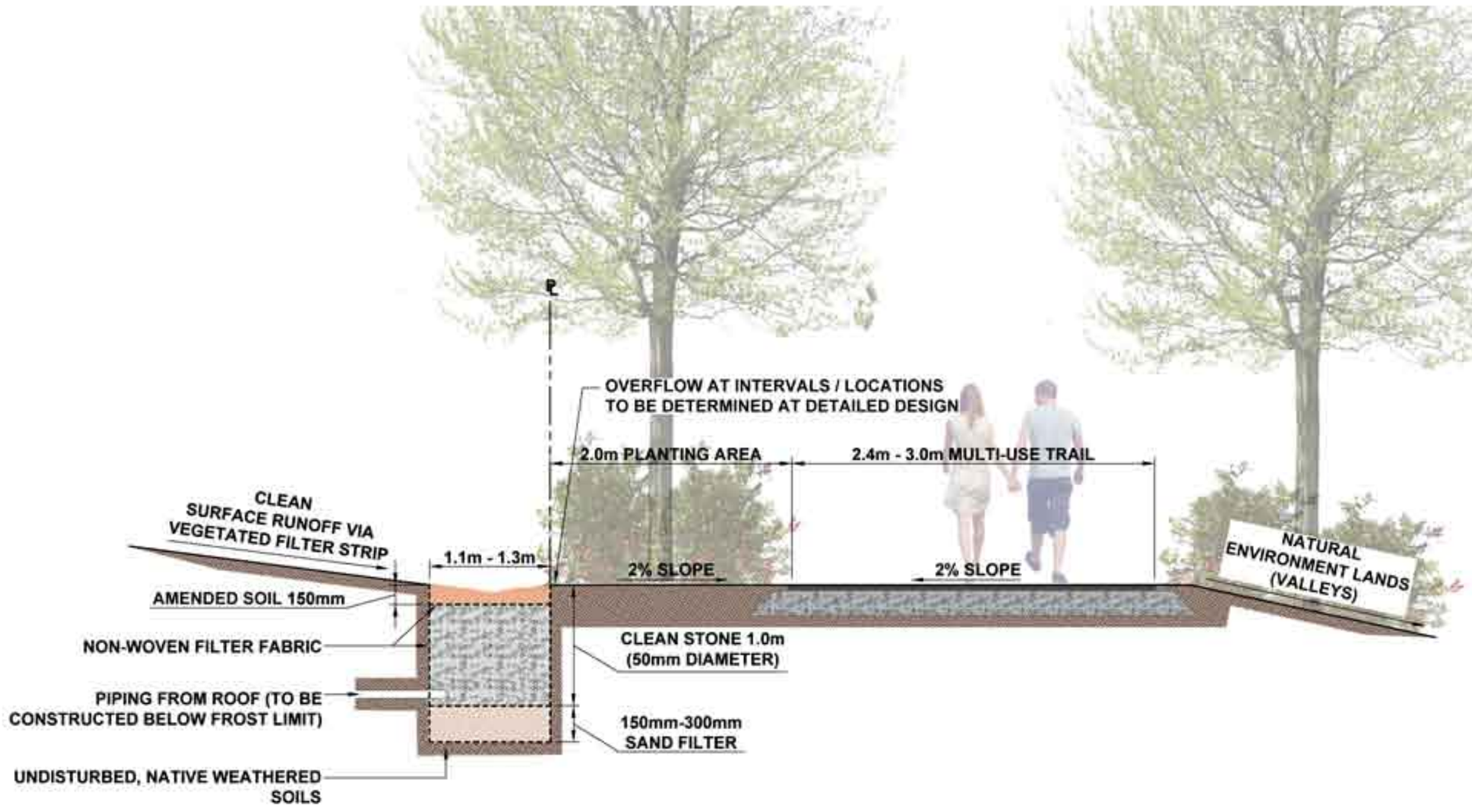
Date: May 2019

Project No. 09M-00013-01

Scale as Shown

Appendix: 4.7

J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.7 Proposed Concept Plan.mxd



NOTES:

1) CONFIRMATION OF LOCATION AND SIZING OF THESE FACILITIES TO BE CARRIED OUT AT DETAILED DESIGN THROUGH ADDITIONAL FIELD INVESTIGATIONS AND PERCOLATION TESTING.
2) INFILTRATION SWALES TO BE CONSTRUCTED AT REAR OF LOTS ADJACENT TO NATURAL ENVIRONMENT FEATURES WHERE FLAT-BOTTOMED INFILTRATION SWALES CANNOT BE BUILT.
3) CLEAN SURFACE RUNOFF DIRECTED TOWARDS THE INFILTRATION SWALES SHALL BE FROM LANDSCAPED AREAS ONLY (NO DRIVEWAY/PARKING LOT RUNOFF) AND SHALL BE DIRECTED TO THE INFILTRATION SWALES VIA SHEET FLOW THROUGH VEGETATED FILTER STRIPS

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Conceptual Infiltration Swale

Scale: N.T.S.

Client: QuadReal

Prepared by: wsp

Date: May 2019

Project No: 09M-00013-01-HG1

Figure 4.8

Figure 4.9: Monthly and Cumulative Infiltration - bcIMC Lands within FM1001
Pre-Development and Post-Development

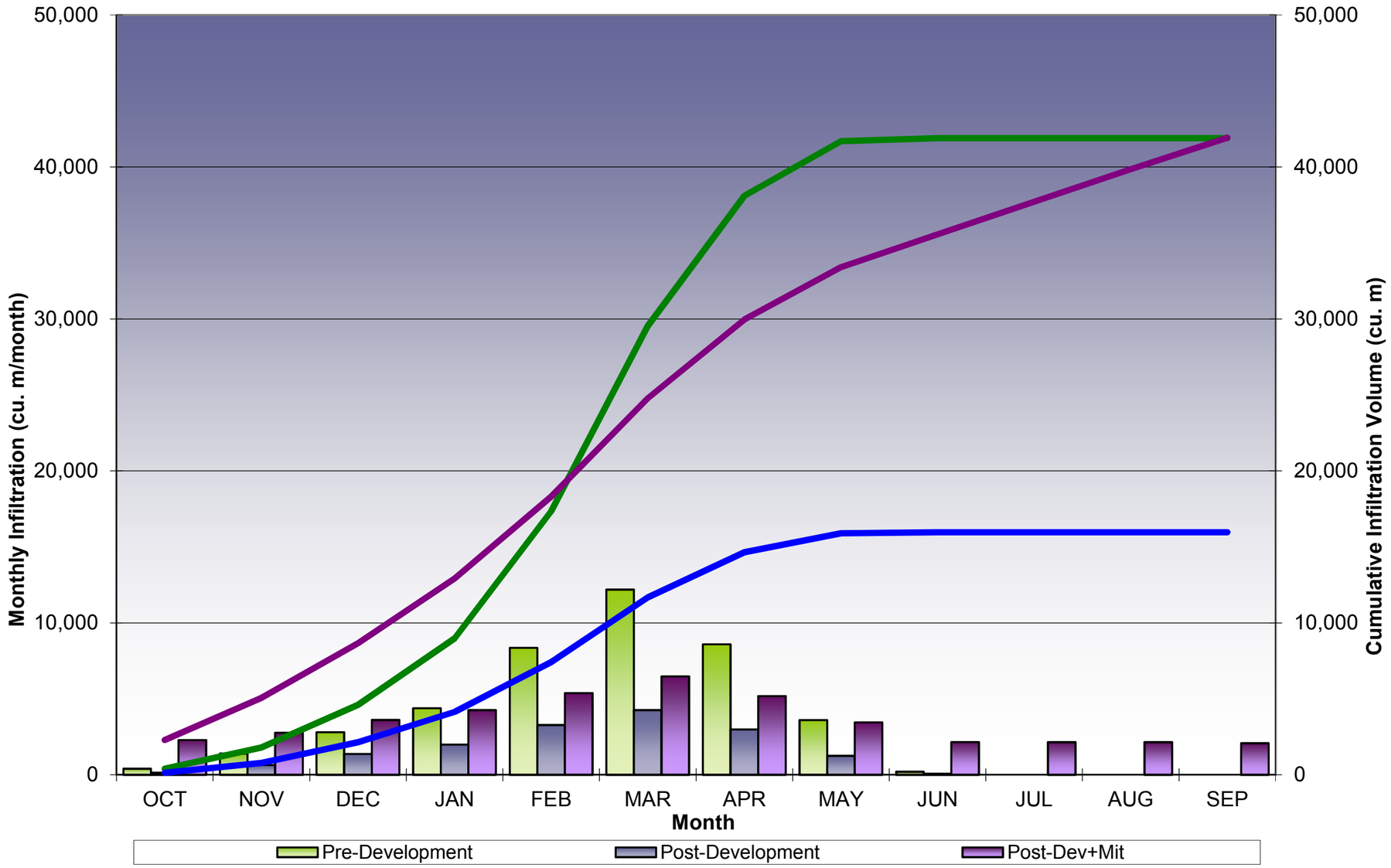
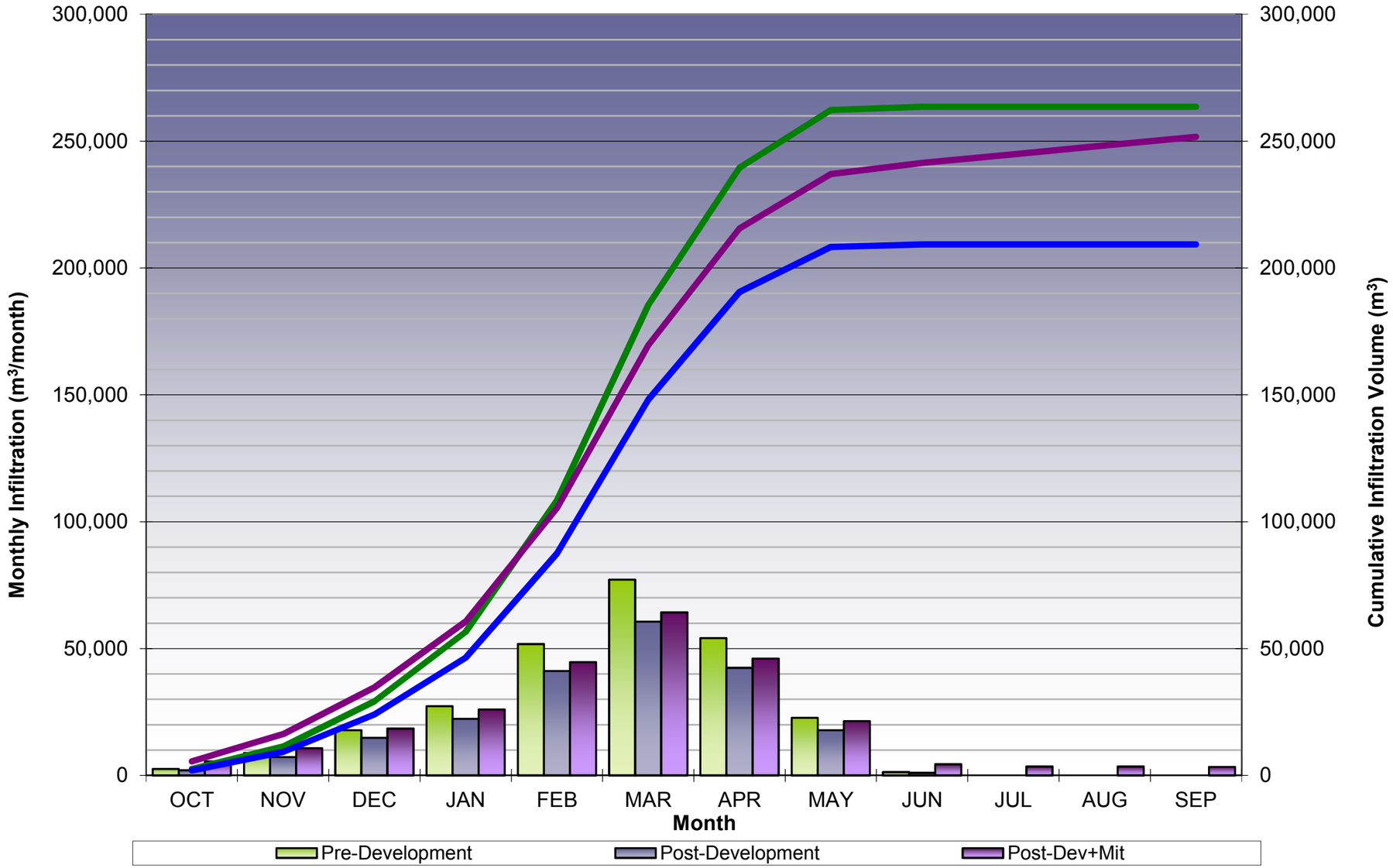
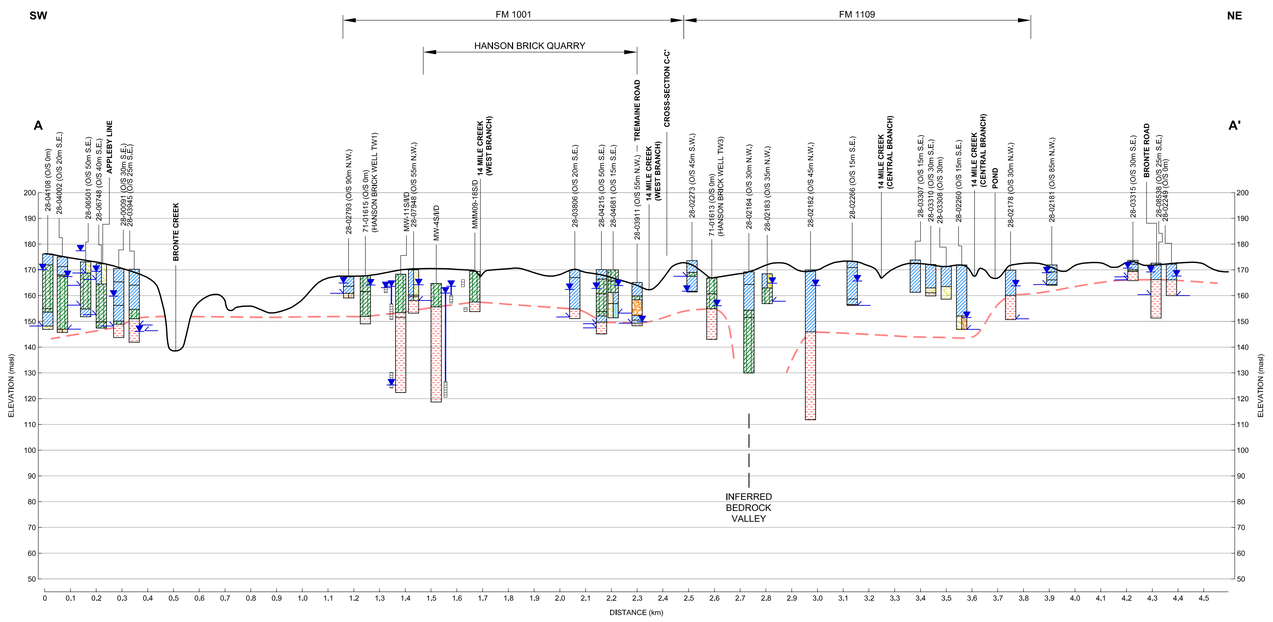


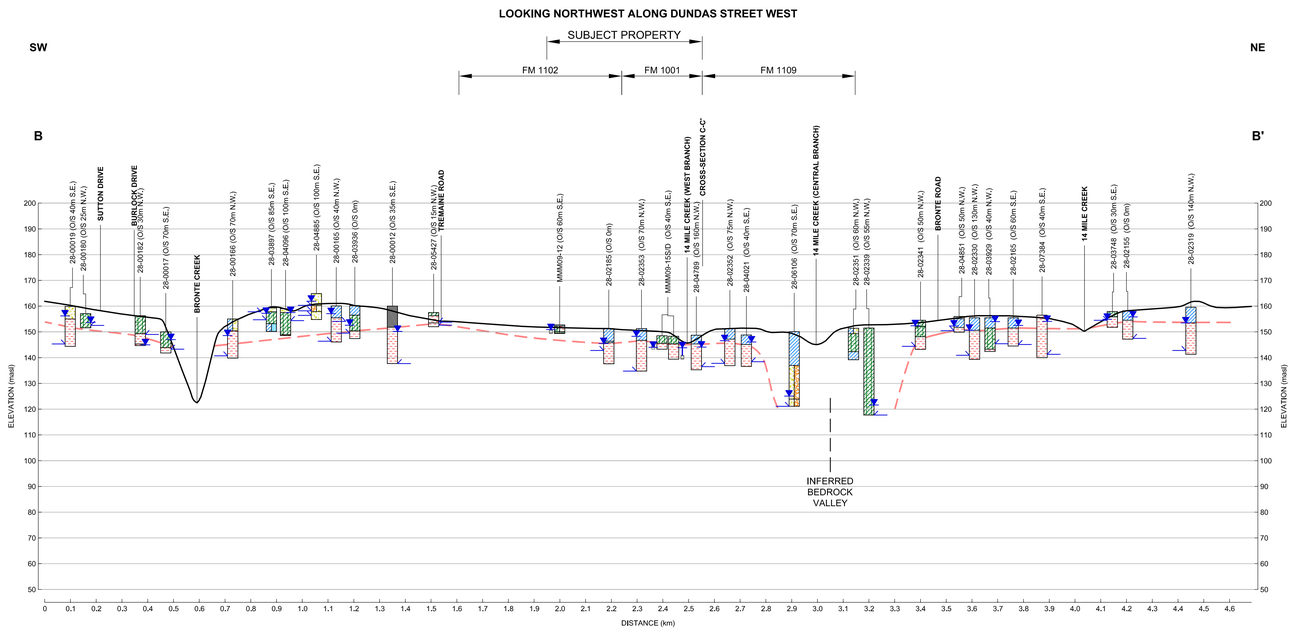
Figure 4.10: Monthly and Cumulative Infiltration - FM1001 Subwatershed
Pre-Development and Post-Development



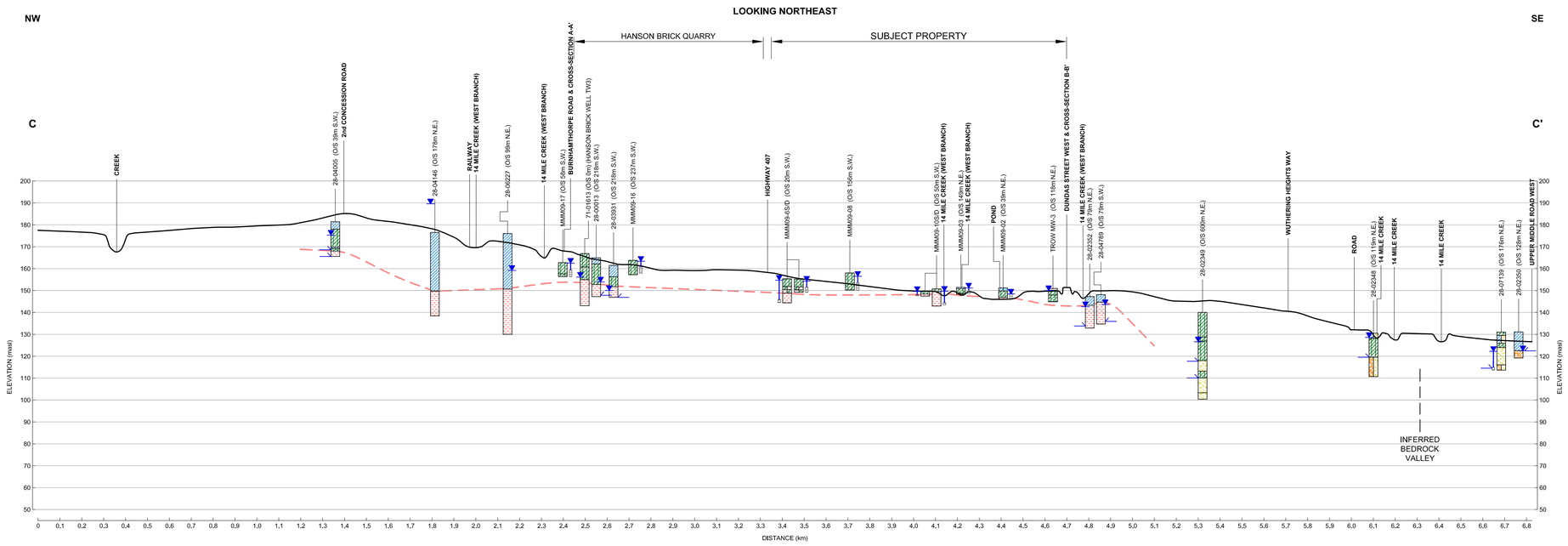
LOOKING NORTHWEST ALONG 1st SIDEROAD / BURNHAMTHORPE ROAD WEST



LOOKING NORTHWEST ALONG DUNDAS STREET WEST



LOOKING NORTHEAST



LEGEND

- CLAY
- SILT
- TILL
- SAND
- GRAVEL
- FILL
- SHALE
- PRE-DUG
- STATIC GROUNDWATER LEVEL
- WATER FOUND
- WELL SCREEN
- INFERRED BEDROCK SURFACE

NOTES:
- MANUAL WATER LEVES FOR MMM AND TROW MONITORING WELLS WERE MEASURED ON APRIL 13, 2010
- MMM AND TROW WELLS WERE PROFESSIONALLY SURVEYED

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Hydrogeologic Cross-Sections A-A', B-B' and C-C'

Scale: Horizontal 1 : 10000 Vertical 1 : 1000

Client: QuadReal

Prepared by: wsp

Date: MAY 2019

Project No.: 09M-00013-01 (1409222-001)

Drawing 4.1

DWG 4.1.dwg Hydrogeologic Cross-Sections AA_ B-B & C-C S:\14-42\1409222-001\HG\1006-REPORT MAY 2019_May 07, 2019 - 1:04pm

5.0 Natural Environment

5.0 Natural Environment

5.1 Introduction

5.1.1 Study and Site Overview

The North Oakville Secondary Planning Areas includes several watercourses that outlet to Sixteen Mile Creek or directly to Lake Ontario. These watercourses include Joshua's Creek, Morrison Creek, Munn's Creek, Shannon Creek, Osenego Creek, Fourteen Mile Creek, Taplow Creek, Glenn Oak Creek, and Sixteen Mile Creek. Generally, the existing land uses in the North Oakville Secondary Planning Areas are a mixture of agriculture, recreation (golf course and riding stable) and rural residential uses that are dissected by a local and regional road network. The North Oakville West Secondary Plan (NOWSP) designates the lands for a variety of residential, employment, commercial, institutional, recreational and natural heritage, and open space uses. The Subject Property is located within the NOWSP and more specifically, the 407 West Employment Area, which is planned to accommodate a variety of employment uses.

Within the catchment areas associated with the Subject Property the land use consists principally of active agriculture. The agricultural areas are intermixed with a variety of natural features of varying sizes and sensitivities. Generally, the notable natural features include the Oakville-Milton Wetlands & Uplands Candidate Life Science Area of Natural and Scientific Interest (ANSI), North Oakville – Milton Wetlands – West Provincially Significant Wetland (PSW) Complex, Trafalgar Moraine Candidate Provincially Significant Earth Science ANSI, Halton Region Significant Woodlands, as well as, features identified in the NOCSS including Core #1 and Linkage to Core #2, Stream Corridors associated with Fourteen Mile Creek including watercourses supporting Redside Dace (*Clinostomus elongatus*) and Hydrological Features. These catchment areas and often the natural features, are traversed by a series of roads including Burnhamthorpe Road, Regional Road 25 (Bronte Road), Highway 407, Dundas Street and Tremaine Road.

5.1.2 Study Objectives and Scope of Work

The objective of this study is to satisfy the requirements for an EIR/FSS for the 14 Mile Creek and the Lazy Pat Farm Property located north of Dundas Street, East of Regional Road 25 (Bronte Road), South of Highway 407 and west of Tremaine Road, in the Town of Oakville hereafter referred to as the "Subject Property" (Figure 1.1).

The NOWSP and the NOCSS identify the requirement to prepare an EIR to "*…characterize and analyze the natural heritage features and functions (of the Subject Property) and to determine and address the potential impacts of the proposed development application, including servicing requirements, on the Natural Heritage System*" as defined in the NOCSS. The North Oakville Environmental Implementation Report and Functional Servicing Study Terms of Reference (Town of Oakville, 2007, Revised May 2013) defines the scope of work required for completion of an EIR.

Table 5.1 summarizes the EIR requirements identified in the ToR, and how this report addresses the requirements.

In this report, we also review and assess: natural heritage provisions of the Provincial Policy Statement, (*PPS)* (2014); Ontario's *Endangered Species Act*, (ESA) (2007); Ontario Regulation 162/06 (CH's Development, Interference with Wetlands and Alterations to Shorelines and Watercourse Regulation); and

the associated Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document (Conservation Halton, 2006), to demonstrate how the proposed development conforms to the requirements of these policies/legislation. The Halton Region Official Plan (2006, 2009) and the Liveable Oakville Plan (Oakville Official Plan 2009) were also reviewed for compliance. However, the Livable Oakville Plan does not apply to lands within the NOWSP, and so is not addressed.

Table 5.1 - Summary of applicable EIR study requirements identified in the North Oakville EIR and FSS Terms of Reference (Town of Oakville, 2007)

NHS[1] Component	EIR Study Requirements According to Terms of Reference	How Requirement is Addressed
Cores and Linkages	Delineate boundaries and Linkage areas based on NOCSS and present the boundaries on recent aerial photographs	Core and Linkage boundaries from NOCSS are presented on 2009 aerial photographs on Figure 5.1 of this report. Core and Linkage boundaries have not been field confirmed or surveyed.
	Assemble background information on natural environment features and functions within the Core(s) and Linkage(s) from the NOCSS and other secondary sources. For Cores, include features, functions and management recommendations.	Designated natural environment features occurring within the overlapping EIR subcatchments are presented on Figure 5.1. A summary of natural environment features, functions and management recommendations for Core #1[2] is presented in Section 5.3.5.5.
	Conduct preliminary field review of features to confirm limits and character of vegetation communities within Cores and Linkages (e.g. roadside review or similar using recent aerial photographs).	Roadside review of Core #1 and the Linkage to Core #2 (located in off-site portion of overlapping subcatchment FM1109) was completed on August 18 and September 11, 2009. A summary of field observations is presented in Section 5.3.5.5.
	Identify any effect of other works (i.e. road crossings, servicing, SWM, etc.) and associated requirements related to Cores and Linkages.	Effects and associated requirements of road and servicing crossings of Core #1 and the Linkage to Core #2 are discussed in Table 5.14 to 5.16.

[1] Natural Heritage System

[2] Core #1 is a component of the proposed Natural Heritage System for North Oakville and is associated with the Fourteen Mile Creek valley. Core #1 is located off-site to the northeast.

NHS[1] Component	EIR Study Requirements According to Terms of Reference	How Requirement is Addressed
	For Linkages, review stream corridor assessment to ensure that any proposed proponent modifications to stream corridors (locations, widths, etc.) that may influence Linkages are identified.	Proposed watercourse modifications do not affect stream corridors associated with Linkages. See Figure 6.4.1 for an overview of proposed watercourse modifications.
Stream Corridors	Identify any relevant fish habitat setbacks, on a reach basis based on the fisheries buffers recommended in the NOCSS Management Report, and as confirmed through the studies.	Fisheries setbacks as recommended by NOCSS have been applied on a reach basis and combined with the stream corridor width delineation to obtain the development limit/open space area.
	With respect to Species at Risk, fish habitat setbacks will be identified on a reach basis with reference to NOCSS, and through discussions with relevant agencies.	The setback associated with the High Constraint reach and those reaches supporting Redside Dace consists of meander belt plus 30 m, consistent with the requirements of the MNRF.
Fish and Fish Habitat	Prepare detailed habitat mapping for all streams that contain fish habitat, which potentially may be impacted by the proposed development.	Habitat within the Subject Property was documented during multi-season field investigations and described in Section 5.3.4.4.
	Additional fish sampling may be necessary to fill information gaps.	Additional fish community sampling was undertaken in the upstream reaches of the watercourses within the Subject Property to document potential seasonal habitat. This information is presented in Section 5.3.4.1. As well, a detailed examination of the Farm Pond (Reach 14W-14A) was presented in NH#1 Technical Memo (Appendix 5.9).
	Detail proposed works (e.g. stormwater management facilities, road crossings, grading) adjacent to the fish habitats and assess/predict the impacts of construction and operation of the works, considering channel length and form, riparian buffers, flow volume and duration, water quality and water temperature.	Potential impacts to aquatic habitat associated with the proposed development are detailed in Section 5.9.1 and Table 5.14.

NHS[1] Component	EIR Study Requirements According to Terms of Reference	How Requirement is Addressed
	Detail mitigation measures and assess potential residual impacts of any works in or adjacent to fish habitats.	Potential mitigation measures and an assessment of residual effects to aquatic habitat associated with the proposed development are detailed in Sections 5.9 and 5.10 and Table 5.14.
Stream Modification or Rehabilitation	Conduct a detailed field investigation of the reach requiring modification or an appropriate reference reach (channel relocation) to determine existing aquatic habitat features.	Habitat within the Subject Property was documented during multi-season field investigations and described in Section 5.3.4.4. This information was obtained in suitable detail to guide modification/relocation works.
	Prepare a fish habitat compensation plan that clearly demonstrates how modified reaches will achieve a net gain in fish habitat and meet the 'no net loss in fish habitat productivity' as required by Section 35(2) of the *Fisheries Act* (FA) (1985).	Fish habitat enhancement concepts are presented in Section 5.9.1. These concepts will form the basis for the preparation of the fish habitat enhancement plan once commented on by the regulatory agencies. The enhancements take into consideration the requirements and focus of the amended FA (1985) (November 2013), effective November 2013. The 'no net loss in fish habitat productivity' is no longer an applicable policy under the amended FA (1985).
	Illustrate the extent of any features supporting critical life stages of fish or other aquatic biota and clearly demonstrate how the proposed compensation will replace the form and function of this habitat.	Due to the type of habitat present within the reaches to be modified/relocated, critical habitat was not identified. The compensation concept considers limiting habitat within the Subject Property with an objective to enhance the habitat present.
Forested Stands within Stream Corridors	Use a combination of aerial photographs, ground truthing, and ELC mapping to determine the extent of forested cover within potential stream corridor(s).	Two (2) forested stands within a stream corridor are present on the Subject Property. ELC mapping of these communities are presented on Figure 5.2 (Vegetation Units 3A and 5A).
	Identify the characteristics of forested stands and their relationship to the stream corridor (including potential implications, if any, on stream corridor width/location.	A summary of vegetation community characteristics is presented in Table 5.7.

NHS[1] Component	EIR Study Requirements According to Terms of Reference	How Requirement is Addressed
	Identify forested stands within the stream corridor(s) and measures to be used to protect and/or manage them as appropriate.	Feature will be protected with setbacks as discussed in Table 5.15 and presented on Figure 5.5 and in Section 6.0, Figures 6.4.1 to 6.4.5.
Hydrologic Features 'A' and 'B'	Use a combination of aerial photographs, ground truthing, and ELC mapping to determine the extent of wetland cover for each Hydrologic Feature 'A'.	The Location of Hydrologic Features 'A' on the Subject Property is presented on Figure 5.1. ELC mapping showing the extent of wetland cover is presented on Figure 5.2 and Table 5.7.
	Identify the form and function of each Hydrologic Feature 'A' and document its ecological and hydrologic relationship to the watercourse (e.g. does the feature represent an online pond or wetland).	A summary of form and function of each Hydrologic Feature 'A' wetland community, including its ecological and hydrologic relationship to the watercourse, is presented in Table 5.7.
	Identify how the ecological and hydrological relationships of the Hydrologic Feature 'A' is considered in the proposed stream modification.	The form and function of Hydrologic Features 'A' will be recreated within realigned stream corridors, as described in Section 5.9.
	There are no EIR Study Requirements for Hydrologic Features 'B'.	The locations of Hydrologic Features 'B' are presented on Figure 5.1. The feature associated with Reach 14W-16 will be retained within the natural heritage setbacks for the stream reach (Figure 5.7).

5.1.3 Agency Consultation

Consultation with CH and the MNRF were undertaken during the preparation of the EIR to verify the classification of the natural environment features on-site. Selected agency communications are provided in Appendix 5.8.

Conservation Halton

- March 30, 2009 – Record of Communication: Temperature and Dissolved Oxygen Monitoring per the NOCSS management strategy. Completed March 31, 2009.
- June 29, 2010 – On-site meeting with CH and Town of Oakville staff to stake the top of bank features.
- August 17, 2010 – CH confirmed the classification of on-site wetlands identified as provincially significant on *Provincially Significant North Oakville – Milton West Wetland Complex* mapping (MNR, 2006). According to Ms. Brenda Axon, the MNRF indicated that they would amend the North Oakville-Milton West wetland complex to remove the wetlands as part of the complex.

- September 23, 2010 - On-site meeting with CH representatives Ms. Leah Smith and Ms. Samantha Mason to discuss on-site fish and fish habitat resources in an effort to confirm the reach classifications, setback requirements and development constraints. Meeting Minutes October 5, 2010.
- November 15, 2010 - North Oakville Agency Review Meeting where MMM Group presented the proposed concept plan including channel realignments, development setbacks, incorporation of the Farm Pond (Reach 14W-14A) into the stormwater management plan and constraint classification of watercourse reaches based on habitat types.
- January 20, 2011 - CH issued comments based on material presented on November 15, 2010. MMM Group responded to the comments on March 1, 2011.
- January 25, 2011 – Meeting with CH representative Samantha Mason, as well as, representatives from the MNRF to discuss the proposed concept plan and presence of sensitive species on the Subject Property. Meeting Minutes February 1, 2011.
- April 19, 2011 – On-site meeting with CH representatives Ms. Leah Smith and Ms. Samantha Mason, as well as, representatives from the MNRF, Town of Oakville and Halton Region to discuss the proposed concept plans. Meeting Minutes April 29, 2011.
- September 6, 2011 – CH and Town of Oakville (September 16, 2011) comments on the draft EIR/FSS.
- October 20, 2011 – On-site meeting with CH representative Leah Smith, as well as, representatives from the MNRF and Fisheries and Oceans Canada (DFO) to discuss the proposed development concepts in relation to existing stream reaches on the Subject Property. Meeting Minutes November 24, 2011.
- March 30, 2012 – MMM response to CH and Town of Oakville Comments (September 6, 2011).
- August 16, 2012 – CH comments on the response to EIR/FSS comments and 2011 Natural Heritage information for Stream Reach 14W-14A.
- August 20, 2012 – North Oakville Agency Review (NOAR) Meeting attended by representatives from CH and the Town of Oakville.
- January 9, 2013 – MMM email response to provide Technical Memorandum NH#1 technical data (Reach 14W-14A)
- March 21, 2013 - CH letter response to EIR/FSS (MMM Group, December 2012).
- July 4, 2013 - MMM Issues Disposition List in advance of the multi-agency September 10, 2013 Workshop.
- September 10, 2013 – Multi-agency Workshop and Presentation.
- September 13, 2013 - MMM Action items in response to September 10, 2013 Multi-Agency Workshop.
- February 27, 2014 – MMM response to CH comments (email communication) February 13, 2014).
- June 11, 2014 - CH correspondence indicating that CH are satisfied with the responses to previous comments.
- November 2014 – MMM submits EIR/FSS 3rd Submission to CH.
- May 27, 2015 – CH issues comments related to the EIR/FSS 3rd Submission.

- June 19, 2015 – MMM response to CH comments.
- August 10 and 11, 2015 – Technical meetings attended by CH and MMM.
- December 23, 2016 – MMM submits a Flow Regime Analysis Memorandum based on CH's comments received on July 15, 2016 on the Hydraulic Model Interim Submission.
- March 10, 2017 - CH issues comments related to the December 23, 2016 Flow Regime Analysis Memorandum.
- May 26, 2017 – Email communication between CH and MMM related to clarification of the CH comments received on March 10, 2017.
- January 12, 2018 – CH issued comments related to the EIR/FSS 4th Submission.
- February 7, 2018 – WSP (MMM) conference call with CH to discuss their EIR/FSS 4th Submission comments.
- January 21, 2019 – NOARM meeting to discuss CH and the Town's comments of the EIR/FSS 5th Submission.

Ministry of Natural Resources and Forestry

- June 22, 2009 - A permit was obtained from the MNRF (Aurora District) for a License to Collect Fish for Scientific Purposes to conduct fish community sampling within the Subject Property (License # 1052019).
- July 15, 2010 – CH to MNRF (email communication) regarding wetland staking: Wetland Units 2 and 3, North Oakville-Milton West Wetland Complex).
- August 17, 2010 – MNRF's decision to declassify the PSW (email communication).
- November 17, 2010 – Request MNRF involvement in discussions related to the proposed development; channel realignments associated with Redside Dace habitat (email communication).
- November 22, 2010 - Melinda Thompson-Black of the MNRF (Aurora District) was consulted to obtain provincial Species at Risk (SAR) records. Email response November 23, 2010.
- January 25, 2011 - Consultation with the MNRF to discuss the proposed concept plan on two species; Redside Dace and Bobolink, protected under the *Endangered Species Act* 2007 (ESA).
- April 19, 2011 – On-site meeting with MNRF representative Mr. John Pisapio, as well as, representatives from the CH, Town of Oakville and Halton Region to discuss the proposed concept plans.
- October 20, 2011 – On-site meeting with MNRF representative Mr. John Pisapio, as well as, representatives from CH and DFO to discuss the proposed development concepts and provincially significant fish species related to existing stream reaches on the Subject Property. Meeting Minutes (November 24, 2011).
- May 31, 2013 – MMM requesting clarification of MNRFs requirements to provide comment to the EIR (email communication).
- July 25, 2013 – MNRF provided Redside Dace habitat classification of watercourses on Lazy Pat Farm lands (email communication).
- October 24, 2013 – MNRF confirmed that no further fish community sampling is required for the Farm Pond (Reach 14W-14A) (email communication).
- December 20, 2013 – MNRF Comments to the EIR/FSS (2nd Submission, December 2012).

- January 15, 2014 (*correspondence mistakenly dated January 15, **2013***) – MMM Response to MNRF December 20, 2013 comments associated with the review of the EIR (2nd Submission, December 2012).
- February 26, 2014 – Meeting at MNRF Aurora District to discuss SAR implications to the Lazy Pat Farm lands. Meeting Minutes (July 4, 2014).
- March 10, 2014 – Circulation of February 26, 2014 Draft Meeting Minutes.
- April 29, 2014 – MNRF revised meeting minutes (email communication).
- June 18, 2014 – MNRF indicated that the Draft Meeting Minutes can be finalized (email communication).
- July 4, 2014 – Meeting Minutes (February 26, 2014) finalized and circulated (email communication).
- July 23, 2014 – MNRF indicates (email communication M. Heaton) that no PSW exists on subject property.
- March 26, 2015 – MMM receives MNRF comments related to ESA (2007) permitting / approvals based on a review of the EIR/FSS 3rd Submission (MNRF letter misdated dated 2014).
- May 23, 2017 – MNRF provides comments to MMM related to the December 23, 2016 Flow Regime Analysis Memorandum (email communication).
- June 6, 2017 – MMM response to MNRF comments dated May 23, 2017 (email communication).

Department of Fisheries and Oceans

- October 20, 2011 – On-site meeting with DFO representative Rick Kiriluk, as well as, representatives from CH and MNRF to discuss the proposed development concepts and FA (1985) Authorization requirements related to existing stream reaches on the Subject Property.

5.1.4 Field Investigations

Field investigations for aquatic, vegetation, wildlife resources and select SAR were undertaken in 2002, 2005, 2009, 2010, 2011, 2012, 2013, 2015, 2016 and 2017. During these years, the surveys and monitoring efforts covered multiple seasons and are summarized in Table 5.1.1 Field Work Chronology in Appendix 5.1.

5.2 Natural Heritage Planning Policy

In this section, we provide an overview of Natural Heritage planning policy and relevance to the Subject Property.

5.2.1 North Oakville Creeks Subwatershed Study

The North Oakville Creeks Subwatershed Study is the main Natural Heritage policy document guiding the development process in North Oakville. The North Oakville Creeks Subwatershed Study (NOCSS) (Town of Oakville, 2004), adopts a Core Areas approach to planning of the Natural Heritage System in North Oakville. Utilizing the Core Area approach, clusters of habitats (i.e. Cores) were identified within the planning area based on several criteria (discussed below), and "Linkages" between Cores were identified. This network of

Cores and Linkages, combined with identified High and Medium Constraint Stream Corridors, comprise the proposed Natural Heritage System in North Oakville.

As stated in the NOCSS Management Report for terrestrial features – "Using this approach, the terrestrial features which are outside the boundaries of the Cores and Linkages may be removed" (Page 6-35). While for the stream corridors, NOCSS stated the following management options:

- **High Constraint -** the corridor is left in its present condition with development occurring outside of its boundaries where it is anticipated that development is not likely to affect the watercourse. Alternatively, if the watercourse is anticipated to be affected, the recommendation is that the reach is to be maintained in the present location and undertake enhancement of the geomorphic and aquatic habitat conditions within the affected watercourse.

- **High Constraint Requiring Rehabilitation -** Maintain the watercourse in its current location; however; provide enhancement opportunities for effective protection while maintaining function.

- **Medium Constraint -** Similar to High Constraint, with an additional option to undertake stream relocation with enhancement of the existing conditions. Medium Constraint reaches typically have been straightened or modified for agricultural drainage purposes, which suggests they have a reduced sensitivity to relocation; therefore, enhancement efforts would provide benefits to the overall form and function of the system.

- **Low Constraint -** Where the watercourse will not be affected, it is recommended that the corridor be left in its present condition, leaving the channel/swale in the existing condition. If the watercourse will be affected, it is first recommended that designs combine stormwater management/surface drainage systems and if this cannot be accommodated, replicate the affected reach through a system of surface water conveyance techniques (i.e. backyard swales).

5.2.1.1 Core(s) and Linkage(s)

Core areas described in the NOCSS were established according to a set of specific criteria, such that when the Cores are linked together, they create the basis for a Natural Heritage System in North Oakville. The criteria are: diversity of habitat, size, contiguity, connectivity, significance, representativeness and overall watershed functionality. The intent was to identify large and sustainable units consisting of a diversity of continuous habitats and adjacent areas that are considered to be integral to the function of the habitat captured by the Core area. Management of Core areas is based on the function of the area with respect to the ecological "theme". These themes include: Forest Interior, Open Country and Habitat Connectivity within Cores. Special Considerations for Redside Dace habitat and Buttonbush swamp influence the management of the Core area where these habitats occur.

Cores are connected to each other via Linkages. Locations of Linkages were generally selected to follow natural features whenever possible and are intended to be of sufficient size and character to ensure the functionality and sustainability of the Natural Heritage System.

No Cores or Linkages are identified on the Subject Property.

Core #1 (Fourteen Mile Creek [Main]) and the Linkage between Core #1 and Core #2 are identified within EIR subcatchment FM1109 which extends on to the north corner of the Subject Property. A summary of background information describing natural environment features and functions within Core #1 and the Linkage to Core #2 from the NOCSS and other secondary sources and coarse level field review is provided in Section 5.3.5.5 and mapped on Figure 5.1.

5.2.1.2 Stream Corridors

Streams require riparian setbacks to protect them from the impacts of urban development and associated human activity. Typically, these setbacks widths range from 15 to 30 m to maintain the biological components of many wetlands and streams. There are occasions when the need for larger setbacks is appropriate. For Redside Dace streams, the stream corridor identified as Redside Dace habitat under the ESA (2007) consists of a 30 m setback on either side of the meander belt width. According to NOCSS, Reach 14W-12 requires the meander belt plus 30 m setback with non-Redside Dace reaches requiring a minimum width of 15 m. The upper reach has been informally identified as Reach 14W-12A and is shown in Figure 5.4. Redside Dace habitat associated with Reach 14W-12 will be retained in full, except for minor encroachments associated with outlets.

A detailed assessment of the appropriate stream corridor width is presented in Section 6.3. The stream corridors setbacks for Reach 14W-11A, Reach 14W-14 and Reach 14W-16 exceed the recommended general 15 m fisheries setback. However, due to the classification of Reach 14W-12 as a High Constraint reach due to Redside Dace habitat in NOCSS, the recommended ESA (2007) fisheries setback exceed these floodplain and fluvial corridors and forms the development limit.

5.2.1.3 Other Features

Woodlots

Woodlots are not specifically identified and afforded management strategies in the NOCSS; however, woodlands larger than 0.5 ha are considered to be an important Natural Heritage feature and are candidates for assessment as *Significant Woodlands* under the Halton Region *Official Plan* (2006)*, Section 130(1)e*.

There is one woodlot (Vegetation Unit 4, Figure 5.2) that was previously identified as regionally significant based on proximity (< 50 m) to a medium constraint stream (NOCSS, p 6-48). This woodlot was excluded from the Natural Heritage System based on the "Core Area Approach" adopted by NOCSS (see Section 1.4.1 for discussion). According to this approach, "the terrestrial features which are outside the boundaries of the Cores and Linkages may be removed" (NOCSS p. 6-35). NOCSS provides additional justification for removal of this feature due to its location within the proposed Highway 407 Transitway right-of-way that will be partially or entirely cleared to accommodate this new corridor. When the proposed Transitway development proceeds, it is anticipated that the woodlot would fall below the area threshold required to be considered for evaluation as a woodland (i.e. 0.5 ha).

The Regional Official Plan (2006) allows local municipalities to substitute a 'Systems Approach' to identifying and protecting the Greenlands System within a Secondary Plan area and permits use of criteria other than those identified in the Regional Official Plan, provided that certain criteria are met, including that the alternative Greenlands System is introduced in an appropriate Local Official Plan amendment and is

approved by the Region. The Natural Heritage System approach proposed in NOCSS and in the NOWSP, has received Ontario Municipal Board (OMB) approval in part, in December 2009.

The NOWSP (Official Plan Amendment No. 289) was adopted by Council on May 25, 2009, which resulted in an amendment to the existing Town's Official Plan (2006) to include the NOWSP. Through the amendment, the Significant Woodland/Greenland B designation in the original Town's Official Plan would be revised as it relates to the North Woodlot (Vegetation Unit 4), based on the inclusion of the Natural Heritage System approach identified in the NOWSP. The new Liveable Oakville Plan (Oakville Official Plan 2009) applies only to "for lands within the Town, south of Dundas Street and north of Highway 407, to 2031". It does not apply to those areas under the NOWSP. The woodlot, based on the Natural Heritage System approach identified in the NOWSP, would therefore not be considered a constraint to development of the Subject Property.

5.2.1.4 Forested Stands within Stream Corridors

The North Oakville EIR and FSS Terms of Reference states that, "preservation of forested stands within stream corridors is generally preferred, and recommendations were provided in the NOCSS for forest preservation within stream corridors". Two forested stands within a stream corridor are present within the Subject Property (Vegetation Units 3A and 5A, Figure 5.2). These features will be retained in full and protected with setbacks.

5.2.1.5 Hydrologic Features 'A' and 'B'

Hydrologic Features 'A' and 'B' are pond or wetland features that have a hydrologic function. Type 'A' features are associated with the Natural Heritage System and are located inside the corridor of a High or Medium Constraint Stream. Type 'B' features are not associated with the Natural Heritage System. EIR study requirements for Hydrologic Features 'A' within the proposed modified stream corridors are summarized in Table 5.1 found in Section 5.1.2.

The NOCSS identifies three type 'A' features and three type 'B' features within the Subject Property (Figure 5.1). The type 'A' features are associated with stream Reach 14W-14 and Reach 14W-16, as well as, the Farm Pond (Reach 14W-14A) connected to stream Reach 14W-12A. Two of the type 'B' features are located to the west of stream Reach 14W-16 and the other feature is located west of 3367 Dundas Street West.[3] In addition to the Hydrologic Features identified in NOCSS, we have identified two additional wetland features through field studies in 2009 and 2010. Both are located within high or medium constraint stream corridors and given their context, these wetlands meet the criteria for classification as Hydrologic Features 'A' and are located within the stream corridors associated with stream Reach 14W-11A and Reach 14W-16 (Figure 5.2). Additionally, the wetlands associated with Hydrologic Features 'A' along Reach 14W-14 and the Farm Pond (Reach 14W-14A) have increased in size from the original NOCSS's assessment.

The development concepts proposed for the relocation of Reach 14W-14 and Reach 14W-11A, as well as, the conversion of Reach 14W-14A into a SWM facility are anticipated to have impacts to wetlands classified as Hydrologic Features 'A' in NOCSS and wetlands that meet the criteria for classification as Hydrologic Features 'A' not included in NOCSS but located within these reaches. A description of the form, function and ecological relationship of Hydrologic Features 'A' is presented in Table 5.7. Hydrologic Features 'A' will be recreated within the proposed modified stream corridors, as illustrated on Figures 6.4.1 to 6.4.5 in Section

[3] Note: these are small topographic depressions that were ploughed in 2009/2010, with no associated wetland vegetation.

6.0. No ecological study requirements for Hydrologic Features 'B' are identified within the EIR ToR; therefore, these features are not considered constraints to development from an ecological perspective under the NOCSS policy framework.

5.2.2 Provincial Policy Statement (MMAH 2014)

The Provincial Policy Statement (PPS) is issued under Section 3 of the *Planning Act*. The current PPS came into effect April 30, 2014. According to the natural heritage provisions of the PPS (Section 2.1.4 and 2.1.5), development and site alteration shall not be permitted in:

(2.1.4):

a. *significant wetlands* in Ecoregions 5E, 6E and 7E[4]; and
b. *significant coastal wetlands*.

or in

(2.1.5):

a. *significant wetlands* in the Canadian Shield north of Ecoregions 5E, 6E and 7E[4];
b. *significant woodlands* in Ecoregions 6E and 7E[4] (excluding islands in Lake Huron and the St. Marys River);
c. *significant valleylands* in Ecoregions 6E and 7E[4] (excluding islands in Lake Huron and the St. Marys River);
d. *significant wildlife habitat*;
e. *significant areas of natural and scientific interest*; and
f. *coastal wetlands* in Ecoregions 5E, 6E and 7E[4] that are not subject to policy 2.1.4(b), unless it has been demonstrated that there will be no *negative impacts* on the natural features or their *ecological functions*.

Based on field work conducted to date, available background information and subsequent analysis, the following information describes the Natural Heritage provisions for sensitive species, PSWs and significant woodlots on the Subject Property:

- **Endangered / Threatened Species**: Three Endangered / Threatened species are known to occur on the Subject Property: Redside Dace, Bobolink (*Dolichonyx oryzivorus*) and Barn Swallow (*Hirundo rustica*). Melinda Thompson-Black of the Aurora District MNRF was consulted on November 22, 2010, to determine the potential presence of SAR on the Subject Property. At that time, two Endangered or Threatened species were identified; Redside Dace and Bobolink. Since that time the status of Barn Swallow (Threatened) that was observed during field reinvestigations have changed and now receive protection under the ESA (2007). In 2013, the Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*) (bats) were classified as Endangered under the ESA (2007). Screening of the site for these bat species was required, as discussed with the MNRF during the February 26, 2014 meeting. The status of species is continually being updated and revised. Below is a summary of the actions that will occur in relation to the Endangered / Threatened species and their associated habitat:
    - Occupied Redside Dace habitat associated with Reach 14W-12 will be retained in full. The proposed setbacks identified were developed in accordance with the policies of the NOCSS and ESA (2007).

[4] The subject property lies within Ecoregion 7E.

- According to the MNRF, Reach 14W-16 is considered Redside Dace Habitat Occupied habitat and is subject to the same development constraints and setbacks associated with Reach 14W-12. Habitat associated with Reach 14W-16 will be retained in full, with exception of a minor encroachment associated with the new crossing for the Burnhamthorpe Road Extension.

- Field Studies and incidental observations in 2005, 2009, and 2010 observed Bobolink (Threatened provincially) on the Subject Property. However, 2013 species specific field investigations did not identify Bobolink onsite. Consultation with MNRF was undertaken to identify potential habitat / planning implications as indicated in the MNRF letter date March 26, 2015 (misdated 2014). The letter indicated that the habitat for Bobolink within the Subject Property is of marginal quality, and as such, the extent to which an ESA (2007) authorization is required will required further examination and discussion.

- Barn Swallow has been documented on the Subject Property during field investigations and site visits in 2005 and 2009. Consultation with MNRF to identify potential habitat / planning implications was conducted. The March 26, 2015 (misdated 2014) letter from MNRF indicated that the removal of Barn Swallow nests and nesting structures (barns) can be addressed by a Notice of Activity as per the requirements of Section 23.5 of Ontario Regulation 242/08.

- Consultation with the MNRF to identify potential habitat / planning implications regarding Little Brown Myotis and Northern Myotis was undertaken. The March 26, 2015 (misdated 2014) letter from MNRF indicated that the candidate habitat for bats (related to the FOD forest communities) within the Subject Property will not be impacted by the proposed development, and as such, the MNRF has no concerns related to *Myotis spp.* and the forest communities.

  The existing farm buildings were also examined as potential habitat for these species. Exit surveys of all structures on the Subject Property was undertaken in 2015. The results indicated that two specimens of the *Myotis spp*. were observed exiting the large barn structure. Given the low numbers observed, either the barn has very few maternity roosting bats or the bats were males. MNRF is aware of these results and advised that any alteration or removal of these buildings would be subject to review under the ESA (2007).

- It should be noted that as of April 1, 2019, the administration of the ESA (2007) has been transferred from the MNRF to the Ministry of Environment, Conservation and Parks (MECP). As such, any further discussions regarding ESA (2007) approvals during detail design will be with the MECP.

- **PSWs**: There are no PSWs on the Subject Property[5]. Portions of the Subject Property are located on 'adjacent lands' to the North Oakville – Milton West PSW as defined within the PPS (i.e. within 120 m of proposed development lands on the Subject Property). Portions of the Oakville-Milton wetland complex are identified within overlapping EIR subcatchments, outside of the Subject Property boundaries, as indicated on Figure 5.1. An overview of this feature is provided in Section 5.3.2.

[5] Portions of the North Oakville-Milton West PSW complex were previously identified on the subject lands, but this designation was rescinded within the Subject Property to comply with NOCSS (personal communication with Conservation Halton, August 2010). This was confirmed by email correspondence with the MNRF (M. Heaton, July, 2014).

- **Significant Woodlands**: The woodland present on the Subject Property (Vegetation Unit 4, Figure 5.2) was assessed as regionally significant during the NOCSS based on size >0.5 ha and proximity (within 50 m of) a medium constraint watercourse. However, this feature was excluded from the proposed Natural Heritage System (NHS) based on the Core Area NHS planning approach adopted by the NOCSS. Additionally, it will not likely qualify as regionally significant if the planned Highway 407 Transitway proceeds. The valley forest (Unit 5, Figure 5.2) may be considered significant under the PPS due to the uncommon status of this community (S3S4 per NHIC S-ranks). No evaluation of the significance of this feature is presented here because it will be retained in full, with setbacks as required under the policies of the NOCSS.
- **Area of Natural Scientific Interest (ANSI):** There are no provincially significant ANSI's on the Subject Property. A portion of the Subject Property is located on 'adjacent lands' to one of the woodlands designated as part of the Oakville – Milton Wetlands & Uplands Candidate Life Science ANSI (i.e., within 120 m of proposed development lands on the Subject Property (Figure 5.1). No impacts to the candidate ANSI associated with the proposed development are anticipated because the feature is functionally isolated from the Subject Property by Highway 407.

5.2.3 Conservation Halton Regulation 162/06 and Wetland Policy (2006)

Under Ontario Regulation 162/06 and the associated policy document "Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document" (Conservation Halton, 2006), CH regulates wetlands and all hazards associated with the watercourses, including the Regional Storm floodplain, stable top of bank and meander belt, as well as, the associated 7.5 m allowances, within the study area. Several wetland areas were identified on the Subject Property through background information review and through the vegetation community mapping undertaken in 2009 and 2010. The location of wetlands on the Subject Property are mapped on Figure 5.2.

5.2.4 Endangered Species Act, 2007

Species documented on the Subject Property that are listed as Threatened or Endangered are subject to species and/or habitat protections under the Provincial ESA (2007) including amendments to the ESA through Ontario Regulations 242/08, 293/11 and 65/12, as described below.

Redside Dace:
Listed in Schedule 2 and classified by Committee on the Status of Species at Risk in Ontario (COSSARO) as an Endangered species. O. Reg. 230/08 (ESA, 2007) and under Ontario Regulation 242/08 Section 29.1.

Within the Subject Property, habitat for Redside Dace in Reach 14W-12 and Reach 14W-16 is subject to Subsection 29.1(1) as these reaches are considered to be Occupied habitat "used by a Redside Dace".

Bobolink:
Listed in Schedule 3 and classified by COSSARO as a Threatened species. O. Reg. 230/08 (ESA, 2007), Ontario Regulation 242/08.

Bobolink has general habitat protection. General habitat was defined on July 2, 2013. This habitat includes the nest, and the area within 10 m of the nest (Category 1), the area between 10 m and 60 m of the nest (Category 2), and the area of continuous suitable habitat between 60 m and 300 m of the nest or

approximated centre of the defended territory. In these areas continuation of agricultural practices, recreational use, and general yard work are generally compatible activities, whilst development activities, and indiscriminate application of pesticides is generally not compatible uses. Exemptions to the ESA (2007) under Section 23.6 (O. Reg. 242/08) would apply to the Subject Property.

Barn Swallow:
Listed in Schedule 3 and classified by COSSARO as a Threatened species. O. Reg. 230/08 (ESA, 2007), Ontario Regulation 242/08.

Barn Swallow has general habitat protection. General habitat for Barn Swallow was defined on July 2, 2013. This general habitat includes the nest (Category 1), habitat within 5 m of a nest (Category 2), and habitat within 200 m of a nest (Category 3). Exemptions to the ESA (2007) under Section 23.5 (O.Reg. 242/08) would apply to the habitat for Barn Swallow on the Subject Property. Several Barn Swallow nests were confirmed to exist on structures within the Subject Property.

5.3 Existing Conditions

5.3.1 Physiography, Drainage and Soils

The Subject Property lies within the South Slope physiographic region, a strip of land between the former Lake Iroquois Shoreline to the south and the Peel Plain to the north (Chapman and Putnam, 1984). The EIR/FSS study area lies just south of the Trafalgar Moraine, which is located north of Highway 407. The region is characterized by low relief drumlinized topography. Detailed descriptions of the physiography, drainage and soils are presented in Section 4.0.

In general, the surface drainage features include a series of four (4) un-named watercourse that function as tributaries to Fourteen Mile Creek. These watercourses generally flow from northwest to southeast across the Subject Property. Three of the watercourse merge near the centre of the property and continue southeast to the culvert at Dundas Street West. The fourth watercourse transects the northeast corner of the property. The swales are generally poorly defined features that convey surface runoff from lands north of Highway 407.

5.3.2 Environmental Designations

Environmental designations have been assigned to several features located on the Subject Property or off-site portions of EIR subcatchments that partially overlap the Subject Property, as described below:

- **Oakville-Milton Wetlands & Uplands Candidate Life Science Area of Natural and Scientific Interest** (ANSI), (MNR 2006). The candidate ANSI consists of 11 woodlots units comprising approximately 290 ha in total area. This candidate ANSI has been selected for its representation of kettle and headwater wetlands and drier tableland forests in Site District 7E4. Three (3) of the woodlots are located within the off-site portions of overlapping EIR subcatchments north of Highway 407 (Figure 5.1). A portion of the Subject Property would be considered “adjacent lands” as defined in the PPS (i.e. within 120 m of the ANSI).

- **North Oakville – Milton Wetlands – West Provincially Significant Wetland (PSW) Complex** (MNR 2006a). The PSW complex includes 147 individual wetlands with a combined area of 20.29 ha comprised of 70% marsh and 30% swamp. The wetlands occur on and around the western

portion of the Trafalgar Moraine, and are primarily situated in headwater areas of tributaries of Sixteen Mile Creek, Fourteen Mile Creek and Taplow Creek and in adjacent internally draining areas. Portions of this PSW complex had previously been identified on the Subject Property; however, these portions were removed from the complex to conform with NOCSS watercourse classifications (personal communication with Brenda Axon, Conservation Halton 2010). Although publicly available, wetlands mapping (MNRF, 2014) shows a portion of this PSW complex present within EIR subcatchments that extend onto the property, none of the mapped PSW's are found on the Subject Property in actuality (Figure 5.1). This has been confirmed by the MNRF staff via e-mail correspondence (M. Heaton, email correspondence, July 23, 2014). A portion of the Subject Property would be considered "adjacent lands" as defined in the PPS (i.e. within 120 m of the PSW).

- **Trafalgar Moraine *Candidate* Provincially Significant Earth Science ANSI (MNR 2006b).** The Trafalgar Moraine is a broad high ridge of glacial till, approximately 20 km long x 30 m high. It is considered an "*excellent example of the last standstill of the Lake Ontario ice lobe…(supported) glacial Lake Peel, and deflect(ed) the path of East Sixteen Mile Creek, creating the most dramatic landscape of Oakville*". This candidate ANSI is located immediately north of the Subject Property, north of Highway 407.

- **Halton Region Significant Woodland/Greenlands B**. The North Woodlot on the Subject Property (Unit 4, Figure 5.2) was determined to be a *Significant Woodland* according to the criteria defined in the Halton Region Official Plan (2006) through analysis completed during the NOCSS. According to policy 130 (1) of the Halton Region Official Plan (2006), *Significant Woodlands* are considered *Greenlands B*, a component of the regional *Greenlands System*. The Regional Official Plan allows local municipalities to adopt a 'Systems Approach' to identifying and protecting the Greenlands System within a Secondary Plan area by using criteria other than those identified in the regional Official Plan, provided that certain criteria are met, including that the alternative Natural Heritage System approach to *Greenlands B* are introduced in an appropriate Local Official Plan amendment and are approved by the Region.

  Through NOCSS, the north woodlot was identified as significant but was not included in the proposed Natural Heritage System. The NOWSP (Official Plan Amendment No. 289) was adopted by Council on May 25, 2009, which resulted in an amendment to the existing Town's Official Plan (2006) to include the NOWSP. The Livable Oakville Plan (Oakville Official Plan, 2009), does not apply to those lands under the NOWSP (Section 1.1a). The woodlot, based on the Natural Heritage System approach identified in NOWSP would; therefore, not be considered a constraint to development of the Subject Property.

- **NOCSS Core #1 and Linkage to Core #2.** The NOCSS identified Cores and Linkages within the North Oakville planning area. These features, combined with medium and high constraint streams, form the proposed Natural Heritage System in North Oakville. No Cores or Linkages are located on the Subject Property. Core #1 and Linkage to Core #2 are located off-site in EIR subcatchment FM1109, a small portion of which extends onto the northeast edge of the Subject Property.

- **Stream Corridors.** NOCSS identifies stream corridors according to the characteristics and processes that affect the health of a stream system within a watershed, which is detailed in the NOCSS and summarized here. These characteristics and processes include: Environmental,

Geomorphologic, Hydrologic and Hydrogeologic. The interaction of the four components, their sensitivities and the ability of the system to respond to development pressures, provided the basis for developing appropriate management strategies. These different levels of management are identified according to the associated constraints to development or alterations permitted within these systems. The following describes the areas of constraints, the management and where these occur within the Subject Property.

High Constraint Stream Corridor (Red Stream)
High Constraint Reaches are considered to be a high-quality resource and in the case with Reach 14W-12 results from the presence of Redside Dace a species classified as Endangered in Ontario and is subject to protection under the *ESA*. There is one High Constraint reach within the limits of the Subject Property; 14W-12 within subcatchment FM1001.

High Constraint Stream Corridor Requiring Rehabilitation (Red Hatched Stream)
Reach 14W-11 in the northeast portion of the site, located within subcatchment FM1109, is classified as a High Constraint Reach Requiring Rehabilitation.

Medium Constraint Stream Corridor (Blue Stream)
Streams identified as Medium Constraint are considered to have the potential for rehabilitation as they may or may not have a well-defined morphology but do maintain a geomorphic function. There are three Medium Constraint streams within the Subject Property including Reach 14W-14, Reach 14W-14A and Reach 14W-16 that discharge into Reach 14W-12 (High Constraint) within subcatchment FM1001. Reach 14W-16 is considered to be a Medium Constraint Stream Corridor in accordance with NOCSS; however, recent consultations with MNRF (October 20, 2011) indicate that constraints associated with Redside Dace are warranted. The MNRF considers Reach 14W-16 to be Redside Dace Occupied habitat up to and to the north of Highway 407 and is; therefore, subject to protection under the ESA (2007) (*ESA Clause (a) Subsection 2(1)* - Ontario Regulation 242/08 S29.1. The remaining Medium Constraint Reach is located in the northeast corner of the Subject Property identified as Reach 14W-11A within subcatchment FM1109 that flows into Reach 14W-11, a High Constraint stream requiring rehabilitation.

Low Constraint Stream Corridor (Green Stream)
Watercourses identified as green are considered to be ephemeral headwater swales that lack definition and function to convey flow and sediments within a system. Reach 14W-13 is the only Low Constraint Reach within the Subject Property. It discharges into Reach 14W-12 (High Constraint).

- **Hydrological Features.** Hydrological features are defined by their association with other Natural Heritage Systems including stream corridors. Type 'A' features are associated with the Natural Heritage System located inside the corridor of a High or Medium Constraint Stream.

  A Hydraulic Feature B is not associated with the Natural Heritage System and may be relocated and consolidated with other wetlands, water features or SWM facilities, provided the hydrologic function of the feature is maintained.

  There are three type 'A' features and three type 'B' features within the Subject Property as identified in NOCSS. The type 'A' features are associated with Reaches 14W-14, Reach 14W-14A and Reach

14W-16 while the type 'B' features are located within the Reach 14W-16 and west of 3367 Dundas Street West (Figure 5.1). In addition, two other wetland features identified through field studies would meet the criteria for classification as Hydrologic Features 'A' which are located within the stream corridors associated with stream Reach 14W-11A and Reach 14W-16.

5.3.3 Species of Conservation Concern

5.3.3.1 Species At Risk

As mentioned in Section *5.1.3 Agency Consultation* the MNRF has been consulted through the process to obtain input related to SAR and implications with the ESA (2007). The MECP will be consulted during detail design as it relates to SAR in subsequent phases of the project related to obtaining ESA (2007) approvals with CH and the Town included and/or circulated on the results of these discussions.

Redside Dace

Redside Dace was previously recorded in a lower section of Reach 14W-12 immediately upstream of Dundas Street. The MNRF has indicated that Reaches 14W-12 and 14W-16 are considered Occupied habitat while Reach 14W-11A, Reach 14W-12A, Reach 14W-13, Reach 14W-14 and Reach 14W-14A are considered Contributing habitat. As a result, the MNRF's interest lies principally with the proposed activities that have the potential to influence groundwater, surface water and physical disturbances within the classified habitat.

The following points summarize the status of Redside Dace and habitat potential on the Subject Property:
Status

- Designated as "Endangered" by the Committee On the Status of Species At Risk in Ontario (COSSARO) under the ESA (2007), and listed as "Endangered" on the Species at Risk in Ontario (SARO) list (Ontario Regulation 230/08, ESA (2007), current June 7, 2017).
- Designated "Endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2007, Schedule 3 and "Endangered" under the Federal Species at Risk Act (SARA) (2002) (current May 3, 2017).
- Redside Dace has a provincial S-Rank of S2 (Imperiled) (current July 30, 2014).
- This species receives protection under the ESA (2007); and species-specific regulation under Section 23.1 of Ontario Regulation 242/08 (current September 14, 2016).
- Species-specific habitat regulation for this species is now afforded under Section 29.1 of Ontario Regulation 242/08 (current September 14, 2016).

Habitat and Field Observations

- Redside Dace are generally found in clean, clear, cool water, slow moving sections of watercourses less than 10 m in width that meander through meadows with scattered trees and shrubs. They are arboreal insectivores which rely on pools and clear water to see their prey and to jump out of the water to catch it. For this reason, they are sensitive to temperature changes, vegetation disturbance, and turbidity (MNRF, 2011).
- Redside Dace were captured in a refuge pool immediately upstream of Dundas Street culvert inlet in September 2001.
- Suitable habitat existing in the lower section of Reach 14W-12 to support this species.

- The project team met with MNRF on January 25, 2011 to discuss ESA (2007) issues and MNRF confirmed on March 26, 2015 (misdated 2014) that the proposed road crossings through regulated habitat would require a permit under the ESA (2007).

Bobolink

Bobolink was recorded on the Subject Property during breeding bird surveys conducted in 2005, and again through incidental observations during the breeding bird season in 2010. Subsequent MNRF endorsed surveys undertaken in 2013 to specifically target Bobolink (and Eastern Meadowlark (*Sturnella magna*)) did not result in the observation of Bobolink.

The following points summarize the status of Bobolink and habitat potential on the Subject Property:

Status

- Designated "Threatened" by COSSARO and listed as "Threatened" on the SARO list (Ontario Regulation 230/08, ESA (2007), and current June 2, 2017).
- This species receives protection under the ESA (2007); and species-specific regulation under Section 4.1, 23.2, and 23.6 of Ontario Regulation 242/08 (current September 14, 2016). Although Section 4.1 of the ESA (2007) (which pertains to agricultural operations) is set to expire on December 31, 2025.
- Because this species was listed as Threatened after June 30, 2008, it receives automatic general habitat protection under the ESA (2007).
- General habitat is defined as: Category 1 - The nest, and the area within 10 m of the nest, Category 2 - the area between 10 m and 60 m of the nest, and Category 3 - the area of continuous suitable habitat between 60 m and 300 m of the nest or approximated centre of the defended territory.
- No species-specific habitat regulation under the ESA (2007) is in force at this time.
- Designated "Threatened" by COSEWIC, No Schedule and No Status under SARA (2002) (current June 1, 2017).
- Bobolink has a provincial S-Rank of S4B (Apparently secure in Ontario, Breeding) (current June 12, 2017).

Habitat and Field Observations

- Bobolink originally nested in tall-grass prairie, but has adapted to nest in forage crops (e.g. hayfields) and open grassland habitats following the conversion of the majority of prairie ecosystems to agricultural uses.
- Suitable grassland/agricultural habitat is present on the Subject Property within the drainage channel network.
- During breeding bird surveys in 2005, 40 Bobolink were recorded at Station # 7 (BB7, Figure 5.3). In addition, approximately 40 Bobolink were recorded in the riparian meadow between Station #6 and Station #7. Based on habitat suitability and the fairly large number of individuals recorded, breeding was likely.
- In 2010, a total of 16 Bobolink were observed over the course of 2 consecutive days (July 13th and 14th) within the drainage channel network as indicated on Figure 5.4. Breeding evidence in 2010 was based on males singing on territory in suitable nesting habitat.
- Two (2) Bobolink were observed in 2010 north of Station #1 during water quality monitoring surveys.

- Surveys in accordance with the MNRF Bobolink survey methodology under the ESA (2007) (MNRF, 2011) undertaken in the Spring of 2013 did not result in an observation of Bobolink.
- Consultation with the MNRF was undertaken to determine general and/or species-specific habitat protection for this species on the Subject Property per the ESA (2007). MNRF indicted in the March 26, 2015 (misdated 2014) correspondence, that only small areas exist on site that would be considered suitable habitat for Bobolink based on their habitat assessment. These include ELC communities 2A, 2B, 2F and 2G which are wholly or partially included in the open spaces designation and will not be damaged. As the habitat is limited to riparian areas and is of marginal quality, the extent to which an ESA (2007) Authorization is needed requires further examination and discussion during detail design.
- If required, the MNRF recommends a 1:1 ratio of replacement could be used to potentially address habitat impacts and that opportunities to incorporate additional suitable habitat into the open space areas and/or NHS (i.e. cultural meadow, grasslands, or meadow marsh) would be beneficial. Consultation during detailed design with the MECP will be undertaken to confirm the requirements for habitat replacement based on current and past records for observations of this species.
- Given the marginal nature of the habitat, the retention of riparian habitat where Bobolink were observed, the proposed incorporation of meadow marsh habitat (as indicated by MNRF as currently providing habitat) in the realigned channels and the availability of mechanisms under the ESA (2007) to address Bobolink habitat removal at off-site locations, we would anticipate that this item would not result in delays to the Draft Plan Approval considering these items can only be addressed at the detail design stage.

Barn Swallow

Barn Swallow was observed on the Subject Property and is using the existing barn for breeding, located at the south end of the property adjacent to the large Farm Pond (Reach 14W-14A). Foraging habitat for this species is likely sufficient in the post-development scenario within the natural corridors. MNRF indicated in March 26, 2015 (misdated 2014) that the removal of nest and nesting habitat can be undertaken through the Notice of Activity as per Ontario Regulation 242/08. Under the registry, the MNRF indicates that removal of habitat (i.e. existing barn) would require replacement habitat structures, which could occur in the natural corridors. Confirmation from the MECP that foraging habitat replacement is not required will be obtained during detailed design.

Status

- Designated "Threatened" by COSSARO and listed as Schedule 3, "Threatened" on the SARO list (Ontario Regulation 230/08, ESA, (2007)) (current June 2, 2017).
- This species receives protection under the ESA (2007); and species-specific regulation under Section 23.5 of Ontario Regulation 242/08 (current September 14, 2016). Because this species was listed as Threatened after June 30, 2008, it receives automatic general habitat protection under the ESA (2007).
- This general habitat includes the nest (Category 1), habitat within 5 m of a nest (Category 2), and habitat within 200 m of a nest (Category 3).
- Designated "Threatened" by COSEWIC (2011), No Schedule and No Status under SARA (2002) (current June 1, 2017).
- Barn Swallow has a provincial S-Rank of S4B (Apparently secure in Ontario, Breeding) (current June 12, 2017).

Habitat and Field Observations

- Evidence of breeding was observed on the Subject Property as recently fledged young or downy young were documented.
- This species shows a preference for open habitats for foraging, including grassy fields, pastures, agricultural crops, lake and river shorelines, cleared rights-of-way, farmyards and wetlands.
- This species nests in small, loose colonies, taking advantage of manmade structures to build nests.
- Barn Swallows are aerial insectivores and have been observed flying over the large Farm Pond (Reach 14W-14A).
- Surveys of the existing barn were undertaken in 2013 to confirm usage by Barn Swallow for nesting. Several barn swallow nests were confirmed to exist on structures within the Subject Property.

Eastern Meadowlark

Eastern Meadowlark was not observed on the Subject Property during 2005 breeding bird surveys or incidental observations on the Subject Property. As with Bobolink, dedicated surveys were carried out in the spring of 2013 to confirm the presence/absence of this species and/or habitat on the Subject Property.

Status

- Designated "Threatened" by COSSARO and listed as Schedule 3, "Threatened" on the SARO list (Ontario Regulation 230/08, ESA (2007), current June 2, 2017).
- Because this species was listed as Threatened after June 30, 2008, it receives automatic general habitat protection under the ESA (2007).
- General Habitat for Eastern Meadowlark includes: Category 1 – The nest and the area within 10 m of the nest, Category 2 – The area between 10 m and 100 m of the nest or centre of approximated territory, Category 3 – The area of continuous suitable habitat between 100 m and 300 m from nest or approximated centre of defended territory.
- Designated "Threatened" by COSEWIC, No Schedule and No Status under SARA (2002) (current June 1, 2017).
- Eastern Meadowlark has a provincial S-Rank of S4B (Apparently Secure in Ontario, "Breeding") (current June 12, 2017).

Habitat and Field Observations

- Preferred breeding habitat for Eastern Meadowlark includes native grasslands, pastures, and savannas, but also hay and alfalfa fields, weedy borders of croplands, roadsides, orchards, golf courses, reclaimed strip mines, airports, shrubby overgrown fields, or other open areas; tall-grass prairie (western edge of range) and desert grassland (southwestern populations).
- This species shows preference for habitats with good grass and litter cover (Lanyon, 1995).
- The Subject Property may provide suitable breeding habitat for Eastern Meadowlark, in areas that contain large wheat fields, pasture, hayfields, a fallow woody agricultural field and wet meadow areas.
- Mowing and harvesting of existing crops both present a risk to the survival of this species.
- Surveys in accordance with the MNRF Eastern Meadowlark survey methodology under the ESA (2007) (MNR, 2011) undertaken in the Spring of 2013 did not result in an observation of Eastern Meadowlark.

Eastern Milksnake

Eastern Milksnake (*Lampropeltis triangulum*) was previously recorded in the general vicinity of the Subject Property (MNRF personal communication, 2010). The following points summarize the status of Eastern Milksnake and habitat potential on the Subject Property:

Status

- Removed from the Species at Risk in Ontario (SARO) list on June 15, 2016 (Ontario Regulation 230/08, current June 2, 2017).
- Designated "Special Concern" by COSEWIC, and listed as "Special Concern" on Schedule 1 of SARA (2002) (current, June 1, 2017).
- Eastern Milksnake has a provincial S-Rank of S4 (Apparently Secure in Ontario) (current June 12, 2017).
- Eastern Milksnake has species only protection. Habitat for Eastern Milksnake is not specifically protected by the ESA (2007) or SARA (2002).

Habitat and Field Observations

- Eastern Milksnake is a habitat generalist that occupies a wide variety of habitats including field, swamp, open woodlot and culturally influenced habitats. In Ontario, this snake is more common in heavily forested areas (deciduous, evergreen and mixed) than in areas of low forest cover but is also common in rural pastures and hayfields, as well as, in and around barns, sheds and houses (COSEWIC 2002).
- Suitable habitat for this species is present on the Subject Property (i.e. within agricultural fields, North Woodlot, Valley Forest, swale network, around barns, etc.).
- No Eastern Milksnake have been observed on the Subject Property to date, although no targeted surveys for this species were conducted.
- Suitable habitat for Eastern Milksnake will persist post-development within retained natural environment features including Vegetation Units 3, 4, 5 and retained portions of Vegetation Unit 2 (Figure 5.2). In addition, the realigned watercourse sections will be restored to natural vegetation cover that will provide potential habitat for habitat generalists including Eastern Milksnake.

Monarch Butterfly

Monarch Butterfly (*Danaus plexippus*) was previously recorded in the general vicinity of the Subject Property (MNRF personal communication, 2010) and was observed on the Subject Property during field surveys in 2009 and 2010. The following points summarize the status of Monarch Butterfly and habitat potential on the Subject Property:

Status

- Designated "Special Concern" by COSSARO and listed as Schedule 4 - "Special Concern" on the SARO list (Ontario Regulation 230/08, current June 2, 2017)
- Designated "Endangered" by COSEWIC and listed as Special Concern on Schedule 1 of SARA (2002) (current October 21, 2014).
- Monarch has a provincial S-Rank of S2N, S4B (Imperiled – Non-breeding, Apparently secure in Ontario - Breeding) (current June 12, 2017).

- Monarch has species only protection. Habitat for Monarch is not specifically protected by the ESA (2007) or SARA (2002).
- Based on the draft Significant Wildlife Habitat Ecoregion Criteria Schedules and Addendum to Significant Wildlife Habitat Technical Guide" (OMNR Working Draft, February 2012), no significant habitat for Monarch is present on-site (i.e. no butterfly migratory route/stopover areas – undisturbed field and forest 10 ha or greater within 5 km of Lake Ontario).
- Monarchs were seen on the subject property during field investigations in 2009, 2010, and 2014.

Habitat and Field Observations

- The Subject Property contains suitable breeding and feeding habitat for this species within cultural meadow/meadow marsh areas. Habitat suitability is defined by the presence of milkweed species (*Asclepias* sp., the only plant on which Monarch caterpillars feed) and the presence of nectar producing plants (which provide a food source for adult Monarchs). The cultural meadow and meadow marsh habitats throughout the Subject Property support occasional stands of Common Milkweed (although no notable stands were observed) and abundant nectar producing plants including asters, goldenrods, thistle, etc.
- It is expected that suitable habitat for this species will persist post-development within retained portions of Vegetation Unit 2 (Figure 5.2). In addition, the realigned watercourse sections will be restored to open meadow/meadow marsh vegetation cover and *Asclepias* sp. and nectar producing plants will be included in re-vegetation seed mixes to enhance habitat potential for Monarch (Section 6.0; Figure 6.4.1 to 6.4.5).

Snapping Turtle

Snapping Turtle (*Chelydra sepentina*) was previously recorded in the general vicinity of the Subject Property (MNRF personal communication, 2010) and its presence confirmed in 2011. The following points summarize the status of Snapping Turtle and habitat potential on the Subject Property:

Status

- Designated "Special Concern" by COSSARO and listed as Schedule 4 "Special Concern" on the SARO list (Ontario Regulation 230/08, current June 2, 2017).
- Designated "Special Concern" by COSEWIC, on Schedule 1 "Special Concern" under SARA (2002) (current June 1, 2017).
- Snapping Turtle has a provincial S-Rank of S3 (Vulnerable in Ontario) (current June 12, 2017).
- Snapping Turtle has only species protection. Habitat for Snapping Turtle is not specifically protected by the ESA (2007) or SARA (2002).

Habitat and Field Observations

- According to COSEWIC Status Report (2008), the preferred habitat for the Snapping Turtle is characterized by slow-moving water with a soft mud bottom and aquatic vegetation. Established populations are most often located in ponds, sloughs, shallow bays or river edges and slow streams.
- Suitable habitat is found within the Farm Pond (Reach 14W-14A) feature. Marginal habitat may be present along wetter portions of the swales, but this habitat is somewhat ephemeral.

Bats

Little Brown Myotis and Northern Myotis were flagged as having the potential to be present on the Subject Property and the MNRF provided accepted protocols for bat surveys within the Subject Property. The site was screened for potential habitat within forest communities and existing structures. All candidate habitat associated with the vegetation (i.e., ELC Forest communities (FOD) – 3A, 3B, 4, 5A and 5B) is located in Open Spaces designated areas and will not be impacted by the proposed development. As such, MNRF has no concern related to *Myotis spp*. in those habitats.

The existing structures were further investigation in 2015 (June and July) for bat maternity roosting habitat through exits surveys. The results were present to the MNRF which indicated that although bats were using the barn structures, only two specimens of the *Myotis spp*. were recorded. The low numbers of exiting *Myotis spp.* (and other bat species) indicate usage of the buildings is likely restricted to either a very small maternal roost site or is a non-maternal roost, such as, that used by males, who tend to roost individually or in low numbers. Any alteration or removal of the large barn will be subject to review under the ESA (2007) which will be undertaken with the MECP during detail design.

Status

Little Brown Myotis (formerly Little Brown Bat)

- Designated "Endangered" by COSSARO and listed as Schedule 2 "Endangered" on the SARO list (ESA (2007), Ontario Regulation 230/08, current June 2, 2017).
- Designated as "Endangered" by COSEWIC, on Schedule 1 "Endangered" under SARA (current June 1, 2017).
- Little Brown Myotis has a provincial S-Rank of S4 (Apparently Secure) (current June 12, 2017), although this data is likely not representative due to quick declines in bat populations.
- Because this species was listed as Endangered after June 30, 2008, it receives automatic species and general habitat protection under the ESA (2007).
- General habitat guidelines have not yet been produced by the MNRF.
- Critical habitat has been partially identified by Environment Canada.

Northern Myotis (formerly Northern Long-eared bat)

- Designated "Endangered" by COSSARO and listed as Schedule 2 "Endangered" on the SARO list (ESA (2007), Ontario Regulation 230/08, current June 2, 2017).
- Designated as "Endangered" by COSEWIC, on Schedule 1 "Endangered" under SARA (2002) (current June 1, 2017).
- Northern Myotis has a provincial S-Rank of S3 (Vulnerable) (current June 12, 2017).
- Because this species was listed as Endangered after June 30, 2008, it receives automatic general habitat protection under the ESA (2007).
- General habitat guidelines have not yet been produced by the MNRF.
- Critical habitat has been partially identified by Environment Canada.

Habitat and Field Observations

- Little Brown Myotis are insectivores, feeding at night and are most active in the two or three hours after sunset. They are nocturnal, roosting during the day in trees and buildings. They often select attics, abandoned buildings and barns for summer colonies.

- Northern Myotis are typically associated with boreal forests, roosting under loose bark and in the cavities of trees. They are found throughout forested areas in southern Ontario.
- Exit surveys of the existing barn structures on the Subject Property were undertaken in 2015 with the results indicating that *Myotis spp.* are using the large barn for roosting.

5.3.3.2 Provincially Significant Species

One provincially significant bird species, Black-crowned Night-heron (*Nycticorax nycticorax, S3B, S3N – Vulnerable – Breeding, Vulnerable – Non-Breeding*), was observed on the Subject Property on August 20, 2009. One adult and one juvenile were flushed from the shallows of the Farm Pond (Reach 14W-14 and Vegetation Unit 1, Figure 5.2). This observation occurred outside of the breeding bird season and does not suggest breeding activity on the Subject Property.

5.3.3.3 Regionally Rare/Uncommon Species

A total of 11 vegetation species considered rare or uncommon in Halton Region and/or the Greater Toronto Area and/or Site District 7E-4 (per Varga *et al*. 2000) were observed on the Subject Property: Panicled Aster (*Symphyotrichum lanceolatum ssp. lanceolatum*), Fringed Sedge (*Carex crinita*), Shagbark Hickory (*Carya ovata var. ovata*), Turtlehead (*Chelone glabra*), Torrey's Rush (*Juncus torreyi*), Eastern Red Cedar (*Juniperus virginiana*), Rice Cutgrass (*Leersia oryzoides*), Sandbar Willow (*Salix interior*), Carolina Rose (*Rosa carolina*), Northern Wild-raisin (*Viburnum nudum var. cassinoides*) and Winterberry (*Ilex verticillata*). The location of regionally rare/uncommon species is noted in Table 5.7 and Table 5.8. All eleven regionally rare/uncommon species observed have provincial S-ranks of S4 or S5 and are considered common in Ontario.

The Halton Natural Areas Inventory (2006) was consulted to identify the potential rarity of species in the region. Based on the rankings provided therein applied to the plant list for the property: Five (5) species considered uncommon (HU) in Halton Region were observed – Common Hornwort (*Ceratophyllum demersum*), Eastern Red Cedar (*Juniperus virginiana*), Fringed Sedge (*Carex crinita*), Torrey's Rush (*Juncus torreyi*), and Narrow-leaved Spring Beauty (*Claytonia virginica*). One (1) species considered rare (HR) in Halton Region was observed: Swamp White Oak (*Quercus bicolor*). One species with a rank of F (requires further review) was observed: Common Evening-primrose (*Oenothera biennis*). Two species that were not listed in the inventory were observed: Northern Wild-raisin (*Viburnum cassinoides*) and Corn-marigold (*Chrysanthemum segetum*).

Nine (9) bird species (both breeding and non-breeding) considered uncommon in Halton Region (Dwyer 2006) were observed on the Subject Property: Gadwall (*Anas strepera*), Blue-wing Teal (*Anas discors*), Black-crowned Night-heron, Northern Harrier (*Nycticorax nycticorax*), Wilson's Snipe (*Gallinago delicata*), Willow Flycatcher (*Empidonax traillii*), Horned Lark (*Eremophila alpestris*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) and Eastern Towhee (*Pipilo erythrophthalmus*). All of these have provincial S-ranks of S4 or S5, except Black-crowned Night-Heron which has an S-rank of S3B (discussed in Section 5.3.3.2). Observation locations are noted in Table 5.8 in Section 5.3.6.2.

5.3.4 Aquatic Resources

Aquatic community and habitat investigations were undertaken through the spring, summer and fall of 2009, as well as, the winter of 2010 by MMM Group aquatic ecologists to supplement the existing information within

NOCSS (2006) and field investigations undertaken in 2002. Subsequent field investigations were undertaken on July 1 and August 31, 2011 in support of Technical Memo NH#1 to address CH comments and then again in 2017 to review the flow regime during the spring freshet to coincide with the timing identified in the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines Approved July 2013* (CVC/TRCA, Finalized January 2014). Sampling and habitat documentation was undertaken in each reach to assist with the characterization of the habitat present across the Subject Property.

With reference to guidance from the NOCSS (pg. 7-16), minor refinements of stream reaches are permitted during studies for the preparation of the EIR/FSS. As such, the refinement of the upstream section of Reach 14W-12 was considered based on the field studies undertaken in support of the EIR/FSS for the Subject Property between 2009 and 2011. During these studies, habitat conditions in Reach 14W-12 were evaluated based on the factors that led to the original reach classification. Observations indicate that the form and function of existing habitat in the upper section of Reach 14W-12, connecting the confluence of Reach 14W-13, Reach 14W-14 and Reach 14W-14A with the confluence of Reach 14W-16 and Reach 14W-12, is functionally distinct from existing habitat within the main section of Reach 14W-12 downstream of the confluence with Reach 14W-16. Therefore, for the purposes of this Report, Reach 14W-12 has been descriptively divided into two reaches; such that the functionally distinct section that originates at the Farm Pond (Reach 14W-14A) and flows westerly to its confluence with Reach 14W-16 is described hereafter as the Reach 14W-12A, while the remaining stream section that continues downstream to Dundas Street retains the original designation as Reach 14W-12. Reach 14W-12A is also considered to be a hydraulically distinct feature from Reach 14W-12.

Aquatic resource investigations within the Subject Property included fish community sampling, benthic macroinvertebrate community sampling, aquatic habitat mapping, and water quality monitoring (Dissolved Oxygen (DO), Temperature, Conductivity, pH, Total Dissolved Solids (TDS) and Water Clarity). Fish community sampling was not undertaken in Reach 14W-12 as part of this study to avoid disturbing Redside Dace and their habitat.

Fish Community Approach

Fish community sampling in 2009 was primarily undertaken in May. Several fish sampling sites were located co-incident with Ontario Stream Assessment Protocol (OSAP) sites. These sites relied on the location to have suitable conditions (i.e. sufficient water) to carry out OSAP, as well as, providing the appropriate fish community sampling conditions. The timing of fish community sampling was selected based on the previous field investigations carried out in 2002, which identified several tributaries as exhibiting intermittent/ephemeral flow regimes. Sampling in stream reaches and spot sampling along the perimeter of the two ponds was conducted using a HT-2000 Halltech Battery Backpack Electroshocker. A single pass method was used in the tributaries where water was observed and in the wadeable nearshore areas of the two ponds. At that time, fish community sampling within potential fish habitat that did not meet the OSAP conditions was undertaken where possible. These areas principally consisted of Highway 407 culvert outlets where refuge pools had been scoured. These areas were spot sampled using the backpack electroshocker where sufficient water was present in July 2009.

Additional sampling surveys were undertaken in 2011 to satisfy September 6, 2011 CH comments related to sampling effort in Reach 14W-14A conducted in 2002 using minnow traps and in 2009 using an electrofisher. Sampling efforts in 2011, consisted of both minnow traps and pot traps, set for a period of approximately 24 hours. Details of the 2011 fish community sampling is described in Technical Memorandum – NH #1 included

in Appendix 5.9 and summarized in Section 5.3.4.1. All fish were processed (i.e. identification, measurement & tally) on-site and returned promptly to the approximate capture site. Fish community sampling locations from all years are shown in Figure 5.4.

Benthic Macroinvertebrate Community Approach

Benthic macroinvertebrate sampling was conducted at each of the OSAP sites using the compatible Ontario Benthos Biomonitoring Network (OBBN) protocol. Benthos collection was completed using the traveling kick and sweep method covering a 10 m distance over three minutes in both pool and riffle habitats. Benthic macroinvertebrate samples were preserved in the field and taken back to the lab for processing according to OBBN. Samples were rinsed and randomly sorted into sub-samples using the bucket method, and the sub-samples were picked until at least 100 organisms were collected. The picked organisms were tallied and identified according to the OBBN coarse 27 group mix of Phyla, Orders, Classes and Families.

Water Quality Approach

The OMB *Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets* (July 12, 2007) indicates that specific target levels are recommended for water temperature and dissolved oxygen for the purposes of fisheries protection. A conservative target maximum daily water temperature of 20ºC is achieved for fisheries protection and applied in the stormwater management for lands draining to Fourteen Mile Creek. Based on the Provincial Water Quality Objective (MOE, 1994) for coldwater fisheries associated with the target water temperature, a conservative DO target of 6 mg/l is to be applied. The OMB decision recommended that a temperature and DO monitoring program be established prior to development to establish a baseline against which target levels can be assessed and modified. This would provide a baseline condition in the intermittent watercourses that may not meet the previously mentioned targets. CH was contacted to determine the best location and procedure to monitor the water quality (specifically DO and temperature) as per the requirements of the mediation (Kim Barrett, Conservation Halton; Pers. Comm. March 30, 2009).

Water quality parameters were recorded at each station every two weeks (bi-monthly) beginning May 12, 2009 and ending October 30, 2009, including water temperature, TDS, conductivity, pH and DO. Water temperature, TDS, conductivity and pH were measured using a Hanna Instruments HI98129 multimeter and DO was measured using an Extech Instruments Waterproof Exstik II Dissolved Oxygen Meter. Temperature monitoring was undertaken using temperature sensors that were installed in the tributaries where sufficient water was believed to persist throughout the monitoring period to keep the sensor submerged. For consistency, water quality sampling was conducted at the water temperature monitoring stations on a bi-monthly basis between May 12, 2009 and October 30, 2009. Water quality parameters were recorded around the same time of day whenever possible, following data retrieval/download of the temperature sensor. Additional water quality data was recorded at benthic and fish community sampling locations in 2009.

A site-specific water quality monitoring program at the request of CH (September 6, 2011) was carried out in the Farm Pond (Reach 14W-14A) to collect data in 2011 to provide a detailed characterization of the quality and type of fish habitat available in this feature. Water quality data collected in this feature included: stratified water temperature data, stratified DO data and water clarity, as well as, TDS, conductivity and pH of the surface water. Sampling occurred at three locations throughout the pond. The details of the sampling method and results of the water quality monitoring are described in the Technical Memorandum – NH#1 included in Appendix 5.9.

Aquatic Habitat Approach

Field investigations undertaken in 2009 and 2010 were developed using the EIR/FSS Terms of Reference (Town of Oakville, August 2, 2007). Beyond the limits of the Subject Property, existing conditions were documented at the subcatchment level of detail to characterize stream reaches. These observations were generally made from road crossings beyond the Subject Property including Highway 407 (ETR), Tremaine Road, GE Company laneway, and downstream of Dundas Street (main channel crossing). This information is used to compare the current conditions with previous findings reported in the NOCSS Characterization Report and to provide context for on-site aquatic habitat documented at a greater level of detail. Within the Subject Property, field staff detailed the existing conditions and drainage characteristics including aquatic habitat features. Specific focus was placed on habitat potential and effects related to Redside Dace, which is considered to inhabit Reach 14W-12.

On-site habitat characterization was detailed using Ontario Stream Assessment Protocol (OSAP) mapping, detailed photographs and notes during multiple site visits during the spring, summer and fall of 2009. The OSAP protocol requires that the sampling site should represent at least one riffle-pool sequence, be at least 40 m long, and beginning and ending at a crossover point. In channelized or modified streams, such as those occurring within the Subject Property, a site can be selected based on a 40 m length of stream with similar bank heights and relative uniformity of depth profile across the channel. Due to the limited amount of flow within the watercourses, only three potential locations met the above criteria during spring field investigations.

In 2011 aquatic habitat conditions were further documented in Reach 14W-14A to supplement documentation of this feature from previous years to provide more details of the available habitat to satisfy CH September 6, 2012 comments on earlier investigations. Habitat in Reach 14W-14A was completed using an underwater camera to view conditions in the open water areas at depths exceeding 2 m. Aquatic vegetation (submergent, emergent and floating) was documented from a canoe to characterize the available habitat visible from the surface (Appendix 5.7 and 5.9).

5.3.4.1 Fish Community

The majority of the fish community for Fourteen Mile Creek consists of generalist species, which are tolerant of warmwater temperatures with moderate amounts of organic enrichment. The exception to this is Redside Dace recorded in the lower section of Reach 14W-12 as this species requires cool, clear flowing water with riffle-pool sequences and overhanging bank vegetation (NOCSS Characterization Report, 2006).

Fish community data presented below summarizes previous field investigations undertaken in 2002, information available in NOCSS, as well as, supplemental field investigations undertaken in 2009 in support of this EIR. Fish community sampling undertaken in 2002 was undertaken during the low flow period (July and September) and used a combination of methods including electrofishing, minnow traps and incidental observations within the main channel and the associated ponds (MMM, 2003). Fish community sampling in 2002 was limited to Reach 14W-12, Reach 14W-16 and Reach 14W-14A due to the lack of water in the remaining reaches. The location of each sampling site is identified in Figure 5.4.

Recognizing the intermittent/ephemeral nature of the other reaches on-site, the 2009 field investigations were undertaken in both the spring (May) and summer (July) to document seasonal fish habitat use and the connectivity of the reaches during this high flow period.

The results of the fish community sampling are summarized in Table 5.2, below.

Table 5.2 – Fish Community Data for QuadReal – Lazy Pat Lands, Oakville (MESP 2003, MMM, 2003 & MMM, 2009)

Fish Species		Reach Identification						
Fish Species	***Scientific Name***	**Reach 14W-11A Site 1**	**Reach 14W-11A Site 2**	**Reach 14W-12 Site 1***	**Reach 14W-12 Site 2***	**Reach 14W-14**	**Reach 14W-14A (Farm Pond)**	**Pond 1 (Dug Pond)**
Blacknose Dace	*Rhinichthys atratulus*			*66*	17			3
Bluntnose Minnow	*Pimephales notatus*	2	8		17			
Brook Stickleback	*Culaea inconstans*		2	*24*	4	8	2	
Brown Bullhead	*Ictalurus nebulosus*			*2*	5		1	
Creek Chub	*Semotilus atromaculatus*	4	15	*82*	67		*37**	
Fathead Minnow	*Pimephales promelas*	9	9	*14*	12	2		
Largemouth Bass (YoY)	*Micropterus salmoides*						*3**	2
Redside Dace	*Clinostomus elongatus*			*2*				
White Sucker	*Catostomus commersonii*			*6*	2		*7**	

**2002 Fish Community Sampling Results*

Reach 14W-11

Fish community within this tributary consists of three species including Brook Stickleback (*Culaea inconstans*), Fathead Minnow (*Culaea inconstans*) and Creek Chub (*Semotilus atromaculatus*) (Table 5.2). Based on the results of sampling efforts, this tributary provides spawning opportunities for both Brook Stickleback and Fathead Minnow, as young of the year were observed. Due to the minor flow observed later in the season and high flows observed on October 20, 2011 it is anticipated that these specimens originate from downstream fish habitat and use this reach seasonally.

Reach 14W-12

The fish community sampling was not undertaken in 2009 due to the classification of this reach as providing Redside Dace habitat (MNR, 2009). Historic fish community sampling in September 2002 resulted in the capture of eight warmwater and coolwater species including Redside Dace. Fish community sampling sites in this reach included a refuge pool located immediately upstream of the Dundas Street culvert inlet, as well as, a second refuge pool located approximately 200 m upstream of Dundas Street at an existing farm road crossing of the watercourse. Fish were only sampled in these areas as the remainder of the watercourse had insufficient flow/water. Redside Dace was only captured at the downstream refuge pool immediately

upstream of Dundas Street during sampling. During 2009 field investigations fish continued to be observed schooling in the downstream refuge section.

The continued presence of fish indicates that this reach continues to directly support what is presumed to be a self-sustaining fish population as the Dundas Street culvert likely functions as a seasonal barrier to fish movement due to the perched outlet (approximately 0.15 m), a second vertical drop within the culvert (approximately 0.15 m) and the base of the culvert that creates shallow sheet flow over smooth concrete with little cover/velocity breaks. During periods of higher flows in this system that may occur during spring freshet conditions or following storm events, fish movement upstream through the Dundas Street culvert may be possible. However, flow velocities during high flows, such as those observed on October 20, 2011 when more than 59.5 mm of rain fell in the Oakville area, may prohibit most fish from navigating through the culvert.

Reach 14W-12A

Fish community sampling was not undertaken in Reach of 14W-12A as there was insufficient flowing water during spring field investigations. Furthermore, fish were not observed in pooled habitat during subsequent water quality monitoring investigations. This section may provide seasonal fish habitat during periods of flow for fish located within the pond (Reach 14W-14A) and perhaps fish originating from Reach 14W-12; however, due to its channel form and the habitat present it would likely only support generalist species during the period when flow is present.

Reach 14W-13

Fish community sampling was conducted within this reach in July downstream of the Highway 407 culvert outlet. Due to the limited amount of water present, this section was selectively sampled using the backpack electroshocker; however, did not result in the capture of any fish. This and historic field observations of a dry channel confirms the NOCSS classification of this system as not functioning as (direct) aquatic habitat.

Reach 14W-14

Fish community sampling was also undertaken in this reach during July in response to the observation of pooled water in the vicinity of the Highway 407 culvert outlet. Similar to sampling in Reach 14W-13 this section was selectively sampled using the backpack electroshocker due to the limited amount of water present. Sampling resulted in the capture of Brook Stickleback and Fathead Minnow. Both are considered warmwater species that are tolerant of a variety of habitat conditions with the substrate and emergent vegetation in pool habitat providing suitable habitat. The absence of other species with more specialized habitat requirements (i.e. coarse substrate, thermal regimes, etc.) indicates that this area provides marginal direct fish habitat. These species may have originated from upstream/downstream habitat during the spring freshet and been unable to migrate downstream due to receding water levels later in the season as field investigations through the year indicate that the channel connecting this refuge pool to permanent habitat (Reaches 14W-14A and 14W-12) appeared to remain dry for the summer months.

Reach 14W-14A (Farm Pond)

Fish community sampling was undertaken in 2002, 2009 and 2011 by MMM Group Aquatic Ecologists, as well as, by the authors of the NOCSS (2006) documents in support of their study. The pond supports a warmwater and coolwater baitfish and warmwater sportfish (Largemouth Bass) community. The presence

of Largemouth Bass (*Micropterus salmoides*) indicates that the pond is productive as they are a top-level predator species that require a substantive forage base. It is likely that the Largemouth Bass have been stocked as the pond is a constructed feature and similar habitat that would have provided a source population is absent in the area. This pond is intermittently connected to adjacent watercourses by a single inlet and outlet at the north end of the pond, providing seasonal access for fish.

Reach 14W-16

Fish community sampling undertaken immediately upstream of the confluence with Reach 14W-12 did not result in the capture of fish; however, one dead Brook Stickleback (*Culaea inconstans*) was observed at the abandoned field crossing located at the upstream limit of the site. Spot shocking was also undertaken in areas where a small amount of water was present between the two OSAP sites yet did not have sufficient water to be used as an OSAP site. This spot sampling did not result in the capture of fish. The 2002 sampling program also intended to sample Reach 14W-16 upstream of its confluence with Reach 14W-12; however, flows were also insufficient at that time. Although, fish were not captured in this reach, they were observed during benthic macroinvertebrate sampling in 2009. The species in this reach included Blacknose Dace *(Rhinichthys atratulus)* and Brook Stickleback upstream of the confluence with Reach 14W-12. These species were also previously recorded in 2002 downstream in the Reach 14W-12, (MMM, 2003). Subsequent evaluation of Redside Dace habitat in North Oakville by the MNRF consider Reach 14W-16 as Redside Dace Occupied habitat and it is therefore, afforded the same protection as Reach 14W-12 (i.e. meander belt plus 30 m setback) and would be subject to protection under the ESA (2007).

Pond 1 (Dug Pond) adjacent to this reach has a low diversity fish community consisting of Blacknose Dace and Largemouth Bass (Table 5.2). Although fish sampling resulted in the capture of 2 Largemouth Bass, more specimens including adult, juvenile and young of year were observed during field investigations. It appears that the Largemouth Bass are present as a result of pond stocking, since this pond has poor connectivity to downstream fish communities and any similar habitat that would have provided a source population is absent in the area. Connectivity of this pond to the adjacent watercourse (14W-16) is limited to high water conditions and periods of flooding, based on observations made on October 20, 2011 when 59.5 mm of rain fell in the Region (EC, Oakville Weather Station). During high water conditions the pond can become directly connected to Reach 14W-16 when water levels in Reach 14W-16 overtop the banks and extend into the floodplain for this reach. Under normal flow conditions, discharge from the pond flows down a relatively steeply sloped, moderately defined narrow channel into Reach 14W-16. Despite the pond's origin as a constructed feature, the poor connection to downstream fish habitat, the apparent stocking of the pond and the absence of its identification in the NOCSS or other documents, this pond is considered to function as direct fish habitat with intermittent/ephemeral connection to Reach 14W-16. As such, DFO and CH have indicated that it is regulated under the FA (1985).

5.3.4.2 Benthic Macroinvertebrate Community

Benthic macroinvertebrates are small, aquatic organisms that exist in the substrate of a watercourse or water body and are excellent indicators of environmental conditions including habitat diversity and water quality (i.e. organic pollutants). They form a crucial component of the aquatic ecosystem by breaking up leaves and other organic debris, feeding on algae and other plants in the watercourse, and are food for many fish species. An assessment of water quality can be conducted using benthic macroinvertebrate communities that will place the watercourse into one of seven categories; excellent, very good, good, fair, fairly poor, poor and very poor.

Benthic macroinvertebrate community sampling was completed at three sites where sufficient water was present to follow the OBBN protocol. The sites were sampled using a transect kick and sweep method to sample both riffle and pool habitat. In the event that there were no significant habitat differences within the site, three random locations were selected for sampling. This sampling provides a representative sample of the benthos within the watercourse. Benthic macroinvertebrate samples were preserved in the field and taken back to the lab for processing according to the OBBN protocol. Samples were rinsed and randomly sorted into sub-samples using the bucket method, and the sub-samples were picked until at least 100 organisms were collected. The picked organisms were tallied and identified according to the OBBN coarse 27 group mix of Phyla, Orders, Classes and Families. Results of the benthic macroinvertebrate community investigations were analyzed using the following metrics typically employed by agencies to assess water quality, with the results of the analysis presented in Table 5.3.

- **Hilsenhoff biotic Index (HBI):** These picked samples were entered into the OSAP *HabProgs* database program to calculate the Hilsenhoff Biotic Index (HBI) for the watercourse. This value then correlates to one of the seven water quality categories. HBI is calculated using scores based on the benthic macroinvertebrates tolerance to organic and toxic pollutants. A lower score indicates a lower tolerance to organic pollution and a higher score indicates increased tolerance to organic pollution (Clayton, *et al*., 2004; Mandaville, 2002; Moring, 2001; Ourso, 2001).

    - HBI and the corresponding water quality conditions are described as:
        - 0.00-3.50 Excellent: No apparent organic pollution
        - 3.51-4.50 Very Good: Possible slight organic pollution
        - 4.51-5.50 Good: Some organic pollution
        - 5.51-6.50 Fair: Fairly significant organic pollution
        - 6.51-7.50 Fairly Poor: Significant organic pollution
        - 7.51-8.50 Poor: Very significant organic pollution
        - 8.51-10.00 Very poor: Severe organic pollution

- **Percent Tolerant Taxa:** A greater abundance of taxa tolerant to impacts typically indicates poor water quality conditions.

- **Percent EPT**: Species that belong to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT) are considered sensitive to pollution and will have higher percentages in healthier streams.

- **Percent Dominant Taxa:** A benthic macroinvertebrate community that is largely dominated by a single species (>20%) indicates poor water quality as a stream that is under environmental stress will have a benthic macroinvertebrate community that is less diverse.

- **Percent Chironomidae:** Benthic macroinvertebrates that belong to the Chironomidae (midge) family are generally considered to have increased tolerance to pollution and will therefore, have increased abundance in streams with poor water quality and a high abundance indicates degraded conditions.

- **Simpson's Diversity Index:** A community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as

well as the relative abundance of each species. As species richness and evenness increase, so does diversity. The value ranges between 0 and 1, with 1 representing infinite diversity and 0 representing no diversity.

Table 5.3 – 2009 Benthic Macroinvertebrate Community Assessment Results

Metric	Reach 14W-11A	Reach 14W-16 (upstream station)	Reach 14W-16 (downstream station)
HBI	6.70 – Fairly Poor	7.36 – Fairly Poor	7.86 – Poor
% Tolerant Taxa	88.5%	97.1%	98.8%
% EPT	1.9%	0.0%	0.0%
% Dominant Taxa	51.0%	42.6%	92.0%
% Chironomidae	51.0%	37.3%	2.8%
Simpson's Diversity Index	0.70	0.67	0.15

Results of the benthic macroinvertebrate community analysis indicate Fairly Poor to Poor water quality throughout the study reach according to the HBI. All of the sites had high proportions of taxa tolerant to human impacts (i.e. Chironomidae, Isopoda), and relatively no representatives of sensitive taxa Ephemeroptera, Plecoptera or Trichoptera (EPT). The Simpson's Diversity Index ranged from 0.15 to 0.70 throughout the study sites, as a good proportion of each community was composed by one or two taxa. The benthic macroinvertebrate community suggests aquatic habitat influence by the adjacent land use including impacts to habitat (i.e. homogeneous altered habitat) and water quality.

5.3.4.3 Water Quality Parameters

Water quality parameters within the Fourteen Mile Creek tributaries were documented during fish community and benthic macroinvertebrate community sampling as a component of the protocols used (OSAP, OBBN). Additional monitoring was also undertaken to comply with the conditions set forth by the Mediation for the North Oakville Subwatershed Study (NOCSS, 2004) to establish baseline targets for future monitoring of water temperature and DO. Water quality parameters sampled included hourly temperature monitoring using water temperature loggers that were left in place from May to October 2009 and bi-monthly monitoring of temperature, DO, conductivity, TDS and pH using hand held units. The data obtained was analyzed to determine thermal regime, thermal stability and average levels of DO. Additional monitoring of Reach 14W-14A was undertaken at the request of CH to further characterize habitat conditions throughout the Farm Pond (Reach 14W-14A). Monitoring occurred between July and October 2011 and included water clarity sampling in addition to parameters described above for the 2009 monitoring (Appendix 5.6).

Water Temperature

Water temperature monitoring was undertaken in stream reaches from late spring (May 2009), through to early fall (October 2009) in order to identify baseline levels for future monitoring requirements. The data recorded was used to determine the existing thermal regime and stability within the reaches. Temperature data was obtained through the use of temperature loggers set to record water temperature every hour. These temperature loggers were downloaded every two weeks to ensure that the site maintained sufficient water to completely submerge the sensor and to allow staff to record water quality data at the same location. The temperature logger placed in the section of Reach 14W-12A located to the north of the Farm Pond (Reach

14W-14A) was removed on June 10, 2009 due to a lack of water in the channel. The logger was not reinstalled as water levels did not reach sufficient levels within the channel to submerge the device. As such, water temperature was only recorded when water was present during bi-monthly site visits.

A summary of the water temperature data recorded in the reaches is presented in Table 5.4, with monthly temperature data and graphing presented in greater detail in Appendix 5.6. The temperature data was assessed using the protocol set forth in the *Ontario Stream Assessment Protocol* (OSAP) (Stanfield, 2005) and *A Thermal Habitat Classification for Lower Michigan Rivers* (Wehrly *et al*., 1999). The average weekly maximum and minimum water temperature was calculated for each of the first three weeks in July. This data was then used to calculate the average weekly temperature fluctuation for the reach. The reaches were placed into one of three thermal regimes described by the MNRF; coldwater (average maximum summer water temperature from 10°C to 18°C), coolwater (18°C to 25°C) or warmwater (25°C or warmer). Based upon water temperature fluctuations described in Wehrly *et al*. (1999), the reaches were then placed into one of three thermal categories; stable (<5°C), moderately stable (5°C to 10°C) and extreme (> 10°C) (MNR, 2004; Stanfield, 2005; Wehrly *et al*., 1999).

Table 5.4 – Summary of Water Temperature Data July (2009)

Tributary	July Weekly Max	July Weekly Min	July Weekly Average Fluctuation	Thermal Category	Thermal Stability
Reach 14W-11[6]	25.1	11.6	13.5	Warmwater	Extreme
Reach 14W-12 downstream limit	27.2	12.5	14.7	Warmwater	Extreme
Reach 14W-16	24.3	14.8	9.5	Coolwater	Moderately Stable

Through consultation with CH, the water temperature data was analyzed using methods identified in Evaluation of a Simple Method to Classify the Thermal Characteristics of Streams Using a Nomogram of Daily Maximum Air and Water Temperature (Chu et *al*., 2009). Following consultation with CH, the temperature recorded at 4pm was selected as the maximum water temperature for the comparison which is consistent with the study that indicated that water temperature recorded between 4pm and 6pm represent the time during which water temperatures are most likely to be at their maximum. The resulting graph of temperature comparisons provided a tool to determine if the water temperature could be characterized as coldwater, cool-coldwater, coolwater, cool-warmwater or warmwater. The preferred nomogram used by CH staff for this purpose is Figure 7 on pg. 1615 of the published study (Chu et *al*., 2009). The approximate temperature ranges for the thermal classifications are summarized in Table 6 in the Technical Memorandum – NH#1 (Appendix 5.9). For the purposes of comparing the results of the two thermal methodologies, the 2009 data was plotted and evaluated using the Chu et al. (2009) method. The graph is included in Appendix 5.6 and the temperature calculations based on the linear trendline equation are summarized in Table 5.5 below.

It is important to note that although efforts were made to document the thermal regime in Reach 14W-12A, it was dry during the summer low flow periods. As a result, the aforementioned analysis of thermal classification and stability could not be undertaken.

[6] The logger was imbedded in saturated fine substrate material on July 8, 2009.

Analysis of the temperature fluctuations for the sampling period between May 12, 2009 and October 30, 2009 using the Wehrly *et al.* (1999) method suggests that the water temperature within the reaches fluctuates greatly in response to elevated air temperatures and rain events (Appendix 5.6). In most cases, water is not retained within the reaches throughout the summer. These factors suggest that the reaches receive insufficient groundwater inputs to maintain base flow, let alone a stable coolwater/coldwater thermal regime. The results of the Wehrly *et al.* (1999) method for thermal categorization are supported by the results obtained using the Chu *et al.* (2009) method. Furthermore, both methods indicate that the water temperatures within the reaches are influenced by air temperature, such that: at cooler air temperatures habitat within the stream reaches is indicative of coolwater habitat, which then changes to resemble that of warmwater habitats at higher air temperatures.

Table 5.5 – Summary of Water Temperature Data Analysis (2009), Chu *et al.* Method

Tributary	Linear Trendline Equation @ 24 ºC	Linear Trendline Equation @ 36 ºC	Thermal Category
Reach 14W-11[7]	19.07	27.78	Coolwater to warmwater
Reach 14W-12 downstream limit	19.89	28.47	Coolwater to warmwater
Reach 14W-16	19.57	27.37	Coolwater to warmwater
Reach 14W-14A (Farm Pond) (2011) Summary Range (bottom to top)	21.79 to 25.28	20.38 to 30.13	Coolwater to warmwater

Water temperature monitoring in the Farm Pond (Reach 14W-14A) was carried out in 2011 and documented in the Technical Memorandum – NH#1 included in the Appendix 5.9. A summary of the temperature ranges is provided in Table 5.5 above. The water temperatures in the pond are consistently higher than stream reaches. An exception is noted with respect to temperatures recorded at the deepest portion of the pond. At first glance, the temperatures recorded at the deepest logger would seem to suggest that the water temperatures at the bottom of the pond have a negative correlation to air temperature and therefore could be influenced by groundwater. This is not the case for the following reason. The temperature data at the deepest logger conflicts with the hydrogeological data collected during the same time frame, which indicates that the pond levels were always higher than the groundwater levels recorded at the surrounding monitoring wells, thus meaning that water from the pond seeps into the ground and therefore cannot receive groundwater discharge at this location. The hydrogeological monitoring data also showed that the pond level declined by about 0.5 m from the beginning of July to the end of September 2011, the period in which the pond temperature monitoring took place.

[7] Given the condition of the logger upon retrieval on July 8, 2009, compared to others in the pond during the same time, it appears that it was imbedded in the substrate and was recording sediment temperature rather than collecting water temperature data.

Dissolved Oxygen

DO levels in each of the reaches were recorded bi-monthly, at the temperature logger location, when water was present in the channel as shown in Figure 5.4 with the data are summarized in Table 5.6 (below).

The OMB *Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets* (July 12, 2007) sets specific targets for DO based on current in-stream conditions, keeping in mind that current conditions may exceed the target levels. For Fourteen Mile Creek, the conservative DO target is 6 mg/l, which is the Provincial Water Quality Objective for coldwater fisheries associated with a water temperature of 20ºC. During 2011 monitoring efforts in Reach 14W-14A, dissolved oxygen readings were collected at various depths in the Farm Pond in August. As expected and likely due to surface agitation, the DO levels in the pond at the surface meet or exceed the OMB target. As the depth increases, the DO levels continue to drop with DO levels at depths of 2.0 m or greater below the OMB target of 6 mg/l associated with recorded water temperatures between 20ºC and 24.3ºC. This distribution of DO is not unexpected considering the shallow depth of the Farm Pond and the likelihood of mixing. The reduced DO in the deeper area is likely attributed to less mixing and bacteria activity in the sediment. There may be periods throughout the year when dissolved oxygen levels may rise in the pond, when algae and/or aquatic plants in the pond receive sufficient exposure to sunlight to produce greater amounts of oxygen during photosynthesis.

Table 5.6 - Dissolved Oxygen Monitoring Summary (mg/l)

Date	Reach			
2009	14W-11A	14W-16	14W-12A	14W-12
May 12	10.31	14.00	-	-
May 28	7.28	8.62	3.38	7.57
June 11	4.58	10.82	-	5.67
June 26	5.30	8.58	-	5.20
July 8	-	6.35	-	5.40
July 30	7.65	7.89	-	7.77
August 28	5.98	7.95	-	7.28
September 10	-	7.50	-	4.88
September 30	8.40	8.89	-	7.25
October 19	6.14	9.95	-	8.93
October 30	7.11	9.35	6.70	8.43
Average	6.97	9.08	5.04	6.84
Max	10.31	14.00	6.70	8.93
Min	4.58	6.35	3.38	4.88

Based on the average recorded DO levels in four reaches within the Subject Property, three out of four reaches exceed the DO target under current conditions. Flow conditions in Reach 14W-12A limited the number of sampling opportunities; therefore, average DO levels may not be representative of conditions when flow is present in this reach.

5.3.4.4 Aquatic Habitat

The tributaries to this branch of Fourteen Mile Creek originate north of Highway 407 in areas dominated by agricultural fields and large forest blocks. According to NOCSS, as these headwater systems flow through the Subject Property, they flow through agricultural fields (Reach 14W-13, Reach 14W-14 and Reach 14W-16) and consists of primarily terrestrial vegetation and isolated pools with the majority demonstrating signs of straightening and agricultural influences. The channel substrate consists of silt and muck within undefined sections while those scattered sections of defined channel consist of coarse substrate. In both conditions, the channels exhibit little meander and minimal to no buffer (i.e. 1 metre or less grassed riparian buffer). The only reaches within the West Branch of Fourteen Mile Creek to have extended sections with a defined channel are Reach 14W-12 and Reach 14W-16. In the lower section of Reach 14W-12 near Dundas Street, the aquatic habitat substantially improves with the presence of riffle, pool, boulder, undercut banks and woody debris providing shelter and food for a diverse fish community. Redside Dace were sampled at this location (NOCSS Characterization Report, 2006).

Two constructed ponds are also located within the Subject Property, identified as Farm Pond (Reach 14W-14A) and a seasonally offline pond associated with 14W-16 (Pond 1/Dug Pond). Based on historic aerial photography and information presented in NOCSS, both ponds appear to have been constructed between 1954 and 1960 and have some form of seasonal connection/contribution to adjacent reaches (Section 6.0). Anecdotal information from the current farmer indicated that the Farm Pond (Reach 14W-14A) had been constructed in 1954, just prior to Hurricane Hazel as the berm impounding water was washed away and had to be rebuilt.

The flow regime of the reaches within the Subject Property are principally intermittent with habitat during summer months restricted to areas of pool refuge. The flow contributions to these reaches consist principally of surface water contributions associated with precipitation events and the spring freshet. Generally, the surficial till found throughout the study area serves to limit infiltration to both the shallow and deep groundwater systems and, as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff.

Groundwater contributions do contribute flow to these reaches to a lesser extent; however, due to the low permeability of the soil, this contribution is limited. The majority of the groundwater inputs to the local reaches are considered to flow laterally through the upper, weathered zone of the till resulting in almost 100% of the groundwater contribution occurring primarily from November to May. This enhanced permeability of this weathered till layer permits the shallow groundwater to travel somewhat quickly through the weathered zone towards the reaches. Due to this enhanced conductivity, approximately 90% of the infiltrating groundwater moves horizontally through the shallow system, and provides a source of flow to the local reaches during the late fall to late spring. During the growing season this shallow groundwater infiltration ceases (there is a water deficit and plants are active and using up water), the shallow system drains, and the reaches become dry (Section 4.0).

Towards the southern portion of watershed FM1001, the reach valleys approach the underlying Queenston Shale bedrock, which is exposed at surface just before it passes under Dundas Street. Minor groundwater inputs from the deeper bedrock groundwater are interpreted to take place in Reaches 14W-12 and Reach 14W-14. In the case of Reach 14W-14, these inputs are interpreted to continue up to a point roughly where this watercourse passes under Highway 407. The seasonal groundwater elevation changes within the bedrock are not as highly variable as in the surficial tills, and thus its contribution of groundwater towards

these two reaches is considered to continue throughout the year. However, the volumetric rate of water moving towards these two reaches is low, and during the summer months, is insufficient to provide enough water to maintain flow in these reaches, particularly, from about the mid-point of the Subject Property and to the north, where the channels have been observed in a dry state during the summer period. Over the lower sections of the main channel there may be greater opportunity for groundwater to maintain refuge pools due to these minor contributions and shade provided by the adjacent large trees/culvert. These refuge pools were observed in Reach 14W-12 at the Dundas Street culvert inlet and upstream at a farm road culvert crossing.

Below is a brief description of the aquatic habitat found on the Subject Property that was documented during field investigations (Appendix 5.7). The data obtained for aquatic habitat on the Subject Property during detailed field investigations is supplemented with site reconnaissance data for the aquatic habitat beyond the limits of the Subject Property documented at the "subcatchment level of detail" identified in the EIR ToR. This supplemental data was generally limited to observations from road crossings and a review of available aerial photography due to landowner access limitations. This information is presented below in association with the detailed data to provide context to the aquatic habitat found on-site. For contextual purposes the following description of aquatic habitat presents the information in an upstream to downstream orientation rather than following the numerical nomenclature of the reaches.

Reach 14W-11A

This watercourse associated with this reach appears to originate north of Burnhamthorpe Road as an online pond. Flow discharging from this pond flows to the south under Burnhamthorpe Road and continues as Reach 14W-20A (reach not identified on figures) downstream through a large woodlot considered a component of the Candidate Oakville-Milton Wetlands and Uplands ANSI. The channel through this reach appears to consist of a combination of wetland habitat (i.e. meadow marsh), an online pond associated with residences fronting onto Burnhamthorpe Road and a defined channel through the forested habitat. Approximately 425 m south of Burnhamthorpe Road, Reach 14W-20A transitions into Reach 14W-19 (reach not identified on figures) and consists of a channel with greater meandering. Reach 14W-19 continues in this meandering form until it approaches Highway 407. A 35 m section of this reach immediately adjacent to the highway has been realigned parallel to Highway 407 prior to flowing into the highway culvert that is approximately 100 m long. Fish observed downstream of the Highway 407 crossing are unlikely to access habitat upstream due to the lack of permanent flow and barriers to fish movement created by a rock apron at the culvert inlet, as well as, a vertical drop of approximately 0.50 m located within the realigned section of the channel.

As the watercourse enters the Subject Property it is considered Reach 14W-11A and is considered a Medium Constraint Corridor that discharges into a High-Constraint Corridor–Requiring Rehabilitation (Reach 14W-11) as identified in Figure 5.4. The watercourse enters the property as it discharges from the Highway 407 culvert located in a small remnant stand of trees that were historically linked to the wooded area north of the highway. Immediately downstream of the culvert the channel is poorly defined with isolated areas of standing water and diffuse flow through a densely vegetated straightened channel. The stream morphology is uniform throughout the straightened channel with primarily silt and clay substrates. Pooled water was observed approximately 225 m downstream of the Highway 407 culvert in an area where farm equipment traverses the watercourse creating rutting and resulting in a wide shallow pooled area. Along the channel the vegetation community is wetland and given its context, this wetland meets the criteria for classification as a Hydrologic Feature 'A'.

Reach 14W-11

This reach is considered High-Constraint Corridor–Requiring Rehabilitation, eventually discharging into Reach 14W-1A (reach not identified on figure), a High Constraint Corridor. It is an intermittent watercourse with flows observed during the spring and following precipitation events. Habitat diversity improves slightly within the wooded area due to the localized presence of woody debris, potentially providing cover and altering flow paths to create pools. This reach is a poorly defined feature with saturated soils and surface water in isolated pools observed during field investigations. The isolated pools are likely associated with precipitation event or seasonal spring flows as the hydrogeology indicates that the watercourse is losing water to the ground. Downstream of the wooded area, Reach 14W-11 offers poor habitat diversity, lacking a defined channel or pools, as it continues beyond the property limits.

Reach 14W-13

The headwaters of Reach 14W-13 appear to originate west of Highway 407 within subcatchment FM1004. Flow upstream of Highway 407 appear to principally consist of highway drainage and surface runoff from the westbound Truck Inspection Station and adjacent lands that is conveyed under Highway 407 via a culvert approximately 115 m in length onto the Subject Property. Due to the rock material at the culvert inlet, lack of a defined natural channel and the absence of fish habitat downstream of Highway 407 on the Subject Property the headwaters of Reach 14W-13 is considered to principally provide surface water flow contributions.

According to NOCSS, Reach 14W-13 is not considered to provide aquatic habitat. Field investigations confirm that this reach does not appear to provide direct fish habitat with contributions to downstream fish habitat principally associated with intermittent flow contributions. Downstream of the Highway 407 culvert outlet, the reach flows through a straightened channel with earthen berms that define the banks. Where water was observed during the spring field investigations, it was in isolated pockets over saturated soils that were heavily vegetated, as well as, in areas of pooled water in tire ruts associated with farm equipment crossings. Similar to Reach 14W-11, the hydrogeology of this reach is interpreted to lose water to the ground and as a result, the pools are likely associated with surface water contributions. Fine substrate materials, composed of clay, sand and organic material provides limited diversity within the channel. The limited canopy cover consisted of individual trees at two locations along the observed flow path. These observations of the type of habitat present were consistent with those made in 2001 background documentation.

Reach 14W-14

The headwaters of this reach originates north of Highway 407 at Burnhamthorpe Road West as a series of agricultural swales. As it flows south of Burnhamthorpe Road it is identified as Reach 14W-15 (reach not identified on figure) and is considered to be a swale conveying flow easterly through active agricultural fields within subcatchment FM 1003b as identified in NOCSS. Reach 14W-15 is characterized as a poorly defined braided channel that flows through a 7 m wide naturally vegetated riparian corridor, bounded by active crop fields on both sides. It enters the truck inspection station ROW at the southwestern end as a series of small braided channels that range in width from 0.15 m to 0.30 m. Within the ROW, water has collected in a pool approximately 0.25 m deep and 0.88 m wide, which receives input from the roadside drainage associated with the truck inspection station and Highway 407. The combined flow is conveyed through three parallel corrugated steel pipe (CSP) culverts approximately 135 m long that cross Highway 407 and discharge flow to stream Reach 14W-14 associated with the Subject Property. Reach 14W-15 appears to be intermittent

as there was no observed flow within the braided channels at the time of field investigations in August 2009. When flow is present, Reach 14W-15 has the potential to provide direct fish habitat to fish documented downstream of Highway 407 in stream Reach 14W-14: however, this habitat is likely limited to the culvert inlet pool due to the absence of channel form and structure located further upstream.

As the channel enters the Subject Property it is identified as Reach 14W-14. The reach immediately downstream of the highway culverts consists of an area of open water with silt substrates as observed in May 2009. This pooled habitat likely originated by the scouring of water discharging from the culvert. The most significant feature of this reach is this culvert outlet pool which functions as refuge habitat for fish species where fish were observed during spring sampling and habitat mapping events. Connection with downstream habitat is seasonally limited to the spring freshet and rain events. It is during these periods that sufficient water may permit temporary access for fish to this refuge habitat. Although the presence of collected water at the culvert outlet may provide periodic refuge habitat during periods of low flow, it is anticipated that the shallow pool would go dry during extended periods without precipitation.

The reach through the Subject Property flows between two active agricultural fields. Approximately half of Reach 14W-14 consists of a combination of defined and undefined flow through meadow marsh habitat (Hydrologic Feature 'A') including its confluence with Reach 14W-13 and downstream to discharging into Reach 14W-12A. The wetland boundary as determine in NOCSS for Hydrologic Feature 'A' has increased in size as noted above. The defined section consists of a narrow and shallow defined channel through dense meadow marsh and cultural meadow vegetation. During field investigations in early May 2009, the channel consisted of saturated soils with dense vegetation that would create pockets of water. This type of habitat was also observed in 2001 background documents. The reach is considered to be intermittent as the channel was predominantly dry throughout the 2009 water quality monitoring period and as documented in 2001 background reports. There is no canopy cover along the entire reach between Highway 407 and the confluence with Reach 14W-13. The only trees present are located along the sparse hedgerow at the upper limit of the reach, south of the highway.

Reach 14W-14A (Farm Pond)

Reach 14W-14A consists of an excavated Farm Pond (Hydrologic Feature 'A') that appears to have been constructed between 1954 and 1960, likely for irrigation purposes. The construction of the pond appears to have resulted in the reconfiguration of the drainage channels on-site to allow for the pond to receive/discharge flow and divert the main channel around the new pond feature. The wetland boundary of the pond as determine in NOCSS for Hydrologic Feature 'A' has increased in size since its original assessment. The pond appears to have been originally constructed in a low-lying area in Reach 14W-14 in which flow from this low area would have likely continued downstream and join with Reach 14W-12 prior to flowing as a single channel under Dundas Street. Based on water surface elevations and groundwater elevation data, this pond appears to be maintained from surface runoff rather than groundwater contributions.

The construction of this pond resulted in flow from Reach 14W-13 and Reach 14W-14 being directed into the pond. Currently, flow enters and discharges from the pond at the same location with discharge only occurring when water levels in the pond reach a certain elevation. This pond is approximately 9,600 m^2 (240 m long x 40 m wide on average) with the shoreline habitat of the pond consisting of cattails, stumps and woody debris with an area of cobbles/concrete debris along the southern shore along the farm road. The substrate within the pond is primarily composed of fine silts, sand and muck. Additional surveys and monitoring of habitat in this pond was undertaken in 2011 to satisfy comments received from CH (September 6, 2011). The results

of this monitoring and additional documentation of this feature are detailed in the Technical Memorandum NH#1 (Appendix 5.9).

This pond supports Largemouth Bass, a top-level predator species requiring a substantive forage base. Detailed thermal datum was collected in 2011 to characterize the stratified thermal regime in the pond and to determine if the water temperatures are influenced through groundwater inputs. Detailed graphs and calculations are presented in the Technical Memorandum NH#1 (Appendix 5.9). The results of temperature monitoring when evaluated in conjunction with the hydrogeological monitoring results, indicate that the pond is not influenced by groundwater. The pond primarily functions as warmwater habitat, which discharges warmwater to downstream Reach 14W-12 via Reach 14W-12A during storm events.

Reach 14W-16

The headwaters of this reach originate north of Burnhamthorpe Road, west of Tremaine Road and receives drainage from a combination of agricultural lands, railway and roadway runoff. It also receives pumped water from the Hanson Brick Quarry located north of Highway 407. According to Golder Associates (2009), in the year 2008, approximately 44,500,000 litres of water was pumped from the quarry into the headwaters, via a settling pond, at an average rate of 1,078 litres/ minute. This is equivalent to an average of about 13 hours discharge per week, which would not be noticeable during fall to spring conditions, but which would lead to additional water to this reach during the summer period when flows are intermittent.

This upstream reach located from the northeast quadrant of the Highway 407/Tremaine Road intersection is identified as Reach 14W-17 (reach not identified on figures) and generally consists of field drainage within subcatchment FM1002. This reach has been modified by planting of crops through the apparent flow path and likely functions primarily as an agricultural swale. Downstream of Highway 407, flow is conveyed through an old field meadow where it becomes Reach 14W-16 prior to entering the Subject Property. In the absence of barriers to fish passage upstream of the limits of the Subject Property to Tremaine Road, this stream reach potentially functions as intermittent direct fish habitat.

Approximately 225 m downstream of Highway 407, Reach 14W-17 ends and is identified as Reach 14W-16 prior to entering the Subject Property. Reach 14W-16 at the western limits of the Subject Property flows intermittently through dense vegetation within a moderately defined channel with a substrate consisting predominately of clay, with silt, interspersed with gravel and sand. The width of the active channel is 1.4 m and the average depth of water is 0.18 m as observed during OSAP investigations. Although this section of the watercourse lacks canopy cover, this reach retains shallow isolated pools that are well shaded by dense overhanging vegetation.

As the channel continues downstream it becomes more defined in the vicinity of Pond 1 (Dug Pond) associated with this reach. With the substrate consisting of coarser material including gravel, cobbles and boulders set in clay and overtopped with silt in this area. The width of the active channel is 0.88 m with an average water depth of 0.20 m as observed during OSAP investigations. The habitat diversity also improves downstream consisting of riffle and pool sequences with deeper pool habitat located at two existing crossings. The active channel is well defined and during periods of low flow water is contained within the channel; however, during periods of moderate to high flows (i.e. spring and heavy rains), water overtops the banks and flows through braided channels located adjacent to the main channel and separated by vegetated hummocks. The floodplain is defined in the downstream section by a steeply sloped valley. This section receives overflow from the small agricultural Pond 1 (Dug Pond) that discharges into the upper part of this

reach. Algae growth within this reach was observed to initiate in late spring and increase through the summer with dense growth that would cover the entire channel. This growth is may be due to the nutrient contributions associated with active agriculture upstream and on-site. This channel did not have flow during field investigations on June 11, 2009 with habitat limited to isolated pools. Flow was only observed in response to precipitation events during subsequent field investigations. Along the channel, there is an existing wetland classified as a Hydrologic Feature 'A' under NOCSS. However, since NOCSS's assessment, another wetland was noted during field investigations and given its context, this wetland meets the criteria for classification as a Hydrologic Feature 'A'.

Pond 1 (Dug Pond) located to the west of this reach is approximately 700 m^2 (35 m long x 20 m wide). As previously indicated, historic aerial photography and information presented in NOCSS indicates that the pond is a constructed feature excavated between 1954 and 1960. This is supported by the relatively uniform habitat present in the pond consisting of steeply sloped banks and rectangular shape. The main in-water cover habitat feature associated with the pond consists of dense algae growth. During field investigations the Largemouth Bass were observed in areas of open water not occupied by the algae mats. Water temperature data recorded during July 8, 2009 field investigations was 26°C, indicating warmwater habitat.

Pond 1 (Dug Pond), which is not identified on mapping, receives flow inputs from a shallow agricultural swale from the agricultural lands to the west. These lands are ploughed during the growing season. Flow discharges from the east end of the pond to Reach 14W-16 via an intermittent channel. This channel appears to have been created naturally by the pond's overflow as indicated by its meandering and heterogeneous form. It continues as a relatively steeply sloped channel that in combination with intermittent flows would likely restrict fish passage seasonally. As previously indicated, this pond may function as direct fish habitat regulated under the federal FA (1985); however, as it is a constructed feature with a poor connection to downstream fish habitat and consisting largely of stocked fish, it likely functions primarily as a Hydrologic Feature 'B' within the floodplain based on mapping in the NOCSS.

Reach 14W-12

This reach is classified as a High Constraint Stream, likely due to its direct support of Redside Dace. According to Section 4W.8.5 of the NOCSS Characterization Report (2006), the upstream limit of Reach 14W-12 consists of a poorly defined swale that transitions to a defined channel immediately upstream of Dundas Street with channel disturbances consisting of the Dundas Street crossing, concrete revetments and farm crossings. The surrounding land use consists of agricultural and livestock grazing, with livestock noted as having access to the stream. The primary geomorphic processes influencing this reach were aggradation and widening. Fallen and leaning trees, exposed tree roots, poorly formed bars, siltation in pools and riffles and accretion on point bars were noted at the site.

Field investigations confirm the presence of the swale component of this reach (renamed Reach 14W-12A) described in NOCSS with its location along a section of the channel located to the north of Reach 14W-14A (Farm Pond). As the channel continues downstream and turns to the south joining with Reach 14W-16, a distinct change from a swale to a defined channel is noted. The section of Reach 14W-12 downstream of this connection point is very different in form and function and, as a result, for the purposes of this report the section of Reach 14W-12 located to the north of Reach 14W-14A (Farm Pond) has informally been identified as Reach 14W-12A and described below separately from the remainder of Reach 14A-12.

Reach 14W-12 is considered to be morphologically and functionally similar to the lower section of Reach 14W-16 with a defined low-flow channel and sections with braided channels through vegetated hummocks. The habitat is provided by pools connected by short shallow riffle segments. The riffle habitat is characterized by gravel and cobbles over clay and a wetted width of approximately 0.80 m and depth ranging from 0.10 m and 0.28 m, when flow was observed. The pool substrate consists of clay overtopped by silt with the water depth ranging from 0.23 cm to 0.31 m during low flow conditions. Dense algae growth observed in Reach 14W-16 extends downstream through the upper section of this reach.

A pool approximately 0.60 m deep has formed at an existing farm road crossing located approximately 200 m upstream of Dundas Street. During each site visit, this feature was observed to function as refuge habitat for fish during low flow as the channel immediately upstream and downstream were dry and fish were sampled in this pool. Downstream of the field crossing the stream flows within a single defined channel characterized by riffle and pool sequences. The substrate associated with riffle habitat consists of exposed shale bedrock, fragmented shale and till with substrate in pool habitat consisting of silt overtop of the same substrate. The in-water cover habitat is similar to upstream sections with an increase in woody material associated with the adjacent willow trees in the riparian zone.

The final 50 m of this reach prior to flowing under Dundas Street has been altered though the lining of the watercourse banks with concrete retaining walls. This in combination with the substrate consisting largely of exposed shale bedrock results in a hardened channel with little morphological diversity. As the channel approaches the culvert a pool has formed at the inlet, perhaps due to the continued scouring of the area as flow is directed into the channel at a right angle. Similar to the refuge pool identified upstream during previous field investigations, this pool, as well as, the remainder of this hardened reach extending upstream provides refuge habitat in the summer and was the location of Redside Dace captured in 2001 noted in background documentation. As previously indicated the substrate in this reach consists largely of exposed bedrock; however, due to the collapse of the decorative façade of the retaining wall into the creek there are large cobble/boulder size blocks present.

The culvert is concrete lined and appears to consist of a series of extensions that were installed to accommodate road widening as indicated by the zigzag structure and difference in elevations between extensions. During periods of low flow, water is directed to the edges of the culvert as the middle of the culvert is slightly elevated. The culvert does not appear to provide fish passage as its base consists of exposed concrete that results in sheet flow over a smooth surface. Furthermore, there were two vertical drops observed within the culvert including an approximate 0.15 m drop within the culvert associated with a culvert extension and the culvert outlet, which is perched approximately 0.15 m based on observations during Spring 2009 field investigations.

Reach 14W-12A

Reach 14W-12A is approximately 125 m long and conveys flow and surface runoff from Reach 14W-13, Reach 14W-14 and Reach 14W-14A. Background data indicates that the drainage network underwent a significant alteration between 1954 and 1960 resulting most notably in the construction of Reach 14W-14A (Farm Pond) and the reconfiguration of the existing network to convey flows to the west of the newly constructed pond. As previously indicated, the individual currently farming the land has indicated that the Farm Pond was constructed in the fall of 1954. This reconfiguration resulted in the construction of Reach 14W-12A (a channel that was not previously part of the drainage network) to direct flow to Reach 14W-12.

Reach 14W-12A is a constructed feature associated with the constructed Farm Pond (14W-14A). It flows through a trapezoidal valley that contains a short section (approximately 40 m long) of a narrow incised channel located between dense cattail growth originating at the Farm Pond (Reach 14W-14A) inlet/outlet and at the convergence of Reach 14W-12A with Reach 14W-112 and Reach 14W-16. The incised channel receives diffuse flow through cattails at the outlet of the Farm Pond (Reach 14W-14A) and extends for approximately 40 m. It has been noted in repeated site visits between 2009 and 2011 that the cattail community originating at the outlet of 14W-14A (Farm Pond) continues to expand, further encroaching downstream within Reach of 14W-12A. During December 2010 site reconnaissance, flow was observed within a wetted channel width of 0.60 m and depth of 0.09 m with a small pooled area (0.23 m deep). During field investigations in June 2009, there was insufficient water to maintain flow with available aquatic habitat consisting of shallow areas of standing water. A temperature logger installed in May 2009 to record water temperature in this reach was removed on June 11, 2009 due to a lack of water. Although the dense substrate remained damp, there is insufficient surface water and groundwater contributions to maintain base flow in this reach.

This reach may provide direct seasonal fish habitat, when water is present and there is connectivity past the dense cattail growth at the confluence with Reach 14W-12/Reach 14W-16 and the Farm Pond (Reach 14W-14A). Notwithstanding the potential connectivity when there is water present, its constructed nature and limited habitat diversity would limit its function as fish habitat.

To obtain a greater understanding of the function of Reach 14W-12A as potential direct fish habitat and contributing habitat, a spring field investigation was undertaken on April 4, 2017. The timing of this investigation followed the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines Approved July 2013* (CVC/TRCA, Finalized January 2014). During this site investigation, Reach 14W-12A had a wetted width of 2.05 m and an average water depth of 0.14 m within the section with the narrow incised channel with a narrower wetted width and deeper depths in the section with the dense cattails at the confluence with Reach 14W-12. Flow was present, but was minimal and was being conveyed from Reach 14W-13 and Reach 14W-14. No flow was observed flowing out of Reach 14W-14A. Fish community sampling was undertaken by dip netting within the incised channel, but did not result in the capture of any fish; potentially due to the dense cattails that would likely impede fish passage at the upstream and downstream limits of Reach 14W-12A.

However, a second spring field investigation on May 10, 2017 after period of wet weather was undertaken. During this visit, the water level in all reaches were elevated above the April observations with increased depths and wetted widths in Reach 14W-12A. Furthermore, flow was observed outleting into Reach 14W-12A from the Farm Pond. The flow from Reach 14W-12A into Reach 14W-12 was of a large enough (volume/depth), that fish passage from downstream into Reach 14W-12A through the dense cattails may have been possible. This observation confirms that a seasonal connection between Reach 14W-12 and Reach 14W-12A does occur, although is likely seasonally dependent on large precipitation events.

Although the function of Reach 14W-12A as seasonal direct fish habitat could not be confirmed, it does provide a function to convey flow along with drift materials/allochthonous inputs to downstream direct fish habitat consisting of Occupied Redside Dace habitat during a critical period in the fish's lifecycle.

5.3.5 Vegetation Resources

5.3.5.1 Vegetation Approach

A three (3) season botanical inventory and assessment of the Subject Property was conducted between 2009 and 2010, with additional surveys completed for verification and soil auger samples in 2014. Soil augers were done in accordance with ELC methodology with reference to the Field Manual for Describing Soils (Ontario Centre for Soil Resource Evaluation, 1993). In 2009, surveys on the Subject Property were completed on August 20 and 21 and off-site subcatchment surveys (as described below) were completed on August 18 and September 11. In 2010, surveys on the Subject Property were completed on April 22 and July 13 and 14. In 2014, surveys were completed on September 24.

The scope of vegetation field work and analysis included the following:

- Due to the vegetation mapping efforts documented in the NOCSS, lack of Cores or Linkages present on the Subject Property and the EIR ToR requires only a preliminary field review of features, the classification, mapping and evaluation of vegetation communities within the Subject Property was carried out using a modified version of *the Ecological Land Classification* (ELC) *System for Southern Ontario* (Lee *et al.* 1998). Field datasheets are provided in Appendix 5.5.
    - The modified ELC approach facilitated the classification of vegetation communities smaller than 0.5 ha in order to capture the smaller natural features on the Subject Property.
    - This method uses additional feature names not specified in the ELC (i.e. tree cluster, pasture), which allows for a complete description of the cultural landscape features.
    - Soil auger samples were taken at representative locations in ELC communities in the proposed Open Space Area corridor (Figures 5.2, 5.5, 5.7).

- Evaluation of community significance according to Bakowsky (1996) and the NHIC database (Current July 30, 2014).

- Review of location and condition of hedgerows and tree clusters.

- Three season botanical inventory and preparation of a vascular plant list (Appendix 5.3).
    - Plant species status was evaluated using the NHIC database provincial rarity ranks (i.e. S-Ranks) (current July 30, 2014); the Species At Risk in Ontario List (current October 31, 2014) for provincial status designations under the ESA (2007); the Rare Vascular Plants of Ontario (Oldham and Brinker, 2009) for provincially rare plants, the Canadian Species At Risk Act list (updated October 21, 2014) for national status designations; and Varga *et al.* (2000) for regional status in Halton Region and Hill's Site Region 7E4.
    - Nomenclature generally follows the Ontario Plant List (Newmaster *et al.,* 1998).

- As required by the North Oakville EIR ToR, coarse level surveys of Cores and Linkages occurring in off-site portions of EIR subcatchments that overlap with the Subject Property were completed. These consisted of drive-by surveys with binoculars, supplemented by aerial photograph review.

- Though no Cores or Linkages are present on the Subject Property, Core #1 and the Linkage to Core #2 are present within off-site portions of Subcatchment FM1109, which extends onto the Subject Property.

Vegetation communities, hedgerows and tree clusters located on the Subject Property are mapped on Figure 5.2 and discussed in detail in Section 5.3.5.2, Section 5.3.5.3, Table 5.7 and Table 5.8. Vegetation communities associated with Core #1 and the Linkage to Core #2 were previously mapped and classified using ELC during the NOCSS; that mapping is presented in Appendix 5.4. These vegetation communities are described in Section 5.3.5.5.

5.3.5.2 Vegetation Overview

The majority of the Subject Property is under active agricultural production. Additional anthropogenic land uses are located along the north side of Dundas Street West; these include 2 rural residential properties, associated farm buildings, and pasture areas (Figure 5.2).

Natural and semi-natural vegetation communities are predominantly associated with a network of drainage features that generally flow from northwest to southeast across the Subject Property, but also include a small (1.27 ha) tableland woodlot, and forested stream valley. Additional vegetation features include isolated hedgerows and tree clusters. North of Dundas Street, the existing land use is predominantly rural residential/agricultural. South of Dundas, agricultural land uses are currently undergoing conversion to primarily urban residential uses.

Key findings of the floral inventory include:

- In total, 120 vascular plant species were identified on the Subject Property during field surveys, not including 3 records identified to the genus level only (Appendix 5.3). Of the 120 species identified, 40 (33%) are not native to Ontario (per NHIC SE ranks).
- No federally or provincially designated SAR or provincially rare (S1-S3 rank) plant species were recorded.

5.3.5.3 Vegetation Communities

A total of 13 vegetation community types in 5 vegetation units were identified on the Subject Property including cultural meadow, meadow marsh, shallow marsh, shallow aquatic, open aquatic, swamp thicket, deciduous swamp and deciduous forest. Hedgerows and tree-clusters are summarized in Section 5.3.5.4 and Table 5.8 of this report.

One vegetation community (Unit 5a, Dry-Fresh Oak-Hickory Deciduous Forest, FOD2-2) is provincially uncommon (S3S4, Bakowsky 1996/NHIC 2014). This unit is located outside of the development envelope and will be retained in full and protected with setbacks. All other vegetation communities identified on the Subject Property are considered common in Ontario.

Terrestrial and wetland vegetation communities were identified on the Subject Property. They are mapped on Figure 5.2 and described in Table 5.7 on the following page.

Table 5.7 – Terrestrial and Wetland Vegetation Community Summary

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
1: Farm Pond (Reach 14W-14A)	• Feature identified as Hydrologic Feature A' within NOCSS. • Reach 14W-14A • 34 species observed. • Notable species: Crested Sedge. • Feature is an online/bypass pond with a fringe of wetland vegetation. • Submerged vegetation in shallow water areas that becomes sparse as water depth increases. • The existing Hydrologic Feature 'A' portion of the Farm Pond is approximately 0.531 ha and consist of SAF1-3, OAO and SAS1-1 vegetation communities. • A new wetland has been noted surrounding the Farm Pond which has an approximate area of 0.767 ha and consist of MAS2-1 vegetation community. • All of the existing Hydrologic Feature 'A' (Farm Pond) and new wetland will be removed;	1A: Cattail Mineral Shallow Marsh (MAS2-1)	• Cattail dominated fringe along periphery of Farm Pond (Reach 14W-14A) feature. • Narrow-leaved Cattail dominates, with Purple Loosestrife, Reed Canary Grass, Broad Leaf Cattail, American Bugleweed, and Climbing Nightshade, • Interspersed with Water Plantain, Lance-leaved Aster, Queen Anne's Lace, Cutgrass, and Fox Sedge. • Overall sensitivity and botanical quality are low (low diversity, common and tolerant wetland species). • Surrounds shallow aquatic and open aquatic communities.
		1B: Duckweed Floating-leaved Shallow Aquatic (SAF1-3)	• A 2 m to 3 m wide band of duckweed surrounding the open central portion of Farm Pond (Reach 14W-14A) feature. • Dominated by Lesser Duckweed. • Community boundary likely variable within and between years due to floating nature of duckweed and the amount of algal growth in the pond throughout the year.
		1C: Open Aquatic (OAO)	• Central portion of Farm Pond (Reach 14W-14A) feature is an open water community lacking vegetation cover.
		1D: Pondweed Submerged Aquatic (SAS1-1)	• Submerged vegetation throughout the shallow areas, dominated by Pondweed (*Potamogeton sp.*) and Coontail (*Ceratophyllum sp.*) species.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
	however, CH confirmed on February 07, 2018, that the open water function of the Hydraulic Feature 'A' (Farm Pond) does not need to be replicated.		
2: Old field and riparian wetlands	• Communities 2B, 2C, 2D, 2F and 2G qualify as "Hydrologic Feature 'A'" per NOCSS because they are wetlands associated with watercourses. The area and extent of these features is greater than indicated by the NOCSS Hydrologic Features 'A' mapping (as indicated on Figure 5.1). • 63 species observed. • Notable species include Panicled Aster, Sandbar Willow, Torrey's Rush, Rice Cutgrass, Crested Sedge and Shagbark Hickory. Notable species generally associated with wetland subunits with exception of Shagbark Hickory. • Presence of Watercress (*Nasturtium officinale*)	2A: Dry-Moist Old Field Meadow (CUM1-1)	• Open old field meadow, dominated by tolerant grasses and forbs (e.g. Smooth Brome, Redtop, Common Teasel, goldenrod and aster species, Queen Anne's Lace) with some scattered clusters of tree and shrub regeneration (predominantly Shagbark Hickory, American Basswood and hawthorn). • Occasional clumps of facultative and obligate wetland species occur within drainage channels. Wetland species observed within Unit 2A include Reed Canary Grass, Woolgrass Bulrush, Torrey's Rush, Purple Loosestrife, Narrow-leaved Cattail, and Soft Rush. • Notable species: Shagbark Hickory, Torrey's Rush. • Comprises the majority of the land area within the Vegetation Unit 2 drainage feature network. Forms the matrix within which other unit 2 communities are found. Occupies slopes of shallow valleys within drainage feature network. • Anthropogenic disturbance: adjacent active agricultural use likely results in periodic disturbance (e.g. chemical spraying/vegetation dieback, grazing) and wetland boundaries likely shift from year to year depending on extent of ploughing. • Low botanical quality and health (dominated by non-native grasses and disturbance tolerant species, disturbed by adjacent agricultural activities); Low sensitivity. • Hand augured soil samples (3) taken as part of ELC mapping in this community shows mineral soil types of Clay to Silty Loam

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
	observed occasionally within drainage features. • The existing Hydrologic Feature 'A' portion of Reach 14W-14 is approximately 1.343 ha and consist of MAM2-2 vegetation community. Approximately 0.94 ha will be removed. • New wetlands have been noted in Reach 14W-14 and consist of MAS2-1 (approximately 0.027 ha) and MAM2-2 (approximately 0.681 ha) vegetation communities. All MAS2-1 and most of MAM-2-2 (approximately 0.607 ha) will be removed.		over bedrock (Queenston shale and limestone). Organics were restricted to a very thin organic litter layer (<5 cm). Augers were consistently refused at 44-62 cm depth due to hitting rock.
		2B: Reed-canary Grass Mineral Meadow Marsh (MAM2-2)	• Open meadow marsh community dominated by Reed Canary Grass. Common associates include Purple Loosestrife, Panicled Aster, *Carex* spp., Redtop and Great-hairy Willow-herb. • Occurs as several relatively large pockets on bottomlands within the drainage channel network. • Some disturbance noted: soil compaction and wheel ruts at farm equipment crossings, presence of non-native species (including invasive species). • Low to moderate botanical quality and health (relatively low species diversity, dominated by tolerant wetland species, but presence of some regionally significant species); moderate sensitivity (due to wetland classification and presence of regionally significant species). • A hand soil auger (associated with ELC) in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were restricted to a very thin organic litter layer (<1 cm), and thin organic fibric layer (5 cm). The auger was refused at 65 cm depth due to hitting rock.
		2C: Willow Mineral Thicket Swamp (SWT2-2)	• Occurs as a small inclusion within the drainage feature network. • Dominated by a dense cover of Sandbar Willow, with cattail and Reed Canary Grass dominating the understory. • Low to moderate quality and health (relatively low species diversity, dominated by tolerant wetland species, with some regionally significant species); moderate sensitivity (due to

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
			wetland characteristics and presence of regionally significant species). • A hand soil auger (associated with ELC) was not taken in this unit due to feasibility reasons (too crowded to move auger effectively)
		2D: Cattail Mineral Shallow Marsh (MAS2-1)	• Cattail dominated pockets within drainage feature network. • Narrow-leaved Cattail dominates, typical associates include Purple Loosestrife, Reed Canary Grass, Broad Leaf Cattail, American Bugleweed, and Climbing Nightshade. • Overall sensitivity and botanical quality are low (low diversity, common and tolerant wetland species). • A hand soil auger (associated with ELC) in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were present as a thin organic litter layer (5 cm), and thin organic humic layer (15 cm). This soil is a "mineral" soil. The auger was refused at 60 cm depth due to hitting rock.
		2F: Broad-leaved Sedge Mineral Meadow Marsh (MAM2-6)	• Open meadow marsh community dominated by sedges, including *Carex vulpinodea*, *Carex cristatella* and *Carex lupulina*. Common associates include Soft Rush, Panicled Aster, Woolgrass Bulrush and Torrey's Rush. • Occurs within the channel in portions of the drainage channel network. • Moderate quality and health (relatively low species diversity, dominated by tolerant wetland species, but presence of some regionally significant species); moderate sensitivity (due to wetland classification and presence of regionally significant species). • No soil auger was taken in this unit.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		2G: Forb Mineral Meadow Marsh (MAM2-10)	• Open meadow marsh community dominated by wetland asters (Panicled Aster and Purple-stemmed Aster. • Occurs as several relatively large pockets on bottomlands within the drainage channel network. • Low to moderate quality and health (relatively low species diversity, dominated by tolerant wetland species, but presence of regionally significant species); moderate sensitivity (due to wetland classification and presence of regionally significant species). • A hand soil auger (associated with ELC) in this community shows a mineral soil type of Silty Clay over bedrock (Queenston shale and limestone). Organics were restricted to an organic litter layer (10 cm). The auger was refused at 80 cm depth due to hitting rock.
3: Lowland deciduous forest	• 26 species observed. • Notable Species include Torrey's Rush, Rice Cutgrass, Panicled Aster.	3A: Fresh-Moist Willow Lowland Deciduous Forest (FOD7-3)	• A young to mid-aged Crack Willow dominated deciduous forest with sparse canopy cover. Moderate understory cover of Riverbank Grape, Thicket Creeper, Gray Dogwood, Buckthorn and Tartarian Honeysuckle. The ground layer is characterized by a mix of disturbance and sun-tolerant species, along with typical riparian species. • Drainage feature transitions to a cement bottom channel adjacent to Dundas Street, and in stream vegetation is largely absent from this portion of the reach. • Disturbance: non-native, invasive plant species are widespread and locally abundant; road noise from Dundas Street. • Moderate botanical sensitivity (several regionally significant species present) with low to moderate ecological quality and health (due to high percentage of non-native species). • No hand soil auger (associated with ELC) was taken in this unit due to its proximity to the occupied residence.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		3B: Mosaic of Mineral Cultural Meadow (CUM1) and Forb Mineral Meadow Marsh (MAM2-10)	• Small, moderately sloped mosaic of Cultural Meadow and Forb Meadow Marsh adjacent to barn. • Dominant species include Smooth Brome, Purple Loosestrife, Reed Canary Grass and goldenrod. • Low botanical sensitivity with low ecological quality and health. • No hand soil auger (associated with ELC) was taken in this unit due to its proximity to the occupied residence.
4: North Woodlot	• 34 species observed. • Notable Species include Fringed Sedge, Shagbark Hickory and Winterberry.	4: Dry-Fresh Sugar Maple-Oak Deciduous Forest (FOD5-3) Inclusion: Mineral Thicket Swamp (SWT2)	• Mid-aged closed canopy tableland forest community. Canopy is dominated by Sugar Maple, with associates of Northern Red Oak, White Oak, Shagbark Hickory, American Basswood and American Beech. Sub-canopy is predominantly Eastern Hop-hornbeam with White Ash and American Basswood. Understory is relatively open and dominated by regenerating Sugar Maple, with occasional Choke Cherry and Buckthorn. Some hawthorn and Gray Dogwood present along edges of unit. Ground layer cover is approximately 20% and includes a mix of common woodland species and spring ephemerals. • East portion of unit adjacent to watercourse was previously cleared and is regenerating to forest– Bur Oak, White Ash and American Basswood more prevalent in this area. • Small swamp thicket inclusion present at south edge of Woodlot is dominated by Winterberry, with a dense ground layer of sedge (*Carex crinita*). • Evidence of disturbance: presence of non-native, invasive species (though not widespread or abundant) noise from adjacent Highway 407, and relatively open understory possibly resulting from deer browse. Canopy (tree and branch) dieback noted at west end of unit, possibly as a result of salt spray from adjacent Highway 407 eastbound lanes.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
			• Overall botanical quality is low to moderate. Ecological health and sensitivity is moderate (relatively low levels of disturbance, presence of swamp-thicket inclusion, presence of regionally significant plant species). • The NOCSS identified this as a 'Significant Woodland' per Halton Region criteria due to size greater than 0.5 ha and proximity (<50 m) to a medium constraint stream corridor (TSH *et al*., 2006). • No hand soil auger (associated with ELC) was taken in this unit.
5: Valley Forest and floodplain marsh	• 31 species observed. • Notable species include Shagbark Hickory, Turtlehead, Torrey's Rush, Panicled Aster and Rice Cutgrass.	5A: Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)	• Provincially uncommon mature Oak-Hickory valley forest stand dominated by Northern Red Oak and Shagbark Hickory on steep valley slopes. Sub-canopy is dominated by Eastern Hop-hornbeam. Understory cover is moderately dense and includes Choke Cherry and Tartarian Honeysuckle with Gray Dogwood, young American Elm, and hawthorn along the edges. Ground layer is sparse and includes a mix of common woodland species including Kidney-leaved Buttercup, Yellow Trout-lily, and Narrow-leaved Spring Beauty. • Canopy trees average approximately 70 to 80 cm diameter at breast height (dbh). • Non-native, invasive plant species are present and locally abundant but not widespread. • Moderate botanical quality, health and moderate to high sensitivity (due to provincially uncommon status). • A hand soil auger (associated with ELC) in this community shows a mineral soil type of very dry compacted Silty fine Sand. Hand auguring at long the watercourse banks. This may be attributed the alluvial deposits associated with the meandering watercourse as the auger could not be advanced beyond 20 cm.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		5B: Jewelweed Mineral Meadow Marsh (MAM2-9)	• Floodplain meadow marsh community dominated by Spotted Jewel-weed, with Reed Canary Grass, Panicled Aster, Rice Cutgrass, Blue Vervain, sedge and Turtlehead. • Frequent standing snags and deadfall logs in floodplain provide good wildlife habitat infrastructure. • Small vernal pool east of Reach 14W-11. • Continues east of property boundary. • Relatively low disturbance. Field ploughed in close proximity floodplain marsh at south end of the valley forest where valley slopes are more moderate. • Moderate botanical quality, health and sensitivity. • A hand soil auger (associated with ELC) in this community shows mineral soil types of medium Sandy Loam and medium Sandy Clay Loam. Organics were restricted to an organic litter layer (8 cm). Hand auguring could not be advanced beyond 45 cm.

5.3.5.4 Hedgerows/Tree Clusters

Hedgerows and tree clusters are also found on the Subject Property. They are mapped on Figure 5.2, and described in Table 5.8 below.

Table 5.8 – Hedgerow/Tree Cluster Summary

Figure 5.2 Reference Code	Dominant Species (in decreasing order of abundance)	General Characteristics
TC1	Bur Oak, Shagbark Hickory, Apple, Hawthorn	• A series of isolated individual trees within active agricultural fields. • Trees range in size from approximately 40 to 70 m dbh; 15 m tall. • Tree health is good overall.
TC2	Bur Oak, Buckthorn, Common Pear	• A small cluster containing several large Bur Oak. • Trees range in size from 60 to 90 cm dbh. • Dense regeneration of Bur Oak saplings, Buckthorn and pear in understory. • Tree health moderate to good.
TC3	Trembling Aspen	• A small aspen stand in an area of active pasture. • Trees range in size from 10 to 30 cm dbh; 10 to15 m tall. • Tree health is good. However, many fallen branches were observed.
HR1	Hawthorn, Buckthorn, Oak	• Broad (approximately 5 m wide) shrub hedgerow with frequent gaps approximately 200 m long. • Dominated by shrubs averaging approximately 2 to 3 m tall. • Sparse small Bur Oak and White Oak less than 10 m tall. • Moderate to good individual health, but overall botanical health lower due to presence of non-natives. • Some connectivity with Unit 2/5, but no connectivity to other natural areas to the north.
HR2	Shagbark Hickory, Bur Oak	• Short hedgerow (approximately 140m) comprised of 7 large, well-spaced open grown trees within active agricultural field. • Trees range from 50 to 70 cm dbh, 15 m tall. • Trees generally in good health; one tree in poor condition. • Some connectivity with stream Reach 14W-13 to north, but no connectivity to other natural areas to the south.

Figure 5.2 Reference Code	Dominant Species (in decreasing order of abundance)	General Characteristics
HR3	Hawthorn, Common Apple	• A shrub hedgerow with frequent large gaps along the west property boundary (total length approximately 470 m). • Hedgerow is 1 tree width, generally. Dominated by shrubs averaging approximately 3 to 4 m tall. • Moderate to good health. • Provides connectivity between stream Reach 14W-14 and Reach 14W-16.
HR4	Hawthorn, Shagbark Hickory, Carolina Rose, Northern Wild-raisin, Buckthorn, Black Raspberry, Common Apple	• Continuous single tree width hedgerow along west boundary of property (approximate length 210 m). • Dominated by shrubs averaging approximately 3 m tall. • Good health. • Some connectivity with stream Reach 14W-16 to north, but no connectivity to other natural areas to the south.
HR5	American Basswood, Hawthorn, Norway Spruce	• Very short (approximately 125 m) hedgerow along west property boundary. • Trees generally young, averaging approximately 15 cm dbh and up to 10 m tall. • Good health.
HR6	Shagbark Hickory, Bur Oak	• Very short (approximately 90 m) hedgerow along the west boundary of the Subject Property just north of Dundas Street. Trees average approximately 45 cm dbh and 10 to 15 m tall. • Moderate health. • Some connectivity with roadside hedgerow to the south.
HR7	Hawthorn, American Elm	• Very short (approximately 110 m) shrub hedgerow located along the east property boundary. • Composed of young trees and shrubs averaging approximately 10 cm dbh and up to 5 m tall. • Moderate health. • Isolated feature with no connectivity to other natural features.

5.3.5.5 Offsite Vegetation Communities associated with Core #1 and the Linkage to Core #2

Vegetation Overview

Core #1 and the Linkage to Core #2 are located within off-site portions of EIR subcatchment FM1109, which extends onto the northeast corner of the Subject Property. Core #1 is associated with the main branch of Fourteen Mile Creek between Tremaine Road and Bronte Road. Eleven distinct ELC vegetation community types were mapped within Core #1 and the Linkage to Core #2 during surveys completed for the NOCSS and are listed below.

- Dry-Moist Old Field Meadow (CUM1-1)

- Mineral Cultural Thicket (CUT1)
- Dry-Fresh Oak-Hardwood Deciduous Forest (FOD2-4)
- Sugar Maple-Oak Deciduous Forest (FOD5-3)
- Sugar Maple-Hickory Deciduous Forest (FOD5-5)
- Mineral Meadow Marsh (MAM2)
- Reed-canary Grass Mineral Meadow Marsh (MAM2-2)
- Narrow-leaved Sedge Mineral Meadow Marsh (MAM2-5)
- Cattail Mineral Shallow Marsh (MAS2-1)
- Rice Cut-grass Mineral Shallow Marsh (MAS2-9)
- Duckweed Floating-leaved Shallow Aquatic

ELC community mapping from the NOCSS covering Core #1 and the Linkage to Core #2 is presented in Appendix 5.4 (Figure 6.3.4; Modified from NOCSS). Several of the wetland communities identified within Core #1 and the Linkage to Core #2 are included within the North Oakville-Milton West PSW complex. The location of PSW within Core #1, the Linkage to Core # 2, as well as, adjacent lands is presented on Figure 5.1 and a description of the PSW complex is provided in Section 5.3.2. All of the ELC communities identified in Core #1 and the Linkage to Core #2 through NOCSS are considered common in Ontario (NHIC S-ranks of S4 or S5).

Reconnaissance Level Field Review and Aerial Photograph Interpretation

A reconnaissance level roadside survey completed on August 18 and September 11, 2009, combined with recent (2009) aerial photograph interpretation of vegetation within Core #1 and the Linkage to Core #2 generally confirmed the character and extent of vegetation communities as reported in NOCSS with the following exceptions (as noted in Appendix 5.4):

- The NOCSS identifies 2 CUM1-1 areas east of the Fourteen Mile Creek valley and south of the large forested area. These areas were partially planted to Soybean in 2009 and are thus smaller.
- The isolated field located between the north edge of the large forested area and Highway 407 was fallow in 2009 and would be classified as CUM1-1.
- The wetlands located within the proposed Linkage to Core #2 appeared to be under cultivation in 2009. The areas remain wet (per 2009 aerial photograph) and would likely revert to wetland plant species cover if left to fallow.

Overall, the character and extent of vegetation associated with Core #1 and the Linkage to Core #2 as identified in NOCSS remains unchanged; relatively minor changes in vegetation cover within Core #1 and the Linkage to Core #2 are restricted to actively managed agricultural areas and are expected given the crop rotation farming practices employed on these lands.

Core #1 Management Themes and Recommendations

NOCSS states that Core #1 includes a diversity of habitat types and themes, including:

- **Forest Interior:** associated with woodland in northern portion of core
- **Linkage:** habitats provide a potential linkage to lands north of Highway 407 and south of Dundas Street

- **Open Country:** open country habitats are found along the northern and eastern edges of this area and
- **Redside Dace: p**opulation of known Redside Dace in lower portions of the creek in this area.

Management recommendations for Core #1 identified in NOCSS are:

- The existing woodlands and wetlands are recommended for retention.
- Linkages between the forested component of the Core and lands to the south should be connected with Linkages approximately 200 m in width. Significant gaps in these connections will be created by major roadways and highways in the area. As well, the connections should be wooded.
- Balance is required between management of the open and wooded habitats. The configuration of the Core would allow for a block of open country habitat in the north of approximately 5.2 ha and a block approximately 8.8ha in area in the southeastern portion of the Core. The rest of the Core should be wooded.

5.3.6 Wildlife Resources

Wildlife resources were evaluated through field surveys. Specific survey methods are described and summary results are discussed below.

5.3.6.1 Wildlife Approach

Avifauna

Breeding bird surveys were conducted by qualified, experienced staff according to Ontario Breeding Bird Atlas (OBBA) protocols on June 7 and July 12, 2005. Seven stations were selected for monitoring based on the habitats present on-site (Figure 5.4). Wind speed varied from none to light, and there was no precipitation. The surveys ran from 6:07 AM to 9:30 AM. Noise from Highway 407 hampered the detection of birds by sound at survey stations #4, #5 and #6. Incidental observations of bird species were also recorded during all environment field surveys, including August 20 and 21, 2009 and April 22, July 13 and July 14 2010. The results section (Section 5.3.6.2) includes a brief habitat description, location information using UTM (NAD 83) coordinates, time of survey, and a list of all bird species detected at each survey station.

Bird species status was evaluated using the NHIC Biodiversity Explorer website for provincial rarity ranks (i.e. S-Ranks); the Species At Risk in Ontario list (MNRF website, updated periodically) for provincial status designations; the Canadian Species At Risk list (COSEWIC website, updated periodically) for national status designations; and the Halton Natural Areas Inventory (Dwyer 2006) for regional conservation status. A complete list of bird species observed on the Subject Property is provided in Appendix 5.2, Table 5-2.1.

Anurans

Amphibian use and habitat assessments were completed on the Subject Property using a combination of visual surveys and incidental observations (2005 and 2009) and amphibian `calling` surveys (2010). Calling amphibian surveys were conducted at eight (8) stations on three dates in 2010: April 21, June 7, and June 25.

Amphibian activity was assessed using the *Marsh Monitoring Program* amphibian calling survey protocol (Bird Studies Canada 2003). Calling surveys were conducted by qualified, experienced, staff under appropriate conditions (i.e. dusk/evening survey with suitable air temperatures). Following this protocol, calling activity was rated as Level 1 (individual calls can be counted – no overlap), Level 2 (some calls can be counted, some overlap) or Level 3 (calls continuous and overlapping, individuals not distinguishable).

Call survey stations are mapped on Figure 5.3. Calling survey results are summarized in Appendix 5.2 Table 5-2.2 and discussed in Section 5.3.6.2.

Bats

Bat habitat in the form of maternity roosting habitat assessments was completed on the Subject Property in 2015. Exit surveys were undertaken using a combination of visual observations and acoustic monitoring. Given that the suitable vegetation communities that could potentially provide roosting habitat for bats are contained within the proposed Open Spaces designated areas and retained, exit surveys were only preformed on the existing structures with bat habitat potential. Two rounds of exit surveys were conducted on the existing structures on four dates in 2015: June 4, 11 and 16, and July 13. If no bats were noted exiting a structure during the first survey, a follow-up survey was not required.

Exit surveys followed MNRF guidance under appropriate conditions (i.e., dusk/evening survey with no rain) and were assessed by placing observers at pre-identified potential exit points with enough observers to achieve full visual coverage of the exits. Combined with the visual survey, acoustic monitoring also was undertaken. Prior to the beginning of each survey, SM3BAT (Wildlife Acoustics) detectors equipped with SMM-U1 omnidirectional ultrasonic microphones were deployed in order to record bat calls. One detector was used to record in stereo on two channels with two microphones extended on cables. Each microphone was positioned 3 to 3.5 m above the ground at each monitoring location and within 5 to 10 m of each building face in order to maximize bat detection and to capture quality sound files.

Detectors were programmed to begin recording at the start of the survey in triggered mode with settings recommended for recording bats. During the survey, observers noted any bats observed exiting the structure or flying in the general vicinity, along with the time of each observation. Additional notes on behavior and flight path were recorded.

The recorded audio files were played through Sonobat® software to determine species or group of bats. Exit survey results are summarized in Appendix 5.2 Table 5-2.3 and discussed in Section 5.3.6.2.

Other Wildlife

Supplemental wildlife observation of other fauna, including reptiles, mammals and butterflies, were recorded during field visits. All observations made during the field surveys were recorded, including sightings of species, as well as, evidence of use (e.g. browse, tracks / trails, scat, burrows, and vocalizations).

5.3.6.2 Wildlife Survey Results

Avifauna

In total, 44 bird species were recorded during 2005 breeding bird surveys and through incidental observations made in 2005, 2009, and 2010 while conducting additional field surveys (Appendix 5.2, Table 5-2.1). Species observed are predominantly common, generalist and urban-adapted species, with some forest-associated species and wetland-associated species also recorded. The avifauna observed and exhibiting breeding evidence in the study area are expected for the disturbed site conditions. Of the total of 44 bird species observed:

- Most (40 species) showed some evidence of breeding (possible, probable or confirmed); a number showed no evidence of breeding and are considered unlikely breeders on the property (Ring-billed Gull, Herring Gull, Great Blue Heron, Black-crowned Night Heron).
- Two (2) federally (COSEWIC) and provincially (COSSARO) designated Threatened species were recorded: Bobolink and Barn Swallow.
- One (1) provincially rare species, Black-crowned Night Heron (*Nycticorax nycticorax, S3B, S3N – Vulnerable – Breeding, Vulnerable – Non-Breeding*), was observed on the Subject Property. This observation does not suggest breeding activity on the Subject Property.
- Two (2) species are considered *Area Sensitive* (species requiring large areas of suitable habitat in order to sustain population numbers) by MNRF (2000)[8]: Northern Harrier and Savannah Sparrow.
- Nine (9) species considered to be "Uncommon" (found at 15-35 survey stations) in Halton Region (Dwyer 2006) were recorded (both breeding and non-breeding).

The avifauna species of conservation concern are listed in Table 5.9 below.

[8] **Area Sensitive** bird species require "a substantial area of suitable habitat for successful breeding and their populations decline when habitat becomes fragmented". This includes birds of various habitats, such as grassland or forest birds. In the case of forest birds, the "minimum forest habitat for area sensitive species is at least 100 metres from any edge habitat" (MNR, 2000; p. 43).

Table 5.9 – Avifauna Species of Conservation Concern

Common Name	COSEWIC[3]	MNRF[4]	SARA Status and Schedule [5]	Halton Region (1993) [6]	MNRF Area Sensitive[7]	BB1	BB2	BB3	BB4	BB5	BB6	BB7	Incidental Observations
Black-crowned Night-heron (*Nycticorax nycticorax*)				U									X
Blue-winged Teal (*Anas discors*)				U									X
Bobolink (*Dolichonyx oryzivorus*)	THR	THR	No Status: No Schedule									X	X
Barn Swallow (*Hirunda rustica*)	THR	THR	No Status, No Schedule										X
Eastern Towhee (*Pipilo erythrophthalmus*)				U									X
Gadwall (*Anas strepera*)				U		FY							
Horned Lark (*Eremophila alpestris*)				U								X	
Northern Harrier (*Circus cyaneus*)	NAR	NAR		U	X								X
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)				U		X	X				X		X
Savannah Sparrow (*Passerculus sandwichensis*)					X	X	X				X	X	X
Willow Flycatcher (*Empidonax traillii*)				U								X	
Wilson's Snipe (*Gallinago delicata*)				U									X

Refer to Legend in Appendix 5.2

Anurans

Table 5.10 provides a composite list of amphibian survey results from 2005, 2009 and 2010. Table 5-2.2 (Appendix 5.2) provides a summary of 2010 amphibian calling survey results.

Table 5.10 – Anuran Survey Summary Results

Species	Amphibian Calling Station							
	A1	A2	A3	A4	A5	A6	A7	A8
	Vegetation Unit and Description							
	Unit 4 Forest	Unit 2B Marsh	TC1 Tree Cluster	Unit 2A Old Field	Unit 5B Meadow Marsh	Dug Pond/ Pond 1	Farm Pond /Reach 14W-14A	Residential
American Bullfrog (*Rana catesbeiana*)							✓	
American Toad (*Bufo americanus*)						✓	✓	
Green Frog (*Rana clamitans*)							✓	
Gray Treefrog (*Hyla versicolor*)							✓	
Northern Leopard Frog (*Rana pipiens*)							✓	

In total, five (5) herpetofaunal species were observed on the Subject Property during the 2005, 2009 and 2010 field surveys.

- No federally (COSEWIC) or provincially (COSSARO) significant herpetofaunal species were recorded.
- No provincially rare species (i.e. S1 to S3 ranked by NHIC) were recorded.
- One (1) species considered "Uncommon" in Halton Region (Dwyer 2006) was recorded: American Bullfrog (*Rana catesbeiana)*.
- The remaining species recorded on the Subject Property are considered to be widespread and abundant within Ontario (S4-S5) (NHIC, 2011).
- Green Frogs and American Toads had the highest relative abundance with other species were present in low or very low numbers.

On the Subject Property, evidence of anuran breeding was primarily restricted to the Farm Pond (Reach 14W-14A) approximately 200 m northwest of Dundas Street and at two locations in shallow isolated pools to the west of the pond (Station A7; Vegetation Unit 1). A small amount of Bullfrog breeding was recorded at Pond 1 (Dug Pond) (Station A6) near the southeast property limit. Refer to Figures 5.3 for locational information.

At the Farm Pond (Reach 14W-14A), five (5) herpetofauna species were recorded:

- Green Frog (*Rana clamitans*) (2010 ~ 40 individuals recorded during calling surveys; 2005 – 4 adults observed).

- American Toad (*Bufo americanus*) (2010 – not recorded during calling surveys; 2005 ~100+ tadpoles observed).
- American Bullfrog (2010 – not recorded during calling surveys; 2005 – 1 tadpole observed during visual surveys).
- Northern Leopard Frog (*Rana pipiens*) (2010 – 1 individual during calling surveys).
- Gray Treefrog (*Hyla versicolor*) (2010 – 2 individuals during calling surveys).

Of these, American Bullfrog, Green Frog and Gray Treefrog are closely associated with the Farm Pond (14W-14A) and its immediate vicinity, while American Toad and Northern Leopard may range into nearby riparian meadow habitats.

At Station A6, small numbers of American Toad were recorded during calling surveys. This species likely utilizes the ponded water during breeding and adjacent meadow habitats during other life cycle stages.

The remainder of the stations (Stations A1-A5) which are located closer to Highway 407 had no anurans breeding within them. This lack of breeding includes the small ponded area where hundreds of tadpoles were noted May 5, 2009. The lack of anuran breeding is consistent with the unsuitable habitat present. Stations A1, A2, A4 and A5 lacked the aquatic habitat required for anuran breeding. Station A3 had a small and insufficient water volume and lacked aquatic vegetation used by tadpoles for concealment and foraging.

Results of the 2010 survey are similar to those collected in 2005 for the Natural Environment Survey (MMM, 2005). As in 2010, anuran breeding was largely confined to the Farm Pond (Reach 14W-14A) near Dundas Street and absent in remaining areas in 2005. There were some minor differences; Gray Treefrog and Northern Leopard Frog were present in 2010 but not observed in 2005. Based on habitat present it is likely that both species were present in 2005 but not recorded since calling surveys weren`t completed. American Bullfrog was recorded in 2005 (one individual). This species was not recorded in 2010 and may have become extirpated.

In summary, anuran breeding is primarily limited to the Farm Pond (Reach 14W-14A) located near Dundas Street. Within this pond, anurans are largely limited to Green Frog. A small number of Gray Treefrogs and Northern Leopard Frogs also breed within this pond. American Toad tadpoles were observed in the riparian areas immediately west of this pond and likely breed within this pond as well. During the non-breeding portion of their life cycle, anuran species are likely within this pond, its vicinity or meadow marsh along intermittent watercourses.

Bats

Bats were observed exiting from Building 1 (large barn) and Building 3 (small barn) during exit surveys while none were observed exiting from the remaining buildings. To identify exiting bats, call files from associated with the barns on both survey nights were analyzed with results presented below.

Call classifications were divided into three types for reporting:

- High-frequency calls belonging to Myotis are denoted as ‘Myo’;
- High-frequency calls of insufficient quality to make a confident species identification are denoted as ‘U-HiF’; and

- Calls identified as belonging to a non-myotid species, such as Big Brown Bat (*Eptesicus fuscus*), are denoted as "N-Myo".

Results are provided in Table 5.11.

Table 5.11 – Species Classifications of Exiting Bats

Survey No.	Date	Building	Observer Position	No. of Exiting Bats	Time of Observation	Call Classification
1	6/4/2015	Building 1	South	1	21:07	Myo
1	6/4/2015	Building 1	South	1	21:12	No recording
1	6/4/2015	Building 1	South	1	21:18	N-Myo
1	6/4/2015	Building 1	South	1	21:26	N-Myo
1	6/4/2015	Building 1	South	1	21:31	U-HiF
1	6/4/2015	Building 1	West	1	21:36	Myo
1	6/4/2015	Building 1	East	0	N/A	N/A
1	6/4/2015	Building 1	North	1	21:26	N-Myo
1	6/4/2015	Building 1	North	1	21:37	U-HiF
2	7/13/2015	Building 1	South	2	21:15	N-Myo
2	7/13/2015	Building 1	South	1	21:16	N-Myo
2	7/13/2015	Building 1	South	1	21:17	No recording
2	7/13/2015	Building 1	South	2	21:21	N-Myo
2	7/13/2015	Building 1	South	2	21:22	N-Myo
2	7/13/2015	Building 1	South	1	22:08	N-Myo
2	7/13/2015	Building 1	West	1	21:34	N-Myo
2	7/13/2015	Building 1	West	1	21:38	N-Myo
2	7/13/2015	Building 1	North	0	N/A	N/A
2	7/13/2015	Building 1	East	1	21:21	N-Myo
1	6/11/2015	Building 3	North	1	21:11	N-Myo
1	6/11/2015	Building 3	Southwest	0	N/A	N/A
1	6/11/2015	Building 3	East	0	N/A	N/A
2	7/13/2015	Building 3	North	0	N/A	N/A
2	7/13/2015	Building 3	East	1	21:25	N-Myo
2	7/13/2015	Building 3	East	0	N/A	N/A
2	7/13/2015	Building 3	Southwest	0	N/A	N/A

A total of 22 bats were observed exiting over the course of the surveys. Results are summarized as follows:

- The majority of exiting bats were observed at Building 1 (20 in total), with similar numbers observed exiting on each survey night (8 and 12 respectively);
- On both survey nights the majority of exiting bats exited from points at the south face of the building; and
- At Building 3, 1 bat was observed exiting on each survey night, from the east and the north faces, respectively.

Table 5.12 provides species classification results by building.

Table 5.12 – Summary of Results by Building and Date

Building	Date	No. of Exiting Bats	No. *Myotis spp.*	No. Non-Myotis	No. Unknown HiF	No. No Recording
Building 1	June 4, 2015	8	2	3	2	1
Building 1	July 13, 2015	12	0	11	0	1
Building 3	June 11, 2015	1	0	1	0	0
Building 3	July 13, 2015	1	0	1	0	0

Results are summarized as follows:

- The only bats observed exiting from Building 3 are non-Myotis species;
- Of the 20 bats observed exiting at Building 1;
    - at least 2 were Myotis spp.;
    - 14 were non-Myotis; and
    - 4 could not be assigned a species ID.

In summary, bats were only observed exiting Buildings 1 and 3 with the remaining buildings showing no evidence of bat use. The majority of bats observed were using Building 1. SAR bats (*Myotis spp*.) were observed exiting in low numbers at Building 1 only. The maximum number of bats observed exiting on any night was 12. The low numbers of exiting *Myotis spp.* (and other bat species) indicate usage of the buildings is likely restricted to either a very small maternal roost site or is a non-maternal roost, such as that used by males, who tend to roost individually or in low numbers.

Due to the recorded presence of *Myotis spp.* exiting a roost in Building 1, any modifications or disturbance to the structure will require an approval under the ESA (2007) which will be determined in consultation with the MECP during detail design.

Other Wildlife

The following points summarize other wildlife (mammal and insect) observations made on the site during field work completed to date:

2005

- Sightings of White-tailed Deer (*Odocoileus virginianus*) or their tracks were made throughout the site.
- A deer bedding area was observed between breeding bird stations #6 and #7 (Figure 5.3) in an upland meadow area between fields and consisted of approximately 20 well-worn spots.
- Raccoon (*Procyon lotor*) tracks were observed throughout the site.
- Coyote (*Canis latrans*) scat was found by survey station #1.
- Eastern Cottontail (*Sylvilaus floridanus*) was observed between stations #2 and #3.

2009 and 2010

- Several Monarch Butterfly adults and 1 Monarch caterpillar were observed within Unit 2 (Figure 5.2) adjacent to the Farm Pond (Reach 14W-14A). Monarch are discussed further in Section 5.3.3.
- Evidence of White-tailed Deer (tracks and browse) were observed in Unit 4 (North Woodlot).
- A Meadow Jumping Mouse (*Zapus hudsonius*) was observed at the edge of the cultivated field south of Unit 4 (North Woodlot).
- Northern brown snake (*Storeria dekayi*) was observed swimming through Reach 14W-12 near Dundas Street. (2009)

2011

- A single Snapping Turtle (*Chelydra serpentina*) was observed in May, 2011.

Monarch and Snapping Turtle are discussed in Section 5.3.3. All mammal species, except for the *Myotis spp*., detected on the Subject Property are considered common and secure in Ontario (per NHIC S-ranks), and are expected based on the site conditions.

5.3.7 Hydrogeology

The surficial fine-grained deposits of Halton Till found throughout the Subject Property serves to limit infiltration to the groundwater system and as a result, the local reaches receive a little over two-thirds of their total water from surface runoff. The upper weathered zone of the till, provides the bulk of the groundwater inputs to the local reaches, but on a seasonal basis, typically from November to May. During this period the entire shallow system, including up gradient reaches of the channel are saturated and contributing water to the reaches. Generally, these same reaches are observed to be dry or with ponded water during the summer months.

The lower reaches of the FM1001 tributaries (generally to the south of Highway 407) are interpreted as receiving minor groundwater contributions from the Queenston Shale bedrock based on water level monitoring carried out at the Subject Property since 2009. However, the rate of influx of bedrock groundwater is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses. In the lower (southern) reaches within the Subject Property, there may be greater opportunity for bedrock-based groundwater to maintain pools within the channel as the bedrock is exposed in the channel and the reaches are shaded somewhat by large trees.

Reach 14W-11 and Reach 14W-11A in the northeast corner of the Subject Property is interpreted to be losing water to the ground, due to the nearby influence of a buried bedrock valley to the east. Reach 14W-14A (Farm Pond) appears to be losing water to the groundwater system on the basis of measured surface water levels at the pond (148.7 masl on average) compared to the interpreted bedrock water levels at the three surrounding monitoring well locations (147.1 to 147.6 masl on average). Further studies undertaken in 2011 supported earlier findings that indicated Reach 14W-14A (Farm Pond) is not influenced by groundwater inputs, but is losing water to the ground and detailed information related to Reach 14W-14A (Farm Pond) was presented in Technical Memorandum HG#1-Hydrogeology. This memo was submitted to CH and the Town of Oakville, March 30, 2012. Additional work was carried out at the upstream end of the pond in 2013 at the request of CH with the installation of a mini-piezometer nest nearby to the inlet/outlet of the pond. The data collected by that end of the pond indicates that groundwater gradients vary between inward and outward relative to the pond levels and that the area where there is potential for groundwater seepage is located

beyond the western limit of the pond. Details of the groundwater monitoring and assessment for the Subject Property are described in Section 4.0 of this EIR.

Overall, the relative contribution of groundwater to the maintenance of aquatic and wetland features on the Subject Property appears to be minor with the reaches and wetlands generally appearing to be maintained largely by surface water inputs.

5.4 Description of the Proposed Development

The development proposal is to accommodate the creation of an office and business park in accordance with the Region's and Town's land use and planning directions for the 407 West Employment Area. The development concept consists of employment uses adjacent to Highway 407 and Bronte Road, due to increased visibility along these major roads with limited commercial and service/retail uses at the major road intersections along the Dundas Street to serve the employment area. It is recognized that more general industrial uses, such as mixed warehousing and office uses may be accommodated internal to the business park. The concept plan is generally consistent with the Town's NOWSP incorporating modest revisions to the proposed road network based on more detailed study. The road pattern and resulting watercourse and buried services crossings follows a modified grid pattern which responds to the existing environmental and site conditions while encouraging accessibility and a viable transit network throughout the 407 West Employment Area as shown in Figure 5.5, Figure 5.6, and Figure 5.7.

5.5 Development of Setback Requirements

Feature limits, setbacks and environmental management requirements were reviewed from the EIR ToR and consideration of grading and servicing requirements. Primary focal areas included the stream corridors and consideration of natural environment features on surrounding lands. The collective review encompassed the following considerations and objectives:

- Consultation with the Town, CH and MNRF.
- Anticipated preliminary grading and servicing requirements.
- Maintenance of groundwater interactions and input to natural areas and receiving reaches.
- Protection of surface water quality in receiving reaches through sediment/erosion control measures, including an approved Sediment and Erosion Control Plan.
- Setback requirements, based on a combination of the nature and sensitivity of features to be protected and endeavoring to be consistent with buffers applied to natural features in the area.
- Tree protection measures.

5.5.1 Determining Stream Corridor Widths

The determination of the stream corridor widths for the associated reaches within the Subject Property was undertaken to address the objectives listed above while adhering to the requirements associated with, NOCSS and the Recovery Strategy for Redside Dace (*Clinostomus elongatus*) in Ontario (2010) in association with the ESA (2007) Ontario Regulation 242/08. Given that the legislative requirements of the ESA (2007), supersedes NOCSS, consultation with the MNRF was undertaken to determine which reaches would be subjected to the ESA (2007) requirements. Based on that consultation, MNRF confirmed the following under Section 29.1 of the Ontario Regulation 242/08 (Jane Devlin, MNRF, pers. comm., December 20, 2013):

- For Reach 14W-12 and Reach 14W-16 – 29.1 Subsection i, ii, iii and iv apply (these subsections refer to Occupied Redside Dace Habitat as having a setback consisting of the meander belt plus 30 m on either side applied as defined in the regulation).
- For Reach 14W-11A, Reach 14W-12A, Reach 14W-13, Reach 14W-14 and Reach 14W-14A - 29.1 Subsection v applies (this subsection refers to Contributing Redside Dace habitat; however, there is no setback width defined in the regulation).

This confirms that Occupied Redside Dace habitat receives setback protection under the ESA (2007) Ontario Regulation 242/08 of MB + 30 m while Contributing habitat does not, and as such, is subjected to the setbacks as define by NOCSS. Within NOCSS, the stream corridor widths associated with each reach are to be determined based on the cumulative total of three factors, which are:

- the meander belt;
- the setback allowance for minor (7.5 m) or major (15 m) streams; and
- the factor of safety (also referred to as the erosion threshold).

To ensure the most stringent setbacks are applied to a stream corridor width, where applicable, both the Ontario Regulation 242/08 setback and the NOCSS setback were calculated, with the setback that resulted in the widest stream corridor width being selected. In addition, where specific features are located along a reach (i.e., wetland, woodland), the NOCSS define setback would also be included. As such, the outside limit of the widest setback will be referred to as the "Development Limit" within the EIR/FSS document.

During the determination of the Development Limit associated with each reach, there was one exception, Reach 14W-12A. Although this reach was not classified as Redside Dace Occupied habitat, this reach is classified as a High Constraint Stream Corridor in NOCSS. By providing the widest stream corridor setback, impacts to the existing form and function of Reach 14W-12A can be reduced by providing flow and allochthonous inputs downstream stream to Reach 14W-12 post-development through this wider stream corridor. In addition, when determining the NOCSS stream corridor, the minor stream setback of 7.5 m was applied to all reaches to further buffer the Natural Heritage features post-development. Refer to Appendix 6.4 in Section 6.0 for a breakdown of how each stream corridor setback was established for each reach under all development phases.

5.6 Proposed Concept Plan

The proposed concept plan was developed to address the above environmental management recommendations. The general characteristics of the proposed plan are as follows:

- The proposed development will consist of an office and business park in accordance with the Region's and Town's land use and planning directions for the 407 West Employment Area.
- Reach 14W-11A will be realigned along the north and eastern Subject Property boundary via new Reach 14W-23.
- Realignment of Reach 14W-14 from where it enters the Subject Property to where it will discharge in existing Reach 14W-12A via new Reach 14W-22.
- Elimination of Reach 14W-13 with upstream flows being directed into Reach 14W-22 (realigned Reach 14W-14) via new Reach 14W-21.
- There are three proposed new road crossings of two reaches, including:

    - Burnhamthorpe Road Extension will cross both Reach 14W-16 and new Reach 14W-22 and
    - Avenue 1 will cross new Reach 14W-22.
- This proposed Burnhamthorpe Road Extension alignment differs from the alignment identified in the Secondary Plan, as well as, the previous concept plans submitted for the Subject Property due to the desire to minimize potential adverse effects to a High Constraint Stream Corridor and reducing the number of watercourse crossings. The Burnhamthorpe Road alignment identified in the Secondary Plan was located to the south of the proposed alignment and would have crossed Reach 14W-12 and Reach 14W-14A (Farm Pond). The proposed alignment identified in the concept plan will instead cross Reach 14W-16, classified as a Medium Constraint Stream Corridor in NOCSS.
- In the Secondary Plan, Avenue 2 was originally proposed to cross Reach 14W-16 to connect Dundas Street, Avenue 1 and Burnhamthorpe Road Extension within the Subject Property. Changes to the road alignments through the Subject Property resulted in the removal of the original crossing of Reach 14W-16 by shifting the proposed alignment for Avenue 2 onto the lands west of the Subject Property. By undertaking this shift in the proposed Avenue 2 alignment, a crossing of Reach 14W-16 and the encroachment into Redside Dace setback associated the Reach 14W-12 can be eliminated.
- The lots will be serviced by municipal water, sanitary and stormwater services.
- Two stormwater management (SWM) facilities are proposed on the Subject Property between the Burnhamthorpe Road Extension and Dundas Street. The SWM facility to the east of Reach 14W-12 will incorporate the existing Farm Pond (Reach 14W-14A) into the design thereby removing this feature. The other facility will be constructed to the west of the Reach 14W-12. Treated outflow from both SWM facilities will be discharged into Reach 14W-12. Originally both facilities were proposed to encroach into the meander belt plus 30 m limit associated with Reach 14W-12. During the preliminary design of these SWM facilities, a major design consideration included minimizing this encroachment. To that effect, these facilities are no longer located within the meander belt plus 30 m setback. A temporary encroachment of up to 6 m will be required to complete the necessary grading for the facilities. Localized permanent encroachment and disturbances within the setback will be necessary to construct the SWM facility overflow outlets which will be further detailed. The disturbed vegetation in these areas will be restored.
- Recreational trails consisting of both On-Roads Trails and Major Trails through the NHS are proposed (see Section 3.0). The Major Trails within the Highway 407 West Employment Area (including the Subject Property) have principally been located along the margins of the NHS to minimize encroachments to the actual natural features and maintain the alignment within the existing disturbed areas (Figure 5.7). The siting of the trails within the NHS of the Lazy Pat Farm property will be undertaken once the stream corridor limits have been agreed upon and involve consultation with the MNRF/MECP and CH.

A considerable amount of environmental work and project team review has been undertaken to evaluate natural features and to identify associated setbacks, and environmental enhancement opportunities. The plan development has been guided by this iterative process and coupled with the EIR ToR, has guided the preparation of this EIR. The intent of this EIR is to evaluate the sensitivity and significance of the features on the Subject Property and any other natural features that could be influenced by the development and to identify mitigation and environmental management measures to protect and enhance those features.

5.7 Stormwater Management

The proposed stormwater management plan recommends two SWM facilities to the east and west of Reach 14W-12 between Dundas Street and the Burnhamthorpe Road Extension. An additional SWM facility is proposed between Avenue 1 and the Burnhamthorpe Road Extension on the west side of Reach 14W-16. These SWM facilities have been sized to provide an *Enhanced* (Level 1) quality control, extended detention and quantity control for the Subject Property. Detailed information is provided in Section 7.0. Key objectives for stormwater management include:

- Controlling post-development flows to allowable flow rates.
- Maintaining hydrological inputs to Reach 14W-12.
- Preventing downstream erosion in Reach 14W-12.
- Providing Enhanced water quality treatment.
- Mitigating temperature increases.
- Monitoring the SWM for condition and performance, specifically related to temperature.

5.8 Sanitary Servicing and Water Distribution

This section briefly outlines proposed servicing of the site. For additional details, refer to Section 8.0 of this EIR/FSS.

The Subject Property is proposed to be serviced via gravity sewers within the right-of-way of the proposed road network, including watercourse crossings, for both storm and sanitary servicing. All sewers will be sized appropriately to accommodate the proposed development using the Region of Halton's and Town of Oakville's design criteria. The storm sewers will discharge to the proposed stormwater management facility for treatment. The sanitary sewers will discharge to the existing sanitary sewer on Colonel William Parkway.

Water servicing will be provided to the Subject Property by a network of trunk and local watermains within the right-of-way of the proposed road network, including watercourse crossings. The watermains will be designed to provide adequate domestic supply and fire protection in accordance with the Region of Halton's design criteria.

5.9 Impact Overview

This section reviews potential impacts or condition changes to natural environmental features on or bordering the Subject Property. The primary impacts relate to:

- The elimination of Reach 14W-13 with flow directed via new Reach 14W-21 to Reach 14W-14.
- The incorporation of Reach 14W-14A into the SWM facility (Farm Pond and Vegetation Unit 1)
- The proposed re-alignments of Reach 14W-14 and Reach 14W-11A (and the associated riparian areas).
- The change in flow in Reach 14W-12A.
- The encroachment into Reach 14W-16 stream corridor associated with the Burnhamthorpe Road Extension alignment.

Additional impacts relate to retained natural environmental features on the Subject Property and/or surrounding lands (e.g. construction related impacts to woodlands or downstream effects on water quality).

Potential impacts related to proposed road and service crossings of Core #1, Linkage to Core #2, trails and watercourse crossings are discussed in Table 5.15, per requirements of the EIR/FSS ToR (Town of Oakville, 2007) for the EIR Subcatchment Area Level of Detail. However, these impacts do not result directly from works proposed on the Subject Property and will be addressed through future studies.

Three primary natural environment factors are discussed: aquatic resources; vegetation; and, wildlife. In Tables 5.14 to 5.16, we review each factor in terms of potential effects, proposed mitigation and residual effects. The identified mitigation measures will be incorporated with appropriate wording on construction drawings and the Lot Grading Plans that will be prepared prior to any site grading (following Draft Plan approval). The proposed concept plan is provided for reference in Figure 5.5 and Figure 5.6 for terrestrial and aquatic habitats.

5.9.1 Fish Habitat Enhancement Concepts

Proposed development activities will require review under the federal FA (1985) to determine whether the works will result in a “serious harm to fish”. For context, the amendments made to the FA (1985) in July 2013 came into effect in November 2013. These amendments seek to focus the Act's regulatory regime on Canada’s commercial, recreational and Aboriginal fisheries. The Act prohibits serious harm to fish, which in the Act is defined as “*the death of fish or any permanent alteration to, or destruction of, fish habitat*”. The following concepts have been prepared to address potential adverse effects associated with Reach14W-11A, Reach 14W-14, Reach14W-14A (Farm Pond) and Reach 14W-16. According to NOCSS, Reach 14W-13 is not considered to function as fish habitat. Provisions made within NOCSS to address its removal have been incorporated in the stormwater management section, and as such, is it only briefly discussed below as it relates to connecting to the proposed realignment of Reach 14W-14. Based on the results of consultation with the DFO and CH, in 2012, a FA (1985) Authorization (previous version) was not anticipated to be required for realignment or relocation of Reach 14W-14 and Reach 14W-14A (Farm Pond) and as a result, did not require compensation or monitoring (Leah Smith, Environmental Planner, CH; August 16, 2012). It is anticipated that a similar outcome will result from the proposed works under the amended Act. Consultation with DFO will be undertaken to confirm review requirements under the FA (1985) during the detailed design phase of the project.

The proposed reach realignments and Farm Pond removal are also subject to review by the MECP under the ESA (2007) due to the presence of Redside Dace Occupied and Contributing habitat. These proposed activities and enhancements were previously presented to the MNRF in the EIR (December 2012), correspondence and meetings. The MNRF has indicated that the proposed approaches outlined below do not appear to be (in concept) prohibited by the ESA (2007); however, a review of the project will occur during detail design stage of the project with MECP. CH will continue to be circulated on the consultation with the MECP.

The intent of the enhancement concepts is to improve habitat diversity by following natural channel design principles to construct riffle and pool habitat that is currently absent in the reaches that will be affected. The existing stream corridors are subject to intermittent disturbances to the reaches and associated riparian habitat principally associated with the current agricultural land use. These concepts are provided in Section 6.0 of the EIR/FSS, illustrated on Figures 6.4.1 to 6.4.5 and are described below for each specific reach along with additional enhancement opportunities. Please note that in order to maintain consistency with hydraulic analysis we have also included reach identifiers identified in Section 6.0 for cross referencing.

Measures to specifically address Redside Dace and their habitat as they relate to ESA (2007) approvals will continue with the MECP at the detailed design phase with CH circulated for their files.

A component of the impact assessment was the examination of the effects of the proposed development including the channel realignments to the flows in the Reaches, and specifically whether the form and function would be retained in the post-development scenario. This required an assessment of flow under three conditions (i.e., wet, dry and average year) in relation to three metrics (i.e., frequency, duration and magnitude) at a number of flow nodes. The assessment related to the ecological form and function is presented in the discussion for Reaches 14W-12A and 14W-22, specifically at three flow nodes, 2 (Reach 14W-12A), 2B (Reach 14W-22) and 9 (Reach 14W-23) as the changes in flows in the remaining nodes were not deemed to have an effect on form and function. Detailed documentation of this analysis is described in detail in the Flow Regime Analysis Memorandum in Appendix 7.4 and Section 7.0.

Reach 14W-13 Realignment (Reach 14W-21) and Removal

This reach will be subjected to removal with a redirection of flow that will recreate a shortened channel length. In order to address the conveyance of seasonal flows onto the Subject Property from the Highway 407 ROW, a new flow conveyance channel (Reach 14W-21) is proposed to be built. Reach 14W-21 will intercept these flows and convey them into Reach 14W-22 (realigned Reach 14W-14). The existing channel associated with Reach 14W-13 located south of the proposed Reach 14W-21, will be removed and all associated downstream flow contributions addressed through SWM facilities. As such, the function of Reach 14W-21 is to maintain the existing headwater flow contribution downstream to Redside Dace habitat in Reach 14W-12 by means of Reach 14W-22. The anticipated reduction in flow and allochthonous inputs that may result from the loss in channel length from Reach 14W-13 is anticipated to be balanced by potential gains from the wider, vegetated and naturalized stream corridor associated with Reach 14W-22.

Reach 14W-14 Realignment (Reach 14W-22)

This reach will be realigned along the north and west boundaries of the Subject Property (Figure 6.4.1, 6.4.2 and 6.4.3). The proposed concept for Reach 14W-22 consists of creating a morphologically diverse channel based on natural channel design principles with pools along the outside bend connected by riffle habitat and

a low flow channel. The realignment will outlet into Reach 14W-12A approximately 5 to 20 m upstream of the confluence with Reach 14W-12. This has resulted in a parallel channel approach that has been accepted (in principle) by the Town, CH and the MNRF. Although the ideal connection of Reach 14W-22 to Reach 14W-12A would be where the existing Reach 14W-14 connects to Reach 14W-12A, this was not possible. Examination of the existing topography was undertaken and identified limited opportunities where the proposed connection point could be created based on grades. As such, the review has confirmed that Reach 14W-22 will connect to the lower section of Reach 14W-12A, approximately 5 to 20 m upstream of the confluence with Reach 14W-12. The exact location will be confirmed during detailed design. Refer to Section 6.6 for a detailed description regarding determining the connection point.

This alternating sequence of riffle/pool habitat will provide suitable habitat for the species present including Blacknose Dace, Creek Chub, Bluntnose Minnow and Fathead Minnow that are found within this reach, as well as, contributing to Redside Dace Occupied habitat within Reach 14W-12 in an improved manner over the function of existing Reach 14W-13, Reach 14W-14 and Reach 14W-14A. The introduction of pool habitat will also provide greater areas of potential refuge habitat where resident fish can congregate during periods of low flow as evidenced in downstream Reach 14W-12. The connecting low flow channel between riffles and pools will potentially provide the opportunities for fish in downstream reaches, included Redside Dace, to access new habitats in Reach 14W-22 when suitable flows are present, thereby expanding their current habitat range. In addition to the pools and riffles providing habitat for fish, this variety of habitat will support micro-populations of benthic macroinvertebrates for fish to forage on both within Reach 14W-22 and in the associated downstream reaches by means of drift during flow events.

The proposed re-alignment of Reach 14W-14 is not anticipated to result in reduced groundwater inputs from the bedrock into this watercourse system (see Section 4.4.4.6). Under existing conditions, Reach 14W-13 is not interpreted to receive groundwater inputs from the bedrock except at its point of convergence with Reach 14W-14. Reach 14W-14 on the other hand is interpreted to receive bedrock groundwater inputs over its entire on-site length down to its confluence with Reach 14W-12A as the elevations of this channel lie below the interpreted bedrock groundwater levels. Under the post-development condition, the length of proposed realigned channel below the bedrock water table will be slightly longer than the existing length along Reach 14W-14, and the upward groundwater head differential is also expected to be higher as the groundwater table in the bedrock to the west where this realigned channel is proposed. Therefore, it is anticipated that there will be a similar degree of groundwater contributions from the bedrock into the proposed realigned channel compared to the existing condition.

An assessment to the potential change in the flow regime associated with the existing Reach 14W-13 and Reach 14W-14 compared to Reach 14W-22 associated with contributing flows downstream to Reach 14W-12A and ultimately to Reach 14W-12 was undertaken. The overall results of the assessment indicate that the post-development flows in Reach 14W-22 will be less by a range of approximately 15 to 20% of the existing combined flows in Reach 14W-13 and Reach 14W-14 due to a reduction in drainage area. However, this range of reduced flow is within the standard normal error factor for this type of flow assessment. When the assessment is further broken down to each metrics (frequency, duration and magnitude) and for all three flow conditions (wet, dry and average), the proposed flow in 14W-22 is comparable to the existing conditions in all situations. Indicating that the form and function of Reach 14W-14 and Reach 14W-13 related to flow will be maintained post-development within Reach 14W-22. Based on the proposed channel design for Reach 14W-22, it is highly likely that the ecological function of Reach 14W-22 will exceed the existing conditions as it relates to potential fish use, benthic macroinvertebrate production and allochthonous inputs based on the proposed pools, riffles, low flow channel and wider planted riparian stream corridor.

Floodplain wetlands consisting of a combination of meadow marsh habitat and small offline open water wetland features have also been incorporated into the design to recreate the function of the wetlands within the existing floodplain of Reach 14W-14 (Figure 6.4.1 to 6.4.5). The meadow marsh habitat has been designed through grading of the floodplain to create areas with greater frequency and duration of flooding. It is anticipated that periodic flooding of the floodplain, resulting from storm events and spring freshet will recharge these offline wetland-pond features. It is also anticipated that the wetland-pond features may also provide some measure of additional infiltration, though this will be limited somewhat by the fact that such ponds are also proposed in an area where groundwater discharge from the underlying bedrock is anticipated (see Section 4.4.4.4). In addition, these proposed offline wetlands will likely provide new habitats for the anurans displaced from Reach 14W-14A (Farm Pond) during the conversion to a SWM facility.

The realigned channel, Reach 14W-22 will result in a longer stream length than the existing reach with an established wider stream corridor than the existing channel. The longer and wider riparian corridor than currently exists will provide the opportunity to enhance the riparian habitat. Plantings to be used will incorporate Conservation Halton's Landscaping and Tree Preservation Guidelines, as well as, principles identified in *Table 6.3.4 Aquatic and Riparian Management by Reach* as noted in NOCSS through the planting and seeding of the valley with native species in a manner that takes into consideration the preferred riparian habitat for the ESA (2007) regulated species. As the majority of the reaches on the Subject Property are devoid of canopy cover largely consisting of active agricultural fields, the planting of these riparian areas will provide an enhancement over the existing conditions. The surrounding riparian vegetation will shade the channel to provide a thermal benefit to water temperature, as well as, offer habitat to wildlife and terrestrial insects. During periods of run-off, organic debris and insects will be wash downstream as allochthonous inputs to support other fish and benthic invertebrate communities in other reaches, specifically Redside Dace in Reach 14W-12.

In summary, Reach 14W-22 is anticipated to offer improved in-water habitat diversity, floodplain wetland habitat and riparian plantings are expected to result in a net gain to fish habitat through:

- Potential expansion in the range of the resident fish population from downstream reaches, including Redside Dace.
- Incorporation of the existing wetland habitat within the floodplain.
- Improved canopy cover through the stream corridor currently consisting of a combination of disturbed riparian habitat and active agricultural fields to increase allochthonous inputs.

As such, it is anticipated that the proposed enhancements will result in an improvement to the productive capacity of this reach over the existing conditions through agricultural operations with a comparable flow contribution to Reach 14W-12A and Reach 14W-12 to the existing conditions. CH in consultation with the DFO consider Reach 14W-14 to provide direct fish habitat; however, the relocation of the channel was considered (in the previous iteration of the FA (1985) to be a low risk harmful alteration, disruption or disruption to fish habitat and would not have required an Authorization (Leah Smith, Environmental Planner, CH; August 16, 2012)). As a result, it is anticipated that these works will not result in "serious harm to fish" and as such, would not require Authorization under the FA (1985).

Timing constraints for in-water works to complete the tie-in of the new stream reach to the existing stream reach (14W-12A), as well as, the proposed two road crossings (Burnhamthorpe Road Extension and Avenue 1) will be confirmed during detailed design through consultation with CH and the MECP. It is anticipated that

construction of the main portion of the realigned channel will not be subject to timing restrictions as it can be constructed entirely offline.

Reach 14W-11A Realignment

Similar to Reach 14W-14, Reach 14W-11A will be realigned along the north and east boundaries of the Subject Property (Figure 6.4.1 to 6.4.5) to become Reach 14W-23. This realignment will provide the opportunity to enhance the existing habitat that has been adversely affected by agricultural practices. This realigned reach will also be designed with natural channel design principles to create a meandering channel consisting of alternating riffle and pool habitat, with the stream corridor planted to improve riparian habitat and in time, canopy cover.

This alternating sequence of riffle/pool habitat will provide suitable habitat for the species present including Creek Chub, Bluntnose Minnow and Fathead Minnow that are found within this reach, as well as, contributing to Redside Dace Occupied habitat located in the downstream section of Reach 14W-11. Similar to the function of Reach 14W-22, the pool habitat will provide potential refuge habitat where resident fish can congregate during periods of low flow while the low flow channel between riffles and pools will potentially provide the opportunities for fish movement within the reach when flows are present. The pools and riffles habitat will support micro-populations of benthic invertebrates for fish to forage on both within Reach 14W-23 and in Reach 14W-11 downstream by means of drift during increased flow events.

An assessment to the potential change in the flow regime associated with the existing Reach 14W-11A compared to Reach 14W-23 was undertaken. The overall results of the assessment indicate that the post-development flows in Reach 14W-23 will be less by a range of 15 to 20% to the existing conditions across all flow metrics and flow conditions. However, this range of reduced flow is within the standard normal error factor for this type of flow assessment. This reduction is the result of the reduced drainage catchment area post-development. However, even with the proposed slight reduction in flows, the additional habitat features proposed will support the existing fish community by confining the reduce flow into the proposed low flow channel and refuge pools associated with the realignment.

A wider stream corridor that will be planted is proposed for Reach 14W-23 that is far greater then what is present around Reach 14W-11A. Opportunities will be reviewed to include wetland/meadow marsh habitat along the reach during detailed design. The realigned channel, Reach 14W-23 will have a longer stream length than the existing reach with a wider stream corridor and an enhancement to the riparian habitat. Plantings to be used will incorporate Conservation Halton's Landscaping and Tree Preservation Guidelines, as well as, principles identified in *Table 6.3.4 Aquatic and Riparian Management by Reach* as noted in NOCSS through the planting and seeding of native species to shade the channel to provide a thermal benefit to water temperature, as well as, offer habitat to wildlife and terrestrial insects. The wider riparian corridor will provide important allochthonous inputs to the reach during periods of run-off as organic debris and insects will be wash into the reach and downstream to support other fish and benthic invertebrate communities, specifically Redside Dace in Reach 14W-11.

Reach 14W-11A, as will realigned Reach 14W-23, connect to Reach 14W-11, a reach considered to be High Constraint Stream Corridor Requiring Rehabilitation. As a result, if rehabilitation measures are undertaken in Reach 14W-11, the enhancements proposed in Reach 14W-11A will provide greater continuity and opportunities for further upstream migration of fish, including potentially Redside Dace.

The anticipated benefits associated with these works are again similar to Reach 14W-22 owing to the similarity in habitat that will be created. In summary, Reach 14W-23 is anticipated to offer improved in-water habitat diversity and riparian plantings are expected to result in a net gain to fish habitat through:

- Potential expansion in the range of the resident fish population from downstream reaches.
- Improved canopy cover of the proposed stream corridor currently consisting of a combination of disturbed riparian habitat and active agricultural fields to increase allochthonous inputs.

It is anticipated that these enhancement concept measures will not result in a "serious harm to fish" and an Authorization under the FA (1985) will not be required as the function of this reach is expected to be improved over the existing agricultural swale. Timing constraints for in-water works to complete the tie-in of the new stream reach to the existing stream reach will be confirmed during detailed design through consultation with the MNRF. As the realigned channel will be constructed in what is now considered tableland, it is anticipated that only the connection to the existing channel will be subject to timing restrictions while the majority of the channel realignment will not.

Removal of Reach 14W-14A (Farm Pond)

Although NOCSS identifies this feature as a stream reach (14W-14A), the Farm Pond does not function as a linear stream and lacks a definable stream length or flow-through nature (i.e. via a separate inlet and outlet), comparable to an online pond. It also is not influenced by groundwater inputs based on results presented in Section 4.0 of this EIR, to function as a headwater wetland. Reach 14W-14A is a human-made bypass/online pond that receives flow from Reach 14W-13 and Reach 14W-14 that supports a self-sustaining tolerant, cool/warmwater fish population that includes Largemouth Bass. When a certain water elevation is reached, flow is discharged from the Farm Pond back into Reach 14W-12A then into Reach 14W-12. During the summer months the surface water is often the warmest water in the Farm Pond due to stratification of water based on temperature and it is this warm surface water that is the first to discharge from the Farm Pond. This warmwater discharged from the Farm Pond during and following storm events, is considered to result in a detrimental influence on Redside Dace habitat downstream, rather than a positive influence as would be expected from a natural headwater wetland. Although the Farm Pond is considered to represent a unique, larger body of water within the watershed, it is a constructed feature with an average maximum depth of 3 m during the summer, which does not provide distinct pelagic habitat that would differ from that of an online stormwater facility with a large open water section.

Considering that the receiving Reach 14W-12 via Reach 14W-12A supports and is classified as coolwater habitat and is managed as Redside Dace Occupied habitat, the removal of this feature and its incorporation into the SWM pond will remove the potential adverse effects associated with water quality (temperature and dissolved oxygen). The following are excerpts from various regulatory agency publications that support this approach;

- *DFO's Working Around Water? Factsheet Series (Ontario Edition)* bypass ponds "… are also prone to dissolved oxygen and water quality problems, increases in water temperature, and sediment accumulation problems." Proposals for bypass ponds on coldwater streams are generally not approved due to the potential that downstream water temperatures may increase beyond levels that coldwater fish need to survive.

- *DRAFT Guidance for Development Activities in Redside Dace Protected Habitat* (MNR, 2011) p.17 states: "Examples of potential overall benefit actions for Redside Dace may include: decommissioning of artificial ponds connected to occupied streams to improve fish passage and/or water quality (e.g. temperature)."

- *Evaluation, Classification and Management of Headwater Drainage Features Guidelines Approved July 2013* (CVC/TRCA, Finalized January 2014) states: "Online or in-line ponds are typically created on headwater features to provide a source for irrigation or water for livestock. Although these features can provide flow retention, extended discharge, permanent fish habitat, and amphibian breeding areas, their disruption to natural geomorphological processes and thermal impacts are generally not desirable."

The removal of pond habitat (i.e., bypass, online) specifically those contributing to cool/coldwater habitats, is anticipated to improve water quality (i.e., water temperature). These types of features are considered detrimental from a temperature moderation perspective. Although the Farm Pond in question is not an online feature, its effects are similar and the removal of these adverse effects would be beneficial to the aquatic habitat of downstream reaches. This has a specific benefit to Redside Dace and their habitat in Reach 14W-12 as it is the receiving watercourse of the Farm Pond (Reach 14W-14A). As indicated above this proposed approach is consistent with the DRAFT Guidance for Development Activities in Redside Dace Protected Habitat (MNR, 2011) as its removal is anticipated to result in an improvement to water quality, specifically as it relates to temperature.

Hydrogeological studies have been undertaken to determine whether there are potential interactions between the groundwater and the constructed Farm Pond feature, please refer to Section 4.0 for greater detail. In general, the hydraulic conductivity of the clay/silt soils found across the site and at the Farm Pond is very low and, as a result, the quantity of groundwater entering into and discharging back into the ground will be low. Based on the hydrogeological investigations that focused on the Farm Pond itself, our understanding is that the Farm Pond does not receive groundwater inputs in sufficient quantities to affect the water level of the Farm Pond, nor to lead to appreciable discharges into the adjacent channel at the top end of the Farm Pond. The water level in the Farm Pond is maintained by surface water inflows and not by groundwater contributions. Groundwater monitoring indicates that the Farm Pond appears to lose water into the ground. Flows from the Farm Pond are associated with surface water inputs that fill the Farm Pond following rain events, and then drains back out to the watercourse network afterward. The very minor groundwater discharge potential that is present near the upstream end of the Farm Pond is far outweighed by the losses back into the ground over the much larger area of the Farm Pond to the east, where the greater downward head differences are recorded. As a result, the removal of the Farm Pond (Reach 14W-14A) from the landscape is not expected to have an adverse effect to the groundwater inputs to the watercourse network.

Considering the manner in which the Farm Pond (Reach 14W-14A) functions and the presence of an ESA (2007) regulated species in the downstream receiving reach that requires coolwater habitat, its removal would be a benefit to aquatic habitat. Based on the existing function, quality of habitat and influence of this feature on receiving reaches, and guidance from NOCSS, CH and DFO, the development plan with respect to the Farm Pond (14W-14A) proposes the following:

- The active storage and hydrologic function of the existing pond will be replicated in the reach corridor.

- The function of the affected aquatic habitat associated with replacing this feature that will be altered by the proposed SWM facility, will be mitigated through further naturalization of the proposed stream corridors associated with other reaches elsewhere on the Subject Property to enhance high constraint reaches.
- The addition of infiltration swales and enhanced treatment of water discharged from the SWM facility to enhance water quality entering red constraint stream reaches that provide direct habitat for a SAR species.

Redirection of Flow from Reach 14W-12A

The proposed, realignment of Reach 14W-14 and removal of the Farm Pond (Reach 14W-14A) and Reach 14W-13 will result in the redirection of flow away from the Reach 14W-12A and redirected to Reach 14W-12. The redirected of flow from Reach 14W-14A upon its conversion to a SWM facility will be to Reach 14W-12 directly through the new SWM facility outlet. The redirected flow associated with Reach 14W-13 and Reach 14W-14 will be combined into the realigned Reach 14W-22 which will outlet into the bottom end of Reach 14W-12A just upstream on the confluence with Reach 14W-12. This redirection of flow has the potential to alter the form and function of a short section of Reach 14W-12A upstream of the tie-in with Reach 14W-22, which NOCSS defines as a poorly defined swale.

Due to the anticipated reduction in flow, an examination to the potential change in the flow regime within with Reach 14W-12A associated with contributing flows downstream to Reach 14W-12 was undertaken. The results suggest that flows will be reduced in Reach 14W-12A under the three assessed flow conditions; wet, dry and average year, when related to frequency, duration and magnitude (refer to the Flow Regime Analysis Memorandum in Appendix 7.4 and described Section 7.0). However, this reduction in flow will only occur in approximately 100 m of Reach 14W-12A upstream of the tie-in of Reach 14W-22 given that the outflow from Reach 14W-22 combined with the proposed flows in Reach 14W-12A post–development have been assessed and determined to provide similar flows to the pre-development condition in Reach 14W-12A. As such, a change in flow to reach 14W-12 and Redside Dace Occupied is not anticipated. In fact, when the proposed combined outflow from Reach 14W-12A, Reach 14W-22 and SWM facilities are combined, there will be increased flows in Reach 14W-12 above the existing condition.

Given the reduction of flow in the upper section of Reach 14W-12A will occur, an assessment to the function of the habitat present was undertaken. Based on habitat descriptions in NOCSS and our multiple site investigations, the habitat in Reach 14W-12A main function appears to provide flow conveyance and nutrient drift (allochthonous inputs) to downstream reaches. Although not confirmed, there is the potential, albeit limited, for the upper section to function as seasonal direct fish habitat should suitable flows be present and passage through the dense cattails at both the upstream and downstream limits is possible.

In order to reduce and mitigate a portion of the anticipated flow change in surface water contributions to the upper section of Reach 14W-12A, the following will be undertaken:

- a portion of surface runoff will be maintained to this reach by:
    - establishing a stream corridor around Reach 14W-12A that is 15 m wider than required by NOCSS;
    - directing flow from infiltration swales to this reach; and.
- capturing and directing roof top runoff to this reach.

The clean runoff from a number of building blocks are to be diverted via a new storm sewer system and a flow splitter that will divert treated runoff to Reach 14W-12A to allow a uniform and sustained level of base flow to be maintained in the receiving reach. Please refer to Section 7.4.3.5 for more details. The wider stream corridor proposed will also function as a source of allochthonous inputs which can be conveyed to the reach along with surface runoff.

Furthermore, the post-development reduction in the function in the upper section of Reach 14W-12A, will be addressed through the habitat created in the realigned Reach 14W-22. The reduction of allochthonous inputs from Reach 14W-13 and Reach 14W-14 via Reach 14W-12A to reach 14W-12 are anticipated to be replicated from the drift inputs from reach 14W-22 and its associated wider vegetated riparian stream corridor with proposed wetlands and meadow march habitats. As Reach 14W-22 will be designed with a riffle/pool habitat sequence connected with a low flow channel, there is an opportunity for fish in Reach 14W-12 to move upstream and expand their range. The pool habitat may provide refuge during periods of intermittent flow while the variety of substrates and overhanging vegetation will likely provide a source of food for foraging opportunities.

Although the post-development impacts to the upper section of Reach 14W-12A are significant as they relate to the existing conditions, the habitat assessment indicates that Reach 14W-12A based on its constructed nature, intermittent flows and homogeneous habitat present with limited access for fish has a limited function. That limited function has been shown to be replicated and potentially increased post-development though the mitigation measures proposed for Reach 14W-12A, as well as the design and anticipated function of Reach 14W-22. As such, the redirection of flow from Reach 14W-12A is not anticipated to have an adverse effect to flow conveyance and nutrient drift downstream to Occupied Redside Dace habitat in Reach 14W-12. These anticipated outcomes will be review during the proposed monitoring program.

Review of Halton Region's Restoration Works in Reach14W-12 (Dundas Street Culvert)

During detail design, WSP will confirm the new right-of-way along Dundas Street and review the extant of Halton Region's restoration work associated with the culvert replacement under Dundas Street for Reach 14W-12. During this review, it will be determined if there is any opportunity for further channel restoration works which may included removing any remaining portion of the hardened block wall and concrete lined channel, realigning the channel away from the roadway embankment and re-positioning the channel so that it is centred within the channel corridor. This could be undertaken through natural channel design and bio-engineering techniques. Also during detailed design, the MECP will confirm if the proposed impacts to Redside Dace habitat will require an approval under the ESA (2007). If so, this area may potentially be an option to restore the channel to a more naturalize condition to improve Redside Dace habitat as part of an overall benefit measure.

Removal of Existing Crossings

The proposed realignment and enhancement works will also provide the opportunity to remove existing functioning and/or abandoned farm crossings within Reach 14W-16. These crossings have the potential to function as barriers (seasonal/permanent) to fish passage and may be unstable due to their age and deteriorated state. As a result, their removal has the potential to result in an improvement to fish habitat. Prior to removing these features their influence on fish habitat will be examined in greater detail as the constriction of flow may have created deep pool habitat that function as refuge pool habitat. As necessary this function may be retained or recreated using other methods to maintain the form and function of these

refuge pools. The proposed removal and channel restoration works will be confirmed and designed during the later detailed design phase of the project.

Green / Open Space Areas

The concept plan incorporates open space areas, sized to accommodate regulatory setbacks. With the exception of compatible land uses within the NHS (NOCSS, Section 6.3.5.2), development in these areas will not occur as the open space areas are defined by regulatory setbacks associated with retained and realigned reaches, wetlands and sensitive natural areas to be retained or considered for rehabilitation during detailed design of the Subject Property. The proposed SWM ponds to the east and west of Reach 14W-12 are located beyond the limits of the identified setbacks for this reach.

The open space provided in the concept plan includes accommodation for the vegetation communities associated with Reach 14W-11, including the Dry-Fresh Oak-Hickory Deciduous Forest (FOD 2-2) and associated floodplain marsh. As the NOCSS has listed this reach as High Constraint with Rehabilitation, this will be left untouched, and retained in full and protected with appropriate setbacks as shown in Figure 5.5.

A designated trail system (Major Trails and On-Roads Trails) associated with the NHS is considered by NOCSS to be the best strategy to discourage informal trail creation. Recreational trails consisting of both On-Roads trails and Major Trails through the NHS are proposed (see Section 3.0). The Major Trails within the Highway 407 West Employment Area (including the Subject Property) have principally been located along the margins of the NHS to minimize encroachments to the actual natural features and maintain the alignment within the existing disturbed areas (Figures 5.7, 5.8a, 5.8b). The impact of these on road trails has been assessed as a part of the road right of way for the road crossing locations.

Within the EIR lands, the trail system largely occurs on existing agricultural land. There are a few locations; however, where the trail system borders the NHS or crosses it. To assess the impacts to these crossings and encroachments additional field investigations were undertaken on September 24, 2014. This investigation assessed impacts in a 20 m corridor from the outer edge of the open space boundary into the open space area. A 20 m width was decided to be a sufficient enough corridor to accommodate the trail location and any grading which may be associated with that trail. Within these corridors, detailed ELC communities were mapped. These are described in the table below, along with possible impacts to these features.

Table 5.13 – Ecological Land Classification and Impacts of Trail System

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
2A: Dry-Moist Old Field Meadow (CUM1-1)	2A (1)	• Open meadow, dominated by tolerant grasses (Smooth Brome, Timothy) with occasional forbs (Common Dandelion, Cow Vetch, Field Thistle). • Vegetation is maintained at a very low height by grazing livestock (goats and sheep observed). • The soil sample in this community shows homogeneous dark brown sandy clay with 2% stoniness underlying 8 cm of organic litter layer. The auger became too tough to turn at 75 cm due to the sticky clay.	• Trail construction in this location would have little impact on the natural heritage system. • Trail would have less impact on the vegetation surrounding communities than grazing. • At present animals are grazing in Reach 14W-12, this trail is well removed from that location and would result in an improvement over current uses.

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
	2A (2)	• Similar to 2A (2). • Open meadow abundant with tolerant grasses (Smooth Brome) and hardy and unpalatable herbaceous species (Teasel, Field Thistle, Wild Carrot/Queen Anne's Lace, Common Ragweed, New England Aster). • Evidence of prior grazing in this location (stunted growth of herbaceous species, abundance of species with prickles and spines). • Wetland species occur in localized depressions and drainage directed from nearby field including (Reed Canary Grass, Redtop, and Field Mint). • The soil sample taken in this community shows a homogeneous dark brown sandy clay underlying 6 cm of organic litter layer. The auger was refused at 55 cm due to stoniness or bedrock.	• Trail construction in this location would have little impact on the natural heritage system. • Some minor reduction in runoff from the current agricultural field to Reach 14W-12 could occur due to trail construction.
	2A (3)	• Old-field meadow bordering agricultural field and road abundant with Common Ragweed, Teasel, and occasional Wild Carrot, Timothy, Smooth Brome, Chicory, thistles, and Viper's Bugloss. Several agricultural crop escapees found in this unit including Soy, Rye, Amaranth, Clovers, Alfalfa, and Squash/Pumpkin. • Anthropogenic disturbance: adjacent active agricultural use likely results in periodic disturbance (e.g., chemical spraying/vegetation dieback, grazing). • Low botanical quality and health (dominated by non-native grasses and disturbance tolerant species, disturbed by adjacent agricultural activities); Low sensitivity. • The soil sample taken in this community shows a layered soil of 26 cm of dark brown silty clay, over 29 cm of orange brown sandy clay and 8 cm of medium brown sandy clay with 4% stoniness of red and grey shale and limestone. The auger was refused at 61 cm due to stoniness or bedrock.	• By and large the proposed trail borders the edge of this unit and very little impact will occur. • The trail goes through this unit at the western edge of the property, not adjacent to the agricultural field. Impacts in this area will include loss of vegetation and possible disruption to small drainage depressions which drains to Reach 14W-16. These impacts are expected to be negligible and habitat loss will be minimal.
	2A (4)	• Old-field meadow abundant with Goldenrods, New-England Aster, Teasel, Heath Aster, and European Common Reed. Sparse low trees of Red Ash, Manitoba Maple and Common Buckthorn exist here. A small wet depression contained wetland plants including Spotted Touch-me-not, Willow-herb species, Blue Vervain, Bittersweet Nightshade, Bugleweed, Bulrush, and Cattail. • The soil sample taken in this community shows a layered soil of 23 cm of dark brown sandy clay, over 32 cm of dark brown clay with 5% fragments of red shale and 7 cm of brown clay with 70% stoniness of red and grey shale and limestone. The auger was refused at 62 cm due to stoniness or bedrock.	• By and large the proposed trail borders the edge of this unit and very little impact will occur. • Impacts in this area will include loss of vegetation and possible disruption to small drainage depressions which drain to Reach 14W-16. These impacts are expected to be negligible and habitat loss will be minimal.
	2A (5)	• Old-field meadow with shrubs on the slope of the creek valley. Small trees included a row of Pussy Willows and sparse Sugar Maple, Red Ash, Manitoba Maple, and American Elm. The ground layers were abundant with Goldenrods and the occasional New-England Aster, Teasel, Smooth Brome, Wild Carrot and European Common Reed.	• By and large the proposed trail stays well within the agricultural field and very little of the trail is in this unit. Very little impact will occur. • Impacts in this area will include loss of vegetation. This impact will be negligible and habitat loss will be minimal.

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
		• The soil sample taken in this community shows a layered soil of 17 cm of brick red silty clay, over 27 cm of brown silty loam. The auger was refused at 44 cm due to stoniness or bedrock.	
2D: Cattail Mineral Shallow Marsh (MAS2-1)		• Cattail dominated wetland coincident with Hydrological feature 'B'. • Narrow-leaved Cattail dominates, with sparse occurrences of Spotted Touch-me-not, Asters, and Goldenrod. • A soil auger in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were present as a thin organic litter layer (5 cm), and thin organic humic layer (15 cm). This soil is a "mineral" soil. The auger was refused at 60 cm depth due to hitting rock.	• The proposed trail crosses this unit. • Impacts will include vegetation loss and possible disruption to water movement, depending on construction methods. • Impacts can be minimized by using a bridge or boardwalk to cross this unit.
2B: Reed-canary Grass Mineral Meadow Marsh (MAM2-2)		• Open meadow marsh community dominated by Reed Canary Grass. Common associates include Purple Loosestrife, Panicled Aster, *Carex* spp., Redtop and Great-hairy Willow-herb. • Occurs on bottomlands within the drainage channel network. • A soil auger in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were restricted to a very thin organic litter layer (<1 cm), and thin organic fibric layer (5 cm). The auger was refused at 65 cm depth due to hitting rock.	• The proposed trail crosses this unit. • Impacts will include vegetation loss and possible disruption to water movement, depending on construction methods. • Impacts can be minimized by using a bridge or culvert structure to cross this unit while maintaining hydrology as is.
5A: Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)		• Provincially uncommon mature oak-hickory valley forest stand dominated by Northern Red Oak and Shagbark Hickory on steep valley slopes. Sub-canopy is dominated by Eastern Hop-hornbeam. Understory cover is moderately dense and includes Choke Cherry and Tartarian Honeysuckle with Gray Dogwood, young American Elm, Red Ash, and hawthorn along the edges. Ground layer is sparse and includes smooth brome, goldenrod, asters, and long-stalked sedge. • A soil auger in this community shows a mineral soil type of very dry compacted Silty fine Sand. Hand auguring became too difficult after 20 cm.	• The proposed trail alignment is located within the buffer setback from this feature consisting of agricultural field and not within the actual feature. • Impacts could include potential grading resulting in vegetation loss, and edge effects if any trees are removed or die due to soil compaction. • Impacts can be minimized by selecting a trail location as far back from the feature as possible and by minimize grading activities in this location.
HR1		• Broad (approximately 5 m wide) shrub hedgerow with frequent gaps approximately 200 m long. • Dominated by hawthorn and gray dogwood shrubs. • Sparse small Bur Oak and White Oak less than 10 m tall. • Ground layer plants are similar to those found in unit 2A: CUM1-1	• The proposed trail crosses this hedgerow at the boundary with the 407 transitway. • Impacts would include minor vegetation loss for the crossing, and edge effects where trees and shrubs are removed • Impacts can be minimized by minimizing the trail width in this location.
TC3		• Grouping of Trembling aspen in the pasture area	• The proposed trail may remove some or all of the trees in this grouping. • Impacts include vegetation loss of this isolated monocultural grouping.

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
			• Impacts can be minimized by avoiding the tree grouping.

During review, CH has expressed interest in the proposed current alignment of the trail, specifically its location in the vicinity of vegetation Unit 5A. As it is WSP's intention to avoid impacts to this unit, the proposed trail has been preliminarily aligned outside of the vegetation Unit 5A but within the buffer setback. During detail design, before the trail alignment is finalized, there will be an opportunity for CH to walk the staked proposed alignment to review and provide comments. At the time, every effort will be reviewed to eliminate impacts to vegetation Unit 5A. If, however; the proposed trail alignment cannot completely avoid impacts to the vegetation Unit 5A (e.g., tree removals), a significant habitat review and targeted SAR surveys will be undertaken in consultation with the MECP during detail design to be in compliance with the NOCSS EIR ToR.

General Channel Realignment Design Considerations

The channel dimensions for the realignments in future reaches 14W-22 and 14W-23 have been established through the use of appropriate geomorphological parameters consistent with this style of feature and have been confirmed through hydraulic modeling. The channels, which are illustrated in Figures 6.4.1 to 6.4.5 incorporate shallow overbank areas consisting of a combination of meadow marsh wetlands and small offline open water wetland features positioned alongside a centralized, meandering channel. This design allows for a greater water storage during moderate to higher flows and opportunities for additional infiltration, while maintaining a low flow channel, which resembles existing channel morphology in Reaches 14W-16 and parts of Reach of 14W-12.

5.9.2 Impacts to Hydrological Features 'A'

The proposed development will impact Hydrological Features 'A', as well as, other wetlands identified within the Subject Property not documented in NOCSS but qualify as Hydrological Features 'A'. As per NOCSS, the form of Hydrological Features 'A' are to be maintained post-development. As such, a preliminary assessment of the impacts to Hydrological Features 'A' and other newly identified wetlands was undertaken based on the proposed development plan to ensure this condition of NOCSS can be met during detail design. This was completed by assessing the area of Hydrological Features 'A' and other wetlands lost to the area proposed within the realigned corridors that would be available for wetland creation. Based on the current proposed development the following losses were noted:

Loss - Hydrological Features 'A'

Reach 14W-14	0.940 ha of MAM2-2
Reach 14W-14A (Farm Pond)	0.531 ha of OAO / SAF1-3 / SAS1-1*

(*CH confirmed on February 07, 2018, that the open water function of the Hydraulic Feature 'A' (Farm Pond) does not need to be replicated)

Loss – Newly Noted Wetlands

Reach 14W-14	0.027 ha MAS2-1
Reach 14W-14	0.607 ha MAM2-2
Reach 14W-14A (Farm Pond)	0.767 ha MAS2-1
Reach 14W-11A	0.102 ha MAM2-2

The total combined loss of Hydrological Features 'A' and newly noted wetlands has been assessed at 2.443 ha.

A review of the proposed new corridors associated with the channel realignments for Reach 14W-14 and Reach 14W-11A was undertaken to determine the potential amount of area available for wetland creation. Based on the current proposed development the following areas were noted:

New Corridor Areas

Reach 14W-22 and Reach 14W-23	2.8 ha

The total potential new area for wetland creation has been estimated at 2.8 ha.

As such, it appears based on a review of the Draft Plan that there will be adequate space to create new wetlands along the realigned channels to meet the condition of NOCSS regarding the form of the Hydrological Features 'A'. These numbers will be reviewed and refined during detail design, as well as, the development of the design and location of the type of wetlands to be created along the realigned channels. The wetlands to be created will be designed to replicate the function of the Hydrological Features 'A' and the newly noted wetlands (i.e., MAM2-2 and MAS2-1).

The new habitats to be created both within the realigned channel and off-line wetlands are anticipated to create opportunities for the species currently inhabiting the Farm Pond, with the exception of the species that will rely on large open habitats (i.e., snapping turtle). The new channels will have a variety of habitat types (i.e., riffles and pools) to increase habitat diversity for aquatic insects and amphibians. The channels along with the wetlands are anticipated to provided foraging opportunities for reptiles, small mammals and birds. Bird nesting is also anticipated to occur in the wetlands.

The function of the channel and wetlands will be reviewed and evaluated during the post-construction monitoring events, including but not limited to breeding bird surveys, anurans calling surveys, fish community surveys and benthic macroinvertebrate surveys. The staging of works regarding the removal of the Farm Pond and the creation of new wetlands will be reviewed by CH during detailed design.

5.9.3 Encroachment into Reach 14W-16 Stream Corridor Setback

The proposed Burnhamthorpe Road alignment identified in Section 5.6 (Proposed Concept Plan) is located within an area of active agricultural fields and cultural meadow. The revised alignment is preferred over the original alignment, identified in the Secondary Plan, as it eliminates two watercourse crossings. Originally, the road alignment crossed Reach 14W-12, a High Constraint stream corridor, and 14W-14, the existing Farm Pond (Reach 14W-14A). The proposed concept plan results in a single watercourse crossing of Reach 14W-16, a Medium Constraint stream corridor in NOCSS (classified by MNRF as Redside Dace Occupied habitat) and two crossings of realigned Reach 14W-22. It is anticipated that the proposed encroachment can be addressed through selection of an appropriately sized stream crossing structure to maintain fish passage and minimize potential serious harm to fish. Encroachment can be further addressed through stream rehabilitation works and the planting for this area adjacent to the proposed road alignment in order to enhance the existing riparian habitat and minimize potential adverse effects to the aquatic habitat.

5.9.4 Elimination of Avenue 2 Crossing of Reach 14W-16

It is anticipated that impacts to fish and fish habitat within Reach 14W-16 will be further mitigated through the changes to the road alignments, which result in the elimination of the Avenue 2 crossing previously proposed in the development plan.

5.9.5 Overview of Mitigation Measures

Specific mitigation measures are identified for each evaluation factor in Tables 5.14, 5.15, and 5.16. A number of mitigation measures are common to the three natural environment evaluation factors, including: Erosion and Sediment Control (ESC) Plan; fencing; stewardship; spills management/best management practices during construction and monitoring. Other measures are specific to certain factors. An overview of mitigation measures is provided below:

1. **Erosion & Sediment Control (ESC) Plan**. This strategy will mitigate impacts on vegetation, wildlife habitat and aquatic resources by implementing ESC fencing at grading limits to avoid sedimentation in adjacent natural features. The ESC Plan will be prepared as a condition of Draft Approval, and approved by CH and the Town of Oakville. The framework of the Plan, including construction sequencing, performance monitoring and monthly reporting, will be detailed in an Erosion and Sediment Control Brief.

2. **SWM Strategy.** The proposed SWM strategy will mitigate impacts to vegetation, wildlife habitat and aquatic resources by:

    - controlling post-development flows (to reduce sedimentation and erosion potential in adjacent vegetation blocks and reaches) and
    - treating stormwater runoff (to reduce potential for degradation of water quality in Reach 14W-12 and receiving watercourses downstream of the Subject Property.

    Furthermore, a review of thermal mitigation measures proposed for SWM ponds discharging to Redside Dace habitat will be undertaken at detail design as a condition of draft plan approval. The purpose of the review is to ensure that the outflowing water from the SWM pond is in thermal compliance with the NOCSS Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets (July 12, 2007). In support of establishing thermal mitigation compliance, WSP has been undertaking thermal monitoring in Reach 14W-12 and Reach 14W-16 in 2018 to determine existing baseline thermal conditions. The information collected will be used as an option to establish the thermal targets for the SWM pond discharging flows.

    Additional details of the SWM strategy are provided in Section 7.0.

3. **Hydrology/Infiltration**. Although the potential for at-source infiltration is limited given soil types (clays and silts), passive infiltration and utilization of at-source measures where local soils permit are recommended. Infiltration swales are recommended for installation at the rear of development lots that back onto natural environmental areas defined by CH hazard limits. These measures will contribute to local recharge. Additional details are provided in Section 4.0 and shown in Figure 4.8.

4. **Fish Relocation/Removal.** The removal of the Farm Pond (Reach 14W-14A) will require the removal of the resident fish population and either their relocation and/or they will need to be euthanized if a

suitable relocation site is unavailable (i.e., stocked fish populations cannot be relocated in Redside Dace habitat) or invasive species are present. A fish community relocation plan will be prepared during detail design and submitted to MNRF for approval prior to undertaking the works. There is the potential that a small offline pond associated with Reach 14W-16 may be suitable for fish relocations from the Farm Pond, this option will also be examined during the detail design phase of the project and incorporated into the fish community relocation plan.

5. **Anurans Relocation/Removal.** The removal of the Farm Pond (Reach 14W-14A) will impact the existing anuran population and, as such, CH has requested that a new habitat be found for these anurans. An anuran relocation plan will be prepared during detail design and submitted to CH for approval prior to undertaking the works. There is the potential that a small offline pond associated with Reach 14W-16, as well as, the wetlands to be created along Reach 14W-22 and Reach 14W-23 are suitable for the anuran relocations from the Farm Pond. As such, staging will be reviewed during detail design to ensure that the new wetlands along the realigned reaches be created before the habitat in the Farm Pond is altered. This should be noted in the anuran relocation plan.

6. **Temporary and Permanent Fencing**. Temporary vegetation protection fencing (which may be combined with ESC measures) is recommended to prevent damage to adjacent retained vegetation areas. Permanent fencing at lot limits abutting the stream corridors associated with realigned/retained reaches is recommended to prevent uncontrolled access and dumping.

7. **Spills Management Plan and Best Management Practices (BMPs).** These during-construction measures will reduce potential for contamination of groundwater, receiving reaches and adjacent vegetation. Guidelines for heavy equipment use reduce potential for damage to natural areas (e.g., stream disturbance, refueling, mechanical damage to trees, soils compaction etc.).

8. **Stewardship.** Initiatives for stewardship of natural heritage features and wildlife will be incorporated into the development plan, through to property development and ownership. CH recommends the Town of Oakville's "Living the Green Life – Oakville's Guide to Environmental Stewardship" as a helpful document for wildlife stewardship. This document provides information to residents and property owners regarding how to live with wildlife found in the Oakville area. Special stewardship initiatives may be developed during the detail design phase to address SAR considered to use the open green spaces.

9. **Monitoring.** Monitoring will be undertaken and will follow the adaptive environmental monitoring (AEM) approach to learning from monitoring outcomes and apply the knowledge gained to improve future monitoring outcomes. AEM approach will allows for flexibility in monitoring plan so that modifications and refinements can be incorporated during the monitoring period. By applying AEM, undesirable environmental effects/results can potentially be identified early in the monitoring program and corrected through management interventions to avoid major problems before they occur, as well as, maximize the fulfillment of the monitoring objectives. Details of the AEM approach, including the determination of the monitoring parameters will developed at the detail design stage in discussion with CH.

   Monitoring prior to development to establish baseline conditions for comparison, specifically related to the creation of the realigned reaches as requested by CH. Monitoring during development (e.g., ESC fencing and SWM facility inspection) to ensure mitigation measures are functioning as intended and whether adaptive mitigation is required to address potential deficiencies. Post-development, a Biological Monitoring program will also be undertaken including aquatic habitat, community vegetation and wildlife

monitoring, focusing on retained and re-aligned reaches of the stream corridor network. This monitoring will include but not limited to fish community surveys, breeding birds surveys, anuran calling surveys, benthic macroinvertebrate surveys, temperature and DO monitoring, as well as, a fluvial geomorphic assessment of the realigned reaches. Additional details of the proposed monitoring program are provided in Appendix 7.8. This integrated monitoring approach will help to identify issues of concern and recommend strategies to address problems in a timely manner.

5.10 Conclusions and Recommendations

Based on this review, we conclude that development of the Lazy Pat lands as proposed can be undertaken while protecting key environmental features. This conclusion reflects the following considerations:

- The 'big picture' has been considered in the following manner:
  - Fulfilling the requirements of NOCSS addresses the ecosystem features/functions and identifies opportunities, constraints and mitigation strategies.
  - The assessment of impacts, constraints and mitigation proposed recognize and anticipate that changes in the landscape matrix will occur. Most notably, this area is undergoing a shift in land use from agricultural to an office and business park.
  - The present work implements the objectives identified in NOCSS, providing a more detailed review and recommendations for the Subject Property and adjacent lands. This is consistent with the consideration of ecosystem function.

- Potential impacts to off-site features (i.e., Core Area 1, Linkage to Core Area 2, Stream Corridors) were examined on a subcatchment level of detail as identified in the EIR ToR. Potential impacts will be examined in greater detail during future EIR/FSS studies specific to those draft plan areas.

- Due to the dominant land use by active agriculture, the terrestrial habitat features are principally contained within the stream corridors identified by a combination of fluvial and aquatic habitat setbacks as defined in NOCSS and ESA (2007) Ontario Regulation 242/08.

- The removal of Reach 14W-14A (Farm pond) and its incorporation into a SWM facility will result in the removal of an adverse thermal influence to downstream coolwater fish habitat. The Farm Pond in its current form contributes warmwater to the coolwater receiving watercourse supporting Redside Dace. Impacts associated with the removal of wetland and amphibian habitat are addressed through the incorporation of wetland habitat within the stream corridor associated with Reach 14W-22 (realigned Reach 14W-14).

- Reaches 14W-14 and 14W-11A will be realigned with the new channel being designed using natural channel design principles (i.e., riffle/pool sequences with a connecting low flow channel).

- Habitat within the upper section of Reach 14W-12A (approximately 100 m) will be subject to a potential alteration; however, measures including maintenance of some surface water contributions from adjacent lots, redirection of rooftop drainage and the construction of infiltration swales along the reach will provide surface flows to this section. While the realignment of Reach 14W-13 and Reach 14W-14 into Reach 14W-22 will provide an opportunity to enhance the existing habitat through the improvement of habitat diversity in both the channel and associated riparian habitat.

- Realignment works will potentially alter fish habitat in Reach 14W-12A. However, these measures are not anticipated to result in *"serious harm to fish"* and as such Authorization under the FA (1985) is not expected to be required.

- Consultation with the MECP specifically related to Redside Dace, Barn Swallow, Bobolink and Bats related to potential ESA (2007) requirements will be confirmed during detail design. Results of these discussions will be forwarded to CH and the Town for their files.

- The SWM drainage strategy implements an Enhanced Level of treatment for stormwater to ensure protection of the receiving reaches. Additional measures to maximize cooling of water in and leaving the basin have been identified for further review/refinement in the detail design.

- Recommended design (i.e., open bottom culverts) and construction (i.e., trenchless construction) methods for servicing (i.e., road crossings, watermain and sanitary/storm sewer) will minimize the potential for in-water works, and as a result, direct impacts to the active channel with reduced impacts to riparian habitat. These options will be examined during detailed design to determine feasibility.

- Standard construction mitigation (i.e., in-water timing restrictions, spoils management, sediment and erosion control plans) will minimize the potential for potential impacts to the natural features.

- Incorporation of infiltration swales receiving clean water (e.g., roof runoff, rear lot drainage, etc.) along the margins of the development setback immediately adjacent to the NHS in order to promote the lateral movement of shallow groundwater through the undisturbed stream corridor soils. This water will be directed to the reaches and constructed floodplain wetland habitat in the realigned valleys.

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- The recommended monitoring program will build on existing information, and assess the operation of the SWM facilities, drainage measures and reach realignments.

- It is concluded that the concept plan, as well as, environmental management and setback implementation, conform to the principles identified in the NOCSS.

To ensure that environmental protection and mitigation is properly managed during site development the following recommendations/actions are identified:

- An Erosion and Sediment Control Plan will be prepared as a pre-condition to Registration of the Draft Plan. The plan will be submitted to the CH and the Town of Oakville for review and approval prior to any grading and site alteration.

- Vegetation and silt protection measures will be implemented (i.e., diversion berms, temporary sediment control basins, temporary wire fencing and silt fencing) and maintained prior to and throughout construction.

- Permanent fencing is recommended along the interface between lots and the stream corridors to minimize encroachment and disturbance.

- Tree management measures will include the preparation of an Arborist Report and a Tree Preservation Plan (TPP). The TPP will be developed through the preparation of Detailed Vegetation Plan that will be submitted in association with the Lot Grading Plan prior to registration.

- An environmental inspector should conduct site checks prior to and periodically during construction to ensure that protection and mitigation measures are properly implemented and to identify if any remedial measures are required.

- The monitoring program will follow the AEM approach and is recommended to ensure that various mitigation and design measures are maintained and operating during construction.