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PROSPECT PARK WELL FIELD AND WPP EXPANSION IMPACT ASSESSMENT REPORT

Prepared for:

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1. INTRODUCTION

The Regional Municipality of Halton (Region) provides drinking water to the Acton urban area in the Town of Halton Hills. The municipal water supply source for Acton is groundwater, obtained from the three source locations as follows: the Prospect Park well field, the Davidson well field and the Fourth Line well field. Water takings from all three sources are governed by Permits to Take Water (PTTW) issued by the Ministry of the Environment and Climate Change (MOECC).

The Prospect Park well field is located in the southwest part of Acton, at the end of a peninsula that extends into Fairy Lake, as shown on Figure 1. There are two production wells at the site: Prospect Park Well No. 1 and Prospect Park Well No. 2, located approximately 20 meters apart.

The PTTW for the Prospect Park well field allows for maximum water taking of 1,137 m^3/day during the period from October 1 to April 30 and a maximum water taking of 2,273 m^3/day for the remainder of the year (May 1 to September 30). Based on the results from a series of comprehensive studies undertaken between approximately 2005 to 2012, the Region is proposing to increase the maximum water taking limit at the well field to 3,500 m^3/day, and to allow the well field to operate at this rate throughout the year. The changes are proposed for a number of reasons including:

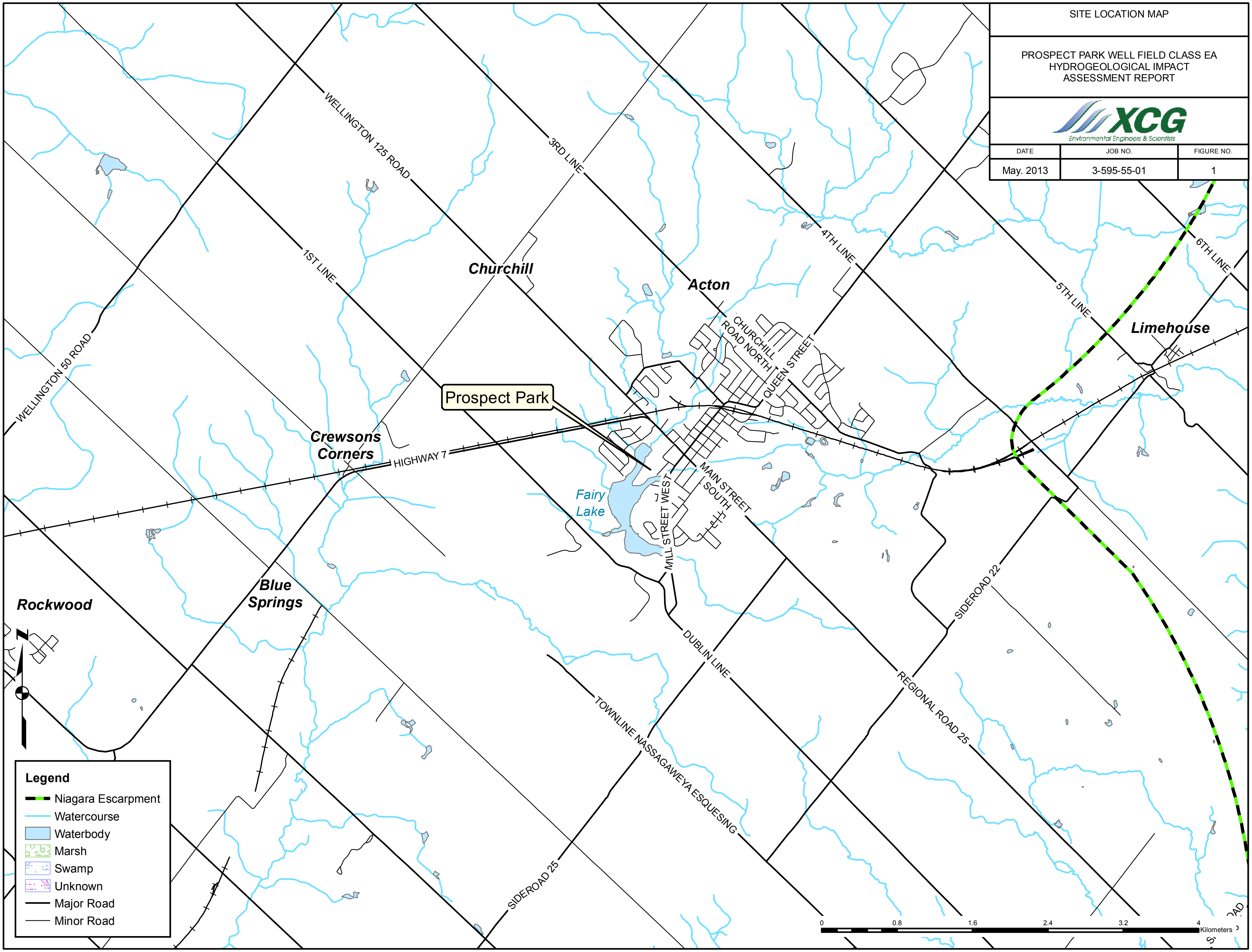
- To reduce the operational issues associated with pumping the wells under a two-tiered PTTW;
- To provide redundancy in the system that will make it easier to plan and implement maintenance activities and needed water system upgrades; and
- To service future growth in the community.

The impact assessment described in this report has been prepared to support an amendment to the PTTW allowing for the proposed increase in water takings. The impact assessment is based on the previous testing programs and studies undertaken at the Prospect Park well field and surrounding area.

1.1 Background on the Prospect Park Production Wells

Prospect Park Well No. 1 (PP1) was originally constructed in 1973 and has been in operation as a municipal water supply source for the Town of Acton since the early 1990s. In 2010, a stainless steel liner was installed in PP1 to address corrosion and other problems that had developed with the original well casing. The well screen is reported to be set at a depth interval from 18.8 to 24.4 m below the pump house floor (Lotowater, 2010). In 2011, a new submersible pump was installed in Well 1 and tested at flow rates of up to 40 L/s.

Prospect Park Well No. 2 (PP2) was constructed in 2002 with a reported screen setting of 17.1 to 23.2 m below surface (IWS, 2003). The well capacity was rated at 4,579 m^3/day (53 L/s) at the time of well construction (IWS, 2003).



SITE LOCATION MAP
PROSPECT PARK WELL FIELD CLASS EA HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT
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DATE
May. 2013
JOB NO.
3-595-55-01
FIGURE NO.
1
Churchill
Acton
Limehouse
Crewsons Corners
Blue Springs
Rockwood
Prospect Park
Fairy Lake
WELLINGTON 125 ROAD
3RD LINE
4TH LINE
5TH LINE
6TH LINE
1ST LINE
WELLINGTON 50 ROAD
HIGHWAY 7
CHURCHILL ROAD NORTH
QUEEN STREET
MAIN STREET SOUTH
MILL STREET WEST
DUBLIN LINE
REGIONAL ROAD 25
SIDEROAD 22
SIDEROAD 25
TOWNLINE NASSAGAWEYA ESQUESING
0
0.8
1.6
2.4
3.2
4
Kilometers
Legend
Niagara Escarpment
Watercourse
Waterbody
Marsh
Swamp
Unknown
Major Road
Minor Road

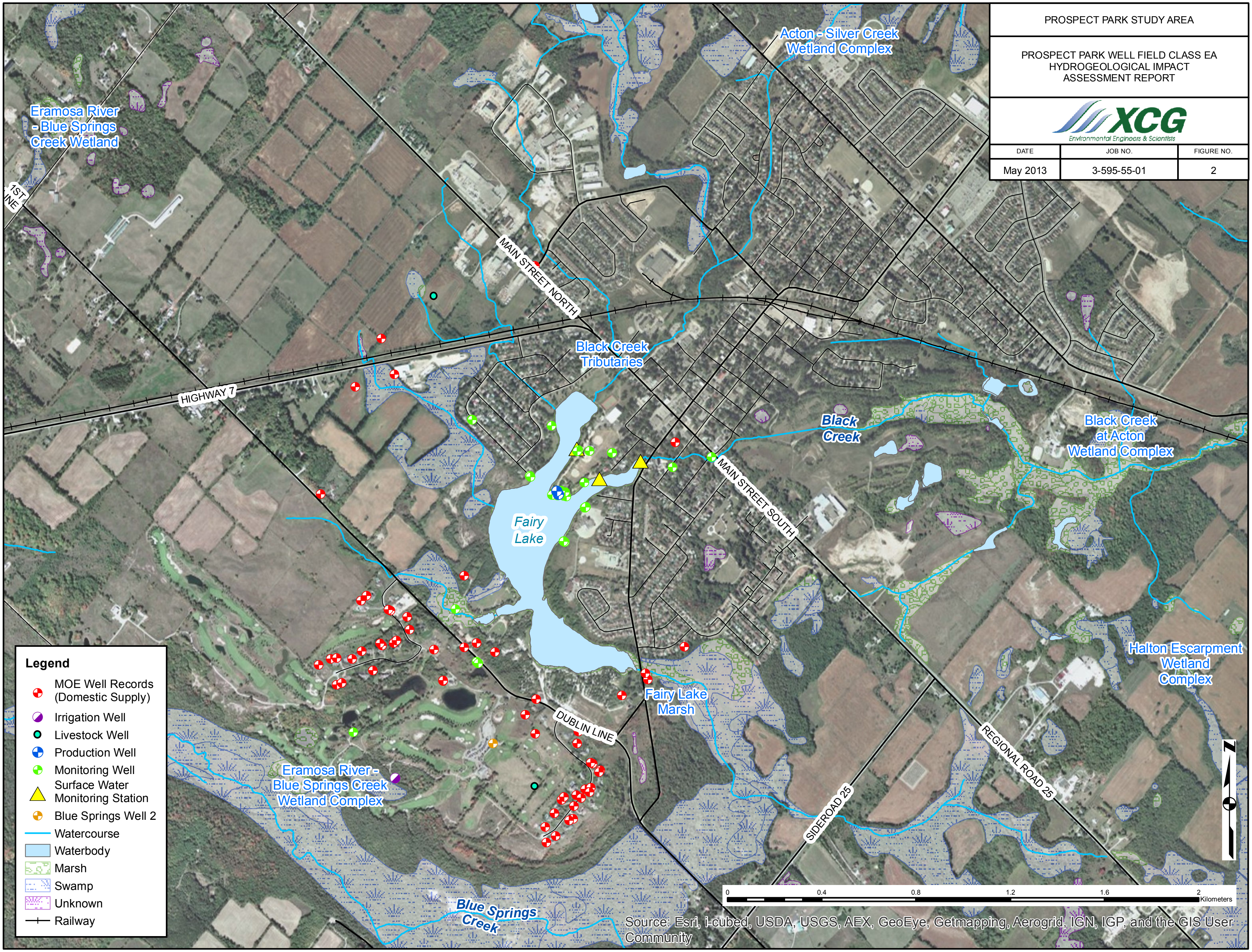
1.2 Site Setting

The regional site setting, land use and surface water features in the area of the well field are shown in Figure 2. The mapping is based on several sources including information from the Region, Ministry of Natural Resources, Credit Valley Conservation Authority and MOECC. Golder Associates recently completed a study for the Region (Prospect Park Groundwater Supply Study, May 2012), which is also an important source of information on the site setting.

A municipal park and some urban areas are located on the Prospect Park peninsula northeast of the well site. Urban areas also exist in the area of Acton northeast of the peninsula, and in areas to the east/southeast and northwest of the peninsula beyond Fairy Lake. All of these urban areas are serviced by the municipal water supply system. Undeveloped lands are located to the west of Fairy Lake; these lands are mostly agricultural and recreational. The Blue Springs Golf Course and nearby estate residential properties are located approximately 900 m southwest of the well field, beyond the edge of Fairy Lake.

The mapping indicates that there are five tributaries that discharge into Fairy Lake. Two of the tributaries flow into the lake from the north. Based on the mapping, at least one of these tributaries appears to originate from the Acton-Silver Creek wetland complex located approximately 2 km to the north of the lake. A third tributary flows into the lake from the northwest. The two remaining tributaries flow into the lake from the south; one of these (the southeast tributary) includes a wetland area referred to as the Fairy Lake Marsh. The Fairy Lake Marsh wetland area appears to merge with the Eramosa River-Blue Springs Creek Wetland Complex further west; a surface water divide is evident in the wetland area between the Fairy Lake Marsh tributary and Blue Springs Creek.

Outflow from Fairy Lake occurs at a dam located on the east side of the lake. The dam controls lake water levels, but it is not actively managed; Black Creek continues east downstream of the dam. The Black Creek at Acton wetland complex is located about 1.5 to 2 km to the east of Fairy Lake.


PROSPECT PARK STUDY AREA
PROSPECT PARK WELL FIELD CLASS EA
HYDROGEOLOGICAL IMPACT
ASSESSMENT REPORT
XCG
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DATE
JOB NO.
FIGURE NO.
May 2013
3-595-55-01
2
Acton - Silver Creek Wetland Complex
Eramosa River - Blue Springs Creek Wetland
1ST LINE
MAIN STREET NORTH
HIGHWAY 7
Black Creek Tributaries
Black Creek
Black Creek at Acton Wetland Complex
MAIN STREET SOUTH
Fairy Lake
Halton Escarpment Wetland Complex
Fairy Lake Marsh
DUBLIN LINE
REGIONAL ROAD 25
SIDEROAD 25
Eramosa River - Blue Springs Creek Wetland Complex
Blue Springs Creek
Legend
MOE Well Records (Domestic Supply)
Irrigation Well
Livestock Well
Production Well
Monitoring Well
Surface Water Monitoring Station
Blue Springs Well 2
Watercourse
Waterbody
Marsh
Swamp
Unknown
Railway
0
0.4
0.8
1.2
1.6
2
Kilometers
N
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

2. REVIEW OF BACKGROUND INFORMATION

Previous reports and studies that were reviewed for the preparation of this impact assessment report include:

- Prospect Park Well Field Impact Assessment (Dillon, 2007);
- Prospect Park Well Field Impact Assessment (Dillon, 2010);
- Prospect Park Well Field Groundwater Supply Study (Golder, 2012);
- Halton Hills Tier 3 Water Budget and Water Quantity Risk Level Assignment Study: Conceptual Model Report (AECOM, AquaResource Inc., 2012); and
- Black Creek Assimilative Capacity Study, Draft Report (Dillon, 2011).

The findings of these studies are described in the following subsections. Copies of these reports are provided in Appendices A through E, respectively.

2.1 Prospect Park Well Field Impact Assessment (Dillon, 2007)

As part of a Master Plan undertaking, an impact assessment of a proposed increase in water taking from the Prospect Park wells was completed in 2007 (Dillon, 2007). The assessment considered an increase to an annual average amount taking of 3,000 m^3/day and a maximum daily taking of 4,546 m^3/day. At the time of the assessment, it was reported that the PTTW allowed the wells to operate at the higher rate (4,546 m^3/day) only in emergency situations.

The impact assessment included an environmental baseline study (EBS) which was undertaken from December 3, 2004 to January 14, 2005, and from August 16, 2005 to August 30, 2005. The EBS included the following components:

- Monitoring of Water Temperature in Black Creek;
- Measurement of Surface Water Quality and Streamflow in Black Creek;
- Investigation of the Fish Community in Black Creek and Fairy lake;
- A survey of Black Creek Spawning Redds for Salmonids;
- A survey of the Black Creek Benthic Community;
- Field Studies to Determine Potential for Herpetofaunal Habitat;
- Investigation of the Mill Street Culvert to Assess Potential For Fish Migration;
- Measurement of Surface Water Levels at Various Wetland Monitoring Stations and comparison to Precipitation Data; and
- Measurement of Groundwater Levels at Monitoring Well and Mini-Piezometer Locations.

Dillon (2007) provided a description of the hydrogeological conceptual model of the study area, which included the following points:

- The regional geology is made up of glacial sediments that are underlain by dolostone bedrock of the Amabel Formation. Note that the Silurian stratigraphy has since been modified by Brunton (2009), and the productive zones of the Amabel Formation are now typically referred to as the Gasport Formation; and
- Previous studies identified a bedrock valley present under the Prospect Park well field, and that Black Creek roughly follows the alignment of this bedrock valley. The bedrock

valley is about 1,800 metres in width in the study area, and is infilled with approximately 30 metres of glaciofluvial sediments (mainly sands and gravels) referred to as the Prospect Park Aquifer.

A long-term pumping test undertaken as part of the impact assessment was completed in five stages, described by Dillon (2007) as follows:

1. **Stage 1 –** Five-day period (August 25, 2005 to August 30, 2005) of reduced pumping at the well field to allow groundwater levels to recover to a pre-test level that approximates a static (pre-pumping) condition;
2. **Stage 2 –** Using Well 2 as the pumping well, conducted a 30-day constant rate pumping test at an average flow rate of 2,924 m^3/day, over the period August 30, 2005 to September 29, 2005;
3. **Stage 3 –** A low-pumping period from September 29, 2005 to November 28, 2005 (between the 30-day and the 15-day pumping tests), during which the average pumping rate was approximately 1,000 m^3/day;
4. **Stage 4 –** Using Well 2 as the pumping well, conducted a 15-day pumping test (November 28, 2005 to December 10, 2005) with an average pumping rate of approximately 4,182 m^3/day; and
5. **Stage 5 –** A five-day recovery period after the 15-day pumping test during which water level recovery was monitored (until December 15, 2005).

The design of the long-term pumping test appeared to balance the need to maintain the municipal drinking water supply from the wells with the need to collect data suitable for analysis under a structured pumping test format.

Based on their analyses of the long term pumping test data, Dillon (2007) reported the following:

- The geometric mean transmissivity (T) estimates obtained from the results were 2.5 x 10^{-2} m^2/s (2,160 m^2/day) from the 30 day pumping period in Stage 2 of the test, and 2.8 x 10^{-2} m^2/s (2,419 m^2/day) from the 15-day pumping period in Stage 4 of the test; and
- The storativity value obtained for both the 30-day test and the 15-day test was 1.4 x 10^{-2}.

Dillon (2007) reported that no measurable effects on Fairy Lake were observed during the 15-day (4,182 m^3/day) and 30-day (2,924 m^3/day) stages of the pumping test. This conclusion was supported by the following analyses and interpretations:

- Analyses using the Darcy equation indicated that vertical leakage to the underlying Prospect Park Aquifer from Fairy Lake during the pumping test was <0.1% of the actual pumping rates; this level of effect corresponds to a lake level drop of less than 1 cm (essentially too low to measure);
- Analyses of the pumping test data indicated that graphs followed the Theis curve and that distance-drawdown plots displayed only one slope, both of which suggest that leakage is insignificant;
- Analyses of the pumping test using Darcy's equation indicated that the pumping wells were being supplied mainly by horizontal flow in the aquifer, with little or no requirement for a vertical leakage component to sustain the flow rates used during the test;

- Fairy Lake water levels were shown to correlate closely with precipitation events; there was no evidence of a correlation to the changes (increases) in pumping rates at the well field; and
- The masking effect of precipitation events on pumping test water levels in Fairy Lake was not significant.

Dillon (2007) also concluded that water taking during the pumping tests did not have any impact on baseflow to Black Creek or on the wetlands adjacent to Fairy Lake, based on the following observations:

- The radii of influence of both tests did not extend beyond Fairy Lake and did not extend east of the Fairy Lake Dam;
- Water levels in a monitoring well (TW6/91) adjacent to Black Creek did not show any drawdown during either of the pumping tests;
- The upward hydraulic gradient under Black Creek was unchanged during the pumping tests;
- The streamflow in Black Creek did not exhibit any decreasing trends during the pumping tests, and did not exhibit any increase in streamflow during the recovery periods; and
- Water level fluctuations in the wetlands around and downstream of Fairy Lake were within pre-test ranges, and the wetlands are also located beyond the calculated zero drawdown contours for the shallow groundwater zone.

Dillon (2007) reported that equilibrium pumping conditions were reached by the end of the 30-day pumping test (at 2,924 m^3/day) and that 97 percent equilibrium was reached at the end of the 15-day pumping test (at 4,182 m^3/day). Essentially, there would be little or no additional drawdown beyond what was observed during the pumping tests if they had been allowed to continue.

Dillon (2007) concluded that water taking from the Prospect Park wells at rates marginally greater than the rates used for the pumping tests would result in drawdown conditions similar to those observed during the pumping tests. The extra flow to the well would be achieved through a deepening of the drawdown near the pumping well, without any significant expansion of the zero drawdown limits.

Dillon (2007) also concluded that the results of their analyses indicated that pumping from PP2 at an average day demand of 3,000 m^3/day and a maximum day demand of 4,544 m^3/day would be sustainable in the long term and would not cause measurable impact on the surface water or groundwater systems, or on the aquatic habitats of Black Creek, Fairy Lake, and the adjacent wetlands.

Correspondence between CVC and the Region during the preparation of this report highlighted extensive comments from the CVC with regards to the analysis and study findings. Further study requirements for ecological features as identified by CVC include:

- Collection of more pumping test data over a stable representative summer period;
- Further interpretation and analysis of the available data to support the conclusion that long term pumping at higher rates will not result in a negative impact to Black Creek and the surrounding features;

- Isolation of the effects of precipitation to more closely examine a relationship with the pumping test and lake levels;
- Collection of additional flow data from the Fairy Lake dam and development of an Operational Management Plan that considers ecological needs both upstream and downstream of the dam;
- Contour mapping to measure areas of littoral and flooded habitats and impacts resulting from water level decreases in Fairy Lake and surrounding wetlands;
- Spawning areas for known trout populations should be identified, and monitoring of groundwater levels and vertical hydraulic gradients conducted;
- Additional characterization of the catchment contributing to Fairy Lake that influences lake levels and downstream flow;
- Determination of threshold(s) for a variety of ecological objectives and relation to a Dam Operations Plan; and
- Integration of data and management plans with other studies in the subwatershed.

These considerations were addressed in part in the subsequent study conducted by Dillon in 2010, which is discussed in the following section. Documentation of the correspondence regarding CVC's comments of the Impact Assessment Report (Dillon, 2007) is provided in Appendix F.

2.2 Prospect Park Well Field Impact Assessment (Dillon, 2010)

In order to address some outstanding concerns following the 2007 assessment, the Region initiated additional testing and study during the period 2008 to 2010. The objective was to complete an impact assessment for a proposed increase in water taking at the well field to an average of 3,000 m^3/day on a continuous basis. The additional work included

- An evaluation of historical groundwater levels since pumping began at the site;
- Installation of monitoring wells at seven locations;
- An extended pumping test from December 2009 to March 2010 (77 days in duration); and
- Detailed analysis and interpretation of the data collected during the pumping test.

The additional monitoring wells were intended to supplement the existing monitoring network and provide additional locations to measure the aquifer system response to pumping. The purpose of the long-term pumping test was to assess changes in the capture zone that would result from the proposed increase in water taking and to further assess the effects on water levels in Fairy Lake, Black Creek and various wetlands.

Details of the pumping test were reported as follows:

- Prior to the start of the test, wells PP1 and PP2 were shut down for an 8-day period (December 14-22, 2009), to allow water levels to recover to approximate static conditions;
- The test started on December 22, 2009, and was run at an average continuous pumping rate of 3,033 m^3/day for 77 days, until March 9, 2010;
- The approximate pumping rates at each individual well were as follows: PP1 at 864 m^3/day (10 L/s); PP2 at 2,160 m^3/day (25 L/s). The wells operated to the distribution system during the test; flow exceeding the system demand was discharged via a temporary pipeline to Black Creek, below Fairy Lake dam;

- Groundwater levels and temperatures were recorded manually and electronically at 35 monitoring wells and at three Fairy Lake monitoring points during the test (from December 14, 2009 to April 1, 2010); and
- The vertical hydraulic gradients were mapped in monitoring well nests to assess impacts around Fairy Lake.

Based on the analysis and interpretation of the test results, Dillon (2010) reported the following:

- No significant aquifer boundary conditions were evident during the 77-day pumping test;
- The time-drawdown and distance-drawdown graphs of the test data indicated that the aquifer response to pumping was similar to that of an ideal aquifer receiving little or no leakage; as a result, traditional analytical methods and assumptions (Theis, Jacob) were valid under the given aquifer conditions;
- Horizontal flow in the aquifer sediments accounted for essentially all of the discharge from the wells. The drawdowns observed in the shallow monitoring wells indicated that vertical hydraulic gradients to the aquifer were present, but these did not show a measureable effect on the time-drawdown data in the production wells and the observation wells completed in the aquifer;
- Analysis of the time-drawdown data produced an aquifer transmissivity (T) value of approximately 1×10^{-2} m^2/sec, similar to the mean T value estimated in the 2007 assessment (2.2×10^{-2} m^2/sec);
- The radius of influence at the end of the 77 day test was estimated to be approximately 500 m in the shallow (water table) groundwater zone and 700 m in the deep (main aquifer) groundwater zone; these estimates were based on distance-drawdown analyses of the pumping test data;
- Monitoring of the water levels in Fairy Lake showed no evidence of a decline that could be correlated with the pumping test; fluctuations in lake level were observed during precipitation/meltwater events;
- Water temperature monitoring data provided no evidence to suggest that the production wells were discharging water originating from Fairy Lake.
- The results of environmental isotope analyses ($^{18}O/^{16}O$, D/H) provided no evidence of a contribution of water from Fairy Lake to the discharge from well PP1. The isotope results were inconclusive for PP2;
- The main source of groundwater produced at the Prospect Park Well Field (PP1 and PP2) is horizontal flow in the aquifer sediments in the buried bedrock valley that occurs in the vicinity of, and to the east of, the well field;
- Pumping from PP1 and PP2 at a combined rate 3,033 m^3/day caused no measurable drop in the water level in Fairy Lake; this conclusion was based on (i) calculations indicating that vertical leakage from the lake would have caused less than a 1 cm drop in lake level (a non-measurable effect), (ii) the analysis showing that well discharge was sustained by horizontal flow in the aquifer (using water level data and horizontal hydraulic gradients near PP1, PP2), (iii) the absence of boundary effects in the pumping test data;

- The pumping test had no measurable effect on the upward hydraulic gradients occurring beneath Black Creek to the east/northeast; as a result, there was no effect of the test on flow in Black Creek;
- The drawdown cone resulting from pumping at wells PP1 and PP2 expands to the east within the bedrock valley containing the Prospect Park aquifer;
- Dillon (2010) concluded that pumping the wells at a combined rate of 3,000 m^3/day is sustainable in the long-term and will not cause measureable impacts to (i) groundwater and surface water systems or (ii) the aquatic habitats in Fairy Lake, Black Creek and the adjacent wetlands; and
- Dillon (2010) provided recommendations for a monitoring program to be implemented once the wells begin operating on a continuous basis; the recommendations included (i) continuous water level monitoring in the production wells and selected monitoring wells, (ii) surface water level monitoring at the Fairy Lake level monitoring stations, (iii) additional sampling and isotope analyses at the production wells.

2.3 Prospect Park Well Field Groundwater Supply Study (Golder, May 2012)

The Region initiated further study of the well field to determine whether the water taking could be increased and modified so that the well field could operate at a constant rate, year-round. The Prospect Park Groundwater Supply Study report (PPGSS) acknowledged at the start that previous testing had indicated that the well field capacity was over 4,500 m^3/day. It also noted that there were concerns about whether higher flow rates were sustainable with respect to impacts on local environmental features and aquatic habitat. The scope of work for the study included the following:

- A background review of relevant available study reports;
- An analysis and interpretation of well field pumping tests undertaken by the Region of Halton in 2009 and 2010;
- Initiation of a surface water monitoring program to support a water budget analysis of Fairy Lake; and
- An assessment of the environmental effects of pumping the Prospect Park well field at a constant rate of 3,400 m^3/day.

An interpretation of the hydrogeology and a summary of the natural environmental features were prepared based on existing information from previous work.

2.3.1 Hydrogeology

Figure 3 presents the hydrogeological conceptual model developed as part of the PPGSS with the following components:

- The main aquifers are the Gasport Formation (bedrock) and Prospect Park aquifer (overburden completion unit for the production wells), which have some connection: horizontal groundwater flow occurs in the aquifers, recharge occurs by direct infiltration of precipitation or leakage (vertical flow) through overlying till (where present);
- The water surplus in the Black Creek catchment area reaches the creek as either runoff or horizontal groundwater discharge; and
- Seepage losses to deeper bedrock units are insignificant relative to the water surplus reaching the creek.

HYDROGEOLOGICAL CONCEPTUAL MODEL
(GOLDER, 2012)

PROSPECT PARK WELL FIELD CLASS EA
HYDROGEOLOGICAL IMPACT
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DATE	JOB NO.	FIGURE NO.
May. 2013	3-595-55-01	3

PLOT DATE: April 16, 2012
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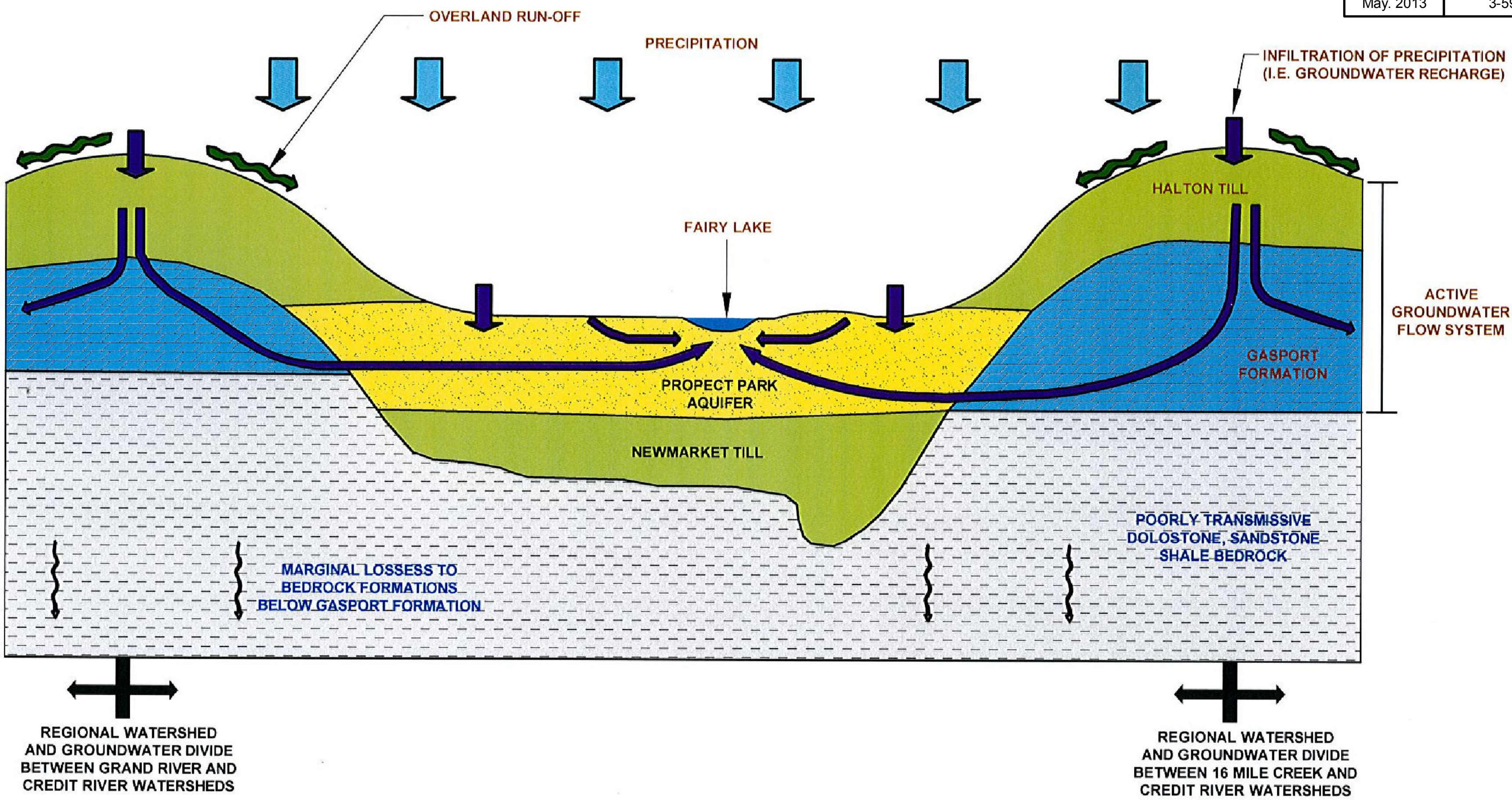

PROJECT
PROSPECT PARK
GROUNDWATER SUPPLY STUDY

TITLE
HYDROGEOLOGICAL CONCEPTUAL MODEL

PROJECT No.		11-1152-0142	FILE No. 1111520142BB010.dwg
DESIGN			SCALE AS SHOWN REV. A
CAD	KD	March 12, 2012	FIGURE No.
CHECK	SMD	March 12, 2012	
REVIEW	SMB	April 26, 2012	10

Golder Associates
Mississauga, Ontario, Canada

2.3.2 Natural Environment

The following general conditions for Fairy Lake and Black Creek were reported:

- Fairy Lake was created by damming Black Creek in the 1800s;
- Fairy Lake and Fairy Lake Marsh are components of the Eramosa River-Blue Springs Wetland Complex;
- Average depth of Fairy Lake is about 3 m, with an approximate range from < 1 to 7 m;
- Fairy Lake has moderate to poor water quality, with elevated nutrient levels;
- Vegetation (native and invasive species) occurs along riparian areas and within the lake;
- Fairy Lake supports a diverse warm water fish population, but lacks high quality fish habitats;
- The dam prevents fish migration between the lake and Black Creek downstream;
- Fairy Lake is a headwater of Black Creek downstream of the dam;
- The upper reaches of Black Creek include sections classified as warm water fish habitats;
- Lower reaches of the creek outside of the study area support cold water fish species and are managed as a cold water fishery; and
- Studies by Dillon (2007) and the CVC (2010) are cited indicating that Brook trout are not present in Black Creek downstream of Fairy Lake to unspecified points past the wastewater treatment facility discharge; benthic surveys in this area of the creek undertaken by Dillon (2007) were cited as showing a low taxa diversity of the benthic macroinvertebrates.

As shown in Figure 2, other significant natural features occurring within the general area include:

- Eramosa River–Blue Springs Wetland Complex;
- Black Creek at Acton Wetland Complex;
- Acton–Silver Creek Wetland Complex; and
- Fairy Lake and Fairy Lake Marshes ESA (part of Eramosa River–Blue Springs Creek Wetland complex.

2.3.3 Well Field Pumping Tests

The results from two extended pumping tests were reviewed and assessed as part of the study. The first was the test undertaken for 77 days during the winter months (December 22, 2009 to March 9, 2010) at a flow rate of 3,045 m^3/day and reported upon by Dillon (2010). The second test was undertaken by the Region at a flow rate of 4,400 m^3/day for a 111 day period during the summer/fall of 2010 (June 14 to November 1, 2010).

The study included a detailed analysis of both pumping tests and documented the analyses in Appendix B of the PPGSS. The main findings from the analyses were reported as follows:

- Transmissivity (T) of the Prospect Park aquifer was interpreted to range from 7.2×10^{-3} m^2/s – 9.3×10^{-3} m^2/s (620 – 800 m^2/day) based on water level responses observed during the first pumping test. Using an average aquifer thickness of 20 m, hydraulic conductivity was estimated to range from 4×10^{-4} m/s to 5×10^{-4} m/s;

- During the second pumping test, drawdown in the aquifer resulting from pumping at the Prospect Park wells stabilized to a steady-state condition. Analysis of the steady-state condition indicated that approximately 73% of the well field production was sustained by horizontal groundwater flow within the groundwater catchment area; the remaining 27% was sustained by vertical drainage within the local surface catchment areas;
- During the second pumping test, drawdown in the Prospect Park aquifer ranged from 2 m near the production wells to < 0.1 m at distances beyond 500 to 2,000 m from the production wells. The area of influence associated with the pumping test was estimated at approximately 1.5 km^2, and occurred mostly within the surface catchment area for Fairy Lake; and
- The zones of influence for the two pumping tests were similar. As a result, groundwater and surface effects arising from steady-state (or long term) pumping at the then target rate of 3,400 m^3/day should be consistent with what was observed during the tests.

2.3.4 Potential Effects of an Increase in Pumping Rate

The study reported the following conclusions with respect to the potential effects of operating the well field at a continuous flow rate of 3,400 m^3/day (relative to current operating rates specified in the PTTW):

- The drawdown cone will be similar to that observed during the pumping tests; the drawdown cone should encompass an area of about 1.2 – 1.5 km^2, with approximately 1 to 2 m of drawdown in the Prospect Park aquifer beneath Fairy Lake and < 0.1 m of drawdown at the fringes of the cone;
- No measurable drawdown of shallow groundwater levels or surface water levels is expected because of the low hydraulic conductivity (K) of the lake bottom sediments and the surficial glacial till sediments;
- Seepage losses from the Blue Springs Catchment area expected to be < 25 m^3/day; this loss is less than 1% of the $7Q_{20}$ at the Blue Springs Creek stream gauge to the west of the study area;
- Fairy Lake could potentially be affected as follows during the spring/summer period: a lake level decline of 5 cm could occur; the lake level would drop below the outflow weir two weeks earlier in the spring (May); the lake level would recover above the weir two weeks later in late summer/early fall (September);
- Groundwater pumped from the well field during the pumping tests would otherwise have mostly discharged to Fairy Lake; therefore, the potential effects of the tests on groundwater discharge to Black Creek downstream of the dam were negligible. Black Creek is known to be intermittent between Fairy Lake and the Acton Wastewater Treatment Plant (WWTP) during the summer months; the proposed increase in pumping rate should have no measurable effect on streamflow rate or temperature in Black Creek; and
- No adverse effects on fish and aquatic habitat (including wetlands in Fairy Lake) are expected. The potential increase of the no-flow duration in Black Creek downstream of the dam (2 weeks earlier in spring and 2 weeks later in late summer) is not expected to have adverse effects on fish and aquatic habitat. It was suggested that offsetting

mitigation measures, such as an adjustment of the weir elevation at the dam, be considered to allow a reduction in the duration and magnitude of the low or no flow condition in the upper section of Black Creek.

2.3.5 Overall Conclusions of the PPGSS

The well field can easily sustain a continuous pumping rate of 3,400 m^3/day year round. At the proposed continuous pumping rate of 3,400 m^3/day:

- Seepage losses from the surface catchments within the zone of influence will account for 27 percent (920 m^3/day) of the water taking; horizontal groundwater flow in the Prospect Park/Gasport Formation aquifers beneath a 0.6 km^2 capture area will account for the remaining 73 percent (2,480 m^3/day) of the water taking;
- No interference with the operation of private wells will occur;
- Existing surface water features in the area have limited catchment areas and are already sensitive to the seasonal weather trends; relative to the existing seasonal variability in the water surplus available to support the surface water features in the area, seepage losses due to the proposed increase in pumping should have no measurable effect on the variation in streamflow rate or temperature currently observed within the surface water features;
- Declines in shallow groundwater levels beneath terrestrial areas (including wetlands) located within the pumping zone of influence will be small and unlikely to create a measurable effect; monitoring can be used to track changes in specific areas such as Provincially Significant Wetlands; and
- The proposed increase in pumping rate should lower the average water level in Fairy Lake by a small amount (estimated at approximately 5 cm) during the summer months. The predicted effect represents a low risk to the fish and aquatic habitat in Fairy Lake.
- There will be no impacts to wildlife habitat.

2.4 Halton Hills Tier 3 Water Budget and Water Quantity Risk Level Assignment Study: Conceptual Model Report (AECOM, AquaResource Inc., October 2012)

The Conceptual Model Report was prepared as part of the ongoing Halton Hills Tier 3 Water Budget and Water Quantity Risk Level Assignment Study (Tier 3 Study-Conceptual Model). The overall objective of the report was to present a revised geological/hydrostratigraphic conceptual model for the Acton and Georgetown study area. The revised conceptual model is to be used as the critical element in the development/refinement of the numerical model required under the Tier 3 Study.

The report provides a description of the Prospect Park production wells and aquifer. In the description, the report notes that the existing PTTW restricts the water taking due to environmental concerns that the well may draw in surface water from Fairy Lake under higher pumping rates. The report notes that the reduced rate of water taking in the PTTW (1,137 m^3/day from October 1 to April 30) coincides with the fish spawning season.

The conceptual model report provides a regional scale interpretation of the hydrogeology in the Halton Hills area, with a focus on conditions relevant to the municipal wells in Georgetown and Acton. The report notes that the Prospect Park wells are screened in a buried bedrock valley aquifer cut into the Niagara Escarpment. The buried bedrock valley was formed by rivers eroding through the bedrock and depositing coarse-grained sediments. Figure 3-3 of the Tier 3 Study-Conceptual Model indicates that the Acton/Georgetown buried bedrock valley extends from Georgetown west through Acton and the Prospect Park well field. The Prospect Park well field is located near the western end of the buried valley. The report notes that the buried bedrock valley between Acton and Georgetown was a focus of the Tier 3-Conceptual Model study as the overburden aquifers in the valley are thought to contribute most of the groundwater produced from the Georgetown municipal wells. The report notes that monitoring well MW15-09, located southwest of the Prospect Park wells and south of Fairy Lake, is upgradient of the Prospect Parks wells. The aquifer is reported to be thinner at the MW15-09 location (3 to 4 m of sand and gravel) compared to the aquifer at the well field (10 to 25 m of coarse-grained sediments). An elevated area or 'notch' in the Acton/Georgetown bedrock valley floor was identified near Limehouse, approximately 5 km east of Prospect Park.

Figure 4 shows the updated regional bedrock geology (AECOM and AQR, 2012), and Figure 5 shows a geologic cross section intersecting the Acton/Georgetown bedrock valley, including the Prospect Park well field (AECOM and AQR, 2012).

UPDATED REGIONAL BEDROCK GEOLOGY
(AECOM AND AQR, 2012)

PROSPECT PARK WELL FIELD CLASS EA
HYDROGEOLOGICAL IMPACT
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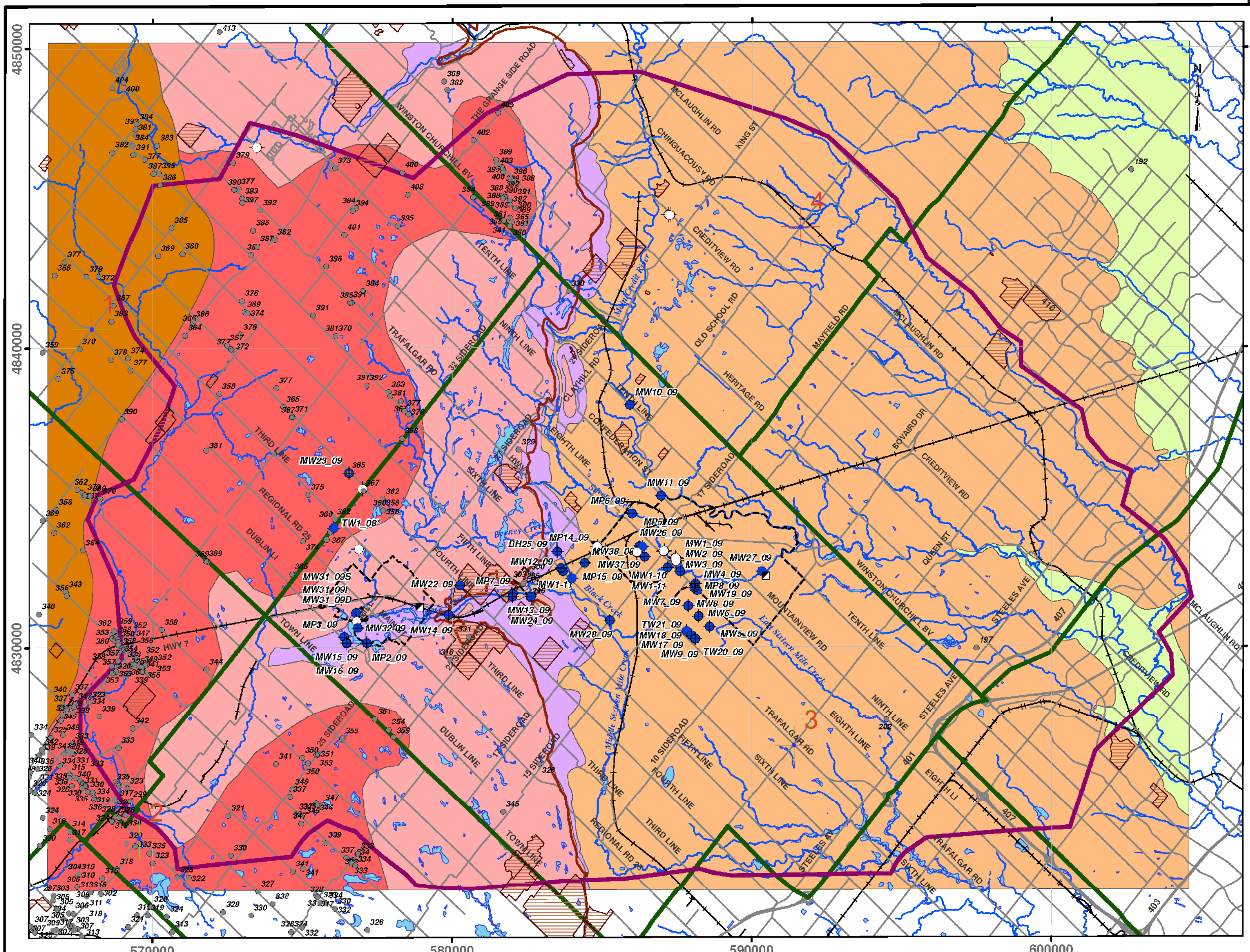
May 2013	3-595-55-01	4



Halton Tier Three Water Budget – Conceptual Model Report

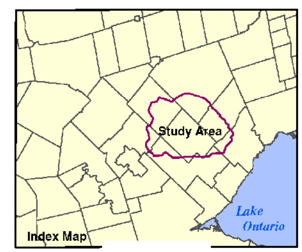
LEGEND

- Municipal Wells
- Halton Wastewater Treatment Plant
- AECOM Wells (2009)
- Probable Vinemount Occurrences
- Roads
- Railways
- Escarpment
- Rivers and Streams
- Lakes and Ponds
- Study Boundary
- Communities
- Municipality
- Pits or Quarries

Paleozoic Geology

- Guelph Fm.
- Eramosa-Vinemount Fm.
- Gasport Fm.
- Whirlpool, Manitoulin, Cabot Head, Fossil Hill
- Queenston Fm.
- Georgian Bay Fm.

NOTES:
TW1_08* - also referred to as AMEC TW1, AMEC TW1_08, or MW32_08



Scale 1:125,000

2.5 0 2.5 5

Kilometers

REFERENCES:

Base Data -

Projection: UTM Zone 17N, NAD 83
Map Version: 1; Map Date: September, 2012; Created By: ccurry

Base data information (interim list):

Base map layers - see Figure 1.
Bedrock Geology - PaleozoicGeology_HT3_v3.shp

AECOM AquaResource A Division of Matrix Solutions Inc.

Figure 3-11. Updated Paleozoic Bedrock Geology

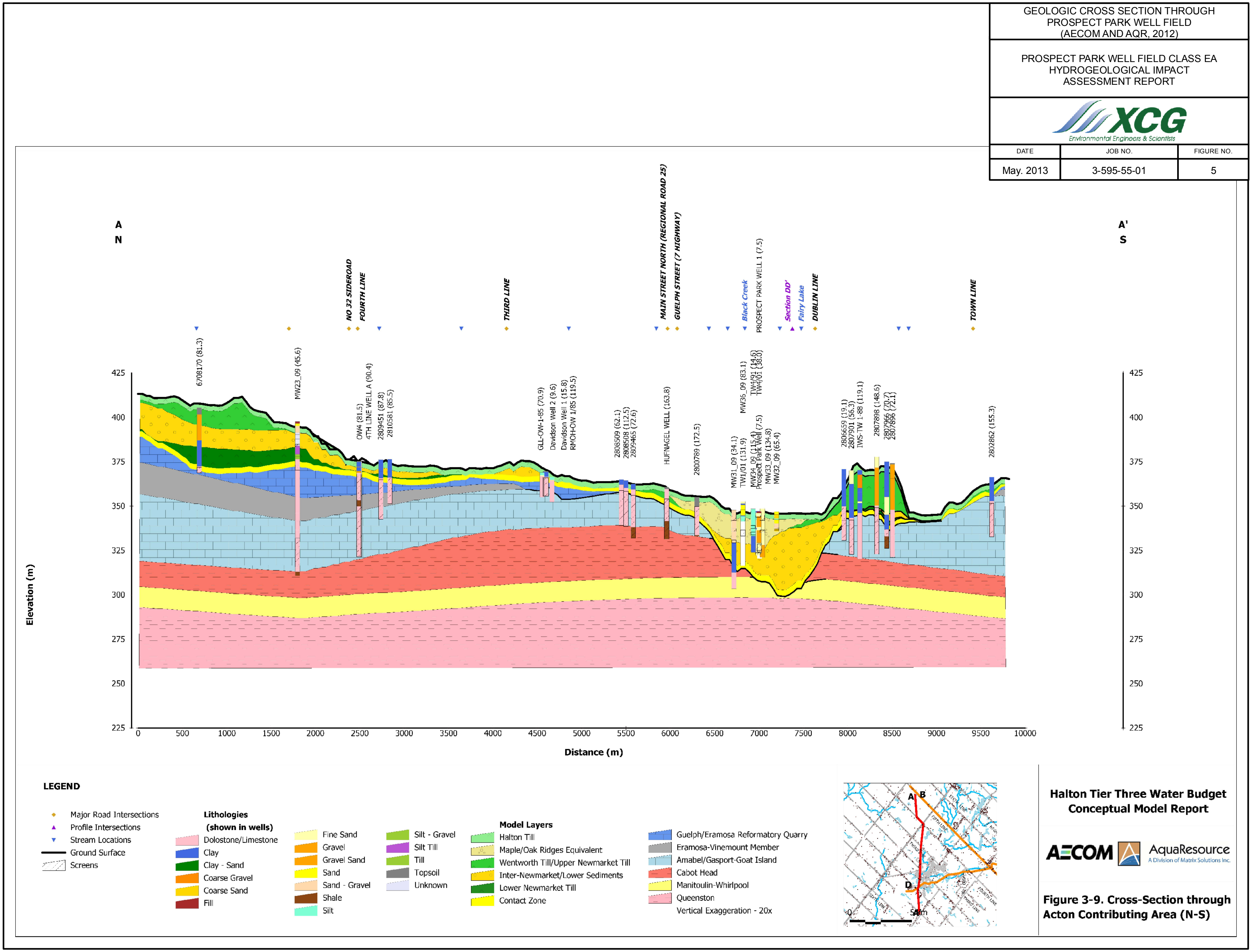


Figure 3-9. Cross-Section through Acton Contributing Area (N-S)

2.5 Black Creek Assimilative Capacity Study, Draft Report (Dillon, 2011)

An assimilative capacity assessment of Black Creek, located downstream of Fairy Lake, was conducted as part of the Acton WWTP Class EA study. Flow data from 2007 to 2009 and water quality data collected as part of a field sampling and monitoring program conducted from June to August of 2007 were assessed. As part of the field program, data was collected from temperature loggers, bi-weekly water sample results, intensive diurnal surveys in June and August of 2007, water depth and velocity measurements, and benthic invertebrate sampling results. Further, low flow analyses and assimilative capacity modelling results were used in conjunction with water quality data to determine the impact of increased WWTP effluent discharge to the receiving stream. A summary of the sampling locations is provided in Table 1.

Table 1 Sampling Program by Location (Dillon, 2011)

Station	Location
B1	Outlet from Fairy Lake
B2	Upstream of Acton WWTP
B3	3rd Line/Glen Lawson
B4	5th Line
B5	No. 17 Sideroad and 6th Line
B6	8th Line (above confluence with Silver Creek)
S1	Acton WWTP Effluent
T1	North Branch Black Creek at 6th Line

A summary of the Black Creek flow rate estimates based on average channel width, velocity, and depth measurements is presented in Table 2. It should be noted that the study defines the 7Q20 flow for Black Creek as 1,400 m^3/d (16.2 L/s).

Table 2 Black Creek Flow Summary Data - Summer 2007 (Dillon, 2011)

Date	Monitoring Station Estimated Flow Rate (L/s)							
	Black Creek							
	B1	B2	S1(1)	B3	B4	B5	B6	T1(2)
14-Jun-2007	28	53	48	164	234	244	342	34
25-Jul-2007	10	22	39	117	170	165	245	14
31-Aug-2007	2	n/a	38	78	198	173	234	3
Average	**13.3**	**37.5**	**41.7**	**119.7**	**200.7**	**194.0**	**273.7**	**17.0**

Notes:
1. Acton WWTP effluent flow data provided by the Regional Municipality of Halton.
2. North Branch of Black Creek.

As shown in Table 2, the average flow rate along Black Creek increases consistently as it moves downstream with the most upstream location at the Fairy Lake outlet (Station B1) contributing the least amount of flow, and the downstream locations providing significantly more flow to the Creek. The noted increasing trend in the system flow rate indicates that the Black Creek study area is subject to groundwater inputs. In addition to the low flows, the study notes beaver dams in the vicinity of Station B2, resulting in backwater effects. On August 31, 2007, a flow estimate at Station B2 could not be made due to backwater movement caused by a high level of beaver activity.

Two options were examined to increase the flow in Black Creek for dilution and mixing of the Acton WWTP effluent discharge: (1) Fairy Lake augmentation and (2) Dufferin Aggregates augmentation. Fairy Lake augmentation involves a strategy for operating the dam and controlling lake water levels and outflows. It is noted that if the water levels were permitted to rise and/or drop by 0.3 m, then 0.3 to 0.6 m of water could be stored and released slowly into Black Creek in addition to the current flow rate over the outlet weir. Implementation of this option would require:

- An assessment of the impacts on the wetland and fishery, and shore land uses;
- Consideration of the acceptability of a change in operation of the lake;
- An analysis of continuous operation of the lake levels to meet various targets with predictions of water level fluctuations; or
- Construction of a low flow outlet at the location of the dam with a manually controlled valve, if acceptable.

The Dufferin Aggregates quarry, located at Station B3, has a daily maximum allowable release to Black Creek of 0.14 m^3/s, based on the Permit to Take Water that was presumably re-issued following its expiration in October 2007. The Dufferin Aggregates augmentation option considers pumping part of the quarry outflow upstream to Black Creek at the WWTP outfall, increasing the receiving stream flow at the effluent discharge. Implementation of this option would require:

- An assessment of the availability of water on a continuous basis and in the long-term;
- Establishment of an agreement for the diversion of water; and
- Costing for pumping, location of the pump operation, and potential routes of a diversion pipe.

3. EXISTING CONDITIONS

The existing conditions in the area of the Prospect Park well field have been described in detail in various previous reports (Halton Hills Tier 3 Conceptual Model Report 2012; PPGSS, 2012; Dillon, 2010; Dillon, 2007; Dillon, 2011). Based on these reports, a relatively brief summary of the existing conditions is provided in this section.

3.1 Quaternary and Bedrock Geology

The study area is located in the physiographic region described by Putnam and Chapman (1984) as the Horseshoe Moraines, located west of and overlying the Niagara Escarpment. The Paris, Galt and Acton Moraines occur in the general area. The moraines are glacial deposits of till, ice contact sediments and glaciofluvial outwash sediments.

Figure 6 shows mapping of the surficial geology of the local area, which was generated from digital mapping data obtained from the Ontario Geological Survey (Surficial Geology of Southern Ontario, Miscellaneous Release- Data 128 Revised).

The Prospect Park well field occurs above the Acton/Georgetown buried bedrock valley. Sediments (sand and gravel) infilling this buried bedrock valley form productive aquifers, including the Prospect Park aquifer. The existing studies provide a detailed interpretation of the overburden and bedrock geology in the area of the Prospect Park aquifer. Based on these previous studies, the overburden geologic units (starting with the uppermost units) in the area can be described as follows:

- **Halton Till**: Fine grained sandy silt till to clayey silt till, generally less than 10 m in thickness;
- **Maple/Oak Ridges Equivalent**: Coarse-grained outwash deposits which form the Prospect Park Aquifer. This unit is approximately 20 metres thick at the Prospect Park Well Field (Golder, 2012);
- **Newmarket Till**: Stony, sandy till with lenses of sand and gravel (Karrow, 2005); and
- **Inter-Newmarket Sediments**: Discontinuous, interbedded sands and silts having aquifer properties. Recent refinements to the overburden stratigraphy undertaken as part of the Tier 3 - Conceptual Model , have modified the stratigraphy in the area, such that the overburden unit underlying the Prospect Park aquifer, formerly interpreted as Newmarket Till, has been re-interpreted as the Inter-Newmarket sediments.

Bedrock in the area consists of Paleozoic deposits of dolostone, sandstone and shale. Using the recent revisions to the Paleozoic stratigraphic nomenclature in southern Ontario by the Ontario Geological Survey (Brunton 2009), bedrock stratigraphy in the area (in descending order) has been described as follows:

- **Goat Island Formation**: Finely crystalline, cross laminated, dolostone deposits that are generally considered an aquitard unit. This unit has not been widely identified in the Prospect Park well field studies, and for conceptual purposes it is considered a component of the Gasport Formation;
- **Gasport Formation**: White to dark-blue grey, generally massively bedded dolostone that forms an extensive bedrock aquifer throughout much of Southern Ontario, and provides water supplies for a number of communities, including Acton, Guelph, Cambridge and Hamilton;
- **Cabot Head Formation**: Green shale with sandstone interbeds;
- **Manitoulin Formation**: Grey dolostone with shale interbeds; and
- **Queenston Formation**: Red shale with siltstone interbeds.

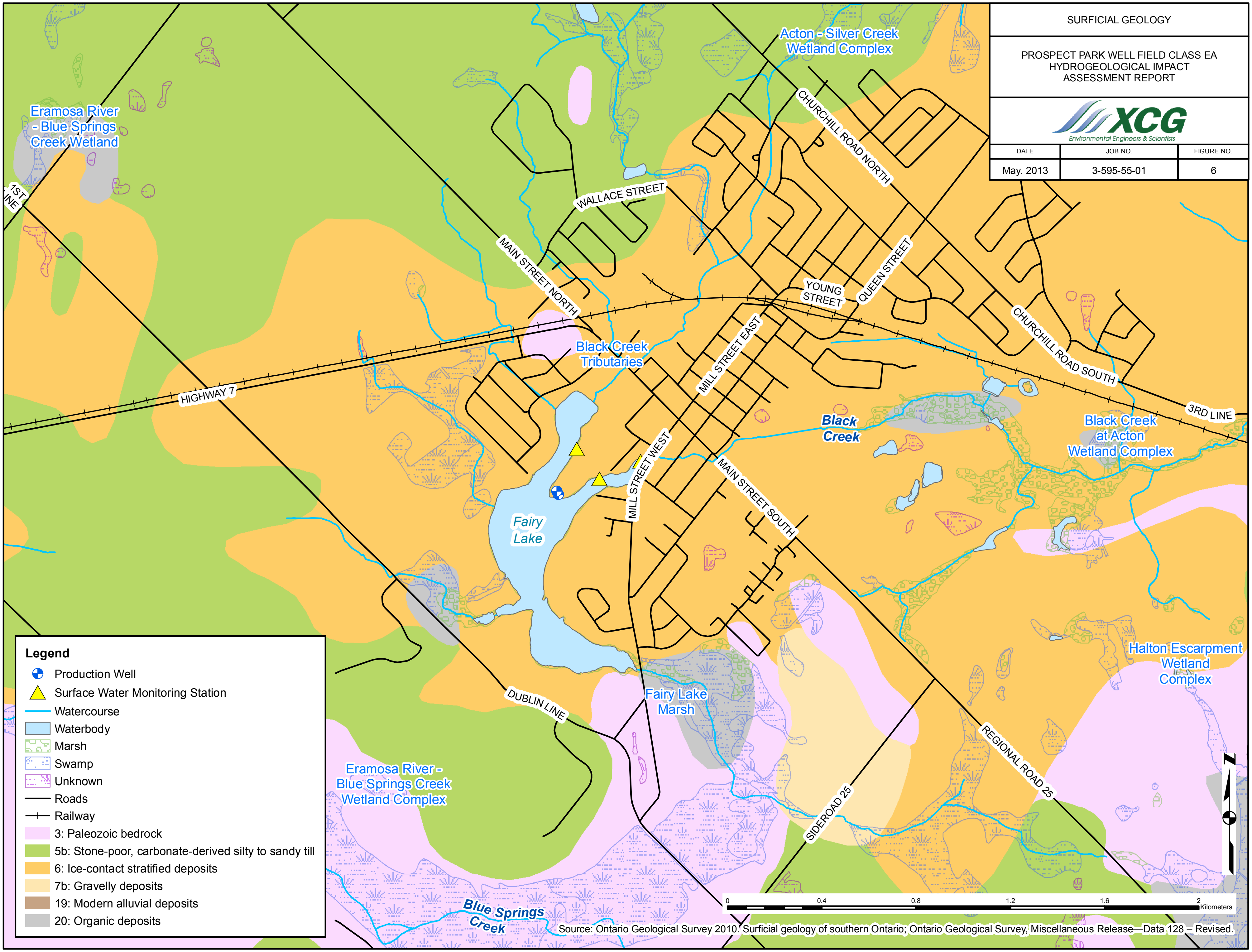

SURFICIAL GEOLOGY
PROSPECT PARK WELL FIELD CLASS EA
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FIGURE NO.
May. 2013
3-595-55-01
6
Acton - Silver Creek
Wetland Complex
Eramosa River
- Blue Springs
Creek Wetland
1ST
LINE
WALLACE STREET
CHURCHILL ROAD NORTH
MAIN STREET NORTH
YOUNG
STREET
QUEEN STREET
Black Creek
Tributaries
MILL STREET EAST
HIGHWAY 7
CHURCHILL ROAD SOUTH
3RD LINE
Black
Creek
Black Creek
at Acton
Wetland Complex
MILL STREET WEST
MAIN STREET SOUTH
Fairy
Lake
Halton Escarpment
Wetland
Complex
DUBLIN LINE
Fairy Lake
Marsh
REGIONAL ROAD 25
Eramosa River -
Blue Springs Creek
Wetland Complex
SIDEROAD 25
Blue Springs
Creek
N
0
0.4
0.8
1.2
1.6
2
Kilometers
Legend
Production Well
Surface Water Monitoring Station
Watercourse
Waterbody
Marsh
Swamp
Unknown
Roads
Railway
3: Paleozoic bedrock
5b: Stone-poor, carbonate-derived silty to sandy till
6: Ice-contact stratified deposits
7b: Gravelly deposits
19: Modern alluvial deposits
20: Organic deposits
Source: Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised.

3.2 Hydrogeology

A conceptual hydrogeological model for the Prospect Park area has been developed as part of the PPGSS and the Tier 3 Study-Conceptual Model. The interpretation is illustrated on Figure 3, and includes the following components:

- Horizontal groundwater in the Prospect Park area occurs in the Prospect Park overburden aquifer and in the Gasport Formation bedrock aquifer;
- Groundwater recharge occurs through precipitation infiltrating surficial areas of the Prospect Park aquifer or through drainage/precipitation infiltrating through surficial glacial till; and
- Due to the relatively low permeability of the bedrock formations which underlie the Gasport Formation, seepage losses to these formations are negligible in comparison to the water surplus of the Black Creek Catchment Area (Golder, 2012).

Groundwater elevations in the Gasport Formation and the Prospect Park aquifer were simulated in the Halton Tier 3 groundwater model (AECOM and AQR, 2012). Golder (2012) produced groundwater flow mapping in the area of the Prospect Park aquifer by combining the simulated groundwater contours from the Tier 3 model with field measurements collected from Region monitoring wells. The resulting groundwater flow pattern is shown on Figure 7. The groundwater flow pattern generally follows the bedrock topography in the Prospect Park area, with groundwater flow in the aquifer generally converging toward the buried bedrock valley, with an easterly flow component. The topography of the bedrock valley around Acton (Dillon, 2010) is shown in Figure 8.

The hydrogeologic units present in the area of the Prospect Park well field and corresponding estimates of hydraulic conductivity/transmissivity provided in some of the background reports are summarized in Table 3.

Table 3 Estimate of Hydraulic Conductivity

Unit/Material	Description	Horizontal Hydraulic Conductivity (m/s)
Halton Till	Fine-grained sandy silt to clayey silt till	1×1^{-8} to 5×10^{-6}(AQR, 2009)
Maple/Oak Ridges Equivalent (Prospect Park Aquifer)	Coarser-grained outwash sediments	4×10^{-4} to 5×10^{-4} (Golder, 2012) (Transmissivity of 620 – 800 m^2/day)
Newmarket Till	Stony, sandy till with lenses of sand and gravel	2×10^{-5} to 5×10^{-9} (AECOM and AQR, 2011)
Inter-Newmarket Sediments	Discontinuous, interbedded sands and silts	Unavailable, but interpreted to function as an aquifer (AECOM and AQR, 2012)
Gasport Formation	Regional dolostone bedrock aquifer	1×10^{-7} to 5×10^{-5} (AQR, 2009)
Cabot Head Formation	Regional shale aquitard	1×10^{-9} to 1×10^{-7} (AQR, 2009)
Manitoulin/Whirlpool	Dolostone/Sandstone	1×10^{-7} to 1×10^{-5} (AQR, 2009)
Queenston Formation	Shale with siltstone interbeds	1×10^{-9} to 1×10^{-6}(AQR, 2009)

GROUNDWATER FLOW IN THE
PROSPECT PARK AQUIFER (GOLDER, 2012)

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HYDROGEOLOGICAL IMPACT
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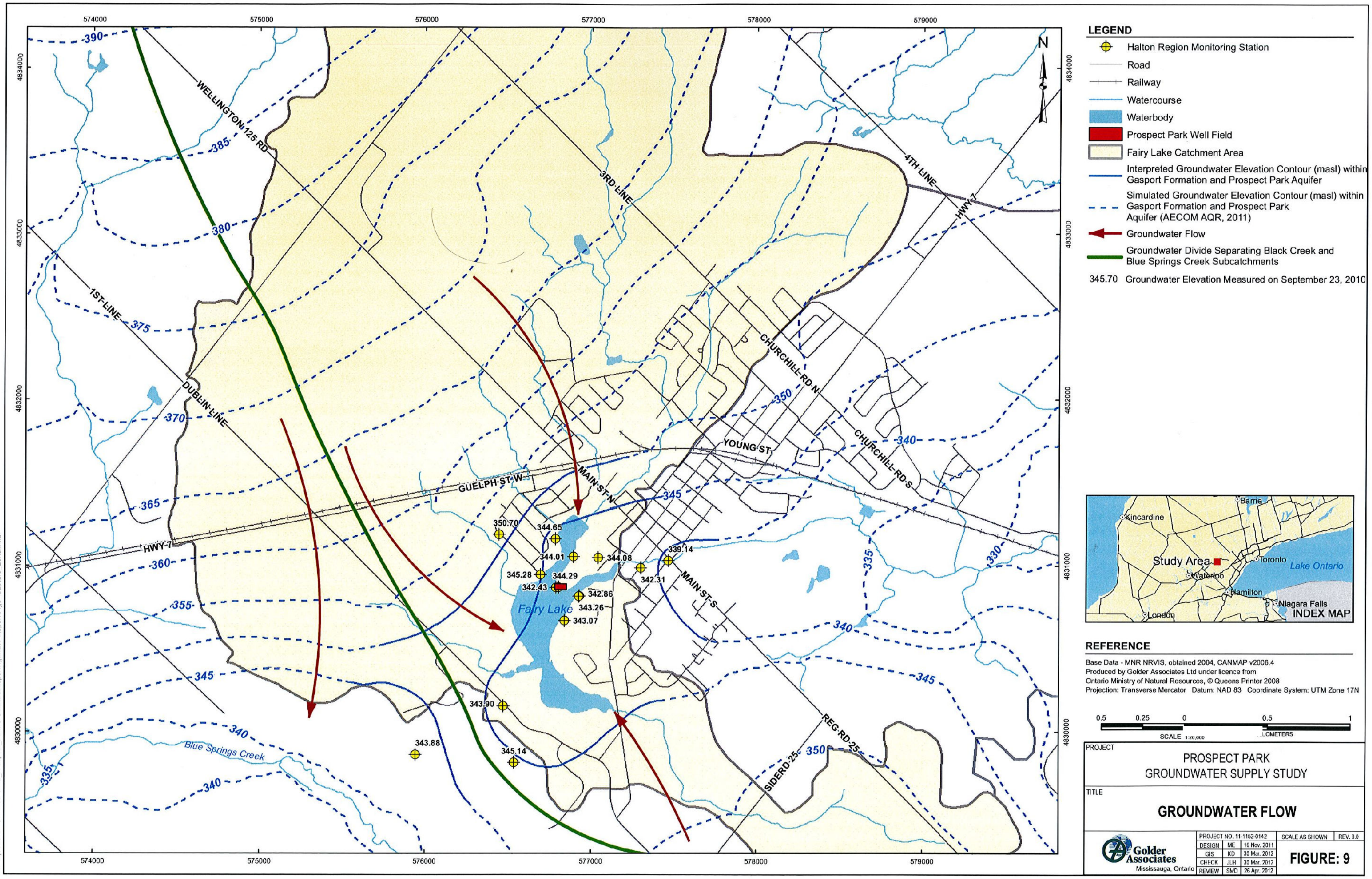
DATE	JOB NO.	FIGURE NO.
May. 2013	3-595-55-01	7



TOPOGRAPHY OF THE ACTON / GEORGETOWN BEDROCK VALLEY NEAR ACTON (DILLON, 2010)		
PROSPECT PARK WELL FIELD CLASS EA HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT		
XCG Environmental Engineers & Scientists		
DATE	JOB NO.	FIGURE NO.
May. 2013	3-595-55-01	8

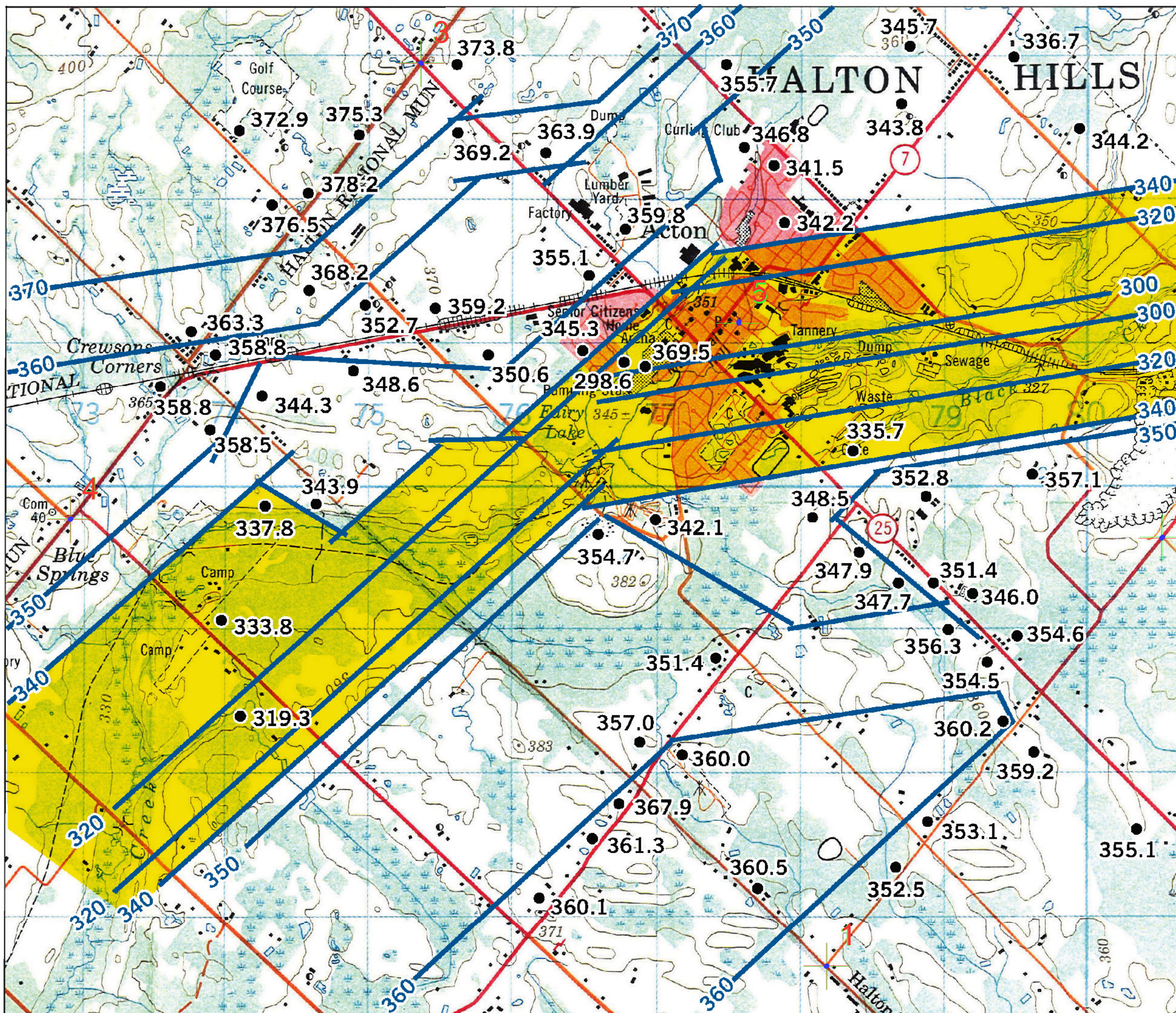


Figure 10: **Topography of Bedrock Valley around Acton**

Legend

- **357.0** Estimated elevation of bedrock surface (masl)
- **340** Interpreted bedrock elevation contour (masl)

Notes:
Bedrock elevations estimated using drift thickness data from Vos (1968).

DILLON CONSULTING

3.3 Other Existing Well Users

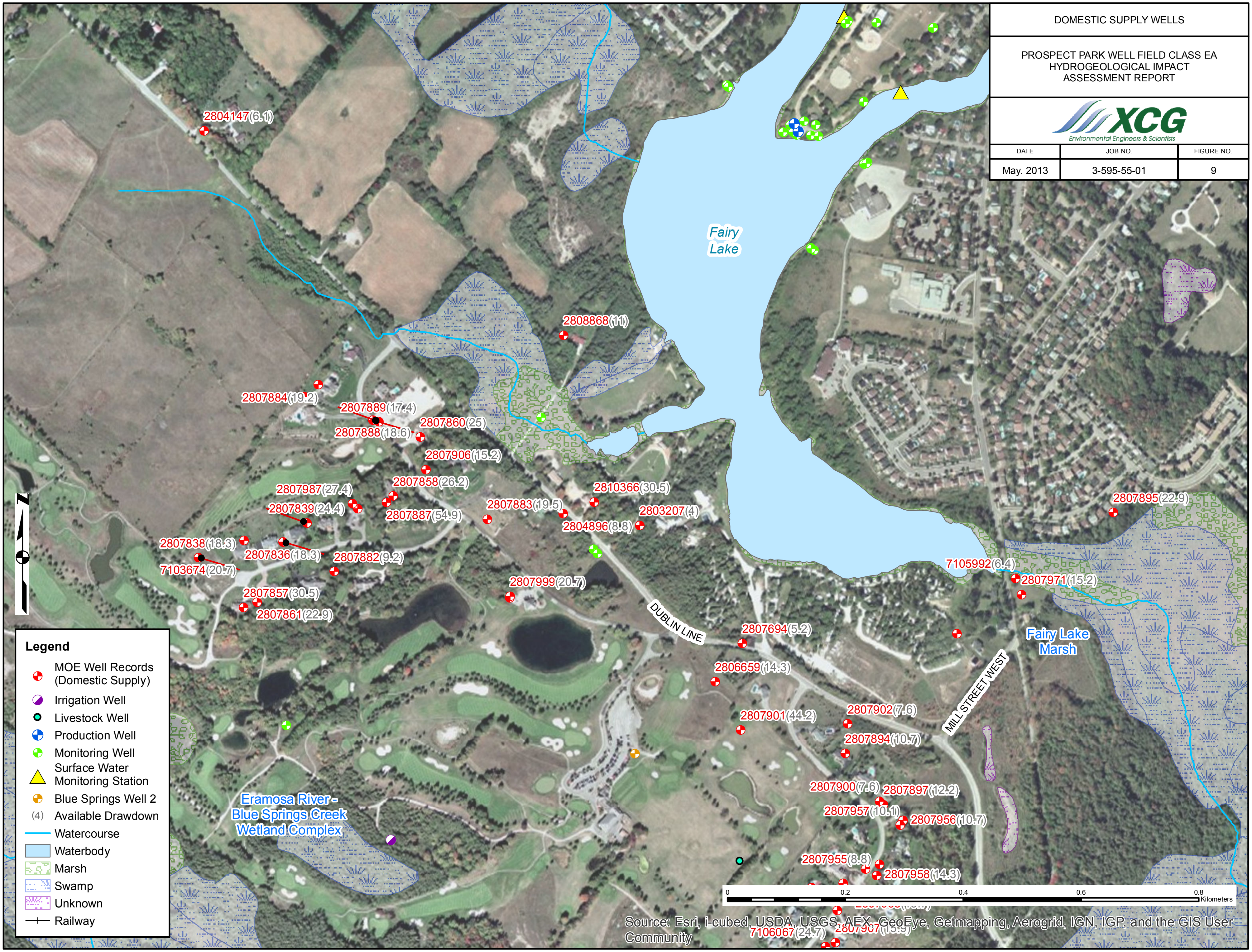
Information on other wells in the area was obtained from the Water Well Information System available from the MOECC. The results indicate that there are approximately 41 domestic supply wells in the rural areas to the west, southwest and south of Fairy Lake, as shown in Figure 9. Four of the well records are reported as overburden well completions and 37 of the well records are reported as bedrock well completions. The four overburden wells (MOECC 2803207, 2804147, 2807999, 2808868) have completion depths ranging from 6.7 to 34.5 m. The bedrock wells have completion depths ranging from 15 to 66 m. Details are provided in Table 4.

Table 4 Well Completion Details – Domestic Supply Wells South of Fairy Lake

Well I.D.	Static Water Level (m)	Depth of Water Found on Construction (m)	Drilled Depth (m)	Pump Setting (m)	Casing Depth (m)	Base Geologic Unit	Available Drawdown (m)
2800784	1.8	11.9, 13.7, 14.6, 16.2	16.5	n/a	16.5	Bedrock	14.7
2803207	1.2	5.2	6.7	5.2	6.4	Overburden	4.0
2804147	9.2	20.7	20.7	15.3	20.7	Overburden	6.1
2804896	4.9	28.7	32.4	13.7	32.9	Bedrock	8.8
2806659	22.3	39.7	40.3	36.6	40.3	Bedrock	14.3
2807694	16.2	20.1, 22.3	23.2	21.4	23.2	Bedrock	5.2
2807836	18.3	54.9	61	36.6	61	Bedrock	18.3
2807838	18.3	51.9	54.9	36.6	54.9	Bedrock	18.3
2807839	16.8	41.2	41.2	41.2	41.2	Bedrock	24.4
2807857	22.9	48.8	54.9	53.4	54.9	Bedrock	30.5
2807858	16.5	44.2	48.8	42.7	48.8	Bedrock	26.2
2807860	8.5	27.8	36.6	33.6	27.8	Bedrock	25.0
2807861	22.9	48.8	54.9	45.8	54.9	Bedrock	22.9
2807882	21.4	39.7, 41.8	42.7	30.5	39.7	Bedrock	9.2
2807883	7.9	34.2, 35.7	36.6	27.5	33.6	Bedrock	19.5
2807884	14.3	35.1	36.6	33.6	33.6	Bedrock	19.2
2807885	15.3	35.4	36.6	33.6	33.6	Bedrock	18.3
2807887	n/a	42.1	61	54.9	30.5	Bedrock	n/a
2807888	4.3	26.8	30.5	22.9	30.5	Bedrock	18.6
2807889	7.0	25.9	29	24.4	29	Bedrock	17.4
2807894	27.5	34.8, 39.7	40	38.1	17.7	Bedrock	10.7
2807895	29.0	51.9	54.9	51.9	54.9	Bedrock	22.9
2807897	25.9	32.9	40	38.1	17.1	Bedrock	12.2
2807900	24.4	32.0	33.6	32	18.3	Bedrock	7.6
2807901	n/a	46.4	47.3	44.2	47.3	Bedrock	n/a
2807902	24.4	35.7, 38.7	40	32	15.9	Bedrock	7.6
2807906	18.3	35.7, 39.0	40	33.6	31.7	Bedrock	15.3

Table 4 Well Completion Details – Domestic Supply Wells South of Fairy Lake

Well I.D.	Static Water Level (m)	Depth of Water Found on Construction (m)	Drilled Depth (m)	Pump Setting (m)	Casing Depth (m)	Base Geologic Unit	Available Drawdown (m)
2807907	39.0	57.0	58	54.9	26.8	Bedrock	15.9
2807953	36.6	52.2	52.8	50.3	25.9	Bedrock	13.7
2807954	37.2	45.8, 51.5	52.8	48.8	27.5	Bedrock	11.6
2807955	29.3	38.7	40	38.1	20.7	Bedrock	8.8
2807956	27.5	19.5, 39.0	40	38.1	17.7	Bedrock	10.7
2807957	29.0	38.4	40	39	18.9	Bedrock	10.1
2807958	32.9	47.3	48.8	47.3	23.5	Bedrock	14.3
2807971	3.1	29.0	30.5	18.3	9.2	Bedrock	15.3
2807999	9.8	30.5	34.5	30.5	34.5	Overburden	20.7
2808868	2.7	14.6	14.9	13.7	14.9	Overburden	11.0
2810366	6.1	59.2, 61.9	65.6	36.6	65.6	Bedrock	30.5
7103674	15.9	13.9	45.4	36.6	32.8	Bedrock	20.7
7105992	2.7	12.0	15.2	9	n/a	Bedrock	6.3
7106067	30.2	41.5, 59.2	62.5	54.9	n/a	Bedrock	24.7


DOMESTIC SUPPLY WELLS
PROSPECT PARK WELL FIELD CLASS EA
HYDROGEOLOGICAL IMPACT
ASSESSMENT REPORT
XCG
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DATE
May. 2013
JOB NO.
3-595-55-01
FIGURE NO.
9
Fairy Lake
Fairy Lake Marsh
Eramosa River - Blue Springs Creek Wetland Complex
DUBLIN LINE
MILL STREET WEST
2804147(6.1)
2808868(11)
2807884(19.2)
2807889(17.4)
2807860(25)
2807888(18.6)
2807906(15.2)
2807858(26.2)
2807987(27.4)
2810366(30.5)
2807883(19.5)
2803207(4)
2807839(24.4)
2807887(54.9)
2804896(8.8)
2807895(22.9)
2807838(18.3)
2807836(18.3)
2807882(9.2)
7103674(20.7)
7105992(6.4)
2807971(15.2)
2807999(20.7)
2807857(30.5)
2807861(22.9)
2807694(5.2)
2806659(14.3)
2807901(44.2)
2807902(7.6)
2807894(10.7)
2807900(7.6)
2807897(12.2)
2807957(10.1)
2807956(10.7)
2807955(8.8)
2807958(14.3)
7106067(24.7)
0
0.2
0.4
0.6
0.8
Kilometers
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
N
Legend
MOE Well Records (Domestic Supply)
Irrigation Well
Livestock Well
Production Well
Monitoring Well
Surface Water Monitoring Station
Blue Springs Well 2
(4) Available Drawdown
Watercourse
Waterbody
Marsh
Swamp
Unknown
Railway

3.4 Local Surface Water Features

The Prospect Park Well Field is located on the shore of Fairy Lake in the community of Acton, within the Town of Halton Hills. Fairy Lake is a man-made feature created in the 1830s by damming Black Creek to supply water to local industry. The Fairy Lake dam is located at the northeast arm of the Lake, near the intersection of Mill Street West and Victoria Street. Black Creek flows eastward below the dam and discharges to the Credit River system. The discharge of the dam is controlled by a series of stop logs that can be adjusted to regulate the elevation of Fairy Lake, currently set at an elevation of 345.36 m above sea level (ASL). There are currently no agreements in place between the Region, the Town of Halton Hills, and CVC regarding responsibility for the operation of the dam.

Fairy Lake is approximately 25 ha in size, and is generally shallow, with reported depths ranging from 1 to 7 m, and an average depth of about 3 m. Approximately 50 percent of its volume is found in the top 1 m of depth. Bathymetry mapping presented in Figure 10 shows the lake depth contours at 1 m intervals (from 0 to 7 m).

Fairy Lake has been described as having a warm-water fishery, with generally high levels of nutrient concentrations and aquatic vegetation, with water quality that was considered low to moderate (Golder, 2012).

In the PPGSS, eight subcatchment areas that drain into Fairy Lake were identified, and are shown on PPGSS Figure A1. The land use in these subcatchment areas includes agriculture, woodlands and urban use. Four of these subcatchments are municipal storm drainage areas, and four are tributary water courses forming the headwaters of Black Creek. Taken together, the subcatchments are referred to as the 'Fairy Lake Catchment of Black Creek'.

The Region operates the Acton WWTP, which is located adjacent to Black Creek, approximately 1.8 km downstream of the Fairy Lake Dam. The average outflow from the Acton WWTP is approximately 4,500 m^3/day. Upstream of the Acton WWTP, portions of Black Creek and associated tributaries to Fairy Lake have been characterized as intermittent with respect to flow (Golder, 2012).

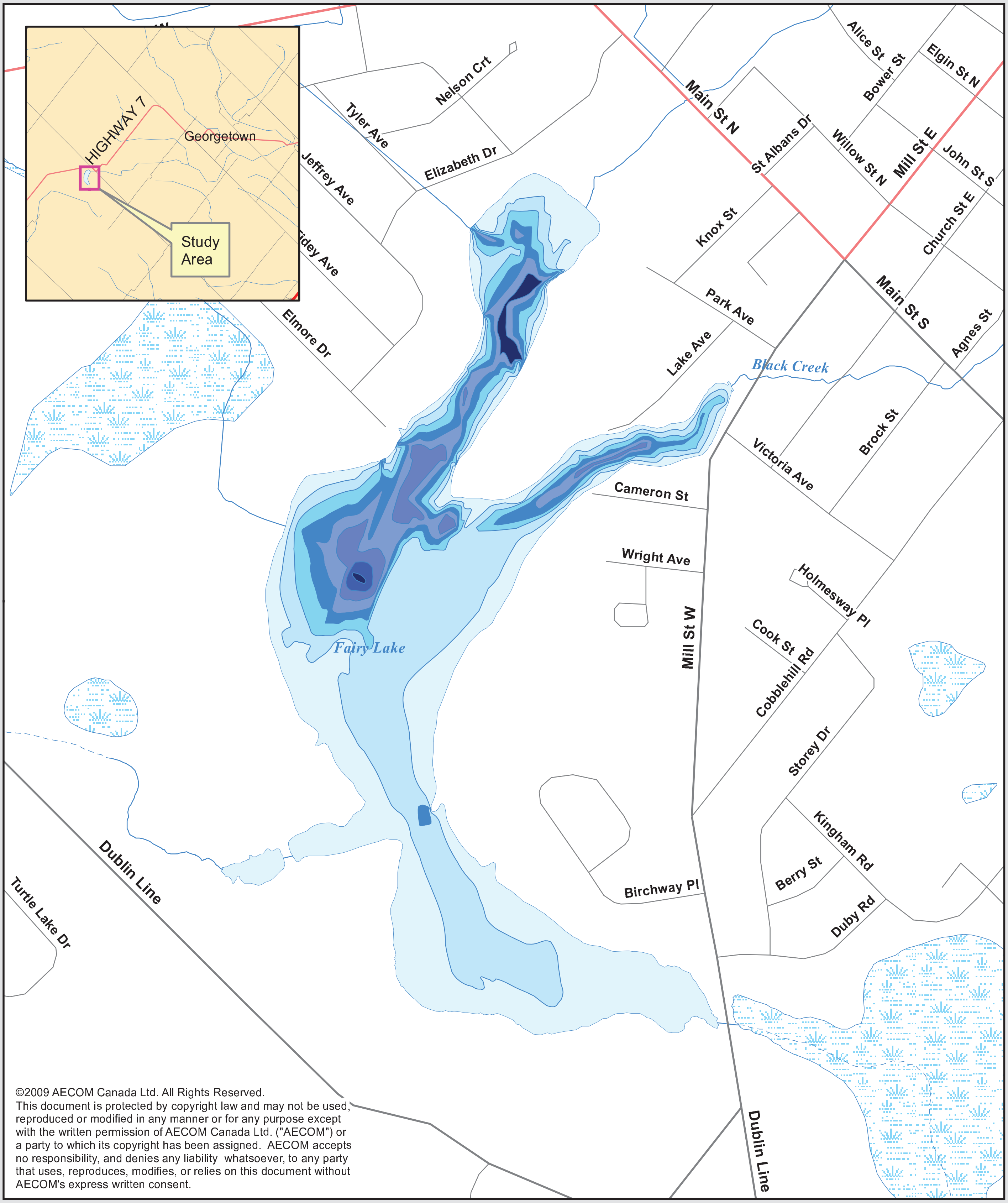
Provincially Significant Wetlands (PSW) located within the study area are shown in Figure 2, and were considered as follows:

- The Black Creek at Acton Wetland Complex (ESA No.47), located approximately 1 km downstream of the Fairy Lake Dam; and
- The Eramosa River-Blue Springs Creek Wetland Complex, located southwest of Fairy Lake.

The Fairy Lake Marsh (ESA No.27), which borders the southeast arm of Fairy Lake, is considered a component of the Eramosa River-Blue Springs Creek Wetland Complex, as is Fairy Lake itself.

3.5 Historic Lake Levels and Outflows

Water from Fairy Lake overflows the dam during a significant portion of the year. The elevation of the top of the dam is approximately 345.25 m above sea level (m ASL).



Basemapping from Ontario Ministry of Natural Resources
Orthophotography:

Legend

Lake Depth
- 0-1m
- 1m
- 2m
- 3m
- 4m
- 5m
- 6m
- 7m

Roads
Type
- Highway
- Major Road
- Local Road

Rivers
- Intermittent Stream
- Permanent Stream

Lakes and Wetlands
- Waterbody Segment
- Wetland Area, Permanent

N W E S

Metres
0 50 100 200 300
1:7,500
UTM Zone 17N, NAD 83

Fairy Lake

Bathymetric Contours

December 2009
Project 107983

AECOM

Figure 4

Map Document: (D:\Projects\107983\GISSpatial\mxd\Revised MXDs July 09\107983_Fig-4_Bathymetric.mxd)
12/21/2009 -- 4:47:01 PM

Weekly lake level measurements for 2007 and 2008 were provided in the *Fairy Lake Water Quality Study* (AECOM, 2009). The lake level measurements and dam elevation are shown in Figure 11. The data indicate that 2007 was a much drier year than 2008, with a decrease in the amount of precipitation observed, resulting in both lower average and maximum water levels. A summary of the water budget data is provided in Table 5.

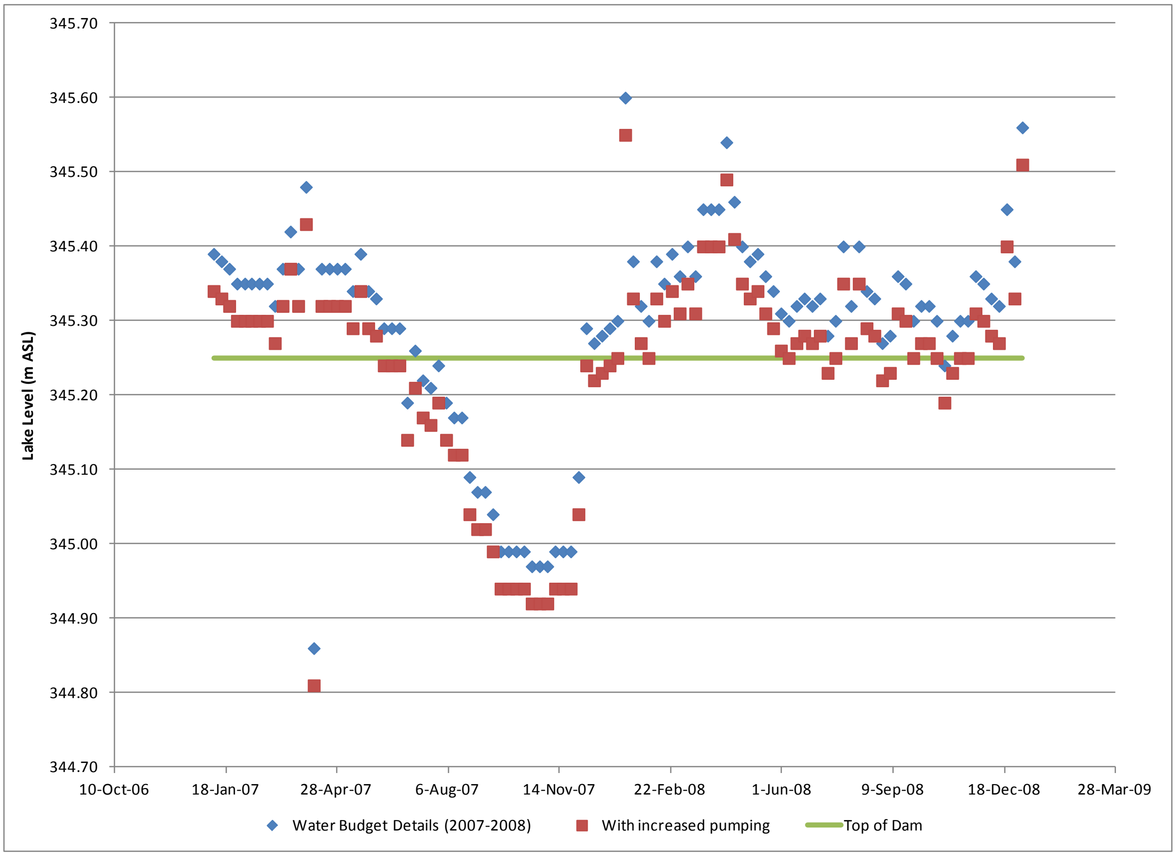


Figure 11 Current and Projected Lake Levels

Table 5 Summary of Water Budget Details for Fairy Lake (2007 - 2008)

Water Levels (m ASL)	**2007**	**2008**
Average	345.22	345.36
Minimum	344.86	345.24
Maximum	345.48	345.60
Weekly Precipitation (m^3/week)	**2007**	**2008**
Average	1,787	2,541
Minimum	0.0	0.0
Maximum	13,185	13,210

Information provided in the PPGSS, suggests that outflow from Fairy Lake to the Acton WWTP outfall in Black Creek is intermittent during the summer months due to the lack of available water surplus. Streamflow in this reach is largely dependent on the overflow of Fairy Lake dam, and therefore sensitive to normal seasonal variations in water surplus for the Black Creek catchment area reporting to the lake. The intermittency of flow readings at the Fairy Lake dam was characterized in the PPGSS.

A review of the water budget details presented in the *Fairy Lake Water Quality Study* (AECOM, 2009) suggests that under current conditions, the lake overflows are dependent on surface water inflows. A summary is provided in Table 6.

Table 6 Summary of Water Budget Details for Fairy Lake, 2007 - 2008 and Dam Elevation (AECOM, 2009)

	2007 Lake Levels	**2007 Levels with projected 0.05 m decrease**	**2008 [1] Lake Levels**	**2008 Levels with projected 0.05 m decrease**	**Two-Year Average[1]**
No. of Weeks Lake Level is Above Top of Dam (overflow)	29	21	52	40	81
No. of Weeks Lake Level is Below Top of Dam (no overflow)	23	31	1	5 [2]	24

Notes:
1. 53 weekly measurements were taken in 2008.
2. During the remaining 7 weeks of the year, the water level would have been equal to the top of the dam.

As shown in Table 6, the effects of the decrease in surface water levels are more pronounced under more severe dry weather conditions.

3.6 Other Ecological Factors

3.6.1 Blanding's Turtle

There is a historical Summer record of a Blanding’s Turtle at a location approximately 1km from the proposed construction site for the expansion of the water purification plant.

Since the construction site is surrounded by manicured grass in an urban park setting there is no potential for direct impact on this species during construction.

Much of the available habitat around Fairy Lake and adjacent marshes is subject to natural fluctuations in water levels due to natural precipitation regimes; as a result, it is predicted that a maximum change in Fairy Lake water levels of 5 cm at maximum proposed future pumping rates would not affect Blanding’s Turtle.

In September 2014, the Region of Halton submitted a completed Information Gathering Form for activities that may affect species or habitat protected under the Endangered Species Act to the Ontario Ministry of Natural Resources and Forestry. On October 17, 2014 the MNRF indicated that the Ministry currently does not have concerns with the proposed undertaking. A copy of the correspondence received from MNRF is provided in Appendix G.

3.6.2 Other Impacts to Wetlands on and Adjacent to Fairy Lake

The aquatic and wetland habitats in Fairy Lake are dynamic and subject to a complex mix of factors, such as seasonal and annual variation in precipitation.

Fluctuations in water levels are a typical feature of such water bodies that are managed to achieve a number of objectives. Prior to 1986, declines in lake level of 80 cm are thought to have occurred. In 1989 water level declines in Fairy Lake of 40 cm were documented (Gartner Lee, 1993).

The present day aquatic and wetland communities have adapted to considerable fluctuations in water levels over a period of many decades. The maximum 5 cm decline in water levels predicted to be associated with the proposed future groundwater well pumping volumes is very small in comparison to historical water level fluctuations. Annual precipitation variation is expected to be responsible for even greater water depth fluctuations.

No detectable impacts on wetlands in and adjacent to Fairy Lake are expected from the predicted reduction in lake levels associated with future well pumping.

3.6.3 Fen within Eramosa-Blue Springs PSW Complex

Upstream of Mill Street there is a wetland area which has been confirmed by MNRF and CVC staff to contain a fen community. CVC has indicated that “fens are dependent on groundwater and therefore the potential impacts of the increase in water taking needs to be assessed and a monitoring/contingency plan may need to be developed”.

Other elements affecting the hydrology of the fen area include Beaver activity within the wetland downstream of the fen and a proposal to replace the culvert that conveys Mill Street over the stream that drains the subject wetland into Fairy Lake.

The fen is located approximately 1km from the well field.

The findings of the study completed by Golder (2012) predicted indicated that the fen is located approximately 500 m outside of and beyond the 10 cm shallow groundwater contour. The Golder (2012) study concluded that changes in this section of the study area will be small and unlikely to create a measurable effect.

Given the potentially complex hydrology of the wetland due to the influences of beavers and the Mill Street culvert, it is recommended that monitoring of the groundwater contribution to the fen prior to implementing the proposed increase in pumping be conducted to obtain a baseline data set. Since the maximum pumping is not expected for to occur for many years, there is ample time to obtain data on groundwater contributions.

The need for vegetation monitoring data should be considered once several years of baseline groundwater data are available. At the time the need for vegetation data is being considered, the status of beaver dams in the wetland upstream of Mill Street should be reviewed.

3.6.4 Impacts to Black Creek Fisheries and Wetlands and Acton Waste Water Treatment Plant

Under currently conditions, flow over the dam at Fairy Lake ceases in late Spring until Autumn. Dates with no outflow from Fairy Lake depend on precipitation conditions during specific years. The PPGSS (Golder, 2012), which was conducted with pumping rates similar to those proposed for the well field expansion, concluded that outflow from Fairy Lake would cease two weeks earlier in the Spring and would extend two weeks longer into the Autumn at the higher water takings.

The features and functions of concern downstream of Fairy Lake are the Black Creek PSW and the Brook Trout population in Black Creek.

The PPGSS (Golder, 2012) has predicted that there will be no groundwater drawdown impact in the area of the Acton WWTP, from the proposed maximum well pumping. As a result, there would be no groundwater effects on existing wetlands and fish associated with Black Creek near the WWTP.

The Brook Trout present in Black Creek are supported by groundwater upwelling located downstream of the Acton WWTP, toward Third Line, and these groundwater sources are not expected to be affected by the proposed increased pumping at the Prospect Park well field.

Beavers are present along Black Creek, between Fairy Lake and the Acton WWTP (Dillon, 2011). Damming of the creek by beavers adds an additional complication to flow maintenance in Black Creek at the Acton WWTP.

The Fairy Lake dam is currently not actively operated to control flow volumes in Black Creek (Warren Harris pers. comm. November 2014). The existing stop logs are each approximately 30 cm in height. A number of private docks and other shoreline structures are currently present around the perimeter of Fairy Lake. If active efforts were undertaken to manipulate flow volumes out of Fairy Lake, several private properties could be affected.

Prior to attempting to manage the Fairy Lake dam to increase discharge to Black Creek in Summer, a thorough review of the technical feasibility and potential effectiveness of increasing flows should be undertaken. Since late Spring flows are principally a function of precipitation in the preceding months, managed flows would also largely be a function of weather; as is currently the case. Increasing early to late Spring storage capacity in Fairy Lake may not be feasible due to the constraints posed by the numerous private docks and structures present.

Since there is no predicted impact on wetlands and fish along Black Creek in the area to the Acton WWTP it may not be necessary to determine the feasibility of effective flow management by manipulating the Fairy Lake dam.

3.6.5 Water Level Management to Avoid Impact on Northern Pike Movement through the Mill Street Culvert

There are two elements to consider regarding Northern Pike reproduction in the study area:

1. Early Spring season (April to early May) movement of adults upstream through the Mill Street culvert; and
2. Movement of young-of-the-year downstream through the Mill Street culvert, probably in late July through early September.

The CVC has indicated that efforts should be made to ensure that neither of the two pike reproduction movements are impacted by the predicted 5 cm drop in Fairy Lake Summer water levels associated with the future proposed pumping volumes.

It is unlikely that Fairy Lake water levels in April to early May will be affected by the increased pumping because the maximum water level declines are expected to occur later in the Summer. Also, it is anticipated that the Spring season elevation of water leaving the marsh through the culvert will be higher than that in Fairy Lake. A small decline in the Fairy Lake elevation would therefore not prevent pike from moving into the marsh.

Movement of any young-of-the-year Northern Pike from the wetland located upstream of Mill Street might occur seasonally at the time when Fairy Lake levels decline due to future well pumping at the proposed rates.

Without existing data on Summer and early Autumn water surface and watercourse bottom elevations upstream, within, and downstream of the Mill Street culvert, it is not possible to predict whether young-of-the-year pike would potentially be stranded in the marsh upstream of Mill Street, if Fairy Lake levels drop by up to 5 cm.

The Town of Halton Hills has undertaken a project to replace the Mill Street culvert. Once the water level and creek bottom elevation data were collected it may be possible to design the new Mill Street culvert in such a manner that pike movement would continue even if Fairy Lake levels dropped an additional 5 cm in Summer.

It is recommended that in 2015:

1. Monitoring be undertaken to determine the timing and size of any Northern Pike movement through the Mill Street culvert; and
2. Data on seasonal water surface elevations and flows, and wetland, culvert and Fairy Lake bottom elevations in the Mill Street culvert area be collected along with any other data that a hydrologist would need to advise on designing the Mill Street culvert to accommodate pike movement if Fairy Lake surface Summer levels dropped an additional 5 cm due to increased groundwater well pumping.

4. IMPACT ASSESSMENT

4.1 Response to Pumping

Four long-term pumping tests have been undertaken for the Prospect Park wells. The two most recent tests (December 22, 2009 to March 9, 2010; June 14 to November 1, 2010) had the benefit of additional instrumentation available for monitoring purposes. As was presented previously, the first test occurred at a reported pumping rate of 3,033 to 3,045 m^3/day for a 77 day period. The second test occurred at a reported pumping rate of 4,400 m^3/day for a 139 day period. The Prospect Park Groundwater Supply Study (PPGSS, Golder 2012) provides details concerning the tests and an analysis/interpretation of the results.

According to the PPGSS, water level monitoring data were recorded at 34 locations during the pumping tests. The 34 monitoring locations included the two production wells (PP1, PP2), 18 monitoring well nests (17 according to Table B1), three surface water monitoring stations, one wetland piezometer and three private wells. The monitoring locations are shown on PPGSS Figure B2. One of the private wells (MOECC 437) is not shown on the PPGSS figures; based on information in the Dillon (2010) report, the location of MOECC 437 is approximately 2 km to the south of Fairy Lake. Data loggers recorded water levels at 37 monitoring stations during the pumping tests.

The water level monitoring data were graphed and presented in a series of hydrographs in Figures B3-B9 of Appendix B of the PPGSS. The hydrographs show data from November 2009 to June 2011, including the period of the two pumping tests.

Pumping Test No. 1 (3,045 m^3/day)

The PPGSS concluded that groundwater levels in the Prospect Park aquifer did not stabilize during the first pumping test (flow rate of 3,045 m^3/day) and, therefore, the aquifer system had not reached equilibrium at the end of the test. Our review of the hydrographs indicates that this conclusion is correct for most of the wells monitored as part of the test. However, water levels at TW5/91D (located to the east of the well field), MW36/09 (northwest of the well field) did appear to stabilize during the pumping test. Hydrographs at the following monitoring locations show no clear evidence of a response to the pumping test: TW6/91, TW2/88, MOECC 437, FL1, FL2, and NSW1. Interpretation of the cone-of-influence was provided in the PPGSS Figure B10, and has been reproduced with additional features shown in Figure 12A.

Pumping Test No. 2 (4,400 m^3/day)

The PPGSS concluded that groundwater levels in the Prospect Park aquifer did stabilize during the second pumping test (flow rate of 4,400 m^3/day), and that the aquifer had reached an equilibrium (steady-state) condition with respect to pumping. A review of the hydrographs indicates that this interpretation appears to be generally correct. However, the hydrographs indicate that the stabilization occurred in early October and corresponded with a slight rise or recovery in water levels in the various wells that were monitored. The rise or recovery appears to correlate with the rising water level in Fairy Lake, which occurred at about the same time (early October). The rise in the water level in Fairy Lake appears to correlate with an increase in precipitation. The hydrographs indicate that there were numerous short-term shutdowns of the pumping wells (PP1, PP2) during the test prior to the period of stabilization in early October. The short-term shutdowns show up as a series of spikes in the hydrographs for wells at the well field (PP1, PP2 and a number of the monitoring wells close to PP1 and PP2) and two monitoring wells approximately 150 m away (MW33/09, MW34/09). Precipitation events appear to correlate with water level rises at the surface water level monitoring stations, in Fairy Lake, as shown on PPGSS Figure B9.

Interpretation of the cone-of-influence for the pumping test was provided in PPGSS Figure B11, and has been reproduced with additional features on Figure 12B in this report. The interpretation is a reasonable and useful representation of the maximum drawdown observed during the pumping test. The cone-of-influence is elliptical in shape with the major axis oriented northeast-southwest. The major axis of the cone generally follows the orientation of the buried bedrock valley containing the Prospect Park aquifer. Drawdown in the aquifer ranged from approximately 3 m near the production wells to 0.1 m near the outer edges. The 0.1 m contour marking the outer limits of the cone-of-influence shown on PPGSS Figure B17 and Figure 12B of this report, occurs at a distances of approximately 750 to 1000 m along the major axis and 450 to 570 m along the minor axis.

Superimposing the cone-of-influence on the area subwatershed map, as shown on PPGSS Figure B17, indicates that drawdown occurs mostly within the Fairy Lake catchment of Black Creek, with a relatively small portion of the cone occurring in the upper portion of Black Creek subwatershed downstream of Fairy Lake and a relatively small portion of the cone occurring in the Blue Springs Creek watershed to the south of Fairy Lake.

4.2 Effects on Other Groundwater Users

The PPGSS concluded that the proposed increase in pumping rate at the Prospect Park well field should have no effect on the operation of local private wells.

According to the MOECC Water Well Information System, most of the local private supply wells are located to the west, southwest and south of Fairy Lake. The drawdown contours from the pumping test at 4,400 m^3/day indicate that drawdown in the vicinity of most of the well locations south of the lake was 0.1 m or less, as shown in Figure 13. To the south of Fairy Lake, there are 6 well record locations between the 0.1 and 0.5 m drawdown contours and one well record location between the 0.5 and 1 m drawdown contours. Five well locations occur to the west/northwest of the lake and four well locations occur southwest of the lake, in the vicinity of the Fairy Lake Marsh. Drawdown, if any, was predicted to be less than 0.1 m in these areas.

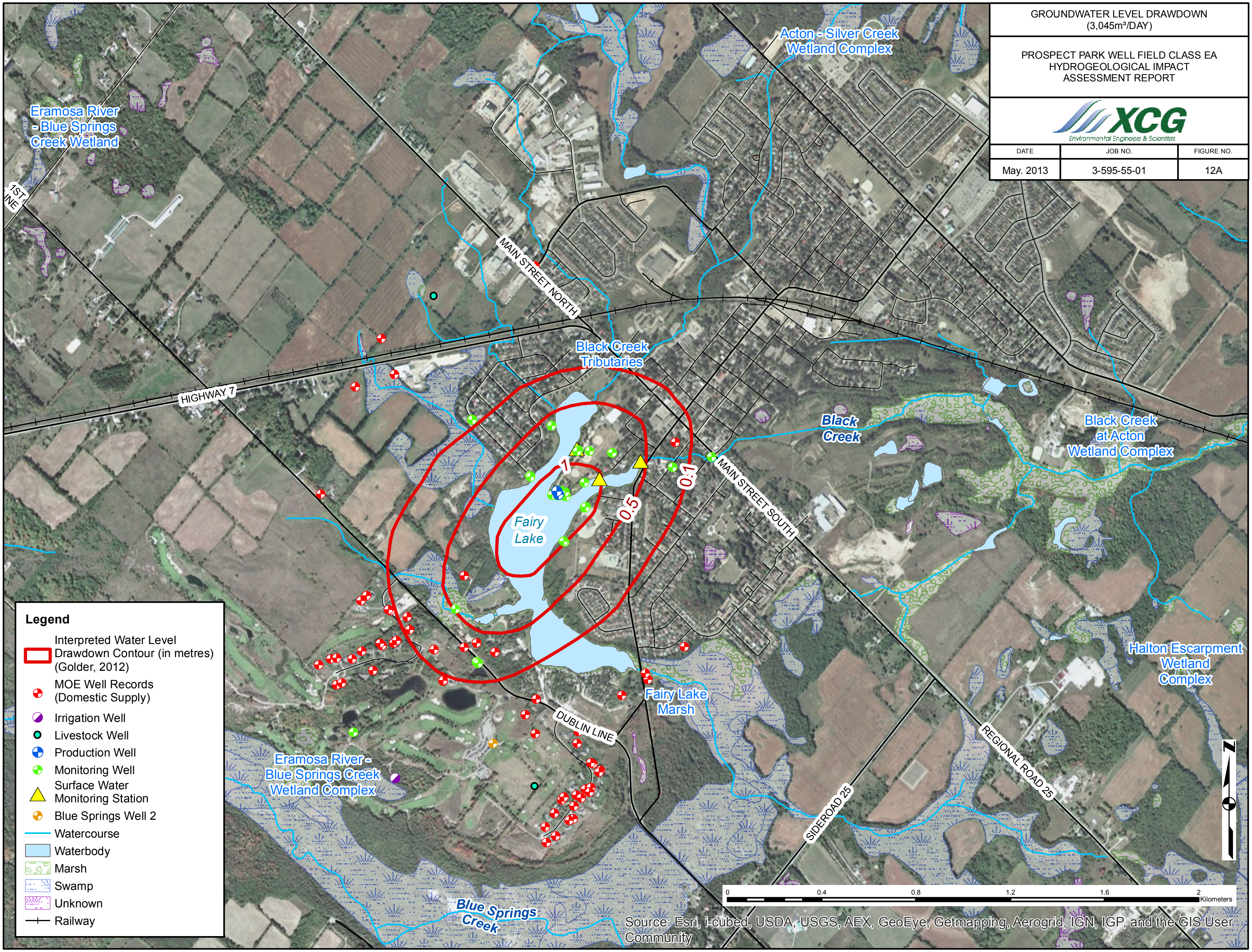
As noted previously, well record information indicates that most of the private supply wells are completed in the bedrock aquifer. Review of available drawdown shown in Table 4 for both the overburden and bedrock wells in this area indicates and that all wells should have sufficient available drawdown (4 to 30 m) to accommodate these drawdown effects without experiencing interference. The well that may have experienced the most drawdown (approximately 1 m) during the pumping test was MOECC No. 2808688, located on Dublin Line. From the water well record information, available drawdown at this well is inferred to be about 11 m.

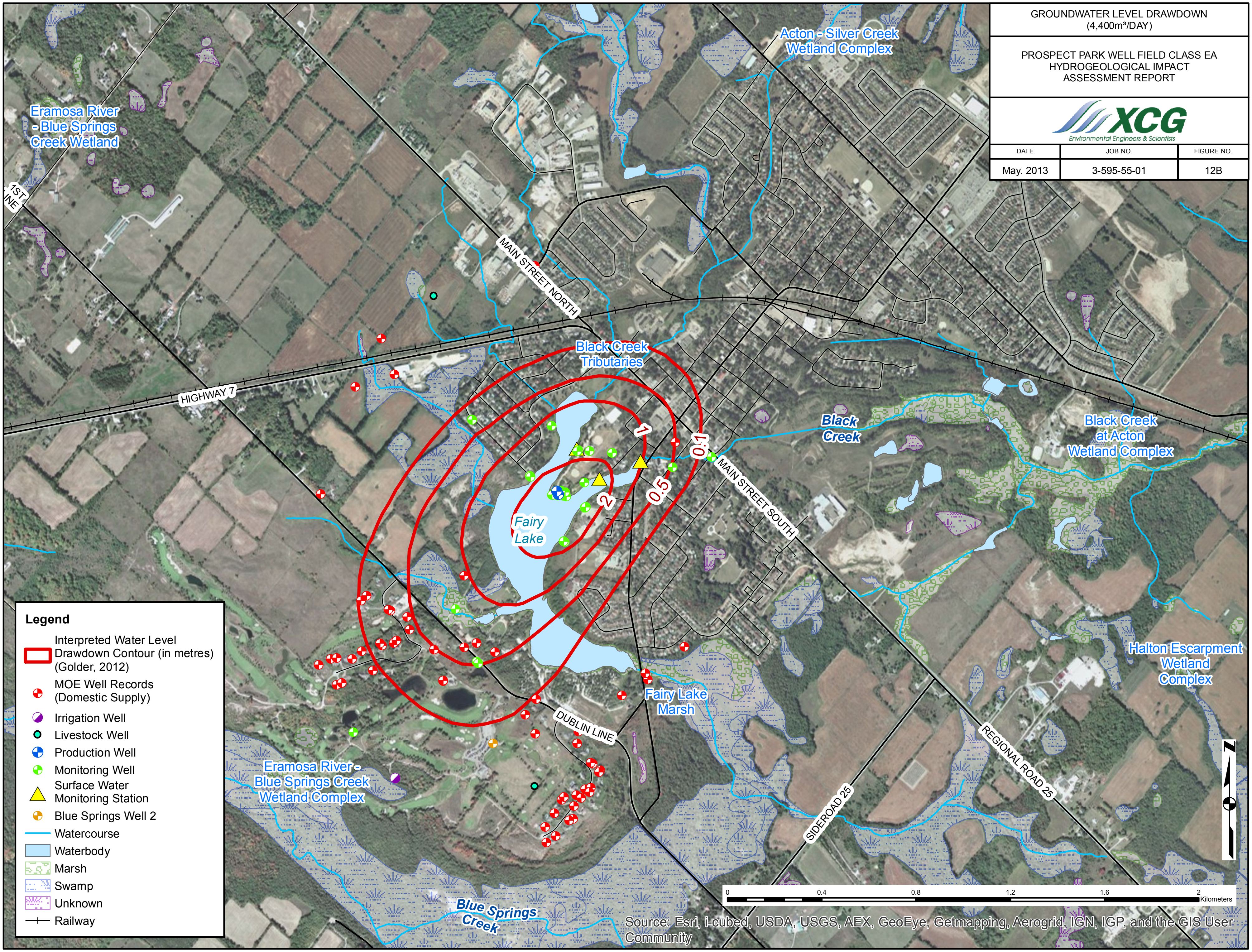
GROUNDWATER LEVEL DRAWDOWN (3,045m³/DAY)

PROSPECT PARK WELL FIELD CLASS EA HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT

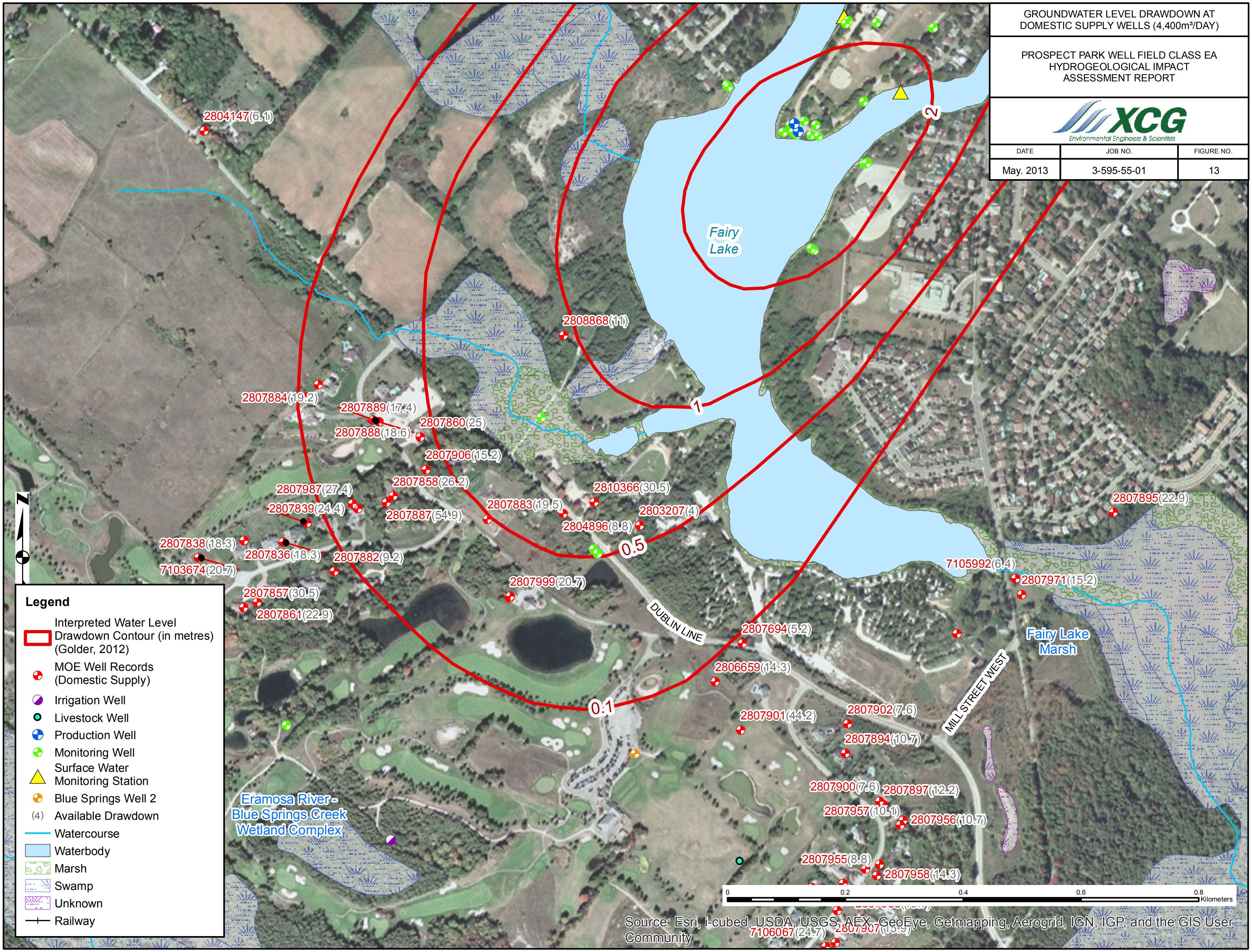
XCG Environmental Engineers & Scientists

DATE	JOB NO.	FIGURE NO.
May. 2013	3-595-55-01	12A





GROUNDWATER LEVEL DRAWDOWN
(4,400m³/DAY)
PROSPECT PARK WELL FIELD CLASS EA
HYDROGEOLOGICAL IMPACT
ASSESSMENT REPORT
XCG
Environmental Engineers & Scientists
DATE
JOB NO.
FIGURE NO.
May. 2013
3-595-55-01
12B
Acton - Silver Creek Wetland Complex
Eramosa River - Blue Springs Creek Wetland
1ST LINE
MAIN STREET NORTH
HIGHWAY 7
Black Creek Tributaries
Black Creek
Black Creek at Acton Wetland Complex
MAIN STREET SOUTH
Fairy Lake
0.1
0.5
1
2
Halton Escarpment Wetland Complex
Fairy Lake Marsh
DUBLIN LINE
Eramosa River - Blue Springs Creek Wetland Complex
REGIONAL ROAD 25
SIDEROAD 25
Blue Springs Creek
0
0.4
0.8
1.2
1.6
2
Kilometers
N
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Legend
Interpreted Water Level Drawdown Contour (in metres) (Golder, 2012)
MOE Well Records (Domestic Supply)
Irrigation Well
Livestock Well
Production Well
Monitoring Well
Surface Water Monitoring Station
Blue Springs Well 2
Watercourse
Waterbody
Marsh
Swamp
Unknown
Railway


GROUNDWATER LEVEL DRAWDOWN AT DOMESTIC SUPPLY WELLS (4,400m³/DAY)
PROSPECT PARK WELL FIELD CLASS EA HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT
XCG
Environmental Engineers & Scientists
DATE | JOB NO. | FIGURE NO.
May. 2013 | 3-595-55-01 | 13
Legend
Interpreted Water Level Drawdown Contour (in metres) (Golder, 2012)
MOE Well Records (Domestic Supply)
Irrigation Well
Livestock Well
Production Well
Monitoring Well
Surface Water Monitoring Station
Blue Springs Well 2
(4) Available Drawdown
Watercourse
Waterbody
Marsh
Swamp
Unknown
Railway
Fairy Lake
Fairy Lake Marsh
Eramosa River - Blue Springs Creek Wetland Complex
DUBLIN LINE
MILL STREET WEST
2
1
0.5
0.1
2804147(6.1)
2808868(11)
2807884(19.2)
2807889(17.4)
2807888(18.6)
2807860(25)
2807906(15.2)
2807858(26.2)
2807987(27.4)
2807839(24.4)
2807887(54.9)
2807883(19.5)
2810366(30.5)
2803207(4)
2804896(8.8)
2807838(18.3)
2807836(18.3)
2807882(9.2)
7103674(20.7)
2807857(30.5)
2807861(22.9)
2807999(20.7)
2807895(22.9)
7105992(6.4)
2807971(15.2)
2807694(5.2)
2806659(14.3)
2807901(44.2)
2807902(7.6)
2807894(10.7)
2807900(7.6)
2807897(12.2)
2807957(10.1)
2807956(10.7)
2807955(8.8)
2807958(14.3)
7106067(24.7)
0 0.2 0.4 0.6 0.8 Kilometers
N
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

4.3 Effects on Local Surface Water Resources

The PPGSS provides an evaluation of the source of water to the Prospect Park well field during the pumping test performed at a flow rate of 4,400 m^3/day. There are two important assumptions in the analysis: (a) the aquifer system reached a steady-state condition during the pumping test and (b) the capture zone for the wells delineated by the Tier 3 water budget assessment is reasonable representation of the natural conditions. The Tier 3 study capture zone used in the analysis is based on a model flow rate of 4,400 m^3/day. It is not stated whether the model capture zone was calibrated using the actual pumping test data.

The first component in the PPGSS evaluation is an analysis of horizontal groundwater flow to the well field within the capture zone for the wells under the steady-state pumping test condition. The analysis is based on Darcy's equation and used the well field capture zone and the aquifer potentiometric surface from the Halton Hills Tier 3 Water Budget Assessment shown on PPGSS Figure B17. The analysis uses the estimates of transmissivity (620 to 800 m^2/day) derived from a Jacob-Theis analysis of the pumping test data from the first pumping test (performed at a flow rate of 3,045 m^3/day). The calculations using Darcy's equation indicate that horizontal flow in the aquifer within the capture zone accounts for between 70 and 90 percent of the 4,400 m^3/day flow rate to the production wells. The capture zone delivering this water to the wells is entirely within the Fairy Lake Catchment of Black Creek (i.e. the catchment upstream of the lake), and appears to include 1 or 2 tributaries upstream of the lake.

The second component in the PPGSS evaluation is an analysis of vertical drainage from the Fairy Lake surface catchment area in the zone-of-influence. The first part of this analysis considers water loss from storage in Fairy Lake based on measured lake level declines in August 2010, when there was no water surplus inflow to the lake and no outflow over the dam. Using a lake stage storage curve, and accounting for evaporation losses, it is stated that leakage from Fairy Lake could account for approximately 1,200 m^3/day of the well field pumping rate as the test was approaching the steady-state condition. The second part of the analysis uses Darcy's equation to estimate the vertical flow across the bottom sediments in Fairy Lake and the till deposits overlying the Prospect Park aquifer. In the analysis, vertical hydraulic conductivity (K) for both the Fairy Lake bottom sediments and the till is set at 2×10^{-8} m/s; this K value is reported to be in the range of K derived from a study of the Fairy Lake bottom sediments (AECOM, 2009). The increase in vertical hydraulic gradient (i) across the lake bottom sediments and till was estimated using the zone-of-influence for the pumping test shown on PPGSS Figure B17 and the interpreted thickness of the lake bottom/till sediments overlying the aquifer (approximately 2 m). The calculations are provided in the PPGSS Table B4 and indicate that the increase in vertical seepage would be 1,200 m^3/day, which is in agreement with the value calculated in the first part of the analysis. The seepage flow rate derived from the vertical flux (K x i) appears to be calculated over the zone-of-influence surface area.

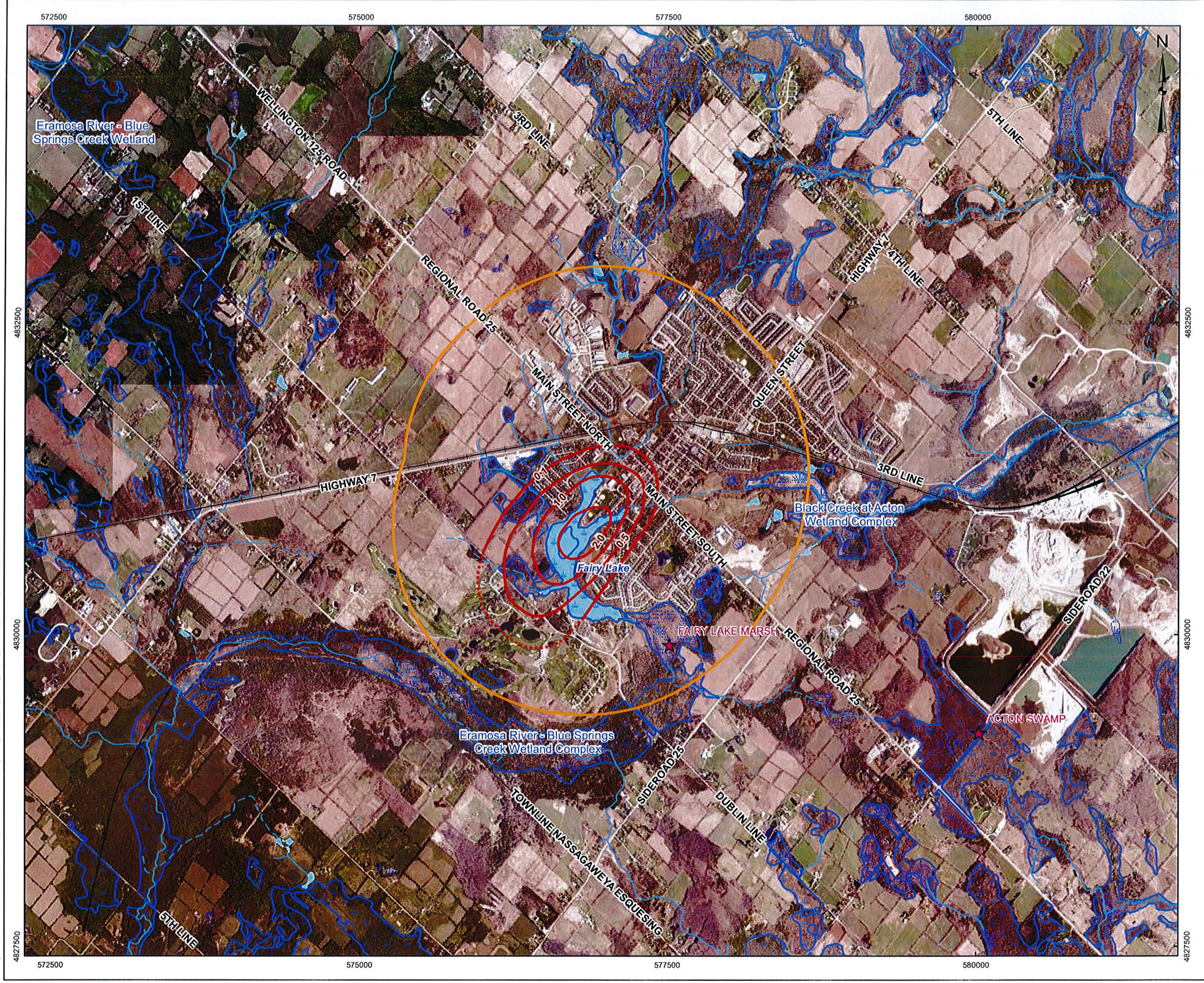
Acknowledging that relatively small portions of the zone-of-influence extend into the Black Creek surface catchment downstream of Fairy Lake and the Blue Springs Creek surface catchment southwest of the lake, similar calculations of vertical drainage arising from the increase in pumping rate were made for those catchments using the same estimates of K and i. Because of the relatively small zone-of-influence area extending into these two catchments, the calculated leakage rates were much lower (25 m^3/day for the Blue Springs Creek catchment area and 53 m^3/day for the Black Creek catchment area downstream of the lake). It should be noted that the analysis does not necessarily mean that the vertical leakage in these catchments will be captured by the Prospect Park wells. If the Tier 3 capture zone derived for the wells at 4,400 m^3/day is accurate, these catchments are outside of the well field capture area and the additional leakage, if any, should re-surface within the catchments.

The PPGSS provides a detailed analysis of the potential effects of the increase in pumping rate on the water levels in Fairy Lake and the wetland areas adjacent to the lake, which is provided in Appendix C of the PPGSS. The work included a water budget analysis for the lake. As noted above, using data for the month of August 2010 when there was no inflow to the lake during the pumping test, the PPGSS analysis indicated that seepage losses from the lake accounted for approximately 27 percent of the well field production (i.e. 1,188 m^3/day of the total 4,400 m^3/day well field test pumping rate). This was based on approximately 0.18 m of the total 0.28 m water level decline observed in Fairy Lake during August 2010 being attributed to seepage losses from the lake. Using the water budget assessment, lake stage-storage curve and existing permitted pumping rates (2,273 m^3/day) during the warm weather period (May to September), the analysis predicts that the proposed increase in pumping rate to a year round constant of 3,400 m^3/day would result in a lake level decline of 5 cm during the warm weather period (May to September) and no change from existing conditions for the remainder of the year. Refer to PPGSS Figure C8. The proposed increase in pumping rate now (3,500 m^3/day) is slightly higher than what was used in the PPGSS. For this slightly higher pumping rate, the corresponding decline in lake level increases to about 5.5 cm. Changes of this small magnitude will be difficult to detect in view of the other factors (precipitation, the dam weir elevation) affecting the lake water level elevation.

Based on the work in the PPGSS, it is understood that the three provincially significant wetlands (PSWs) in the area are as follows: (1) Eramosa River –Blue Springs Wetland Complex, which includes the Fairy Lake Marsh, (2) Black Creek at Acton Wetland Complex, (3) Acton-Silver Creek Wetland Complex. The location of these features and the drawdown cones are shown in Figure 14. The drawdown cones from the pumping tests demonstrate that the Black Creek at Acton Wetland Complex and the Acton Swamp were outside of the measurable zone of influence during the pumping test and that there was no measurable effect on groundwater or surface water levels at these PSWs. They are both considered to be beyond the measurable zone of influence of the wells.

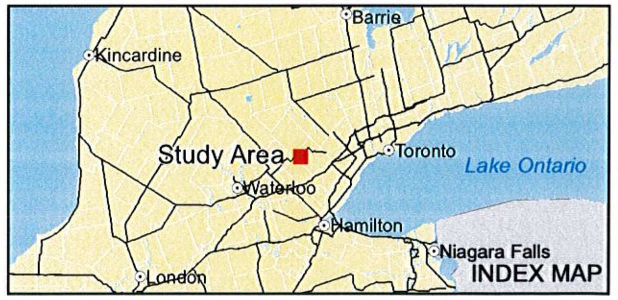
Note that the interpretations concerning the zone of influence were taken at the test flow rate of 4,400 m^3/d, which is higher than the proposed increase in water taking of 3,500 m^3/d.

The Fairy Lake Marsh borders the south end of the lake; the 0.1 m drawdown contour in the aquifer at the higher pumping rate of 4,400 m^3/d does not extend beneath the marsh or any other part of the Eramosa River – Blue Springs Creek Wetland Complex. The zone–of–influence mapping indicates negligible drawdown in the aquifer beneath these wetland features, it is therefore reasonable to conclude that there was no influence on the groundwater/surface water interactions beneath these provincially significant wetland areas (Eramosa River-Blue Springs Creek Wetland Complex; Fairy Lake Marsh, Black Creek at Acton Wetland Complex). There appears to be only minimal risk of an effect on these features arising from operating the Prospect Park municipal wells at a constant flow rate of 3,500 m^3/day.



LEGEND

- Environmentally Significant Feature
- Road
- Railway
- Interpreted Water Level Drawdown Contour (m) In Response to Pumping at 4,400 m³ /day
- Watercourse
- Watercourse, Intermittent
- Waterbody
- Wetland
- Provincially Significant Wetland
- Prospect Park Study Area



REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Imagery: Bing Maps © 2009 Microsoft Corporation and its data suppliers.
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

0.5 0.25 0 0.5 1 1.5

SCALE 1:30,000 KILOMETERS

PROJECT

PROSPECT PARK
GROUNDWATER SUPPLY STUDY

TITLE

SIGNIFICANT NATURAL FEATURES

Golder Associates
Mississauga, Ontario

PROJECT NO. 11-1152-0142			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	16 Nov. 2011	FIGURE: 11	
GIS	KD	9 May. 2012		
CHECK	JH	9 May. 2012		
REVIEW	SMD	9 May. 2012		

4.4 Effects on Lake Water Levels and Downstream Flows

The Fairy Lake Watershed is approximately 2,031 ha and the lake itself has a surface area of 26 ha, a perimeter of 4.6 km, and a total volume of 400,656 m^3. The bathymetry mapping in Figure 10 shows the lake depth contours at 1 m intervals (from 0 to 7 m). The lake is relatively shallow, with 50 percent of its volume occurring in the top 1 m of depth. A strict interpretation of the figure would suggest that the lake itself is distinct from the surrounding wetlands. Based on these contours, it is estimated that the total "dried out" area caused by a 0.05 m (5 cm) reduction in surface water levels would be 6,800 m^2 (0.7 ha). Based on the estimated perimeter of the lake, the average width of the dried out area would be 1.5 m. This represents 2.6 percent of the existing lake surface area.

PPGSS pumping tests conducted at 4,400 m^3/d, which is greater than the proposed water taking of 3,500 m^3/d, suggested that the estimated change in surface water levels in Fairy Lake would be in the order of 0.05 m (see Section 4.3). A change of this magnitude is within the existing seasonal fluctuations (between 0.40 and 0.60 m) as presented in Table 5. The Fairy Lake water level data presented in Table 5 suggest that lake levels are heavily influenced by surface water inflow (as shown in Figure 15), and the amount of inflow is dependent on the amount of precipitation (as shown in Figure 16). The data support the assertions that the impacts of increased groundwater takings are not expected to have a significant impact on surface water levels.

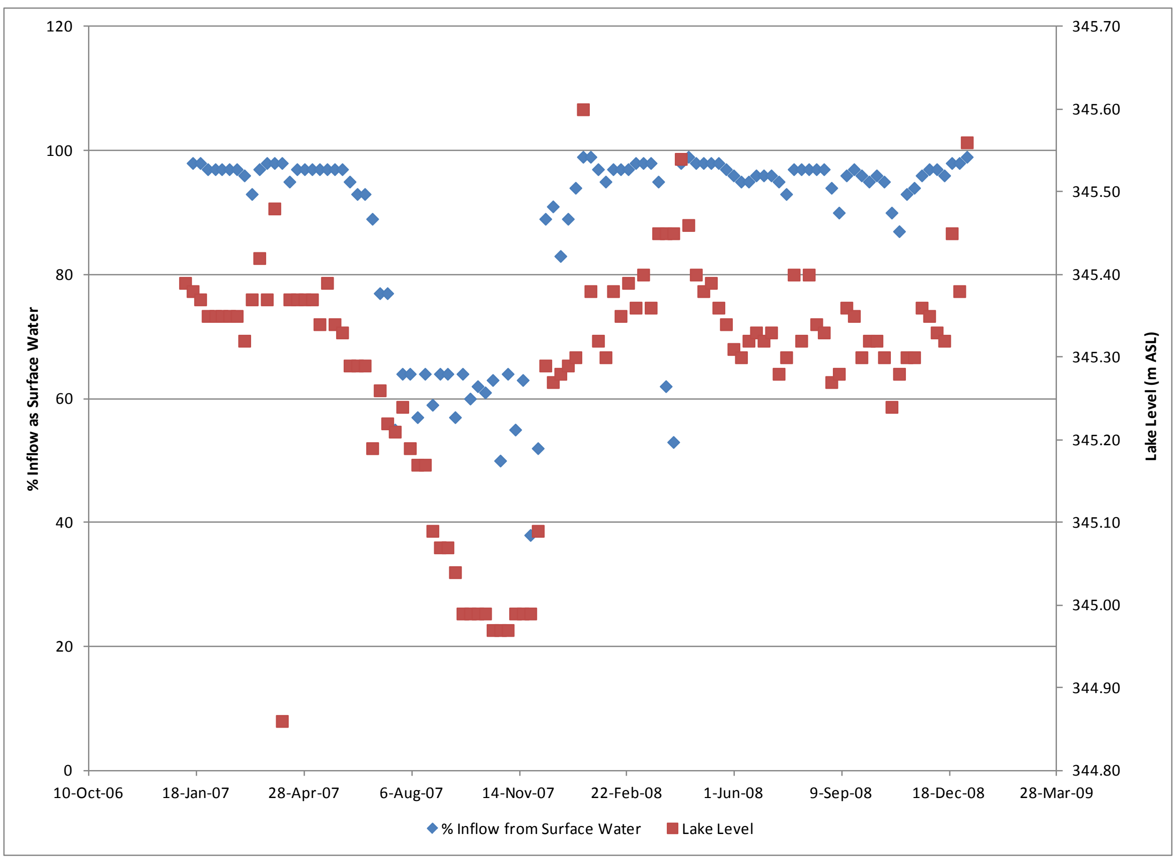


Figure 15 Lake Levels and Surface Water Inflow

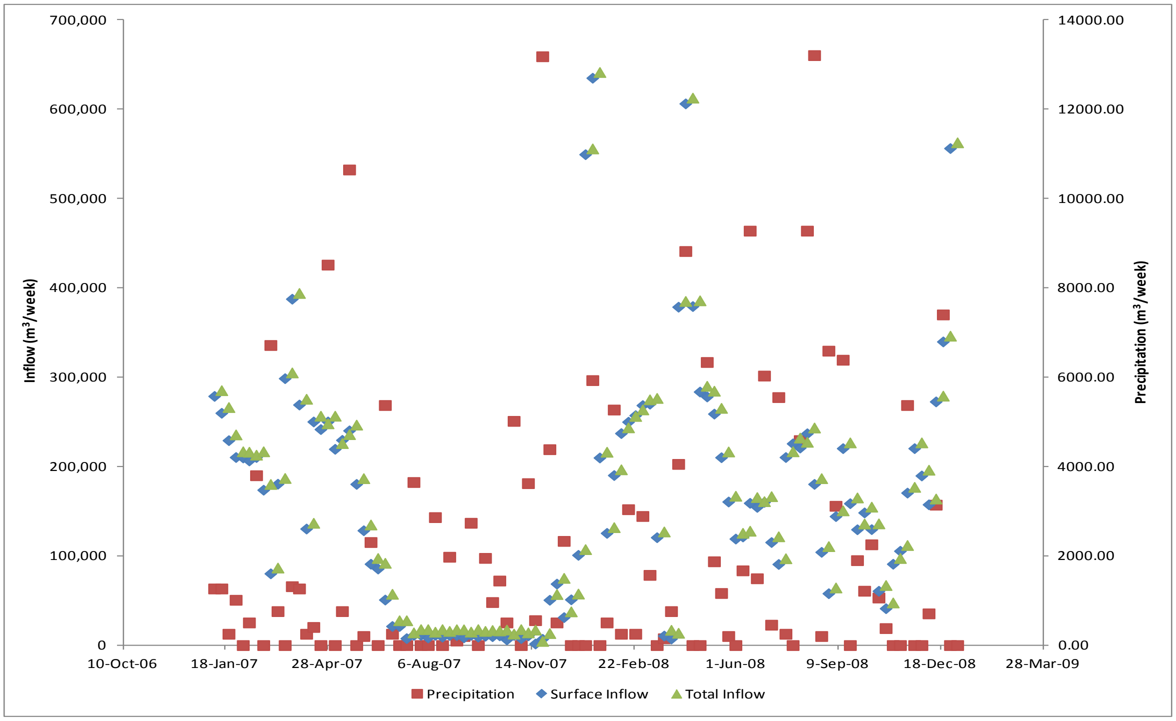


Figure 16 Inflow and Precipitation

It should be noted that the shallower areas of the lake are mainly located in the South Basin. The drawdown maps (Figures 12A, 12B, and 13) show very minor impacts on the South Basin, and the drawdown contours do not include the Fairy Lake Marsh.

Further, it is not anticipated that there will be implications on the assimilative capacity of Black Creek needed for the Acton WWTP. As shown in Table 2, Fairy Lake contributes little to the flow in Black Creek compared to other downstream sources, namely groundwater inflow. However, options for the control of the Fairy Lake outflow and other opportunities to increase flow Black Creek are describe in the Black Creek Assimilative Capacity Study Draft Report (Dillon, 2011). These options are Fairy Lake augmentation and Dufferin Aggregates augmentation and were described in Section 2.5.

4.5 Effects on Vegetation and Aquatic Wildlife

The hydrological pathways for potential impacts to the natural environment have been assessed in detail as part of the work completed to date. The assessment shows that there will be minimal impacts to the natural environment via the hydrological pathways, and therefore the biological impacts by way of this pathway are expected to be minimal.

There are potential impacts to the open/vegetated space on the west side of the Main Basin, however, given the depth of the lake in this area, a 5 cm decrease in water levels at this location may not generate as wide of a “dried out” area as in the shallower areas described in Section 4.4. Based on the information presented in the vegetation mapping shown in Figures 11a and 11b in the Tier 3 Water Budget Conceptual Model Report (AECOM, 2012), this area is mainly classified as Dry-Moist Old Field Meadow and Cultural Deciduous Woodland. On the east side, there are some areas designated as Thicket Swamp. The Marsh classified areas appear to be limited to the South Basin and are generally outside the projected zone of influence.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Studies conducted at the Prospect Park well field and surrounding area provide an acceptable technical basis for the impact assessment associated with proposed changes to water takings. The work indicates that the well field can sustain a pumping rate of 3,500 m^3/day on a continuous basis without causing adverse effects to other groundwater users or environmental features in the area that are dependent on groundwater.

Based on the previous studies, and the impact assessment presented in this report, it can be concluded that increasing the pumping rate at the existing production wells to 3,500 m^3/day will have minimal adverse effect on private supply wells in the pumping zone-of-influence.

It is further concluded that operation of the wells at a maximum pumping rate of 3,500 m^3/day will have only minimal adverse effect on surface water resources in the Black Creek catchment area downstream of Fairy Lake, or the Blue Springs Creek catchment area to the southwest of Fairy Lake. Measurable effects of the increase in pumping rate should be limited to

1. A potential groundwater level decline in the range of 0 to 1 m in the Prospect Park aquifer beneath the uppermost part of the Black Creek catchment immediately downstream of Fairy Lake; and
2. A potential groundwater level decline in the range of 0 to 0.5 m at the edge of the Blue Springs Creek catchment southwest of Fairy Lake.

Neither of these potential groundwater declines in the aquifer will result in a measurable effect on surface water levels in these areas or have significant influence on the assimilative capacity of Black Creek.

The analysis provided in the PPGSS provides a sound basis for concluding that the increase in pumping rate will have a small and largely insignificant effect on the water level in Fairy Lake, and the tributaries upstream of the lake. The predicted effect (5 to 6 cm) is small in magnitude in relation to existing seasonal variations that occur in the lake level under existing conditions.

It is also anticipated that the increase in pumping rate will have no measurable or limited adverse effect on groundwater levels or surface water levels at the three provincially significant wetlands that have been identified in the area.

5.2 Recommendations for the Monitoring Program

The Region currently implements a monitoring program associated with the operation of the Prospect Park well field. The monitoring program includes measurement of groundwater levels, water temperatures, surface water levels and surface water flows in the area. Details concerning the monitoring stations, methods and frequency of measurement are provided in Table 5 (Surface Water) and Table 6 (Groundwater). The surface water monitoring stations all relate to the measurement of surface water flows into and out of Fairy Lake.

The overall objectives of the existing monitoring program are to collect and use the data to further the understanding of the effects of municipal pumping on groundwater and surface water resources in the area. These objectives have now been largely achieved, therefore the objectives that guide the monitoring program can now focus on confirming the long-term effects of the proposed change in pumping conditions at Prospect Park and confirming the predictions made in the impact assessment.

To meet this objective, the monitoring program (as summarized in Tables 7 and 8) is recommended, with data review, interpretation and reporting under the direction of a qualified professional (P.Eng. or P.Geo.). Modifications to the recommended monitoring program should be allowed based on review and interpretation of the results by the qualified professional in consultation with the MOECC.

The recommended monitoring locations are shown on Figure 17.

5.2.1 Data Collection, Review, and Annual Monitoring Report

The data collected from the monitoring program should be processed and reviewed concurrently with the data collection schedule to monitor for any significant or anomalous results and the results of the monitoring program should be summarized in an annual report prepared by a qualified professional. The annual review should consider the surface and groundwater level data, surface water flow measurements, municipal pumping records and precipitation records.

The report should include a clear presentation of the data, observations and interpretations arising from the technical review of the data, and the identification of the effects of municipal pumping, if any, that are evident from the review. The annual report should present the data for the calendar year in comparison to data available from previous years.

The report should contain the following items:

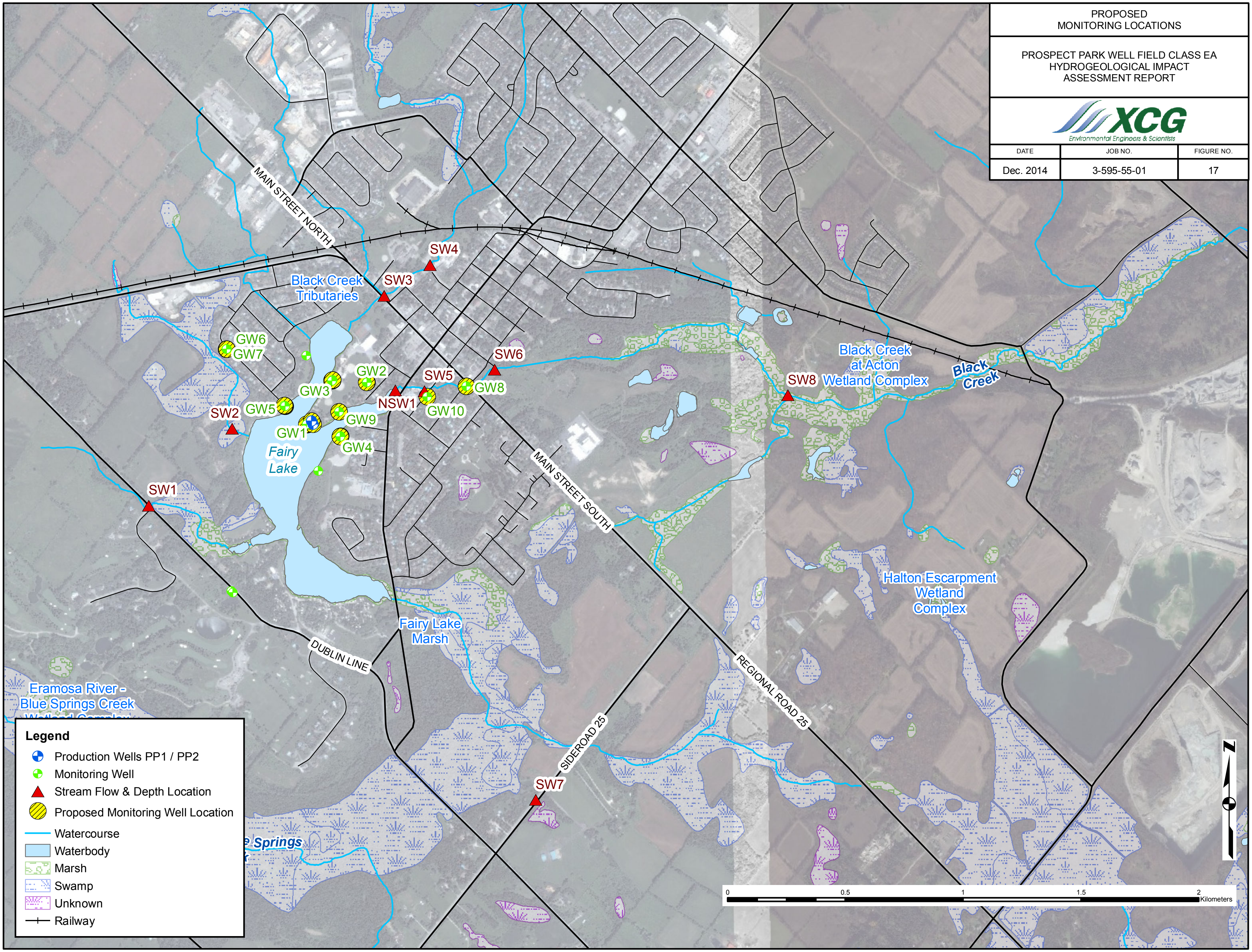
- Hydrographs facilitating a clear comparison of the different data types;
- Hydrographs of the water level data, including available historical results;
- A summary of production well pumping records in the form of hydrographs and/or histograms;
- Summary of stream flow measurements;
- Graphs of the data are to be prepared to the same time scale so that different types of data can be easily compared by visual means;
- An assessment of observed impacts if any due to the increased water taking at the well field;
- Descriptions of any mitigative measures undertaken;
- Recommendations for modifications to the monitoring program, where appropriate (the recommendations could include adding or removing monitoring stations and items, and increasing or decreasing the frequency of monitoring at the various stations); and
- Installation details, borehole logs, survey results and other information related to new or modified monitoring locations.

Table 7 Surface Water: Proposed Stream Flow/Water Level Locations for the Monitoring Program

Identifier	Monitoring Location	Data Collected During Monitoring
SW1	Black Creek Tributary 1 to Fairy Lake (at Dublin Line)	Water level datalogger, monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW2	Black Creek Tributary 2 to Fairy Lake	Water level datalogger, monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW3	Black Creek Tributary 3 to Fairy Lake (at Library; Hwy 25)	Water level datalogger, monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW4	Black Creek Tributary 3 to Fairy Lake (HH Hydro; Alice St.)	monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW5	Black Creek Downstream of Dam, above WWTP (Mill; Church St.)	Water level datalogger, monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW6	Black Creek Downstream of Dam, above WWTP (Agnes St.)	Monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW7	Black Creek Tributary to Fairy Lake Marsh (25th Side Rd.)	Water level datalogger, monthly readings and stream flow (when water levels fall below the dam), weather permitting
SW8	Black Creek at the WWTP (Churchill Rd)	Water level datalogger, monthly readings and stream flow (when water levels fall below the dam), weather permitting
NSW1	Fairy Lake Gauge Level at the Dam	Water level datalogger, bi-weekly manual water level measurement

Table 8 Groundwater: Proposed Well Locations for the Monitoring Program

Identifier	Monitoring Location	Hydrostratigraphic Unit	Data Collected and Frequency
PP1	Prospect Park 1	Prospect Park Aquifer (Deep)	Continuous using either the Region's SCADA system or data loggers
PP2	Prospect Park 2	Prospect Park Aquifer (Deep)	Continuous using either the Region's SCADA system or data loggers
GW1	MW29-08 S&D	Prospect Park Aquifer (Intermediate/Deep)	Water level and temperature datalogger, monthly manual water level measurement
GW2	MW30-08 S&D	Prospect Park Aquifer (Intermediate/Deep)	Water level datalogger, monthly manual water level measurement
GW3	MW30-09 S,I&D	Prospect Park Aquifer (Shallow/Intermediate/Deep)	Water level datalogger, monthly manual water level measurement
GW4	MW33-09 S,I&D	Prospect Park Aquifer (Shallow/Intermediate/Deep)	Water level datalogger, monthly manual water level measurement
GW5	MW34-09 S,I&D	Prospect Park Aquifer (Shallow/Intermediate/Deep)	Water level datalogger, monthly manual water level measurement
GW6	MW36-09 S&I	Prospect Park Aquifer (Shallow/Intermediate)	Water level datalogger, monthly manual water level measurement
GW7	MW36-09 D	Shallow Bedrock (Gasport Formation)	Water level datalogger, monthly manual water level measurement
GW8	TW6-91 S&D	Prospect Park Aquifer (Shallow/Intermediate)	Water level datalogger, monthly manual water level measurement
GW9	OW3 S&D	Prospect Park Aquifer (Shallow/Deep)	Continuous using either the Region's SCADA system or data loggers
GW10	TW5/91	Prospect Park Aquifer (Deep)	Continuous using either the Region's SCADA system or data loggers


PROPOSED
MONITORING LOCATIONS
PROSPECT PARK WELL FIELD CLASS EA
HYDROGEOLOGICAL IMPACT
ASSESSMENT REPORT
XCG
Environmental Engineers & Scientists
DATE
Dec. 2014
JOB NO.
3-595-55-01
FIGURE NO.
17
MAIN STREET NORTH
MAIN STREET SOUTH
DUBLIN LINE
REGIONAL ROAD 25
SIDEROAD 25
Black Creek
Tributaries
Black Creek
at Acton
Wetland Complex
Black
Creek
Fairy
Lake
Fairy Lake
Marsh
Halton Escarpment
Wetland
Complex
Eramosa River -
Blue Springs Creek
SW1
SW2
SW3
SW4
SW5
SW6
SW7
SW8
NSW1
GW1
GW2
GW3
GW4
GW5
GW6
GW7
GW8
GW9
GW10
Legend
Production Wells PP1 / PP2
Monitoring Well
Stream Flow & Depth Location
Proposed Monitoring Well Location
Watercourse
Waterbody
Marsh
Swamp
Unknown
Railway
0
0.5
1
1.5
2
Kilometers
N

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APPENDIX A
PROSPECT PARK WELL FIELD IMPACT ASSESSMENT, DILLON CONSULTING, 2007

APPENDIX B
PROSPECT PARK WELL FIELD IMPACT ASSESSMENT, DILLON CONSULTING, 2010

APPENDIX C
PROSPECT PARK WELL FIELD

APPENDIX D
HALTON HILLS TIER THREE WATER BUDGET AND WATER QUANTITY RISK LEVEL ASSIGNMENT STUDY: CONCEPTUAL MODEL REPORT, AECOM & AQUARESOURCE INC., 2012

APPENDIX E
BLACK CREEK ASSIMILATIVE CAPACITY STUDY, DILLON CONSULTING, 2011

APPENDIX F
CORRESPONDENCE WITH CVC REGARDING THE 2007 DILLON WELL FIELD IMPACT ASSESSMENT

APPENDIX G
CORRESPONDENCE WITH MNRF REGARDING THE CURRENT PROSPECT PARK CLASS EA