Appendix B

Hydrogeological Investigation

CITY OF HAMILTON

HYDROGEOLOGICAL ASSESSMENT – REV. 3

BLOCK 1, FRUITLAND-WINONA BLOCK SERVICING STRATEGY REPORT

MARCH 2024

HYDROGEOLOGICAL ASSESSMENT – REV. 3

BLOCK 1, FRUITLAND-WINONA BLOCK SERVICING STRATEGY REPORT

CITY OF HAMILTON

PROJECT NO.: TP115082
MARCH 2024

WSP Canada Inc.
3450 Harvester Road
Burlington, Ontario, L7N 3W5

T: +1-905-335-2353

WSP.com

WSP Canada Inc. (WSP) prepared this report solely for the use of the intended recipient, City of Hamilton, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

The original of this digital file will be conserved by WSP for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP, its integrity cannot be assured. As such, WSP does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.

REVISION HISTORY

Revision Number	Revision Date	Purpose of Revision
R0	November 2015	Hydrogeological Assessment Draft Report issued
R1	August 2017	Assessment updated with data up to 2017 and compiled as Block 1 Servicing Strategies
R2	November 2021	Update to Report based on comments received
R3	March 2024	Final

EXECUTIVE SUMMARY

WSP Canada Inc. (WSP) (formerly known as Wood Environment & Infrastructure Solutions) has carried out a hydrogeological assessment at Block 1 of the Fruitland-Winona Secondary Plan to fulfil the requirements of the Terms of Reference for the Fruitland-Winona Block Servicing Strategy (January 2014). WSP issued a draft Hydrogeological Assessment Report in November 2015. Subsequently, the hydrogeological assessment was updated in 2017 as part of a larger Servicing Strategies Report. Following comments, this Hydrogeological Assessment Report (Rev. 2) has been prepared to update the assessment based on the current understanding for the site.

The field work associated with the investigation consisted of installation of 6 monitoring wells, monitoring of groundwater levels, sampling and chemical analysis of groundwater from 3 monitoring wells, installation of pressure transducers in 4 monitoring wells, installation of pressure transducers in 4 monitoring wells, slug testing at 5 monitoring wells, and stream flow monitoring.

In the vicinity of Block 1, the surface topography is relatively flat with a gentle slope down towards the north, generally following the bedrock topography. The site is bordered by two permanent watercourses, Watercourse 5, which flows from south to north along the west edge of Block 1 (east of, but roughly parallel to Fruitland Road), and Watercourse 6, which flows from south to north along the east edge of Block 1 (east of Jones Road). While these are mapped as permanent watercourse features, observed flow in these features tended to be slow to intermittent.

Block 1 is located within the Iroquois Plain Physiographic Region (Chapman and Putnam, 1984) of Southern Ontario. According to Chapman and Putnam, 1984, the region of the Iroquois Plain to the west of Grimsby is characterized by heavy textured, low permeability soil developed on red clay derived from the underlying Queenston Formation. The Queenston Formation Shale is generally compact and dense with poor pore space interconnectivity and poor water yielding capabilities. During drilling on the site, bedrock was found to occur at depths from 1.0 to 2.2 m below ground surface. The surficial soil is identified as Halton Till, a clayey silt-clay till which is in agreement with the observations from boreholes drilled as part of the current field program.

Groundwater level monitoring using automatic pressure transducers indicated a trend of seasonal water level fluctuations with groundwater levels generally rising annually from February to April then generally decreasing between April and December. The range of water level fluctuations observed during the period from June 2015 to April 2017 was approximately 1.5 m at BH-2, 1.9 m at BH-1 and 3.6 m at BH-4.

Hydraulic conductivities determined from slug tests carried out in the monitoring wells ranged from 8.7x 10-5 m/s to 2.8 x 10-8 (geometric mean 8.5 x 10-7 m/s). The degree of variability in hydraulic conductivity is likely a reflection of the variability of the amount of weathering and fracturing occurring at different locations on the site. The groundwater flow direction is generally from the south-southwest towards the north-northeast with an average gradient of approximately 1.9%.

Groundwater sampling was carried out at monitoring wells BH/MW-1, BH/MW-2, and BH/MW-5 on August 4, 2015. In general, the water chemistry analyses show values typically found in groundwater derived from the Queenston Shale formation. The analysis results were compared with standards obtained from the Ontario Provincial Water Quality Objectives (PWQO) and from Table 7 – Non-potable groundwater, Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition. No values were obtained which exceed the Table 7 values. Results in excess of the PWQO were obtained for Boron and Uranium at all locations, and for Cobalt and Silver at BH/MW-1 and BH/MW-2. These results are likely naturally occurring as they are typical of the underlying Shale bedrock found in the area.

Surface water flow measurements and observations were carried out at Watercourse 5 and Watercourse 6 at two locations each (upstream – Regional Road 8 and downstream – Barton Street) on September 4, 2015. Low flows were measured at the upstream locations (12 m^3/day at Watercourse 5 and 6.9 m^3/day at Watercourse 6). Both watercourses were observed to be dry at the downstream locations.

Water balance calculations for Block 1 was carried out based on existing conditions and proposed post-development conditions. Comparison between the pre- and post-development calculations indicates a reduction in evapotranspiration and infiltration and an increase in runoff volumes resulting from the increase in impervious surfaces. In order to address the deficit of infiltration due to development a number of LID measures can be used. The measures most likely to be implemented on this site would be downspout disconnection; increased topsoil depths (200 mm minimum); grassed swales to promote infiltration and TSS removal; infiltration trenches/swales (rear yard drainage swales with 150 mm topsoil rock gallery/storage median and perforated underdrain; soak away pits (rock filled galleries or chambers to store and infiltrate runoff; enhanced tree pits (enlarged chamber to receive direct runoff from streets); and bioswales (enhanced vegetative swale with filtration, attenuation and infiltration capabilities.

Development of Block 1 will tend to reduce the amount of infiltration of precipitation towards the water table primarily due to reduction in the amount of permeable area. Other factors which could contribute to this effect include increased compaction of the subsurface soils due to heavy vehicle traffic during construction, effects due to changes in site grading and changes in surface soils and vegetation type. Additionally, the excavation of trenches to accommodate underground utilities could create more permeable pathways for groundwater flow. Taken together, these factors would tend to result in a lowering of the water table in the vicinity of the development.

In the southern half of the Block 1 area, the low permeability of the surficial materials over which the watercourses flow (Halton Till) allow for very little interaction between the surface water and groundwater in these areas. Additionally, the watercourses do not transport large volumes of water and are observed to become dry during periods with low precipitation (such as during the summer months).

Groundwater levels near ground surface were measured at some locations during the field investigation, therefore it is likely that foundation drainage and sump pumps will be required for buildings having basements.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

WSP Canada Inc. (WSP) carried out a hydrogeological assessment at Block 1 of the Fruitland-Winona Secondary Plan to fulfill the requirements of the Terms of Reference for the Fruitland-Winona Block Servicing Strategy (January 2014). WSP issued a draft Hydrogeological Assessment Report in November 2015. Subsequently, the hydrogeological assessment was updated in 2017 as part of a larger Servicing Strategies Report. Following comments, this Hydrogeological Assessment Report (Rev. 2) has been prepared to update the assessment based on the current understanding for the site.

Block 1 (the 'site') is located in the City of Hamilton and is bounded on the west by Fruitland Road, on the north by Barton Street on the south by Regional Road 8 and on the east by Watercourse 6, which runs south to north on the east side of Jones Road (Figure 1). Current land use is primarily residential and commercial or institutional along the roadways, with the interior of the block being open space (former agricultural land).

The field work associated with the investigation consisted of the following items:

- Installation of 6 monitoring wells;
- Monitoring of groundwater levels;
- Sampling of groundwater from 3 monitoring wells;
- Installation of pressure transducers in 4 monitoring wells;
- Slug testing at 5 monitoring wells; and
- Stream flow monitoring.

2 GEOLOGIC SETTING

In the vicinity of Block 1, the surface topography is relatively flat with a gentle slope down towards the north, generally following the bedrock topography. The site is bordered by two permanent watercourses, Watercourse 5, which flows from south to north along the west edge of Block 1 (east of, but roughly parallel to Fruitland Road), and Watercourse 6, which flows from south to north along the east edge of Block 1 (east of Jones Road). While these are mapped as permanent watercourse features, observed flow in these features tended to be slow to intermittent.

Block 1 is located within the Iroquois Plain Physiographic Region (Chapman and Putnam, 1984) of Southern Ontario, a lowland bordering Lake Ontario which was occupied by Lake Iroquois during the period when the last glaciation was receding but remained in the St. Lawrence Valley. According to Chapman and Putnam, 1984, the region of the Iroquois Plain to the west of Grimsby is characterized by heavy textured, low permeability soil developed on red clay derived from the underlying Queenston Formation.

The bedrock is identified as Queenston Formation Shale on Preliminary Map P.993, Quaternary Geology, Grimsby Area, Southern Ontario (Ontario Division of Mines, 1975. According to Singer et al. (2003), the Queenston Shale is generally compact and dense with poor pore space interconnectivity and poor water yielding capabilities. Data obtained from water well records indicate a relatively wide range of transmissivity values with 10 and 90 percentile values ranging between 0.5 and 27.9 m^2/day respectively. In general, only the weathered zone in upper 3 to 5 m of the shale provide sufficient water supplies for domestic use.

According to Preliminary Map 2401, Bedrock Topography Series, Grimsby Area, Ontario Geological Survey, 1981, the bedrock slopes down towards Lake Ontario from approximately 92 m asl in the vicinity of Regional Road 8 to approximately 85 m asl in the vicinity of Barton Street. For comparison, the ground surface elevation varies from 93 to 88 m asl, indicating that the overburden is approximately 1 to 3 m thick.

On Quaternary Geology mapping prepared by the Ontario Geological Survey (2012), the area of Block 1 is identified as being an area of shallow bedrock, with some outcropping at or near ground surface, however the surficial soil of the surrounding area is identified as Halton Till: clayey silt-clay till (Figure 2), which is in agreement with the observations from boreholes drilled as part of the current field program. During drilling on the site, bedrock was found to occur at depths from 1.0 to 2.2 m below ground surface.

The Water Well Database of the Ontario Ministry of the Environment and Climate Change indicated at the time of the search (2015) that a total of 18 wells located within Block 1, of which 2 are recent 2” diameter plastic monitoring wells and the remainder being 6” diameter water wells drilled in the 1950’s, primarily for domestic water supply (Figure 3).

The 2” diameter monitoring wells would likely have been installed as part of development, or other investigative work in the area. These wells are assumed to be abandoned if not still in use. The domestic water wells are primarily associated with residences located along the roads at the perimeter of the block and were generally drilled into the shale bedrock at depths of about 8 to 16 m below ground surface. According to the well records, the wells generally yielded fresh water at flow rates of about 9 to 23 L/min. It is unlikely that these wells are in current use for domestic water supply as the area is serviced by the municipal water supply system.

3 FIELD WORK

In conjunction with the geotechnical field work, a total of 6 monitoring wells, constructed of 50 mm diameter PVC screen and riser were installed from June 8 to June 10, 2015 in order to monitor water levels and obtain groundwater samples. The locations of the monitoring wells are shown in Figure 4. A seventh monitoring well, intended for the southern area adjacent to the cemetery along Regional Road 8, was not able to be installed due to site access limitations. Ground surface elevations at the borehole locations were determined from topographic mapping.

The monitoring wells consisted of 2 in. diameter, 1.5 m long screens placed at the bottom of each borehole to depths between 3.8 m and 5.2 m below ground surface and riser pipe extending to above ground surface. Each monitoring well was provided with a steel protective casing. Logs of the boreholes showing the position of the well screens are presented in Appendix A.

As indicated in the logs of boreholes, the site stratigraphy consists of a thin topsoil layer underlain by Silty Clay, which is in turn underlain by red weathered Shale. The shale was encountered at depths ranging from 1.07 m to 2.21 m below ground surface. In all cases the well screens were placed within the weathered shale unit.

The elevations of the wells were estimated using available topographic mapping, with ground surface elevations at each of the monitoring wells ranging between 87.4 m and 92.7 m.

3.1 WATER LEVELS

Water levels were obtained from all wells at the time of drilling on June 8, 9, and 10, 2015. Additional water levels were obtained on July 20 prior to well development, on July 21/22 prior to carrying out slug testing, and on August 4, and September 4 and 14, 2015. Pressure transducers were deployed in select monitoring wells in late 2015 to automatically record water levels in the monitoring wells over an extended period of time. The pressure transducers were installed in BH/MW-6 on August 5, 2015, in BH/MW 5 on August 31, 2015 and in BH/MW-1, BH/MW-2, BH/MW-4 on September 4, 2015. The transducers in BH/MW-5 and BH/MW-6 were removed on September 29, 2015 and the transducers in BH/MW-1, BH/MW-2, and BH/MW-4 remained in place until April 12, 2017.

Water level readings obtained in 2015 and 2017 are presented in **Table 1**.

Table 1: Water Levels Recorded in the Monitoring Wells

Monitoring Well ID	**Ground Surface Elevation (masl)**	**Date of Water Level Measurement**							
		12/06/2015	**20/07/2015**	**21/07/2015**	**22/07/2015**	**04/08/2015**	**04/09/2015**	**14/09/2015**	**12/04/2017**
		Water Level Measurement (mbgs)							
BH/MW-1	92.7	1.78	0.3*	0.22*		0.65	1.16	1.19	1.26
BH/MW-2	92.3	1.49	1.67		1.80	1.97	2.31	2.16	1.87
BH/MW-3	87.4	1.76	2.23		2.33				
BH/MW-4	91.2	dry	1.91		2.35		3.02	3.17	1.68
BH/MW-5	89.4	0.13	0.49	0.54		0.95		1.54	0.67
BH/MW-6	88.0	1.16	1.68	1.68				2.26	1.80

Note:
*Red text indicates water levels readings above ground surface

A hydrograph of water level elevations recorded by manual measurement and automatic pressure transducers programmed for hourly readings is presented as Figure 5. The hydrograph also shows daily precipitation as recorded by the Vineland weather station.

The locations of geological cross sections based on the units encountered during drilling are presented in Figure 7. The cross sections showing the site stratigraphy and groundwater level are presented in Figure 8.

In general, although short term periods of artesian conditions were noted in July 2015 in BH/MW-1, water levels were seen to be declining over the initial period of measurement during August to September 2015. The overall decline in water levels varied between the monitoring locations from about 0.5 m at BH/MW-2 to about 1.5 m at BH/MW-1 during this period. Figure 5 shows that water levels continued to decline at BH/MW-1 to about October 19, 2015, at BH/MW-2 to about December 26, 2015, and at BH/MW-4 to about January 2, 2016. At BH/MW-1 there was a slow rise in water level between October and the end of 2015 followed by a more rapid rise at all three locations where transducers were present until a high point was reached during the first half of April 2016.

The transducer records show a trend throughout 2016 and 2017 of rising water levels from January through to April, then lowering levels beginning in April. In 2016, the lowering trend at BH/MW-1 continues through to mid-December whereas BH/MW-2 is relatively stable from mid- July through to December. At BH/MW-4 the transducer appears to have been out of the water for a period between the end of October and mid-January and therefore the lowest level reached at this location was not recorded. The yearly magnitude of water level variation at BH/MW 1 is about 1.85 m during 2016, and at BH/MW 2 is about 1.34 m. BH/MW-4 showed the greatest magnitude of seasonal variation in water level with a value of greater than 3.5 m between the maximum and minimum levels. This amount of seasonal change at this location results in water levels at BH/MW-4 being higher than at BH/MW-2 during the period from February to July 2016 and lower than at BH/MW-2 during the remainder of the year. The same trend is evident beginning in February 2017 up to the point at which the transducers were removed in April.

The precipitation data collected at the Vineland Station RCS were compared to the 1961-1990, 1971-2000 and 1981-2010 Climate Normal Data available from Environment Canada’s Vineland Rittenhouse Meteorological Station (ID: 6139143; location: 43°10'00.000" N, 79°25'00.000" W; elevation: 94.50 m), located approximately 30 km east of Block 1. This location was chosen for its similarity in elevation, topography and location with respect to Lake Ontario and the Niagara Escarpment when compared with other Meteorological Stations in the vicinity.

Comparison of the three “normal” annual precipitation values indicates a trend towards somewhat higher yearly precipitation totals as more recent data is incorporated. At the Vineland Station RCS, comparison of the 2015 and 2016 data with the Climate Normal data shows that overall these years were comparatively drier than the normal values. In addition, the totals for January to June for 2015 and 2016 were also drier than the normal totals for these months.

In contrast, the precipitation totals for the first 6 months of 2017 are significantly higher than the previous two years and also significantly higher than the Climate Normal data. In fact, the total precipitation recorded from January to June 2017 exceeds the total precipitation recorded in all of 2016.

It would be expected that peak water levels recorded at Block 1 during 2017 would be higher than those recorded during 2016, however the latest data recorded for 2017 appears to suggest that the peak values had been reached at about April 6-8 and had been dropping somewhat from then until the transducers were removed on April 12. It is possible, however that higher values were achieved at a later time and have not been recorded. The highest recorded values during April 2017 are comparable to those observed during 2016 at BH/MW-1 and BH/MW-4 and were about 0.23 m higher at BH/MW-2.

3.2 SLUG TESTING

The monitoring wells were developed by pumping using Waterra tubing on July 20, 2015, followed by slug testing on July 21 and 22, 2015. After allowing the water levels in the monitoring wells to recover to their pre-pumping levels after development, rising head slug testing was carried out at each well location. Results of slug testing are presented in Table 2. Details of the slug test analyses are presented in Appendix B.

Table 2: Hydraulic Conductivities from Slug Testing

Monitoring Well ID	Hydraulic Conductivity (K) (m/s)
BH/MW-1	1.5E-07
BH/MW-2	1.4E-06
BH/MW-3	2.7E-06
BH/MW-4	2.8E-08
BH/MW-5	8.7E-05
BH/MW-6	2.8E-07

All the monitoring wells tested had screened intervals located within the shale bedrock, although BH/MW-1 had a short section within the overlying Clayey Silt/Silty Clay. As can be seen in Table 2, there was a wide range of hydraulic conductivity values determined from the shallow shale bedrock, with values varying over a range of more than three and a half orders of magnitude, from a low of 2.8×10^{-8} m/s at BH/MW-4 to 8.7×10^{-5} m/s at BH/MW-5. The average value obtained was 1.5×10^{-5} m/s and the geometric mean was 8.5×10^{-7} m/s. There does not appear to be any correlation between the magnitude of the hydraulic conductivity and the depth of the well screen below the bedrock surface or water level. The degree of variability in hydraulic conductivity is likely a reflection of the variability of the amount of weathering and fracturing occurring at different locations on the site.

3.3 GROUNDWATER FLOW

Approximate surface elevations for each of the borehole locations were used to calculate the approximate high groundwater elevation which was then plotted in order to estimate the direction of groundwater flow and gradient. Contours of groundwater elevation are presented in Figure 5. The figure shows that the groundwater direction is generally from the south-southwest towards the north-northeast with an average gradient of approximately 1.9 %.

The surface water features, such as the streams located along the west and east edges of the site, would serve as local groundwater discharge zones, with Lake Ontario to the north serving as the regional discharge zone. Additionally, any ponds located on the site may also function as either local groundwater discharge features, or alternatively, may collect local ponded surface water and allow it to infiltrate back into the groundwater system.

3.4 GROUNDWATER SAMPLING

Groundwater sampling was carried out at monitoring wells BH/MW-1, BH/MW-2, and BH/MW-5 on August 4, 2015. Prior to the collection of samples, a minimum of three well volumes of water were purged from each well in order to remove any stagnant water and ensure that water representative of that in the formation was obtained.

Prior to the collection of samples, field parameters (Temperature, pH, Conductivity, Total Dissolved Solids, and Salinity) were measured using a PCSTestr 35 water tester. The field parameters obtained are presented in Table 3. Samples were transported to an accredited laboratory and submitted for analysis of general chemistry parameters and metals. Samples submitted for analysis of metals were filtered in the field at the time of sampling. The results of the analyses are presented in Table 4. The Laboratory Certificate of Analysis is presented in Appendix C.

Table 3: Chemical Field Parameters

Field Parameter	Units	BH/MW-1	BH/MW-2	BH/MW-5
Temperature	°C	13.7	12	14.2
pH		6.74	6.72	6.95
Conductivity	uS	2,470	5,040	2,730
TDS	ppt	1.73	3.57	1.94
Salinity	ppt	7.37	3.02	1.57

Table 4: Results of Chemical Analysis

		Sampling Date	04/08/2015	04/08/2015	04/08/2015	Published Standards		
Chemistry Parameters		Units	BH/MW-1	BH/MW-2	BH/MW-5	PWQO	Hamilton Sewer Bylaw	Table 7
Calculated Parameters	Anion Sum	me/L	33.6	64.1	30.5			
	Bicarb. Alkalinity (calc. as CaCO3)	mg/L	270	230	310			
	Calculated TDS	mg/L	2,000	4,000	1,900			
	Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	<1.0	1.0			
	Cation Sum	me/L	28.3	61.7	32.1			
	Hardness (CaCO3)	mg/L	1,200	2,000	1,000			
	Ion Balance (% Difference)	%	8.65	1.89	2.61			
	Langelier Index (@ 20C)	N/A	0.579	0.705	0.777			
	Langelier Index (@ 4C)	N/A	0.335	0.464	0.534			
	Saturation pH (@ 20C)	N/A	6.76	6.70	6.78			
	Saturation pH (@ 4C)	N/A	7.01	6.94	7.02			
Inorganics	Total Ammonia-N	mg/L	0.61	0.26	0.47			
	Unionized Ammonia (calculated)	ug/L	3.28	1.75	4.24	20 ug/L^2		
	Conductivity	umho/cm	2,900	5,400	2,800			
	Dissolved Organic Carbon	mg/L	2.4	2.9	2.6			
	Orthophosphate (P)	mg/L	<0.010	<0.010	<0.010			
	pH	pH	7.34	7.40	7.55	6.5 - 8.5	6.0 – 11.0	
	Dissolved Sulphate (SO_4)	mg/L	1,100	2,000	860		1500^3	
	Alkalinity (Total as CaCO3)	mg/L	270	230	310			
	Dissolved Chloride (Cl)	mg/L	160	670	230		1500^3	1,800
	Nitrite (N)	mg/L	<0.010	<0.010	<0.010			
	Nitrate (N)	mg/L	1.27	<0.10	<0.10			
	Nitrate + Nitrite	mg/L	1.27	<0.10	<0.10			
Metals	Dissolved Aluminum (Al)	ug/L	<5.0	22	<5.0	75	50^{3,4}	
	Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	20	5^{3,4}	16,000
	Dissolved Arsenic (As)	ug/L	<1.0	<1.0	<1.0	5	1^{3,4}	1,500
	Dissolved Barium (Ba)	ug/L	69	39	49			23,000
	Dissolved Beryllium (Be)	ug/L	<0.50	<0.50	<0.50	1,100		53
	Dissolved Boron (B)	ug/L	970	4,800	2,400	200		36,000
	Dissolved Cadmium (Cd)	ug/L	<0.10	<0.10	<0.10	1	1^{3,4}/0.008^5	2.1
	Dissolved Calcium (Ca)	ug/L	280,000	490,000	230,000			
	Dissolved Chromium (Cr)	ug/L	<5.0	<5.0	<5.0		5^{3,4}/0.08^5	640
	Dissolved Cobalt (Co)	ug/L	0.97	2.0	0.76/0.008	0.9	5^{3,4}	52
	Dissolved Copper (Cu)	ug/L	1.1	<2.0	<1.0	5	2^{3,4}/0.05^5	69
	Dissolved Iron (Fe)	ug/L	<100	<100	<100	300	50^{3,4}	

Sampling Date		04/08/2015	04/08/2015	04/08/2015	Published Standards		
Chemistry Parameters	**Units**	**BH/MW-1**	**BH/MW-2**	**BH/MW-5**	**PWQO**	**Hamilton Sewer Bylaw**	**Table 7**
Dissolved Lead (Pb)	ug/L	<0.50	<0.50	<0.50	25	2^{3,4}/0.12^{5}	20
Dissolved Magnesium (Mg)	ug/L	130,000	190,000	110,000			
Dissolved Manganese (Mn)	ug/L	190	290	150		5^{3,4}	
Dissolved Molybdenum (Mo)	ug/L	4.0	5.4	7.4	40	1^{3,4}	7,300
Dissolved Nickel (Ni)	ug/L	<1.0	<2.0 (1)	<1.0	25	2^{3,4}/0.08^{5}	390
Dissolved Phosphorus (P)	ug/L	<100	<100	<100	10 - 30^{1}		
Dissolved Potassium (K)	ug/L	23,000	46,000	28,000			
Dissolved Selenium (Se)	ug/L	<2.0	3.2	<2.0	100		50
Dissolved Silicon (Si)	ug/L	3,700	4,000	3,500			
Dissolved Silver (Ag)	ug/L	0.20	0.10	<0.10	0.10	5	1.2
Dissolved Sodium (Na)	ug/L	73,000	470,000	250,000			1,800,000
Dissolved Strontium (Sr)	ug/L	8,900	13,000	5,200			
Dissolved Thallium (Tl)	ug/L	0.050	0.060	<0.050	0.3		400
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0		5^{3,4}	
Dissolved Uranium (U)	ug/L	27	34	53	5		330
Dissolved Vanadium (V)	ug/L	<0.50	0.63	<0.50	6	5^{3,4}	200
Dissolved Zinc (Zn)	ug/L	13	<25 (1)	<10 (1)	30	2^{3,4}/0.5^{5}	890

Notes:

PWQO	Ontario Provincial Water Quality Objectives.
Table 7	Non-potable groundwater, Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition, Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, MOE, 2011.
[1]	PWQO for phosphorus is a general guideline intended to limit excessive algal or plant growth in surface waters.
[2]	PWQO for ammonia is based on the percentage of unionized ammonia which varies according to temperature and pH. Calculations based on these factors indicate that the percentage of unionized ammonia in these samples is below the PWQO.
[3]	Parameter measured in mg/L.
[4]	Analysis result refers to total metal.
[5]	Storm sewer limit, otherwise sanitary-combined limit.
(1)	Detection Limit was raised due to matrix interferences.

In general, the water chemistry analyses show values typically found in groundwater derived from the Queenston Shale formation. According to Singer, et al (2003), the water quality varies from poor to good, with hardness generally hard to very hard and high values of Total Dissolved Solids, Sodium, Chloride, and Iron are commonly encountered.

In Table 4 previous versions of this reported were compared with standards obtained from the Ontario Provincial Water Quality Objectives (PWQO) and from Table 7 – Non-potable groundwater, Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition. In this report revision Table 4 also includes comparison of the results to the limits established in the City of Hamilton Sewer Bylaw. In order to establish the suitability of disposal of excess water during construction future groundwater sampling results will also be compared with the City of Hamilton Sewer Bylaw.

No values were obtained which exceed the Table 7 values. Results in excess of the PWQO were obtained for Boron and Uranium at all locations, and for Cobalt and Silver at BH/MW-1 and BH/MW-2. A result for Sulphate exceeded the limit for Sulphate at BH/MW-2. These results are likely naturally occurring as they are typical of the underlying Shale bedrock found in the area.

3.5 STREAM FLOW

Three surface water courses, designated Watercourse 5, Tributary to Watercourse 5, and Watercourse 6 occur within Block 1 (Figure 4).

Watercourse 5 drains northerly adjacent to Fruitland Road and discharges to Lake Ontario approximately 1.3 km downstream. The Tributary to Watercourse 5 drains to the north and discharges into a storm sewer on Barton Street. Watercourse 6 is located along the eastern boundary of Block 1 to the east of Jones Street. It also drains towards the north and discharges into Lake Ontario approximately 1.8 km to the north.

On September 4, 2015 the site was visited in order to attempt to measure stream flow volumes under low flow conditions. No precipitation had been recorded for a minimum period of at least 72 consecutive hours immediately preceding the collection of the stream flow measurements. The months of July and August had recorded unseasonably low amounts of precipitation compared to local climate normal data.

One upstream and one downstream location, adjacent to the north and south boundaries of Block 1 were investigated for each of Watercourse 5 and Watercourse 6. These locations are shown on Figure 4. Where water was observed at the measuring point station, a Hach 950 handheld flowmeter was used to estimate the flow rates in the watercourses.

The streambeds were observed to be dry at both of the Watercourse 5 and Watercourse 6 crossings at Barton Street on September 4, 2015.

At Watercourse 5, flow was observed and measured at the upstream end of Block 1, near Regional Road 8. At the location measured, water was observed to be flowing slowly in a channel 1.3 m wide and varying in depth from 1 to 10 cm. Based on measurements taken a flow rate of 1.4×10^{-4} m^3/s (12 m^3/day) was calculated.

At Watercourse 6, a low amount of flow was observed at the upstream side of Block 1 just north of the culvert at Regional Road 8. Flow was confined to a narrow channel between the rocky creek bed at this location and was calculated to be 8.0×10^{-5} m^3/s (6.9 m^3/day). Neither of these flows represent more than a trickle of water flowing onto the site.

3.6 GROUNDWATER RECHARGE AND DISCHARGE

In the vicinity of Block 1, the Niagara Escarpment serves as a major groundwater recharge feature. This is due to the change in elevation at the Escarpment face, as well as the karstic features in the bedrock that makes up the Escarpment, which allow for rapid vertical and horizontal movement of groundwater through the rock.

The proximity of the Escarpment to the south end of Block 1 can result in strong hydraulic gradients (rapid change in groundwater levels over a very short distance), which may result in higher groundwater levels and groundwater flows closer to the Escarpment, which typically lessen as the gradients become lower away from the Escarpment.

The watercourses that flow across the site showed little flow at the south end of the site (closer to the Escarpment) and were dry at the north end of the site. These watercourses originate on the Escarpment or from seeps along the Escarpment face and enter the site travelling over relatively low permeable material (Halton Till). As the watercourses move across the site, they move across bedrock units that are at or near ground surface (**Figure 3**). These bedrock units may be fractured and may be permeable enough to allow for some of the water to infiltrate. This, in combination with evaporation from the watercourse channel may result in the dry streams along the north end of the site.

Mapping of site surface water features suggest the presence of at least one pond on the site, located towards the southwest corner of the site and situated on the Halton Till. During the field investigation, no evidence of this pond was found. It is possible that it is a depression that seasonally fills with water and this water eventually evaporates or infiltrates, but additional monitoring would be required to determine the presence of this pond.

As the summer of 2015 was an unseasonably dry summer, this may have impacted both the observed flows in the streams, and the presence of any ponds or other potential wetland areas.

Generally, groundwater discharge zones would be expected to be found around areas of lower elevations and/or areas where rapid changes in elevation are found. While watercourses can also be indications of groundwater discharge zones, it is likely that the watercourses present at this site have little to no connection with the groundwater system as long as they are flowing across the low permeability Halton Till soils carrying water from the Escarpment area, however they may serve as groundwater recharge zones as they move across the bedrock units along the north half of the Block 1 area.

4 WATER BALANCE CALCULATION

A water balance calculation for Block 1 was carried out based on existing conditions and proposed post-development conditions. Existing conditions were based on the classification of land use presented in Appendix D - Figure 3.2 - Ecological Land Classification, Appendix C – Natural Heritage Assessment Report, Fruitland Road Municipal Class Environmental Assessment (AECOM, 2011). Calculations for the proposed post-development conditions were based on areas of pervious and impervious conditions for the post- development land uses provided by Urbantech Consulting.

The existing water balance for Block 1 depends upon the current site conditions, such as location and climatic factors, soil texture, topography and type of vegetative cover and the extent of existing impervious cover, such as roads, driveways and buildings.

Potential impacts of development upon recharge to aquifers due to development of the property may occur due to reductions in pervious areas available for infiltration of precipitation, and changes to the soil texture, topography and vegetative cover. Installation of underground site services (sewers and watermains) may also act to intercept and redirect infiltrating water away from natural pathways.

4.1 METHODOLOGY

Recharge to aquifers occurs through a number of mechanisms, which may include direct infiltration from precipitation, infiltration from watercourses, agricultural irrigation, leakage from municipal utilities such as water mains and sewers, and flow between aquifers. Recharge is a complex process dependent upon the interaction of numerous factors such as rainfall duration and intensity, temperature fluctuations, wind velocity, duration of sunlight, soil texture and moisture holding capacity, depth of water table, topography and type of vegetation, all of which vary in both space and time. Precise measurement of the components of recharge is difficult to achieve in practice and therefore approximations and simplifications are commonly employed to characterize the water balance of a particular property.

A water balance is generally evaluated using an equation having the following form:

$$P = \Delta S + ET + RO + I$$

Where

P = precipitation
ΔS = change in soil moisture storage
ET= evapotranspiration
RO = surface runoff
I = infiltration

Meteorological data in the form of monthly average temperature and precipitation data, available from Environment Canada - Canadian Climate Normals 1981-2010 for the Vineland Rittenhouse Meteorological Station (43°10'00.000" N, 79°25'00.000" W, elevation 94.50 m), located approximately 30 km east of Block 1, was used to prepare the water balance.

While soil moisture storage fluctuates on a short term basis between precipitation events and seasonally due to cycles of freezing and thawing, the net change in storage over the long term is assumed to be zero. Calculation of evapotranspiration was carried out using a computer program, EVAP, which uses an accounting procedure based on the methodology originally presented by Thornthwaite (1948). Inputs to the computer model are mean monthly temperature, monthly total precipitation, latitude and hemisphere of the location of interest and soil moisture holding capacity of the soil based upon the soil properties and vegetation. The difference between the mean annual precipitation and the mean annual evapotranspiration is the annual water surplus, which is available to either infiltrate the soil surface or to flow over the land surface. A portion of the infiltration may flow vertically and percolate down to recharge groundwater, while a second component, termed interflow, may move laterally through shallow soils and re-emerge locally to the surface in low lying areas or stream beds. Both the interflow and direct runoff, which has not infiltrated the ground surface, together form the total surface runoff component.

Information regarding existing soil conditions at Block 1 was obtained from the observations made from samples collected during the field program. The logs of boreholes indicate that the surficial soils are brown to red and grey Silty Clay to Clayey Silt with a trace of Sand, Gravel and Shale at the borehole locations (Appendix A).

4.2 EXISTING CONDITIONS

Information regarding existing land use at Block 1 was obtained from examination of satellite imagery and from Appendix D - Figure 3.2 Ecological Land Classification, presented in Appendix C Natural Heritage, Municipal Class Environmental Assessment Study Phases 1 & 2 Report (AECOM, 2011 – Appendix D). The existing land use was classified based on a review of the above-referenced figure, available satellite imagery and on-site observations to determine approximate pervious and impervious areas for each land use type. Approximate areas for each land use type were calculated for the purpose of water balance calculations. The water balance for each of the existing land uses on Block 1 was calculated separately and then combined to produce the overall water balance for the site.

For the purpose of determining the soil moisture and infiltration factors for use in the calculations, the vegetative cover was categorized according to the descriptions provided in the above referenced Figure 3.2. Tables provided in the documentation accompanying the EVAP program were then used to determine the applicable soil moisture retention value to be used for each vegetative category. The vegetative categories and soil moisture retention values chosen for each category are presented in Table 5.

Table 5: Land Classification for Determination of Pervious Areas and Soil Moisture Values

Land Classification	Area		Water Balance Classification	Pervious Status	Pervious Area	Impervious Area	Soil Moisture
Units	**m²**	**ha**			**m²**	**m²**	**mm**
CEM	57,361	5.74	cemetery	90% pervious	51,625	5,736	100
CVC_1	42,373	4.24	business	5% pervious	2,119	40,254	100
CVR_3	164,575	16.46	residential	60% pervious	98,745	65,830	100
CVR_4	192,988	19.30	residential - rural	70% pervious	135,092	57,897	100
DECW	4,072	0.41	woodland	100% pervious	4,072	0	400
FODM7-2	5,097	0.51	woodland	100% pervious	5,097	0	400
FODM9-6	19,931	1.99	woodland	100% pervious	19,931	0	400
H	46,959	4.70	hedgerow	100% pervious	46,959	0	400
MAMM1-15	1,288	0.13	wetland	100% pervious	1,288	0	250
MAMM2-5	4,393	0.44	wetland	100% pervious	4,393	0	250
MEMM-4	249,614	24.96	meadow	100% pervious	249,614	0	250
OAGM1	99,441	9.94	agricultural	100% pervious	99,441	0	200
PR	35,912	3.59	plantation removed	100% pervious	35,912	0	100
SAGM1	16,739	1.67	agricultural	100% pervious	16,739	0	250

Land Classification	Area		Water Balance Classification	Pervious Status	Pervious Area	Impervious Area	Soil Moisture
Units	m²	ha			m²	m²	mm
SAGM2	6,532	0.65	agricultural	100% pervious	6,532	0	250
SWDM2-2	8,035	0.80	woodland	100% pervious	8,035	0	250
SWDM4-1	2,785	0.28	woodland	100% pervious	2,785	0	250
TAGM1	4,179	0.42	agricultural	100% pervious	4,179	0	250
TAGM3	3,243	0.32	agricultural	100% pervious	3,243	0	250
THDM2-11	48,640	4.86	agricultural/woodland	100% pervious	48,640	0	250
THDM4-1	12,523	1.25	agricultural/woodland	100% pervious	12,523	0	250
Totals	1,026,681	102.67			856,964	169,717	

In order to calculate the water balance for existing conditions, the separate land use categories were consolidated into four groups according to the assigned soil moisture storage values. The EVAP program was then run for each of the four consolidated groups to determine the actual evapotranspiration expected for each group. The total evapotranspiration for each group was calculated by multiplying the area of each group by the depth of actual evapotranspiration calculated by the EVAP program. In the case of the shallow rooted group, which includes both pervious (lawns) and impervious (buildings and parking lots) areas, the evapotranspiration was calculated by multiplying the EVAP value by the pervious area and assuming a 10% evaporation value for the impervious area.

A summary of the climatic water balance for existing conditions on Block 1 is provided in Table 6. Total annual surplus is the amount of water available after evapotranspiration has occurred. Water surpluses of 315.1 mm/yr., 290.1 mm/yr. and 284.1 mm/yr. were calculated for shallow rooted, moderately rooted and deeply rooted vegetation, respectively and 273.1 mm/yr. for wooded areas.

Table 6: Existing Annual Water Balance for Existing Conditions on Block 1

Vegetation	Soil Moisture Storage (mm/yr)	Annual Precipitation (mm/yr)	Potential Evapotranspiration (mm/yr)	Actual Evapotranspiration (mm/yr)	Annual Surplus (mm/yr)
Shallow rooted	100	891.6	639.8	576.5	315.1
Medium rooted	200	891.6	639.8	601.5	290.1
Deep rooted	250	891.6	639.8	607.5	284.1
Woodland	400	891.6	639.8	618.5	273.1

Partitioning of water surplus between runoff and infiltration is dependent upon the soil type, texture, topography and type of vegetation cover. These are accounted for by the use of infiltration factors according to a method referenced in MOE (2003) and MOEE (1995) and are calculated by summing individual factors representing the contributions of topography, soil type and vegetative cover conditions. For Block 1, the factors are calculated for the individual land use types in order to calculate the individual volumes then summed to obtain the total volume for the area as a whole based on the proportional area of each land use. For the wooded areas, a topographic infiltration factor of 0.3, a soil infiltration factor of 0.2 and a vegetative cover factor of 0.2 was obtained from Table 2 in MOEE (1995). These factors were summed to obtain an infiltration factor of 0.7, meaning that 70% of the surplus will infiltrate. For the remaining areas the individual factors were 0.3, 0.2 and 0.1, for topography, soil, and vegetative cover factors respectively giving an infiltration factor of 0.6. Table 7 shows the resulting water balance for existing site conditions.

From Table 7 it is seen that under existing conditions, evapotranspiration is the largest component of the water balance, accounting for almost 57.5% of annual precipitation. Infiltration is 25.8 % of precipitation and runoff is 16.8%.

Table 7: Pre-Development Water Balance Volumes for Block 1

Land Use/Vegetation	Area (m^2)	Precipitation (m^3/yr)	Evapotranspiration (m^3/yr)	Infiltration (m^3/yr)	Runoff (m^3/yr)
Shallow rooted	493,209	439,745	201,616	142,877.9	95,251.9
Medium rooted	99,441	88,662	59,811	17,311	11,540
Deep rooted	357,972	319,168	217,457	61,026	40,684
Woodland	76,058	67,814	47,040	14,542	6,232
Total	1,026,681	915,389	527,763	234,653	152,973
% of Precipitation		**100**	**57.5**	**25.8**	**16.8**

4.3 POST-DEVELOPMENT CONDITIONS

Development of property from rural and agricultural land use to urban residential and commercial/industrial land uses has effects on the natural water balance, primarily due to the addition of impervious surfaces, such as roads, parking lots, driveways and buildings. Impervious surfaces retain water at the surface, preventing infiltration into the soil, and removal of vegetation decreases the evapotranspiration component of the water balance within the affected area. Evaporation from impervious surfaces is a relatively minor component (estimated herein at 10% of precipitation) as compared to the 58% of precipitation occurring with existing vegetation. The net effect of the creation of impervious surfaces is therefore that most of the precipitation incident upon the area becomes surplus water and direct runoff, and natural infiltration is reduced.

Additional effects may also occur due to compaction of soil due to heavy vehicle traffic during construction, which acts to reduce the infiltration capacity of the underlying soils. Also, conversion of agricultural land or wooded areas to lawns affects the amount of evapotranspiration, as shallow rooted grasses draw water from less deep soil zones than trees and some agricultural crops. Runoff may also be reduced by reducing the surface gradient due to cut and fill operations during construction.

To calculate a post-development water balance for the Subject Property, areas of proposed post-development land uses and percent of the associated impervious areas for each type of land use were provided by Urbantech Consulting. The percentage of impervious area for each of the land use categories was then used in the calculation of infiltration and runoff for each proposed land use area. The soil moisture retention value was reduced to 100 mm for the pervious areas to account for the change in vegetation from the pre-development vegetation types to grass (shallow rooted) when calculating evapotranspiration using the EVAP program. For the impervious areas, an evaporation factor of 10% was estimated to account for direct evaporation. The results of the post development calculations are presented in Table 8.

Table 8: Post-Development Water Balance for Block 1 (No Mitigation)

Land Use/Vegetation	Area (m^2)	Precipitation (m^3/yr)	Evapotranspiration (m^3/yr)	Infiltration (m^3/yr)	Runoff (m^3/yr)
Roads	80925.0	72152.7	7215.3	0	64937.5
Other impervious areas	556602.0	496266.3	49626.6	0	446639.7
Pervious – lawns	349973.0	312035.9	201748.9	66172.2	44114.8
Pervious – wooded	39200.0	34950.7	24244.0	7494.7	3212.0
Total	1026700.0	915405.7	282834.9	73666.9	558904.0
% of precipitation		**100**	**30.9**	**8.0**	**61.1**

As can be seen in comparison with the results of the pre-development calculations presented in Table 7, the percentage of evapotranspiration has been reduced from 57.5% of precipitation to 30.9% due to the effects of development. Infiltration has also been reduced from 25.8% to 8.0% of precipitation and the largest component of the water balance is now surface runoff due to increasing the area of impervious surfaces.

The reduction of evapotranspiration and infiltration and resultant increase in runoff volumes would tend to reduce the amount of water available for local recharge to groundwater potentially lowering the local water table elevation and affecting the downstream groundwater gradients and flow directions. Surface water volumes, if allowed to flow towards surface watercourses would tend to increase due to the increase of runoff volumes. This could result in increased flows in watercourses downstream of the Site following development. This effect could be offset to some extent by decreasing contributions to surface flow from groundwater discharge to surface water bodies.

4.4 MITIGATION OF EFFECTS OF DEVELOPMENT ON THE WATER BALANCE

Potential impacts to the water balance from development may be minimized through the use of various low impact development (LID) measures for stormwater management to attempt to maintain the post-development infiltration volumes as close to the pre-development levels as possible. Mitigation measures may include such components as directing roof leaders to pervious areas, increasing topsoil thickness to retain more water in storage, soak away pits and dry wells, constructed infiltration galleries or trenches, pervious pipe systems, and grass swales.

Block 1 is underlain by primarily clayey silt soil and shale bedrock having relatively low hydraulic conductivity, which tends to limit the rate of infiltration. In response an LID storm water management system promoting the utilization of solutions that absorb, attenuate and exfiltrate storm water runoff rather than those that rely on infiltration would be appropriate. Notwithstanding the relatively low hydraulic conductivity of the soils, biofilters, rain gardens, permeable pavement and detention areas will achieve some degree of incidental infiltration. Despite the relatively low infiltration rates, the provision of storage within the LID management practices can attenuate a portion of the rainfall volume.

Despite the relatively low infiltration capacity of the soil, there is still potential for mitigation of the some of the effects of the increased impermeable area due to development and measures such as directing runoff from roofs, driveways and parking lots to bioretention areas, utilizing permeable pavement, implementing rainwater harvesting systems and increasing topsoil depth will be effective in attenuating runoff and improving water quality.

Infiltration targets for the proposed development have been provided by Urbantech based on the soil type and proposed land use (2.5 mm infiltration for sandy loam and all land uses, 1 mm for silty clay loam over residential, 2.5 mm for silty clay loam over commercial and institutional land use. For the total area of the development these targets result in a total infiltration requirement of 178,221 m^3/yr. This represents an increase of the overall infiltration volume of approximately 104,000 m^3/yr. The required infiltration targets for the site areas by soil type and land use type are presented in Table 9.

Table 9: Infiltration Targets by Soil Type and Land Use

Drainage Area	Land Use Type	Area	Soil Type	Precipitation (Assuming 891.6 mm/year) m^3/year	Infiltration (mm)	Percent of Annual Infiltration Assuming 891.6 mm/year	Total Precipitation to be Infiltrated
508	Residential, Institutional, Commercial	2.15	Sandy Loam	19,169	2.5	30	5,751
570	Channel	1.02	Sandy Loam	-	-	-	-
567	Channel	0.74	Silty Clay	-	-	-	-
502	Channel	2.29	Silty Clay	-	-	-	-
573	Pond	2.47	Silty Clay	22,023	2.5	-	-
509	Residential	1.97	Silty Clay	17,565	1.0	15	2,635
510	Commercial	0.32	Silty Clay	2,853	2.5	30	856
	Residential	0.33	Silty Clay	2,942	1.0	15	441
520	Residential	2.18	Silty Clay	19,437	1.0	15	2,916
569	Residential	2.13	Sandy Loam	18,991	2.5	30	5,697
572	Residential	11.15	Silty Clay	99,413	1.0	15	14,912
574	Residential	0.06	Silty Clay	526	1.0	15	79
	Commercial	1.43	Silty Clay	12,750	2.5	30	3,825
526	Residential	0.92	Silty Clay	8,203	1.0	15	1,230
527	Residential	1.65	Silty Clay	14,711	1.0	15	2,207
528 - portion of Gordon Dean	Residential	0.44	Silty Clay	3,923	1.0	15	588
616	Residential	2.43	Silty Clay	21,666	1.0	15	3,250
610	Residential	2.47	Silty Clay	22,023	1.0	15	3,303
622	Residential	2.02	Silty Clay	18,010	1.0	15	2,702
524	Residential	7.22	Sandy Loam/ Silty Clay	64,374	1.0	15	9,656
525	Residential	1.25	Silty Clay	11,145	1.0	15	1,672
571	Residential/ Commercial	18.17	Sandy Loam	162,004	2.5	30	48,601
519	Residential	2.02	Sandy Loam	18,010	2.5	30	5,403
529	Institutional	1.8	Sandy Loam	16,049	2.5	30	4,815
606 - residential lots	Residential	0.63	Sandy Loam	5,617	2.5	30	1,685
522	Residential	3.31	Sandy Loam	29,512	2.5	30	8,854
613	Cemetery	1.77	Sandy Loam	-	-	-	-
620	Commercial	2.1	Sandy Loam	18,724	2.5	30	5,617
612	Commercial	1.64	Sandy Loam	14,622	2.5	30	4,387
523	Residential	6.7	Sandy Loam	59,737	2.5	30	17,921
614	Residential	1.5	Sandy Loam	13,374	2.5	30	4,012
618	Residential	1.62	Sandy Loam	14,444	2.5	30	4,333
615	Institutional	2.14	Sandy Loam/ Silty Clay	19,080	2.5	30	5,724
617	Residential	1.19	Sandy Loam	10,610	2.5	30	3,183
	Residential	1.09	Silty Clay	9,718	1.0	15	1,458
621 - Street B	Residential	0.19	Sandy Loam	1,694	2.5	30	508
Total							178,221

In order to address the deficit of infiltration due to development a number of LID measures can be used. The measures most likely to be implemented on this site would be downspout disconnection; increased topsoil depths

(200 mm minimum); grassed swales to promote infiltration and TSS removal; infiltration trenches/swales (rear yard drainage swales with 150 mm topsoil rock gallery/storage median and perforated underdrain; soak away pits (rock filled galleries or chambers to store and infiltrate runoff; enhanced tree pits (enlarged chamber to receive direct runoff from streets); and bioswales (enhanced vegetative swale with filtration, attenuation and infiltration capabilities.

5 POTENTIAL EFFECTS ON DEVELOPMENT

5.1 EFFECTS ON AQUIFERS AND WATER LEVELS

The subsurface materials at Block 1 consist of generally low permeability shale, a poor aquifer within its upper weathered zone, which is overlain by a low permeability till. There are no significant aquifers or recharge/ discharge zones present at Block 1.

Development of Block 1 will tend to reduce the amount of infiltration of precipitation towards the water table primarily due to reduction in the amount of permeable area. Other factors which could contribute to this effect include increased compaction of the subsurface soils due to heavy vehicle traffic during construction, effects due to changes in site grading and changes in surface soils and vegetation type. Additionally, the excavation of trenches to accommodate underground utilities could create more permeable pathways for groundwater flow. Taken together, these factors would tend to result in a lowering of the water table in the vicinity of the development.

5.2 EFFECTS ON SURFACE WATER

In the southern half of the Block 1 area, the low permeability of the surficial materials over which the watercourses flow (Halton Till) allow for very little interaction between the surface water and groundwater in these areas. The watercourses therefore primarily transport runoff from upstream areas (above the Escarpment and/or seeps at the Escarpment face). As the watercourses move across the site and encounter the bedrock units at or near ground surface, the surface water may infiltrate and the watercourses become dry. Additionally, the watercourses do not transport large volumes of water and are observed to become dry during periods with low precipitation (such as during the summer months).

Surface water volumes, if allowed to flow towards surface watercourses would tend to increase surface flow downstream of the Site, due to the increase of runoff volumes. This could result in increased flows in these watercourses following development. This effect could be offset to some extent by decreasing contributions to surface flow from any groundwater discharge to surface water bodies, however due to the factors outlined above, the groundwater contribution to surface flow is expected to be small.

6 FOUNDATION DRAIN FLOW

Groundwater levels were found near ground surface at some locations during the field investigation, therefore, it is likely that foundation drainage and sump pumps will be required for buildings having basements. The amount of flow to the drainage system will likely vary at different times and locations due to variations in the subsurface permeability across the area of the site and seasonal variations in water level. Flows are also expected to increase following large precipitation events and during the spring melt.

The amount of expected flow to the drainage system will depend on the length of the perimeter to be drained, the groundwater level, hydraulic conductivity of the subsurface materials and the amount of infiltrating precipitation intercepted by the drain.

Based on a building area of 2000 ft^2 (185.9 m^2) and using a range of water levels and hydraulic conductivities observed at Block 1, groundwater flows to perimeter drainage are estimated to be in the range of 0.08 L/min to 4.3 L/min with a geometric mean of 0.9 L/min. These estimates are based on existing groundwater conditions and assume that groundwater storage is not depleted by the withdrawal of water. It is likely that the pore space and bedrock fractures of limited extent and that groundwater storage will become depleted as pumping occurs, thus limiting the amount of water to be removed. As groundwater storage is depleted, the water levels will decline and flows will be reduced from these values. Grading of lots to direct surface water away from building perimeters, perimeter drainage and underfloor drainage may help to mitigate the amount of seepage. There would also be a collective effect of multiple adjacent sump pumps operating simultaneously to draw down the water level in the vicinity of their operation. Due to the proximity of the Escarpment to the south of the property (a major source of groundwater recharge and high hydraulic gradients), it would be expected that houses located towards the south end of the site would be required to pump higher volumes than those located towards the north, where the gradients have lessened, resulting in lower groundwater flow rates.

It is generally recommended that sump drains should be designed to handle 30 L/min flow in low permeability conditions for each 1000 ft^2 of building area and 53 L/min for each 1000 ft^2 in permeable conditions (example at *abe-research.illinois.edu/pubs/factsheets/SumpPumps.pdf*).

7 CONSTRUCTION DEWATERING

Due to the presence of high water tables and variability of the hydraulic conductivity of the subsurface materials, some dewatering may be required during construction when excavating for basements and utility trenches. The amount of dewatering required will be dependent upon the size of the excavation, variations in hydraulic conductivity with location across the property and variations in water levels depending upon location and seasonal factors.

As an example, based on the assumptions made for inflows to sumps, flows to a typical residential excavation would experience the same range of flows of 0.08 o 4.3 L/min (115.2 to 6192 L/day) with a geometric mean of 0.9 L/min (1296 L/day).

Flows to trenches for construction of underground services are also expected to require some dewatering. Based on existing conditions, the geometric mean value for hydraulic conductivity and a 10 m long trench of 3 m width excavated to 2 m below the water table, groundwater inflow of about 4.17 m^3/day (4,175 L/day) would be expected. Flows of this magnitude are expected to be able to be removed by sumps. Initial inflows could be higher, depending upon the hydraulic conductivity of the fractured shale in the vicinity of the excavation, however it is expected that flows will decline as water is removed from storage in the fractures. The extent of open trenches should be kept to the minimum required for the work to proceed in order to minimize the need to remove water from the excavation. If possible, scheduling of excavation works during periods of low groundwater level, such as late summer, would minimize dewatering requirements.

Placement of granular bedding materials may result in the creation of preferential flow paths for infiltrating surface water or groundwater. Anti-seepage collars should be provided at strategic points along sewers and other utility trenches, including between utility trenches and basements in order to prevent continuous flow along the backfilled excavations towards down gradient areas and basements and to retain the very low groundwater flows present under pre-development conditions. Collars should have an upper elevation or relief pipe to allow water to overtop the collars in the event of backup of water levels.

8 CONTINGENCY PLANNING

No significant aquifers were encountered during the field investigation and are not expected to be encountered during construction and development of the property. Groundwater is likely to be encountered during excavation for basements and utilities, but the amount of flow is expected to be low to moderate and to be able to be removed by pumping from sumps. Continuous pumping from sump pumps from residential basements is not expected to occur, however is expected to be more frequent in areas near surface water and at times of high water levels. No on site water supplies sewage disposal systems or surface and groundwater related infrastructure are known to be present.

Effects of development are expected to be a lowering of infiltration due to an increase in the area of impermeable ground cover such as roads, driveways and buildings, changes to grade, vegetative and soil cover and potential compaction of surface soil.

It is recommended that groundwater levels be monitored during the pre-construction and construction periods in order to be able to further assess the amount of natural seasonal fluctuation and the effect of construction on the groundwater levels at the property. During construction, it is recommended that any dewatering required for construction of basements or utility trenches be measured in order to assess the effect of dewatering.

9 CLOSURE

We trust that the information provided in this report is sufficient for your present purposes. Should you have any questions or concerns please do not hesitate to contact the undersigned.

Respectfully submitted,

WSP Canada Inc.

Prepared by:	Reviewed by,
Michael Anderson, M.Sc., P.Geo. Hydrogeologist	Simon Gautrey, M.Sc., MBA, P.Geo., F.G.C. Fellow Hydrogeologist

10 REFERENCES

AECOM. 2011. Fruitland Road from Barton Street to Highway 8 Municipal Class Environmental Assessment Study, Phases 1 & 2 Report, January 2011.

Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario, 3rd Edition. Ontario Geological Survey Special Volume 2. Accompanied by Map P.2715 (coloured), scale 1:600,000. Ontario Ministry of Natural Resources, Toronto, Canada : 270 pp.

Environment Canada, "Canadian Climate Normals, Vineland Rittenhouse". 1981-2010. Environment Canada, "Climate Data, Vineland Station RCS", 2015.

MOE. Water Well Information System. Ontario Water Well Records.

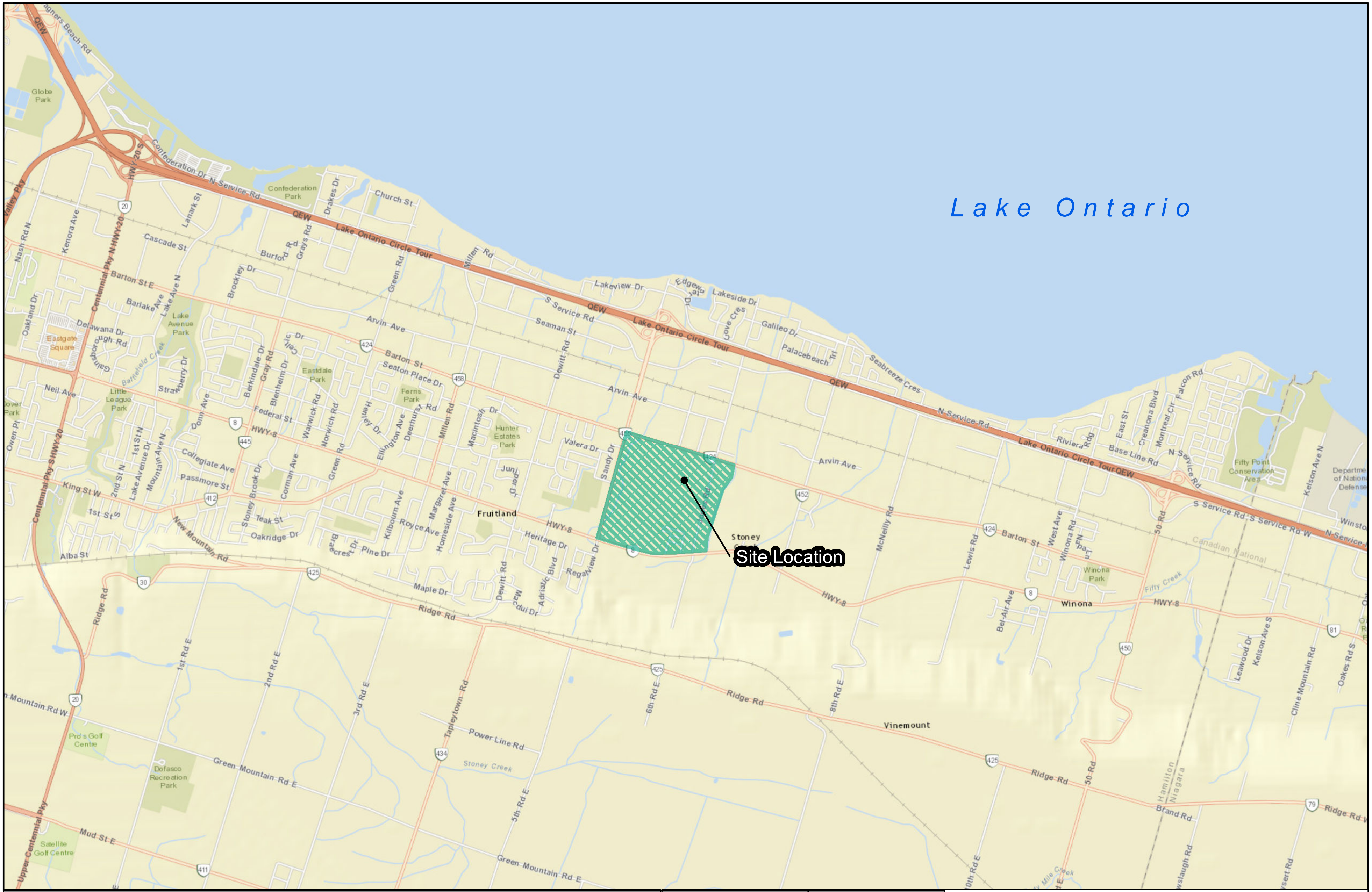
MOE. 2003. Stormwater Planning and Design Manual. Ontario Ministry of the Environment.

MOEE. 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. Ontario Ministry of the Environment and Energy.

Ontario Geological Survey. 2011. 1:250,000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release Data 126-Revision 1.

Ontario Geological Survey. 1997. Quarternary geology, seamless coverage of the Province of Ontario: Ontario Geological Survey, Data Set 14 (EDS014).

Powers, J. Patrick, A.B. Corwin, P.C. Schmall, and W.E. Kaeck. 2007. Construction Dewatering : New Methods And Applications, 3rd Edition. John Wiley & Sons Inc. New Jersey, USA : 656 pp.



LEGEND

▨ Approximate Block 1 Property Boundary

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

Conditions encountered in the field may be different from the interpreted information presented on this figure.

This drawing should be read in conjunction with the corresponding Amec FosterWheeler Environment & Infrastructure Report.

SOURCE: ESRI ArcGIS Online, World Imagery, 2013.

CLIENT:

Block 1 Land Owners Group

Drawn By: KR	Checked By: KG
Revision: A	Projection: UTM Zone 17N

SCALE: 1:50,000

N
W E
S

HYDROGEOLOGICAL ASSESSMENT
Block 1, Fruitland-Winona Servicing Strategy
Hamilton, Ontario

Site Location Plan

PROJECT N°: TP115082

DATE: November 2021

FIGURE: 1

Wood Environment & Infrastructure Solutions
3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5
tel: 905-335-2353 www.woodplc.com

wood.

LEGEND

- 🟩 Approximate Block 1 Property Boundary
- ⊕ Borehole/Monitoring Well (labelled with ID; Amec Foster Wheeler, 2015)
- ▲ Surface Water Flow Measurement Location (Amec Foster Wheeler, 2015)
- — Watercourse (OHN, 2012)
- 🟦 Waterbody (OHN, 2012)

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

Conditions encountered in the field may be different from the interpreted information presented on this figure.

This drawing should be read in conjunction with the corresponding Amec FosterWheeler Environment & Infrastructure Report.

SOURCE: ESRI ArcGIS Online, World Imagery, 2013.

CLIENT:
Block 1 Land Owners Group

Drawn By: KR
Checked By: KG
Revision:
Projection: UTM Zone 17N
SCALE: 1:8,000

HYDROGEOLOGICAL ASSESSMENT

Block 1, Fruitland-Winona Servicing Strategy
Hamilton, Ontario

Monitoring Location Plan

PROJECT N°: TP115082
DATE: November 2015
FIGURE: 2

Wood Environment & Infrastructure Solutions
3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5
tel: 905-335-2353 www.woodplc.com

C:\Users\tana.yun\OneDrive - Wood PLC\Desktop\6. Small Tasks\FruitlandWinona Servicing_MAPS\Fig3_GW flow.mxd

LEGEND

▭ Approximate Block 1 Property Boundary

— Groundwater Contours

⊕ Borehole/Monitoring Well

— Watercourse

NOTES:
LOCATION OF FEATURES ARE APPROXIMATE

Conditions encountered in the field may be different from the interpreted information presented on this figure.

CLIENT: Block 1
Land Owners Group

wood.

HYDROGEOLOGICAL INVESTIGATION
Block 1, Fruitland-Winona Servicing Strategy
Hamilton, Ontario

Groundwater Flow

Scale: 1:8,000

N
W E
S

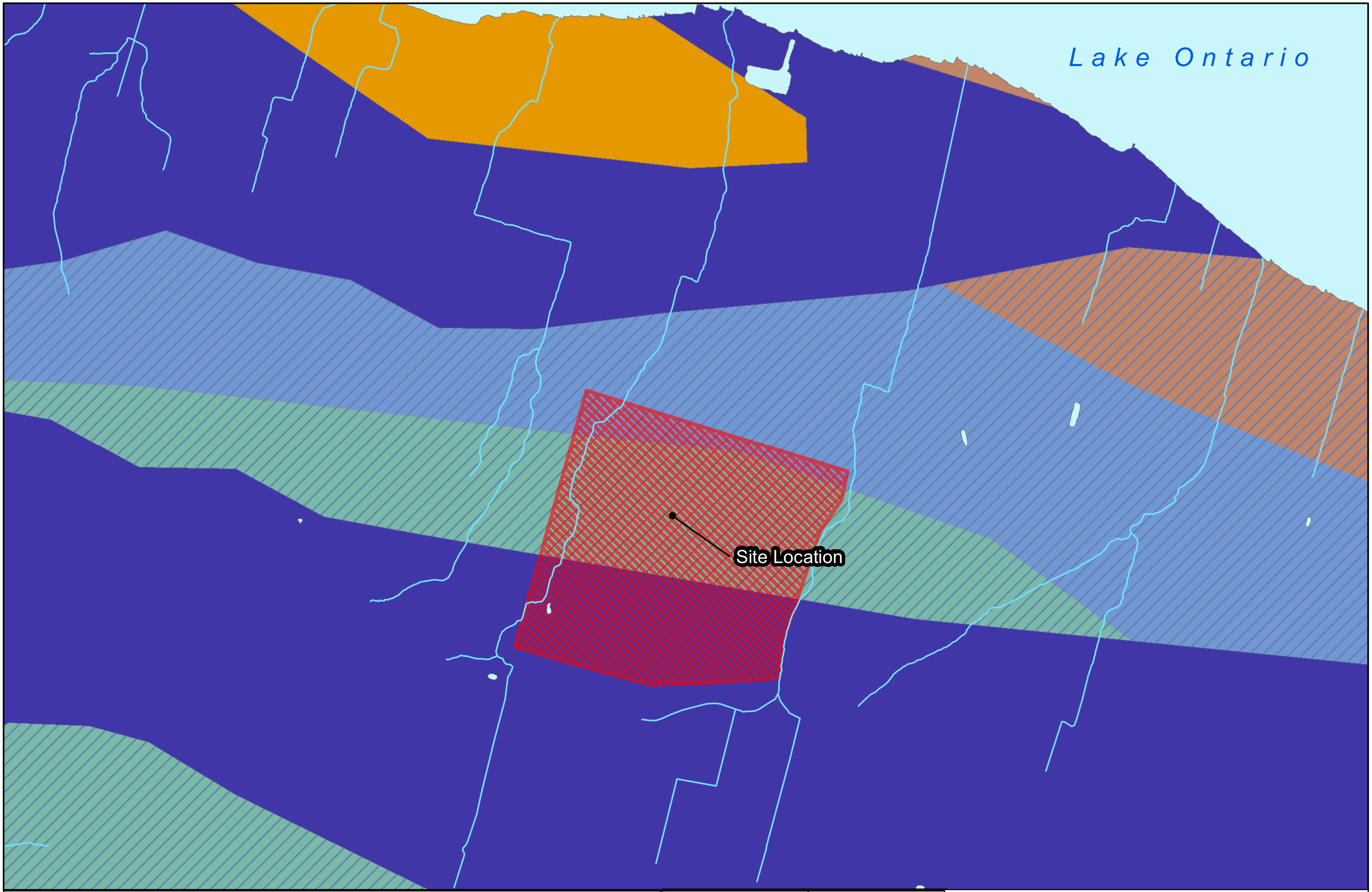
PROJECT N°: TP115082

FIGURE: 3

SCALE: NTS

DATE: Nov 2021

0 125 250 500 750 1,000 Meters



LEGEND

▭ Waterbody (OHN, 2012)

— Watercourse (OHN, 2012)

▨ Approximate Block 1 Property Boundary

Surficial (Quaternary) Geologic Unit (OGS, 2012)

▨ Bedrock

■ Glaciolacustrine deposits

■ Halton Till

Bedrock Geology (OGS, 2012)

■ Clinton Group; Cataract Group

■ Lockport Formation

■ Queenston Formation

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

Conditions encountered in the field may be different from the interpreted information presented on this figure.

This drawing should be read in conjunction with the corresponding Amec FosterWheeler Environment & Infrastructure Report.

SOURCE: ESRI ArcGIS Online, World Imagery, 2013.

CLIENT:
Block 1 Land Owners Group

Drawn By: KR
Checked By: KG
Revision: A
Projection: UTM Zone 17N
SCALE: 1:20,594

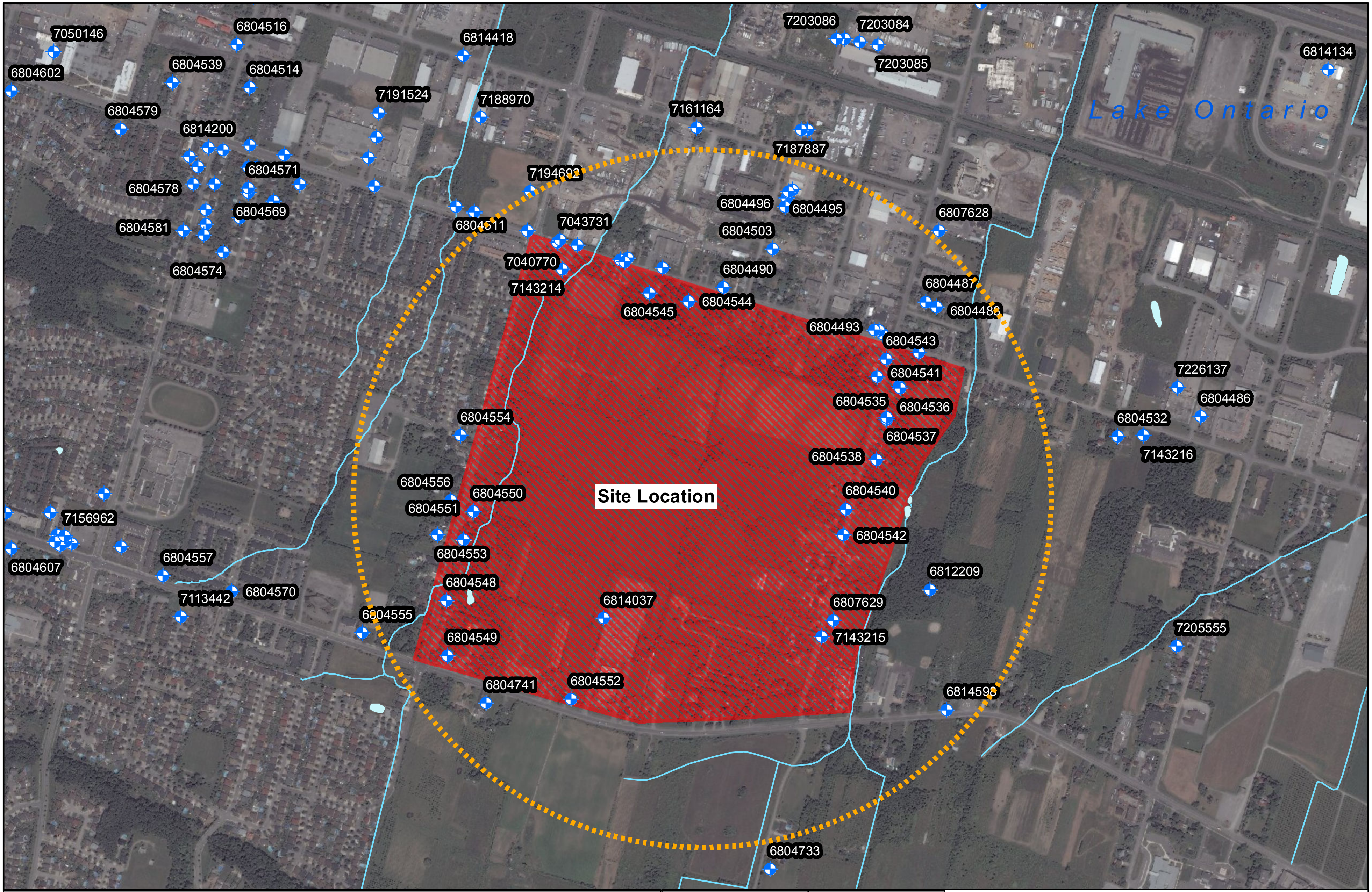
N
W E
S

HYDROGEOLOGICAL ASSESSMENT
Block 1, Fruitland-Winona Servicing Strategy
Hamilton, Ontario

Surficial Geology

PROJECT N^{o}: TP115082
DATE: November 2015
FIGURE: **4**

Wood Environment & Infrastructure Solutions
3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5
tel: 905-335-2353 www.woodplc.com



LEGEND

⊕ Water Well Records (labelled with ID; MOE WWIS, 03/2015)

▨ Approximate Block 1 Property Boundary

─ Watercourse (OHN, 2012)

🟦 Waterbody (OHN, 2012)

⬚ 500m Radius

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

Conditions encountered in the field may be different from the interpreted information presented on this figure.

This drawing should be read in conjunction with the corresponding Amec FosterWheeler Environment & Infrastructure Report.

SOURCE: ESRI ArcGIS Online, World Imagery, 2013.

CLIENT:
Block 1 Land Owners Group

Drawn By: KR	Checked By: KG
Revision: A	Projection: UTM Zone 17N

SCALE: 1:12,479

N
W E
S

HYDROGEOLOGICAL ASSESSMENT

Block 1, Fruitland-Winona Servicing Strategy
Hamilton, Ontario

Water Well Records

PROJECT Nº: TP115082

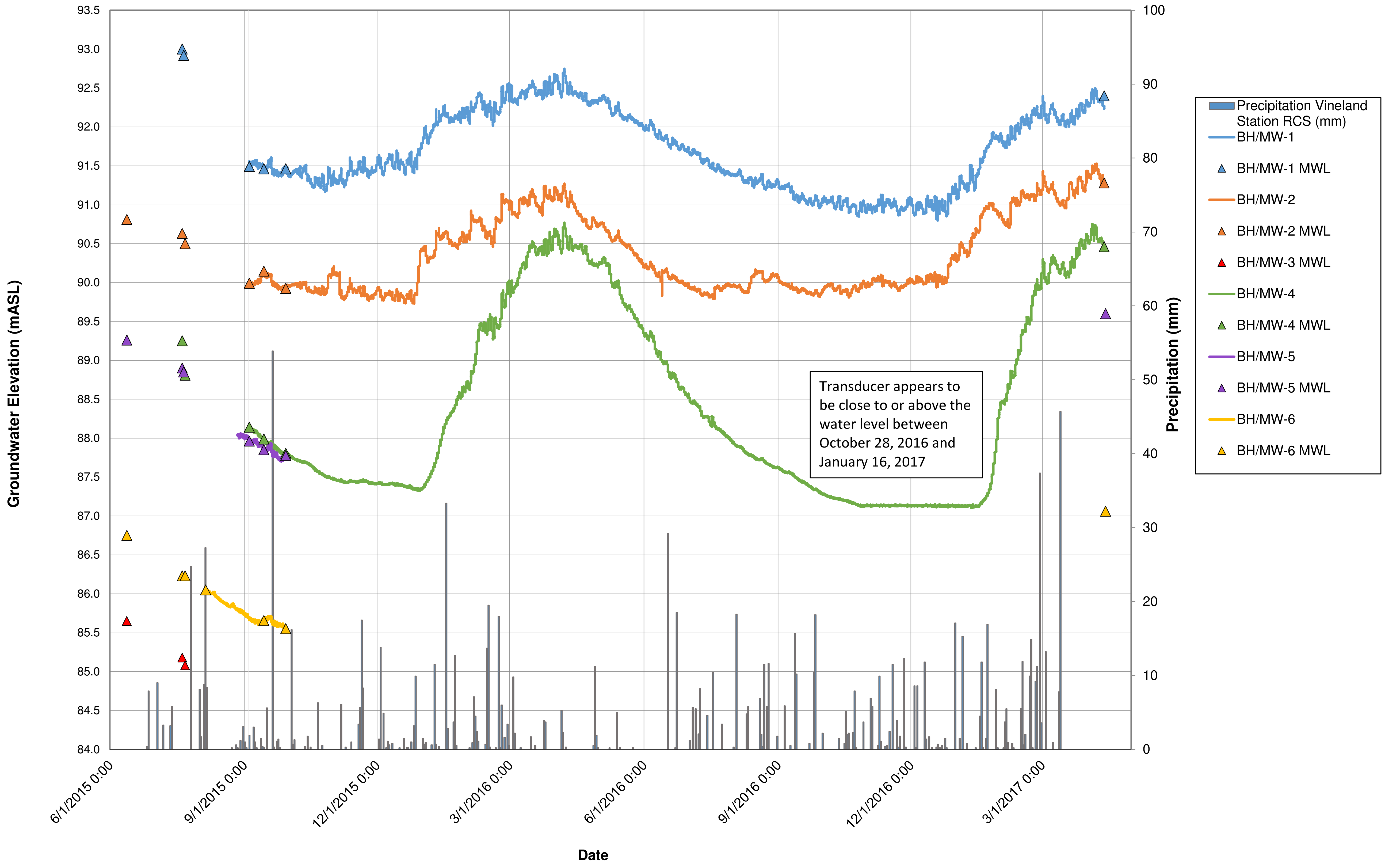
DATE: November 2015

FIGURE: 5

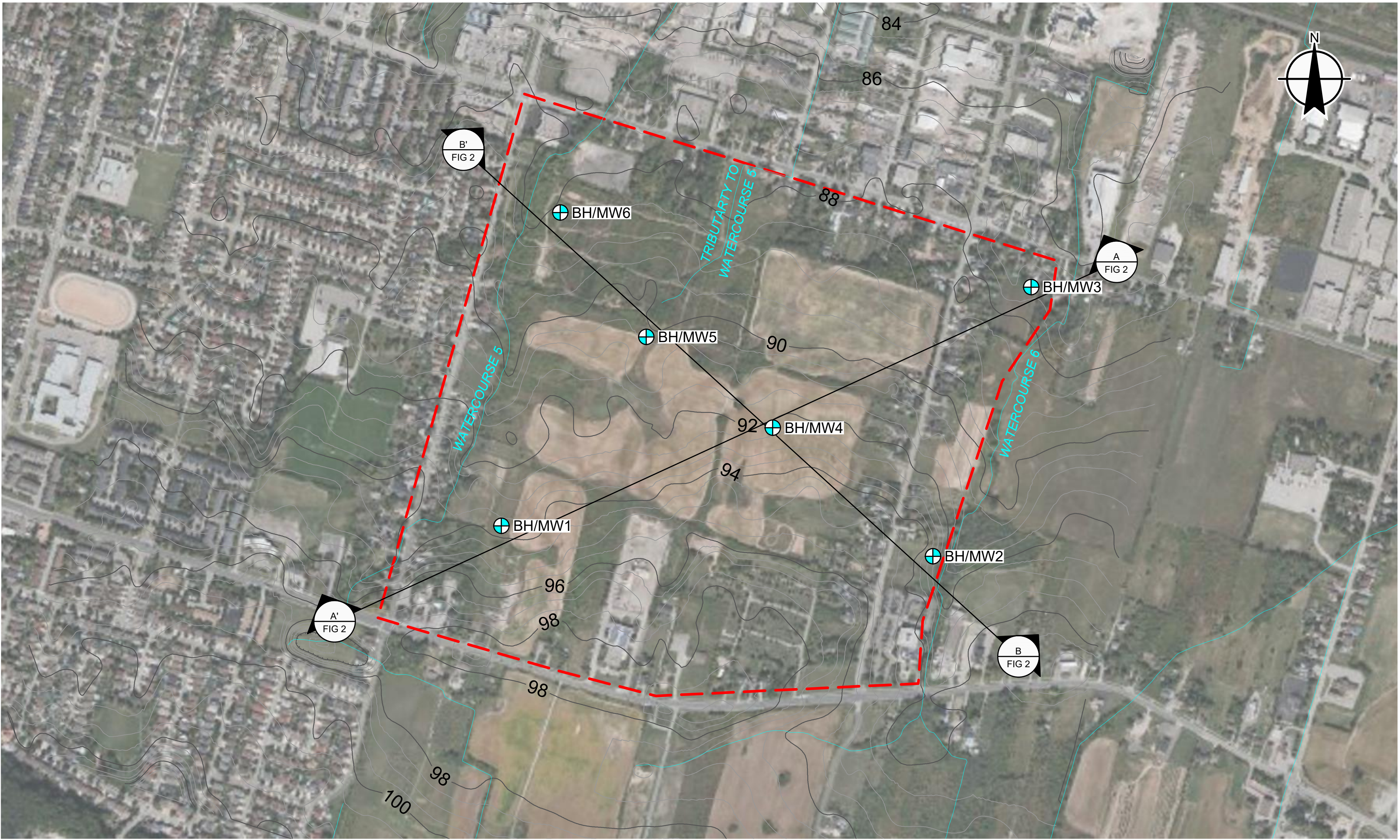
Wood Environment & Infrastructure Solutions
3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5
tel: 905-335-2353 www.woodplc.com

wood.

Figure 6: Hydrograph of Site Groundwater Monitoring Data



Transducer appears to be close to or above the water level between October 28, 2016 and January 16, 2017



LEGEND:

- - - - SITE BOUNDARY

⊕ BOREHOLE LOCATION

◓—◓ CROSS-SECTION LOCATION

CLIENT:
Hamilton

wsp

SCALE:
0m 100 200 300 400
1 : 10000

DATUM:
NAD83

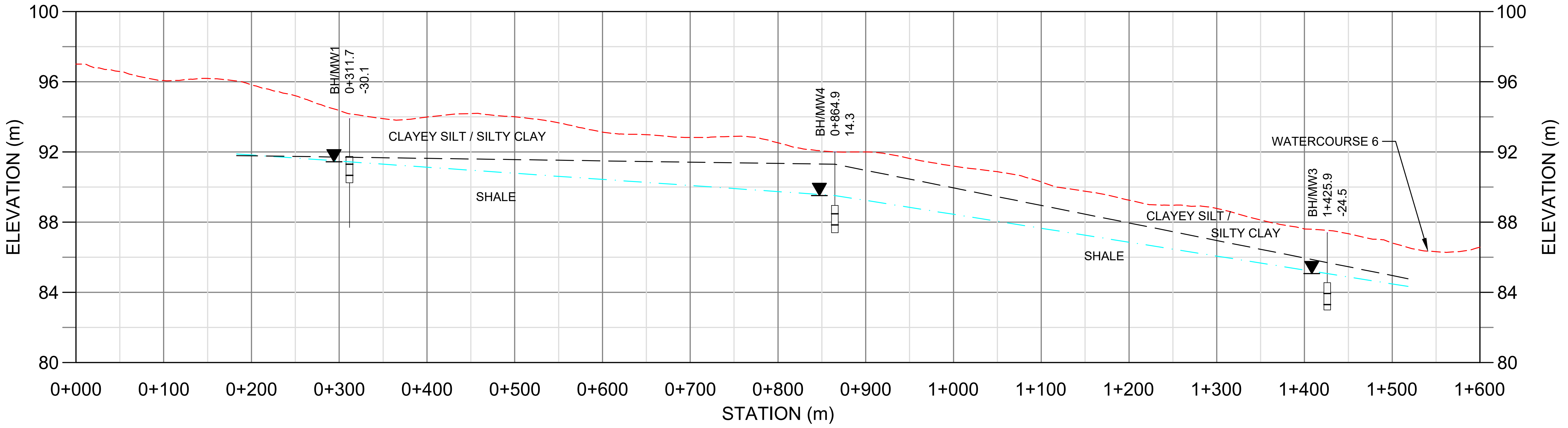
PROJECTION:
UTM ZONE 17 NORTH

PROJECT:
HYDROGEOLOGICAL ASSESSMENT
BLOCK 1, FRUITLAND-WINONA
BLOCK SERVICING STRATEGY
CITY OF HAMILTON, ON

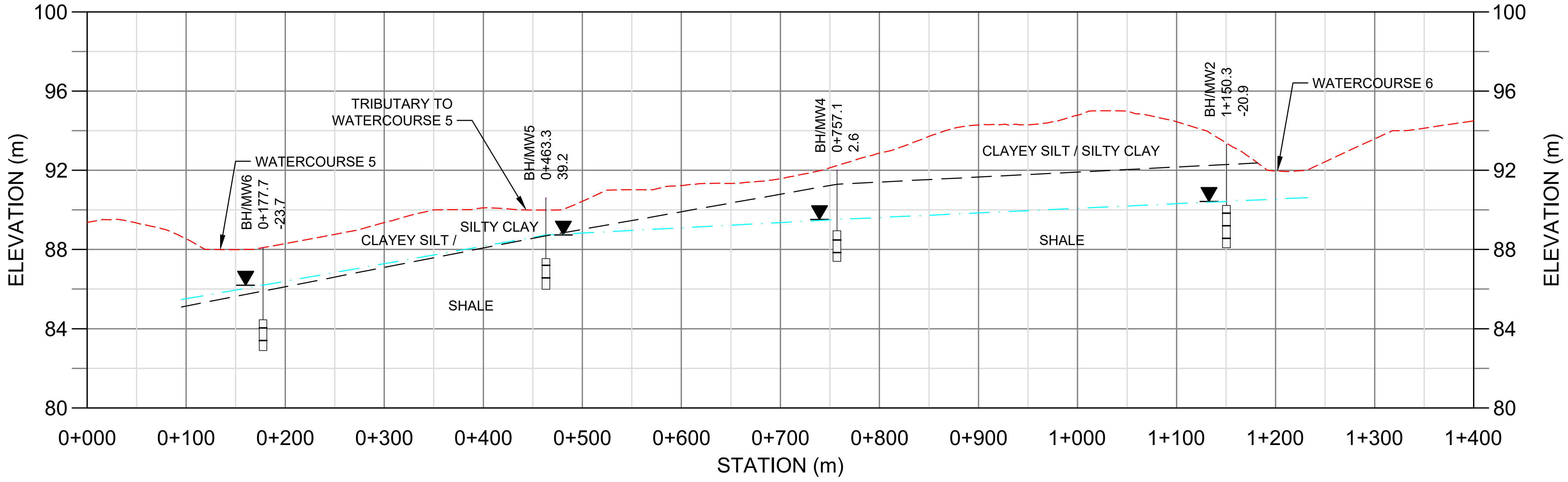
TITLE:
BOREHOLE LOCATION PLAN

DWN BY: DM	DSGN'D BY: -
CHK'D BY: -	CHK'D (LEAD): MA
PROJECT NO: TP115082	
REV. DATE: 2024/02/07	REV. NO: 0
FIGURE NO: 7	

X:\CA\CAFRE300-FRD\projectg$\PROJECTS\TP115082_Fruitland_Winona_Servicing_Strategy\CAD\TP115082_FRUITLAND.dwg - 2/7/2024 11:06 AM - McCoy, Dale



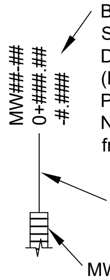
SECTION AA'
SCALE=1:5000 H
1:250 V
FIG 1



SECTION BB'
SCALE=1:5000 H
1:250 V
FIG 1

LEGEND:

- - - - EXISTING GROUND SURFACE
▼ WATER LEVEL (AT TIME OF SURVEY)
— — — INFERRED STRATIGRAPHY
— · — INFERRED WATER LEVEL



BH/MW ID
STATIONING
DISTANCE FROM PLANE OF PROFILE ALIGNMENT (Negative Number Indicates MW Location is "Into the Page" from the Plane of Profile Alignment. Positive Number Indicates MW Location is "Out of the Page from the Plane of Profile Alignment)

Vertical Line is Positioned at Correct Stationing and BH/MW Installation Elevation and Depth

MW Screen Installation

CLIENT:	SCALE: AS SHOWN	PROJECT: HYDROGEOLOGICAL ASSESSMENT BLOCK 1, FRUITLAND-WINONA BLOCK SERVICING STRATEGY CITY OF HAMILTON, ON	DWN BY: DM	DSGN'D BY: -
			CHK'D BY: -	CHK'D BY (LEAD): MA
			PROJECT NO: TP115082	
	DATUM: NAD83	TITLE: STRATIGRAPHY	REV. DATE: 2024/02/07	REV. NO: 0
	PROJECTION: UTM ZONE 17 NORTH		FIGURE NO: 8	

X:\CA\CAFRE300-FRD\projectg$\PROJECTS\TP115082_Fruitland_Winona_Servicing_Strategy\CAD\TP115082_FRUITLAND.dwg - 2/7/2024 11:06 AM - McCoy, Dale

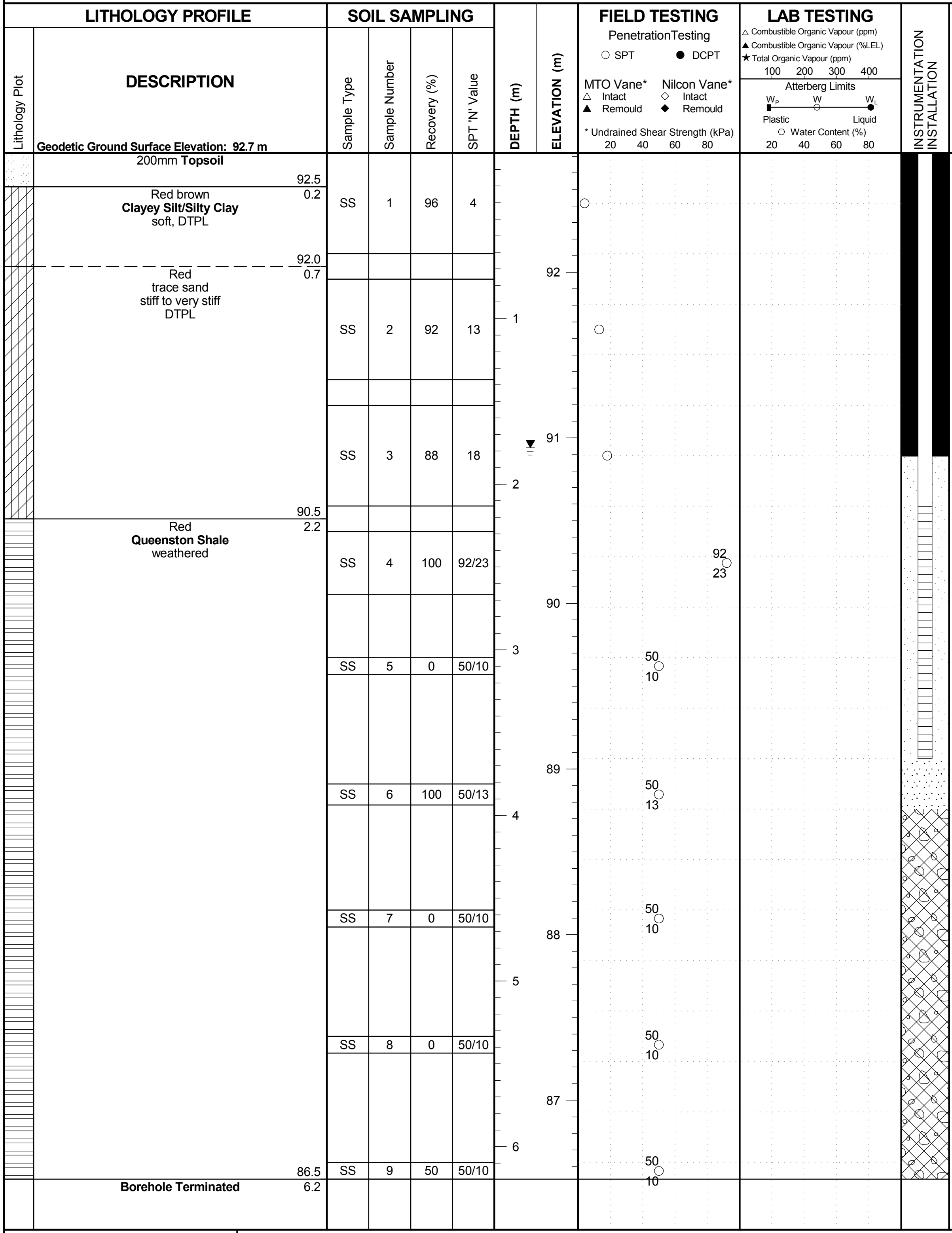
Appendix A

Borehole Logs

RECORD OF BOREHOLE No. BH/MW 1

Project Number: **TP115082**
Project Client: **Amec Foster Wheeler Burlington**
Project Name: **Fruitland-Winona Servicing Strategy**
Project Location: **Block 1, Stoney Creek, Ontario**
Drilling Location: **4785518N; 605512E**

Drilling Method: **150 mm Hollow Stem Augering**
Drilling Machine: **Track Mounted Drill**
Date Started: **8 Jun 15** Date Completed: **8 Jun 15**
Logged by: **TR** Compiled by: **TR**
Reviewed by: **KG** Revision No.: **0, 16/10/15**



DESCRIPTION

Geodetic Ground Surface Elevation: 92.7 m

DESCRIPTION	ELEVATION (m)	DEPTH (m)
200mm **Topsoil**		
Red brown **Clayey Silt/Silty Clay** soft, DTPL	92.5	0.2
Red trace sand stiff to very stiff DTPL	92.0	0.7
Red **Queenston Shale** weathered	90.5	2.2
Borehole Terminated	86.5	6.2

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	96	4
SS	2	92	13
SS	3	88	18
SS	4	100	92/23
SS	5	0	50/10
SS	6	100	50/13
SS	7	0	50/10
SS	8	0	50/10
SS	9	50	50/10

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Well Details: 50 mm diameter slotted PVC pipe with sand pack (1.8-4.0m), bentonite plug above sand pack, locking J-plug and aboveground casing.

Augers removed upon completion on June 8, 2015. Borehole caved to 4.0m and water level at 1.5m in open borehole prior to well installation on June 9, 2015.

Amec Foster Wheeler
Environment & Infrastructure
1-505 Woodward Avenue
Hamilton, Ontario L8H 6N6
Tel: (905) 312-0700
Fax: (905) 312-0771
www.amecfw.com

▽ No freestanding groundwater measured in open borehole on completion of drilling.

▼ Groundwater depth observed on 12/06/2015 at a depth of: 1.8 m.

Scale: 1 : 36

RECORD OF BOREHOLE No. BH/MW 2

Project Number: **TP115082**
Project Client: **Amec Foster Wheeler Burlington**
Project Name: **Fruitland-Winona Servicing Strategy**
Project Location: **Block 1, Stoney Creek, Ontario**
Drilling Location: **4785460N; 606334E**

Drilling Method: **150 mm Hollow Stem Augering**
Drilling Machine: **Track Mounted Drill**
Date Started: **8 Jun 15** Date Completed: **8 Jun 15**
Logged by: **TR** Compiled by: **TR**
Reviewed by: **KG** Revision No.: **0, 16/10/15**

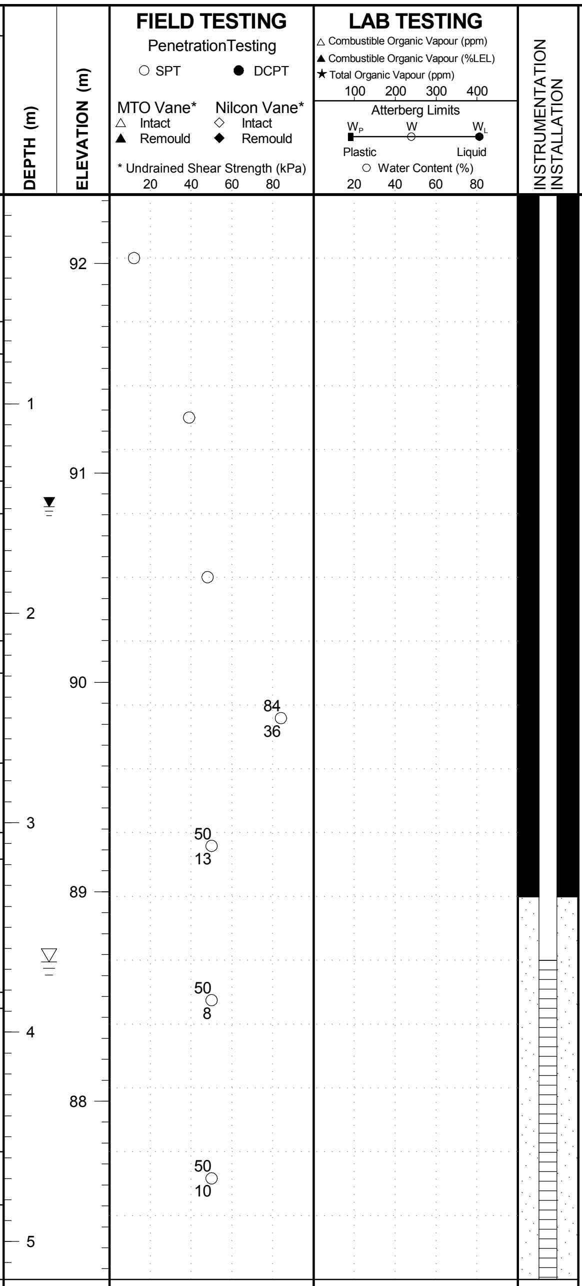
LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 92.3 m

DESCRIPTION	Elevation (m)	Depth (m)
200mm **Topsoil**	92.1	
Red **Silty Clay/Clayey Silt** trace sand stiff to hard DTPL	92.1 91.4	0.2
Red and grey **Queenston Shale** weathered	91.4 87.1	1.0
Borehole Terminated	87.1	5.2

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	83	12
SS	2	100	39
SS	3	75	48
SS	4	100	84/36
SS	5	100	50/13
SS	6	33	50/8
SS	7	100	50/10



LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm)
100 200 300 400
Atterberg Limits
W_P W W_L
Plastic Liquid
○ Water Content (%)
20 40 60 80

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Well Details: 50 mm diameter slotted PVC pipe with sand pack (3.4-5.2 m), bentonite plug above sand pack, locking J-plug and aboveground casing.

Amec Foster Wheeler Environment & Infrastructure

1-505 Woodward Avenue
Hamilton, Ontario L8H 6N6
Tel: (905) 312-0700
Fax: (905) 312-0771
www.amecfw.com

▽ Groundwater depth encountered on completion of drilling: 3.7 m.

▼ Groundwater depth observed on 12/06/2015 at a depth of: 1.5 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 36

RECORD OF BOREHOLE No. BH/MW 3

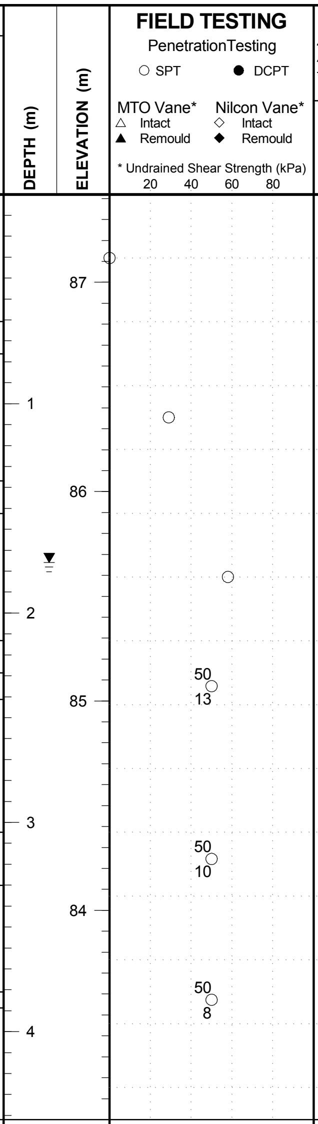
Project Number: **TP115082**
Project Client: **Amec Foster Wheeler Burlington**
Project Name: **Fruitland-Winona Servicing Strategy**
Project Location: **Block 1, Stoney Creek, Ontario**
Drilling Location: **4785973N; 606521E**

Drilling Method: **150 mm Hollow Stem Augering**
Drilling Machine: **Track Mounted Drill**
Date Started: **8 Jun 15** Date Completed: **8 Jun 15**
Logged by: **TR** Compiled by: **TR**
Reviewed by: **KG** Revision No.: **0, 16/10/15**

LITHOLOGY PROFILE / SOIL SAMPLING

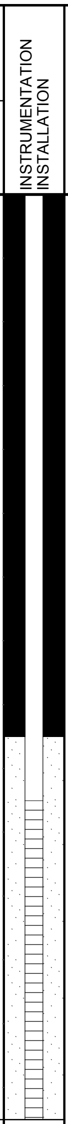
Geodetic Ground Surface Elevation: 87.4 m

DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
200mm **Topsoil**					
Brown Clayey Silt/Silty Clay **FILL** with sand, trace gravel and organics WTPL	87.2 0.2	SS	1	63	0
Red **Silty Clay/Clayey Silt** trace gravel and sand very stiff DTPL	86.7 0.7	SS	2	83	29
Red **Queenston Shale** weathered	85.7 1.7	SS	3	100	58
		SS	4	80	50/13
		SS	5	100	50/10
		SS	6	33	50/8
Borehole Terminated	83.0 4.4				



LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm)
100 200 300 400
Atterberg Limits
W_P W W_L
Plastic Liquid
○ Water Content (%)
20 40 60 80



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Well Details: 50 mm diameter slotted PVC pipe with sand pack (2.6-4.4 m), bentonite plug above sand pack, locking J-plug and aboveground casing.

Amec Foster Wheeler
Environment & Infrastructure
1-505 Woodward Avenue
Hamilton, Ontario L8H 6N6
Tel: (905) 312-0700
Fax: (905) 312-0771
www.amecfw.com

▽ No freestanding groundwater measured in open borehole on completion of drilling.

▼ Groundwater depth observed on 12/06/2015 at a depth of: 1.8 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 36

RECORD OF BOREHOLE No. BH/MW 4

Project Number: **TP115082**
Project Client: **Amec Foster Wheeler Burlington**
Project Name: **Fruitland-Winona Servicing Strategy**
Project Location: **Block 1, Stoney Creek, Ontario**
Drilling Location: **4785705N; 606029E**

Drilling Method: **150 mm Hollow Stem Augering**
Drilling Machine: **Track Mounted Drill**
Date Started: **10 Jun 15**
Date Completed: **10 Jun 15**
Logged by: **TR**
Compiled by: **TR**
Reviewed by: **KG**
Revision No.: **0, 16/10/15**

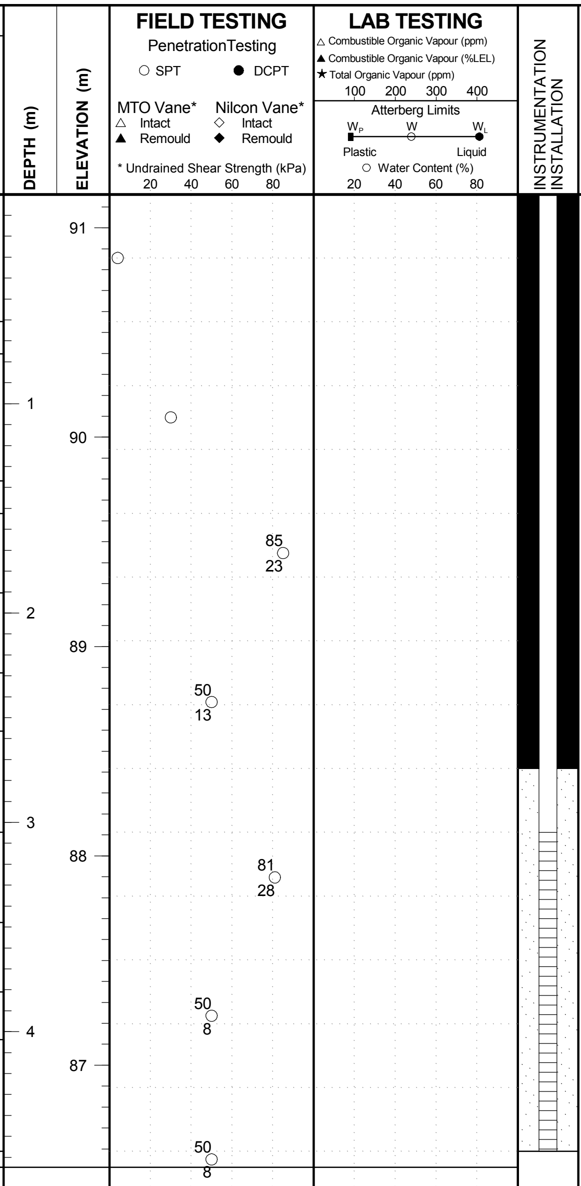
LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 91.2 m

DESCRIPTION	Elevation (m)	Depth (m)
300mm **Topsoil**	90.9	0.3
Red **Silty Clay/Clayey Silt** trace sand DTPL	90.5	0.7
Grey trace shale pieces very stiff	90.0	1.1
Red	89.7	1.4
Red and grey **Queenston Shale** weathered	86.5	4.6
Borehole Terminated		

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	92	4
SS	2	100	30
SS	3	100	85/23
SS	4	100	50/13
SS	5	100	81/28
SS	6	100	50/8
SS	7	33	50/8



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Well Details: 50 mm diameter slotted PVC pipe with sand pack (2.7-4.6 m), bentonite plug above sand pack, locking J-plug and aboveground casing.

Monitoring well dry on June 12/15.

Amec Foster Wheeler
Environment & Infrastructure

1-505 Woodward Avenue
Hamilton, Ontario L8H 6N6
Tel: (905) 312-0700
Fax: (905) 312-0771
www.amecfw.com

No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 36

RECORD OF BOREHOLE No. BH/MW 5

Project Number:	TP115082	Drilling Method:	150 mm Hollow Stem Augering
Project Client:	Amec Foster Wheeler Burlington	Drilling Machine:	Track Mounted Drill
Project Name:	Fruitland-Winona Servicing Strategy	Date Started:	10 Jun 15
		Date Completed:	10 Jun 15
Project Location:	Block 1, Stoney Creek, Ontario	Logged by:	TR
		Compiled by:	TR
Drilling Location:	4785878N; 605788E	Reviewed by:	KG
		Revision No.:	0, 16/10/15

LITHOLOGY PROFILE

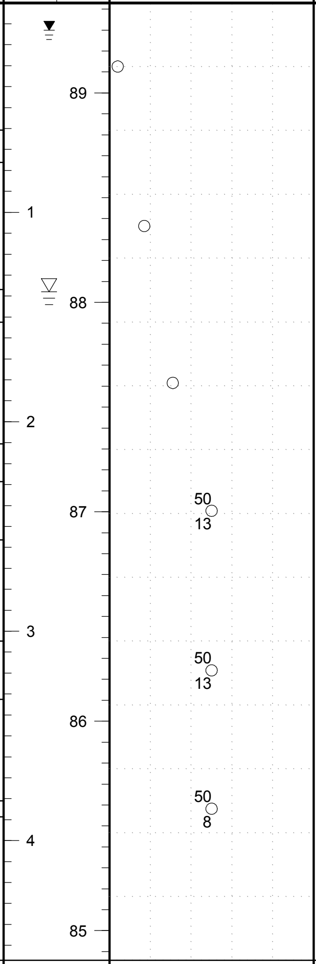
Geodetic Ground Surface Elevation: 89.4 m

DESCRIPTION	Elevation (m)	Depth (m)
300mm **Topsoil**	89.1	0.3
Red and grey **Silty Clay/Clayey Silt** trace shale and sand vert stiff to hard DTPL	87.5	1.9
Red **Queenston Shale** weathered	84.9	4.6
Borehole Terminated		

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	92	4
SS	2	100	17
SS	3	100	31
SS	4	91	50/13
SS	5	100	50/13
SS	6	100	50/8

FIELD TESTING



LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm)
100 200 300 400
Atterberg Limits
W_P W W_L
Plastic Liquid
○ Water Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Well Details: 50 mm diameter slotted PVC pipe with sand pack (2.7-4.6 m), bentonite plug above sand pack, locking J-plug and aboveground casing.

Amec Foster Wheeler
Environment & Infrastructure

1-505 Woodward Avenue
Hamilton, Ontario L8H 6N6
Tel: (905) 312-0700
Fax: (905) 312-0771
www.amecfw.com

▽ Groundwater depth encountered on completion of drilling: 1.4 m.

▼ Groundwater depth observed on 12/06/2015 at a depth of: 0.1 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 36

RECORD OF BOREHOLE No. BH/MW 6

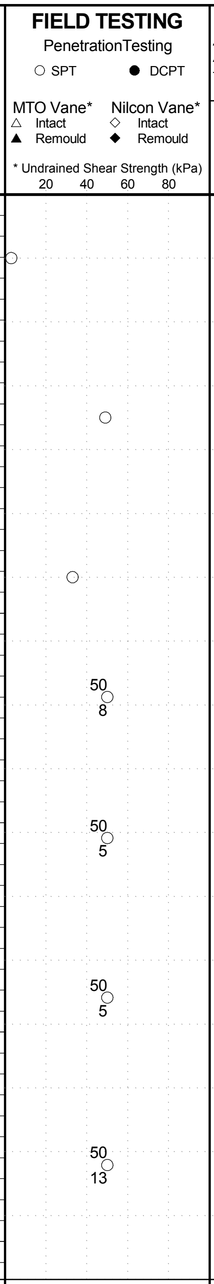
Project Number:	**TP115082**	Drilling Method:	**150 mm Hollow Stem Augering**		
Project Client:	**Amec Foster Wheeler Burlington**	Drilling Machine:	**Track Mounted Drill**		
Project Name:	**Fruitland-Winona Servicing Strategy**	Date Started:	**9 Jun 15**	Date Completed:	**9 Jun 15**
Project Location:	**Block 1, Stoney Creek, Ontario**	Logged by:	**TR**	Compiled by:	**TR**
Drilling Location:	**4786115N; 605624E**	Reviewed by:	**KG**	Revision No.:	**0, 16/10/15**

Geodetic Ground Surface Elevation: 88.0 m

Elevation / Depth (m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
88.0 / 0.0	300mm **Topsoil**				
87.7 / 0.3	Red and grey **Silty Clay/Clayey Silt** trace sand and shale hard DTPL	SS	1	71	3
		SS	2	100	49
		SS	3	100	33
85.8 / 2.2	Red **Queenston Shale** weathered	SS	4	44	50/8
		SS	5	0	50/5
		SS	6	50	50/5
		SS	7	20	50/13
82.8 / 5.2	**Borehole Terminated**				

DEPTH (m)	ELEVATION (m)
1	87
2	86
3	85
4	84
5	83

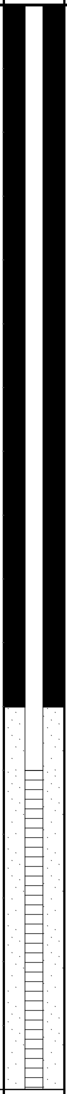
FIELD TESTING



LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm)
100 200 300 400
Atterberg Limits
W_P W W_L
Plastic Liquid
○ Water Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Well Details: 50 mm diameter slotted PVC pipe with sand pack (3.4-5.2 m), bentonite plug above sand pack, locking J-plug and aboveground casing.

Amec Foster Wheeler
Environment & Infrastructure

1-505 Woodward Avenue
Hamilton, Ontario L8H 6N6
Tel: (905) 312-0700
Fax: (905) 312-0771
www.amecfw.com

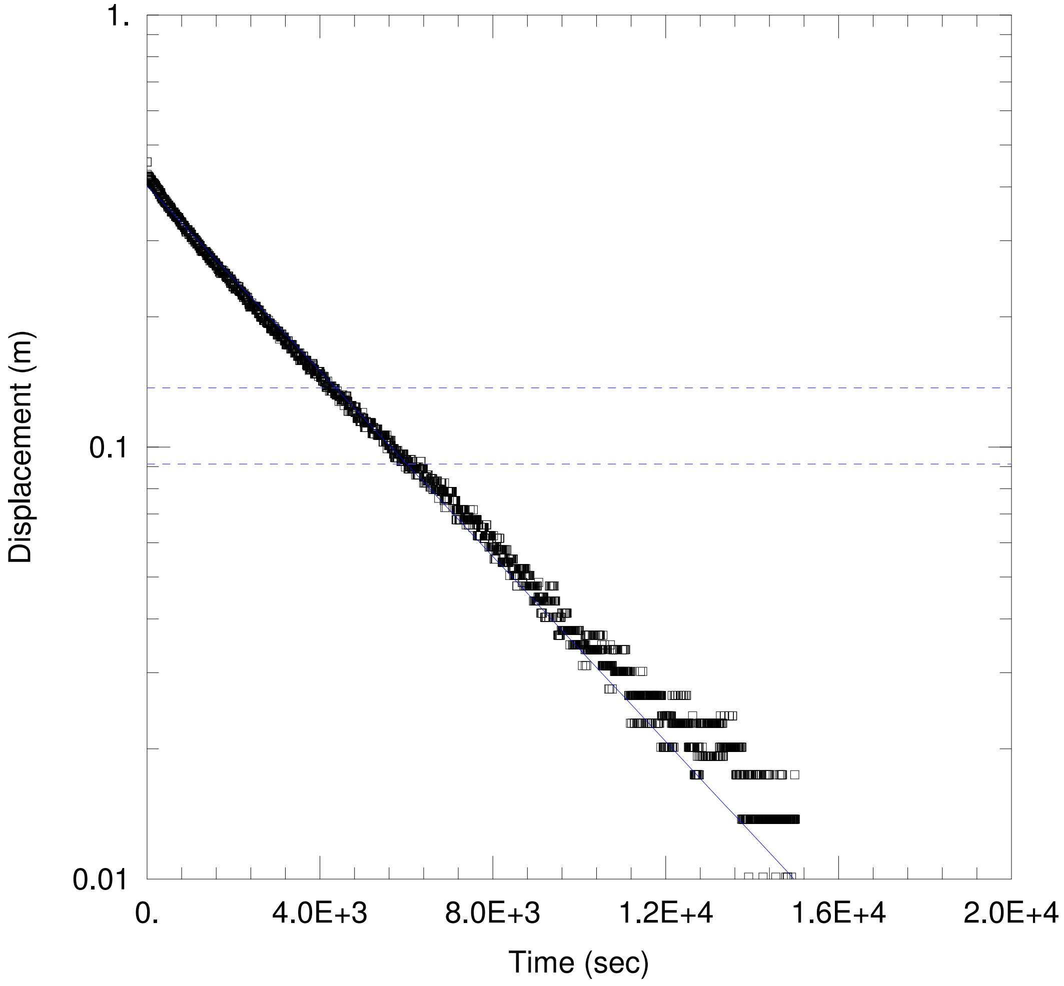
☿ No freestanding groundwater measured in open borehole on completion of drilling.

▼ Groundwater depth observed on 12/06/2015 at a depth of: 1.2 m.

Scale: 1 : 36

Appendix B

Slug Test Analysis



WELL TEST ANALYSIS

Data Set: Q:\...\BH1.aqt
Date: 10/15/15 Time: 16:18:23

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: Amec Foster Wheeler
Project: TP115082
Location: Fruitland-Winona
Test Well: BH/MW 1
Test Date: July 21, 2015

AQUIFER DATA

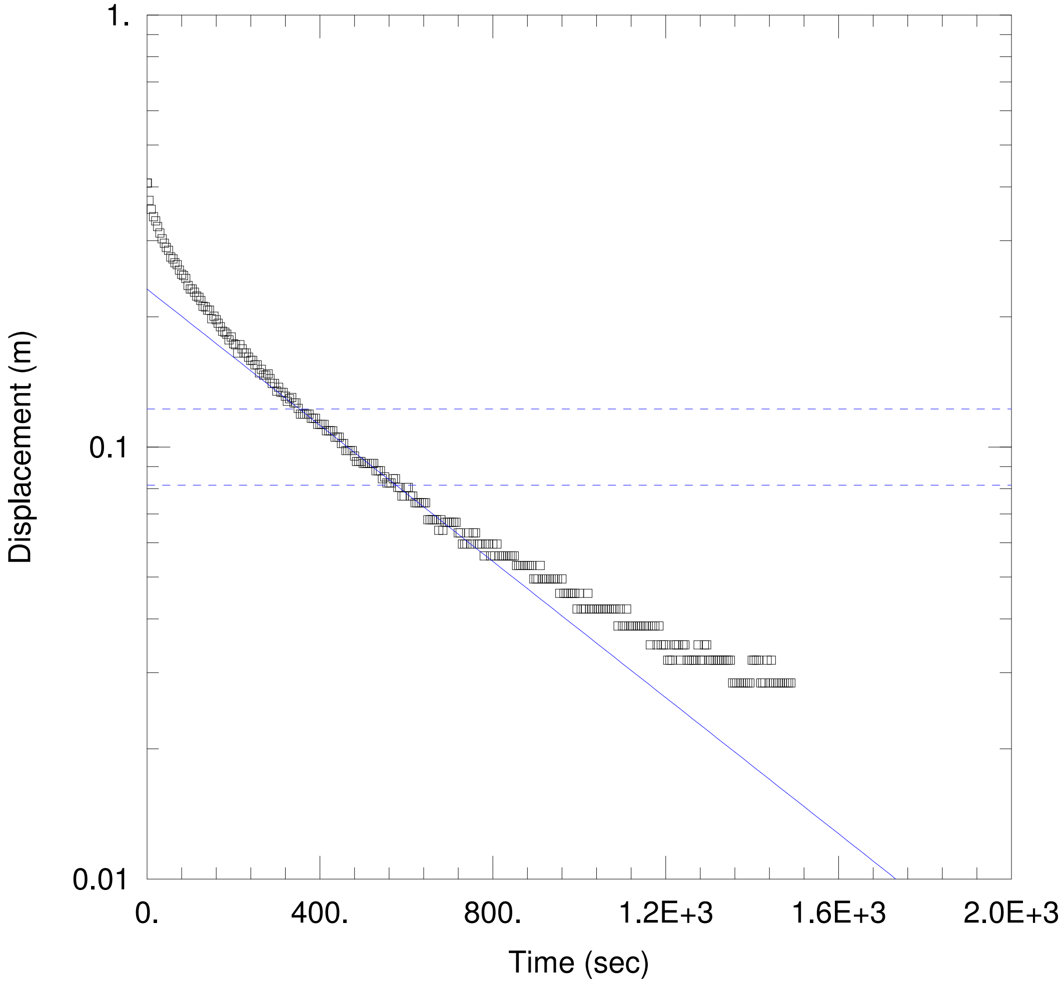
Saturated Thickness: 4. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH/MW 1)

Initial Displacement: 0.4565 m
Static Water Column Height: 3.87 m
Total Well Penetration Depth: 1.5 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.47E-7 m/sec
y0 = 0.4014 m



WELL TEST ANALYSIS

Data Set: Q:\...\BH2.aqt
Date: 10/15/15
Time: 16:19:06

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: Amec Foster Wheeler
Project: TP115082
Location: Fruitland-Winona
Test Well: BH/MW 2
Test Date: July 22, 2015

AQUIFER DATA

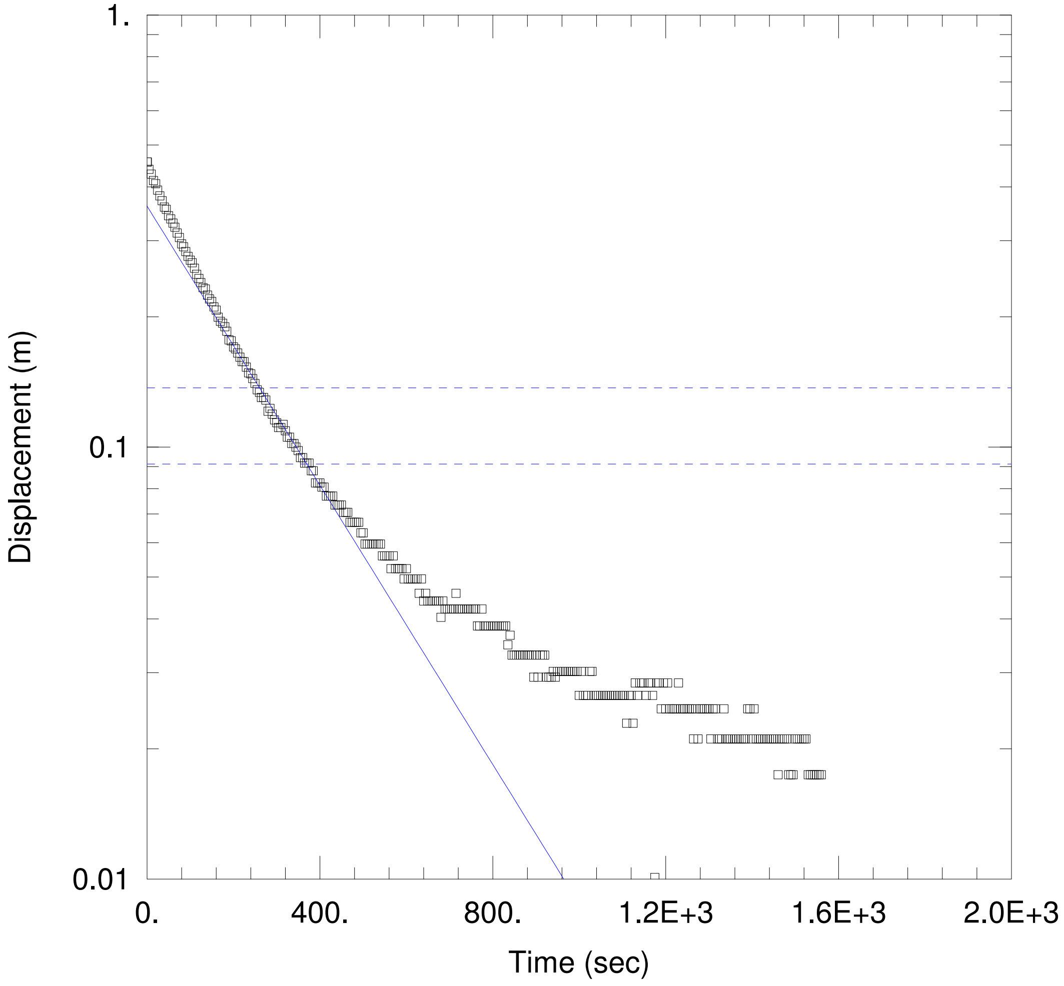
Saturated Thickness: 3.4 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH/MW 2)

Initial Displacement: 0.4079 m
Static Water Column Height: 3.4 m
Total Well Penetration Depth: 3.4 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.442E-6 m/sec
y0 = 0.2319 m



WELL TEST ANALYSIS

Data Set: Q:\...\BH3.aqt
Date: 10/15/15 Time: 16:19:28

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: Amec Foster Wheeler
Project: TP115082
Location: Fruitland-Winona
Test Well: BH/MW 3
Test Date: July 22, 2015

AQUIFER DATA

Saturated Thickness: 2.075 m
Anisotropy Ratio (Kz/Kr): 0.1

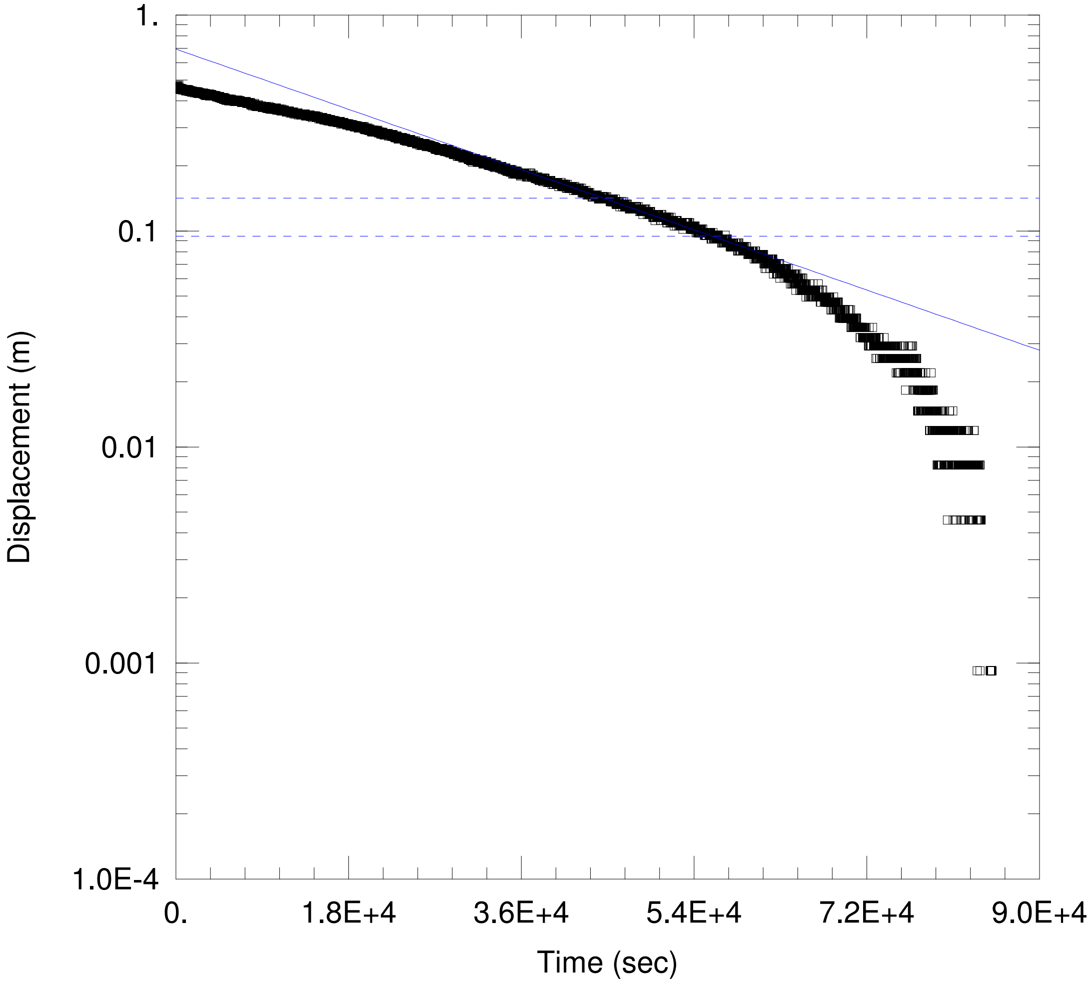
WELL DATA (BH/MW 3)

Initial Displacement: 0.4565 m
Static Water Column Height: 2.075 m
Total Well Penetration Depth: 2.075 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.712E-6 m/sec
y0 = 0.3608 m



WELL TEST ANALYSIS

Data Set: Q:\...\BH4.aqt
Date: 10/15/15 Time: 16:19:42

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: Amec Foster Wheeler
Project: TP115082
Location: Fruitland-Winona
Test Well: BH/MW 4
Test Date: July 22, 2015

AQUIFER DATA

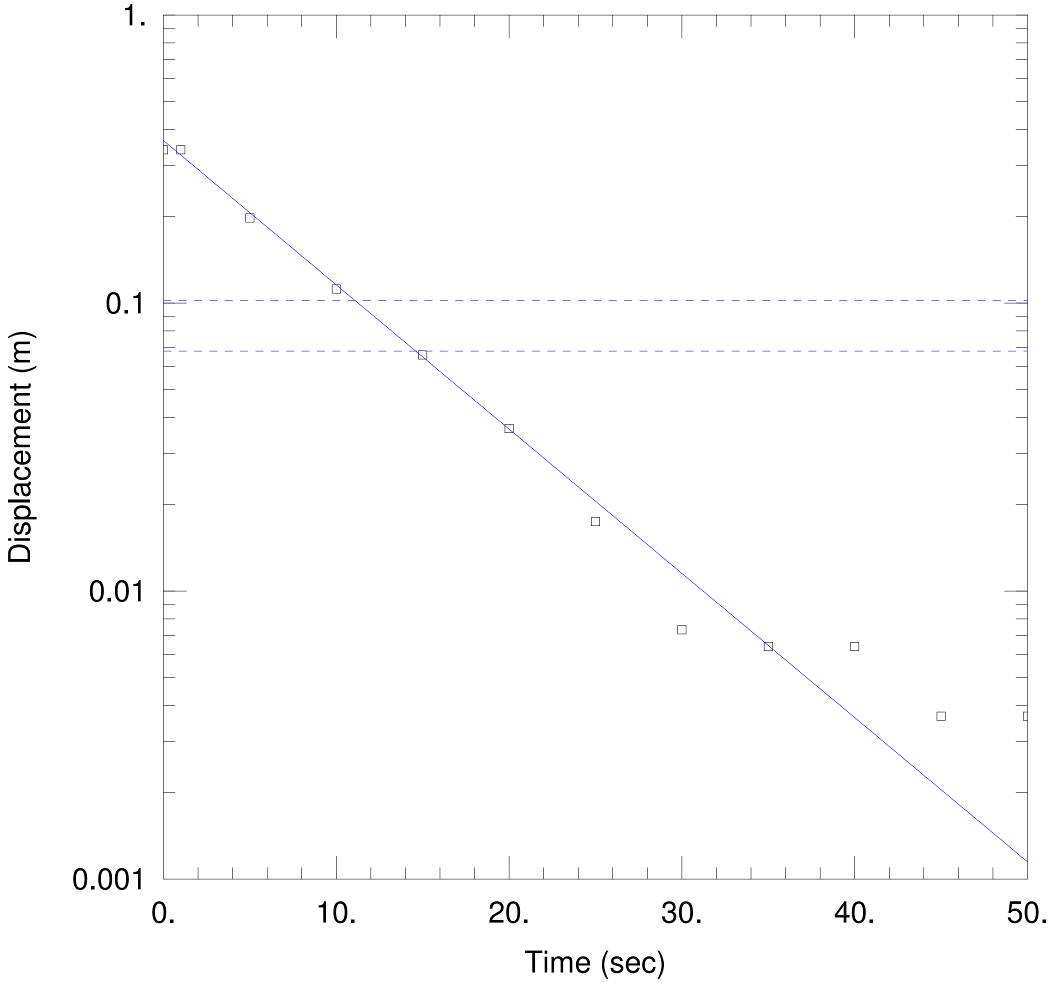
Saturated Thickness: 2.15 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (New Well)

Initial Displacement: 0.4721 m
Static Water Column Height: 2.15 m
Total Well Penetration Depth: 3.1 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.792E-8 m/sec
y0 = 0.6947 m



WELL TEST ANALYSIS

Data Set: Q:\...\BH5.aqt
Date: 10/15/15 Time: 16:19:57

PROJECT INFORMATION

Company: AMEC Foster Wheeler
Location: Fruitland-Winona
Test Well: BH/MW 5
Test Date: July 21, 2015

AQUIFER DATA

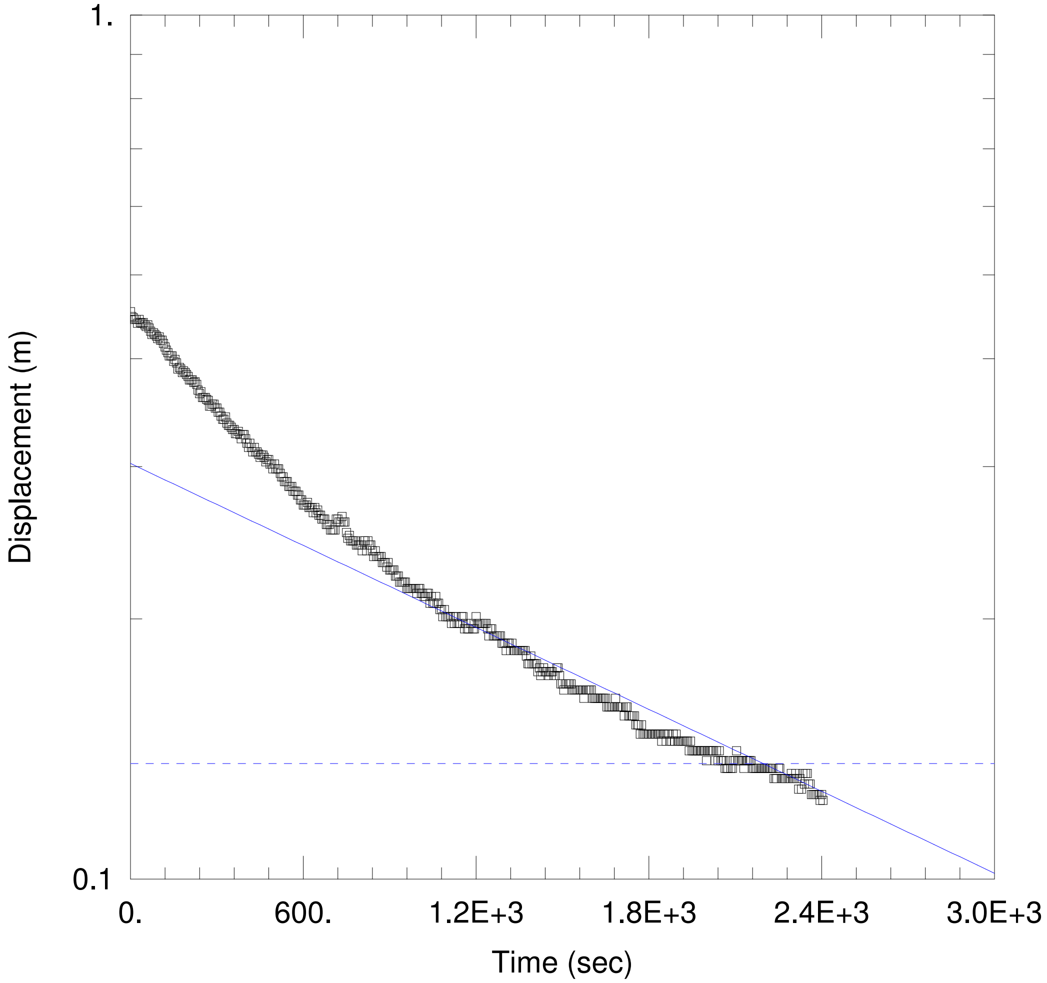
Saturated Thickness: 2.7 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH/MW 5)

Initial Displacement: 0.3401 m
Static Water Column Height: 4.06 m
Total Well Penetration Depth: 2.72 m
Screen Length: 1.52 m
Casing Radius: 0.0254 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 8.715E-5 m/sec
y0 = 0.366 m



WELL TEST ANALYSIS

Data Set: Q:\...\BH6.aqt
Date: 10/15/15 Time: 16:20:09

PROJECT INFORMATION

Company: AMEC Foster Wheeler
Location: Fruitland-Winona
Test Well: BH/MW 6
Test Date: July 21, 2015

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH/MW 6)

Initial Displacement: 0.4533 m
Static Water Column Height: 3.52 m
Total Well Penetration Depth: 3. m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.832E-7 m/sec
y0 = 0.3025 m

Appendix C

Certificates of Analysis

Your Project #: 5500MKTG.010150
Site#: BLOCK 1
Site Location: FRUITLAND - WINONA
Your C.O.C. #: 521643-01-01

Attention:Michael Anderson

AMEC Foster Wheeler Environment & Infrastructure
Hamilton - Standing Offer
505 Woodward Ave
Unit 1
Hamilton, ON
L8H 6N6

Report Date: 2015/08/13
Report #: R3627003
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5F4677
Received: 2015/08/05, 17:10

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	3	N/A	2015/08/10	CAM SOP-00448	SM 22 2320 B m
Carbonate, Bicarbonate and Hydroxide	3	N/A	2015/08/09	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	3	N/A	2015/08/10	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2015/08/07	CAM SOP-00414	SM 22 2510 m
Dissolved Organic Carbon (DOC) (1)	3	N/A	2015/08/10	CAM SOP-00446	SM 22 5310 B m
Hardness (calculated as CaCO3)	3	N/A	2015/08/13	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	3	N/A	2015/08/12	CAM SOP-00447	EPA 6020A m
Ion Balance (% Difference)	3	N/A	2015/08/13		
Anion and Cation Sum	3	N/A	2015/08/13		
Total Ammonia-N	3	N/A	2015/08/12	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	3	N/A	2015/08/07	CAM SOP-00440	SM 22 4500-NO3I/NO2B
pH	3	N/A	2015/08/07	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	3	N/A	2015/08/09	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	3	N/A	2015/08/13		
Sat. pH and Langelier Index (@ 4C)	3	N/A	2015/08/13		
Sulphate by Automated Colourimetry	3	N/A	2015/08/10	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	3	N/A	2015/08/13		

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Your Project #: 5500MKTG.010150
Site#: BLOCK 1
Site Location: FRUITLAND - WINONA
Your C.O.C. #: 521643-01-01

Attention:Michael Anderson

AMEC Foster Wheeler Environment & Infrastructure
Hamilton - Standing Offer
505 Woodward Ave
Unit 1
Hamilton, ON
L8H 6N6

Report Date: 2015/08/13
Report #: R3627003
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5F4677
Received: 2015/08/05, 17:10

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Marijane Cruz, Senior Project Manager
Email: MCruz@maxxam.ca
Phone# (905)817-5756
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B5F4677
Report Date: 2015/08/13

AMEC Foster Wheeler Environment & Infrastructure
Client Project #: 5500MKTG.010150
Site Location: FRUITLAND - WINONA
Sampler Initials: MA

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		ATC707	ATC707			ATC708		ATC709		
Sampling Date		2015/08/04 17:15	2015/08/04 17:15			2015/08/04 18:15		2015/08/04 16:15		
COC Number		521643-01-01	521643-01-01			521643-01-01		521643-01-01		
	Units	**MW-1**	**MW-1 Lab-Dup**	**RDL**	**QC Batch**	**MW-2**	**RDL**	**MW-5**	**RDL**	**QC Batch**
Calculated Parameters										
Anion Sum	me/L	33.6		N/A	4135281	64.1	N/A	30.5	N/A	4135281
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	270		1.0	4134705	230	1.0	310	1.0	4134705
Calculated TDS	mg/L	2000		1.0	4134702	4000	1.0	1900	1.0	4134702
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0		1.0	4134705	<1.0	1.0	1.0	1.0	4134705
Cation Sum	me/L	28.3		N/A	4135281	61.7	N/A	32.1	N/A	4135281
Hardness (CaCO3)	mg/L	1200		1.0	4134012	2000	1.0	1000	1.0	4135384
Ion Balance (% Difference)	%	8.65		N/A	4135280	1.89	N/A	2.61	N/A	4135280
Langelier Index (@ 20C)	N/A	0.579			4134703	0.705		0.777		4134703
Langelier Index (@ 4C)	N/A	0.335			4134704	0.464		0.534		4134704
Saturation pH (@ 20C)	N/A	6.76			4134703	6.70		6.78		4134703
Saturation pH (@ 4C)	N/A	7.01			4134704	6.94		7.02		4134704
Inorganics										
Total Ammonia-N	mg/L	0.61		0.050	4138919	0.26	0.050	0.47	0.050	4138919
Conductivity	umho/cm	2900	2900	1.0	4139390	5400	1.0	2800	1.0	4139390
Dissolved Organic Carbon	mg/L	2.4		0.20	4140209	2.9	0.20	2.6	0.20	4140209
Orthophosphate (P)	mg/L	<0.010	<0.010	0.010	4140166	<0.010	0.010	<0.010	0.010	4140166
pH	pH	7.34	7.36	N/A	4139396	7.40	N/A	7.55	N/A	4139396
Dissolved Sulphate (SO4)	mg/L	1100	1100	5.0	4140164	2000	5.0	860	5.0	4140164
Alkalinity (Total as CaCO3)	mg/L	270	270	1.0	4139372	230	1.0	310	1.0	4139372
Dissolved Chloride (Cl)	mg/L	160	170	2.0	4140161	670	7.0	230	3.0	4140161
Nitrite (N)	mg/L	<0.010	<0.010	0.010	4138439	<0.010	0.010	<0.010	0.010	4138439
Nitrate (N)	mg/L	1.27	1.26	0.10	4138439	<0.10	0.10	<0.10	0.10	4138439
Nitrate + Nitrite	mg/L	1.27	1.26	0.10	4138439	<0.10	0.10	<0.10	0.10	4138439
Metals										
Dissolved Aluminum (Al)	ug/L	<5.0		5.0	4144512	22	5.0	<5.0	5.0	4144512
Dissolved Antimony (Sb)	ug/L	<0.50		0.50	4144512	<0.50	0.50	<0.50	0.50	4144512
Dissolved Arsenic (As)	ug/L	<1.0		1.0	4144512	<1.0	1.0	<1.0	1.0	4144512
Dissolved Barium (Ba)	ug/L	69		2.0	4144512	39	2.0	49	2.0	4144512
Dissolved Beryllium (Be)	ug/L	<0.50		0.50	4144512	<0.50	0.50	<0.50	0.50	4144512
Dissolved Boron (B)	ug/L	970		10	4144512	4800	10	2400	10	4144512
Dissolved Cadmium (Cd)	ug/L	<0.10		0.10	4144512	<0.10	0.10	<0.10	0.10	4144512
Dissolved Calcium (Ca)	ug/L	280000		400	4144512	490000	1000	230000	400	4144512

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		ATC707	ATC707			ATC708		ATC709		
Sampling Date		2015/08/04 17:15	2015/08/04 17:15			2015/08/04 18:15		2015/08/04 16:15		
COC Number		521643-01-01	521643-01-01			521643-01-01		521643-01-01		
	Units	**MW-1**	**MW-1 Lab-Dup**	**RDL**	**QC Batch**	**MW-2**	**RDL**	**MW-5**	**RDL**	**QC Batch**
Dissolved Chromium (Cr)	ug/L	<5.0		5.0	4144512	<5.0	5.0	<5.0	5.0	4144512
Dissolved Cobalt (Co)	ug/L	0.97		0.50	4144512	2.0	1.0	0.76	0.50	4144512
Dissolved Copper (Cu)	ug/L	1.1		1.0	4144512	<2.0	2.0	<1.0	1.0	4144512
Dissolved Iron (Fe)	ug/L	<100		100	4144512	<100	100	<100	100	4144512
Dissolved Lead (Pb)	ug/L	<0.50		0.50	4144512	<0.50	0.50	<0.50	0.50	4144512
Dissolved Magnesium (Mg)	ug/L	130000		50	4144512	190000	50	110000	50	4144512
Dissolved Manganese (Mn)	ug/L	190		2.0	4144512	290	2.0	150	2.0	4144512
Dissolved Molybdenum (Mo)	ug/L	4.0		0.50	4144512	5.4	0.50	7.4	0.50	4144512
Dissolved Nickel (Ni)	ug/L	<1.0		1.0	4144512	<2.0 (1)	2.0	<1.0	1.0	4144512
Dissolved Phosphorus (P)	ug/L	<100		100	4144512	<100	100	<100	100	4144512
Dissolved Potassium (K)	ug/L	23000		200	4144512	46000	200	28000	200	4144512
Dissolved Selenium (Se)	ug/L	<2.0		2.0	4144512	3.2	2.0	<2.0	2.0	4144512
Dissolved Silicon (Si)	ug/L	3700		50	4144512	4000	50	3500	50	4144512
Dissolved Silver (Ag)	ug/L	0.20		0.10	4144512	0.10	0.10	<0.10	0.10	4144512
Dissolved Sodium (Na)	ug/L	73000		100	4144512	470000	100	250000	100	4144512
Dissolved Strontium (Sr)	ug/L	8900		1.0	4144512	13000	1.0	5200	1.0	4144512
Dissolved Thallium (Tl)	ug/L	0.050		0.050	4144512	0.060	0.050	<0.050	0.050	4144512
Dissolved Titanium (Ti)	ug/L	<5.0		5.0	4144512	<5.0	5.0	<5.0	5.0	4144512
Dissolved Uranium (U)	ug/L	27		0.10	4144512	34	0.10	53	0.10	4144512
Dissolved Vanadium (V)	ug/L	<0.50		0.50	4144512	0.63	0.50	<0.50	0.50	4144512
Dissolved Zinc (Zn)	ug/L	13		5.0	4144512	<25 (1)	25	<10 (1)	10	4144512

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
(1) Detection Limit was raised due to matrix interferences.

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		ATC709		
Sampling Date		2015/08/04 16:15		
COC Number		521643-01-01		
	Units	**MW-5 Lab-Dup**	**RDL**	**QC Batch**
Metals				
Dissolved Aluminum (Al)	ug/L	<5.0	5.0	4144512
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	4144512
Dissolved Arsenic (As)	ug/L	<1.0	1.0	4144512
Dissolved Barium (Ba)	ug/L	49	2.0	4144512
Dissolved Beryllium (Be)	ug/L	<0.50	0.50	4144512
Dissolved Boron (B)	ug/L	2400	10	4144512
Dissolved Cadmium (Cd)	ug/L	<0.10	0.10	4144512
Dissolved Calcium (Ca)	ug/L	240000	400	4144512
Dissolved Chromium (Cr)	ug/L	<5.0	5.0	4144512
Dissolved Cobalt (Co)	ug/L	0.81	0.50	4144512
Dissolved Copper (Cu)	ug/L	<1.0	1.0	4144512
Dissolved Iron (Fe)	ug/L	<100	100	4144512
Dissolved Lead (Pb)	ug/L	<0.50	0.50	4144512
Dissolved Magnesium (Mg)	ug/L	110000	50	4144512
Dissolved Manganese (Mn)	ug/L	150	2.0	4144512
Dissolved Molybdenum (Mo)	ug/L	7.0	0.50	4144512
Dissolved Nickel (Ni)	ug/L	<1.0	1.0	4144512
Dissolved Phosphorus (P)	ug/L	<100	100	4144512
Dissolved Potassium (K)	ug/L	28000	200	4144512
Dissolved Selenium (Se)	ug/L	<2.0	2.0	4144512
Dissolved Silicon (Si)	ug/L	3500	50	4144512
Dissolved Silver (Ag)	ug/L	<0.10	0.10	4144512
Dissolved Sodium (Na)	ug/L	250000	100	4144512
Dissolved Strontium (Sr)	ug/L	5200	1.0	4144512
Dissolved Thallium (Tl)	ug/L	0.055	0.050	4144512
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	4144512
Dissolved Uranium (U)	ug/L	53	0.10	4144512
Dissolved Vanadium (V)	ug/L	<0.50	0.50	4144512
Dissolved Zinc (Zn)	ug/L	<10	10	4144512

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Maxxam ID: ATC707
Sample ID: MW-1
Matrix: Water

Collected: 2015/08/04
Shipped:
Received: 2015/08/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	4139372	N/A	2015/08/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	4134705	N/A	2015/08/09	Automated Statchk
Chloride by Automated Colourimetry	KONE	4140161	N/A	2015/08/10	Alina Dobreanu
Conductivity	AT	4139390	N/A	2015/08/07	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	4140209	N/A	2015/08/10	Anastasia Hamanov
Hardness (calculated as CaCO3)		4134012	N/A	2015/08/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	4144512	N/A	2015/08/12	Kevin Comerford
Ion Balance (% Difference)	CALC	4135280	N/A	2015/08/13	Automated Statchk
Anion and Cation Sum	CALC	4135281	N/A	2015/08/13	Automated Statchk
Total Ammonia-N	LACH/NH4	4138919	N/A	2015/08/12	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	4138439	N/A	2015/08/07	Chandra Nandlal
pH	AT	4139396	N/A	2015/08/07	Neil Dassanayake
Orthophosphate	KONE	4140166	N/A	2015/08/09	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	4134703	N/A	2015/08/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	4134704	N/A	2015/08/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4140164	N/A	2015/08/10	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	4134702	N/A	2015/08/13	Automated Statchk

Maxxam ID: ATC707 Dup
Sample ID: MW-1
Matrix: Water

Collected: 2015/08/04
Shipped:
Received: 2015/08/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	4139372	N/A	2015/08/10	Neil Dassanayake
Chloride by Automated Colourimetry	KONE	4140161	N/A	2015/08/10	Alina Dobreanu
Conductivity	AT	4139390	N/A	2015/08/07	Neil Dassanayake
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	4138439	N/A	2015/08/07	Chandra Nandlal
pH	AT	4139396	N/A	2015/08/07	Neil Dassanayake
Orthophosphate	KONE	4140166	N/A	2015/08/09	Alina Dobreanu
Sulphate by Automated Colourimetry	KONE	4140164	N/A	2015/08/10	Alina Dobreanu

Maxxam ID: ATC708
Sample ID: MW-2
Matrix: Water

Collected: 2015/08/04
Shipped:
Received: 2015/08/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	4139372	N/A	2015/08/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	4134705	N/A	2015/08/09	Automated Statchk
Chloride by Automated Colourimetry	KONE	4140161	N/A	2015/08/10	Alina Dobreanu
Conductivity	AT	4139390	N/A	2015/08/07	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	4140209	N/A	2015/08/10	Anastasia Hamanov
Hardness (calculated as CaCO3)		4135384	N/A	2015/08/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	4144512	N/A	2015/08/12	Kevin Comerford
Ion Balance (% Difference)	CALC	4135280	N/A	2015/08/13	Automated Statchk

Maxxam Job #: B5F4677
Report Date: 2015/08/13

AMEC Foster Wheeler Environment & Infrastructure
Client Project #: 5500MKTG.010150
Site Location: FRUITLAND - WINONA
Sampler Initials: MA

TEST SUMMARY

Maxxam ID: ATC708
Sample ID: MW-2
Matrix: Water

Collected: 2015/08/04
Shipped:
Received: 2015/08/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Anion and Cation Sum	CALC	4135281	N/A	2015/08/13	Automated Statchk
Total Ammonia-N	LACH/NH4	4138919	N/A	2015/08/12	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	4138439	N/A	2015/08/07	Chandra Nandlal
pH	AT	4139396	N/A	2015/08/07	Neil Dassanayake
Orthophosphate	KONE	4140166	N/A	2015/08/09	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	4134703	N/A	2015/08/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	4134704	N/A	2015/08/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4140164	N/A	2015/08/10	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	4134702	N/A	2015/08/13	Automated Statchk

Maxxam ID: ATC709
Sample ID: MW-5
Matrix: Water

Collected: 2015/08/04
Shipped:
Received: 2015/08/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	4139372	N/A	2015/08/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	4134705	N/A	2015/08/09	Automated Statchk
Chloride by Automated Colourimetry	KONE	4140161	N/A	2015/08/10	Alina Dobreanu
Conductivity	AT	4139390	N/A	2015/08/07	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	4140209	N/A	2015/08/10	Anastasia Hamanov
Hardness (calculated as CaCO3)		4135384	N/A	2015/08/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	4144512	N/A	2015/08/12	Kevin Comerford
Ion Balance (% Difference)	CALC	4135280	N/A	2015/08/13	Automated Statchk
Anion and Cation Sum	CALC	4135281	N/A	2015/08/13	Automated Statchk
Total Ammonia-N	LACH/NH4	4138919	N/A	2015/08/12	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	4138439	N/A	2015/08/07	Chandra Nandlal
pH	AT	4139396	N/A	2015/08/07	Neil Dassanayake
Orthophosphate	KONE	4140166	N/A	2015/08/09	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	4134703	N/A	2015/08/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	4134704	N/A	2015/08/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4140164	N/A	2015/08/10	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	4134702	N/A	2015/08/13	Automated Statchk

Maxxam ID: ATC709 Dup
Sample ID: MW-5
Matrix: Water

Collected: 2015/08/04
Shipped:
Received: 2015/08/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Metals by ICPMS	ICP/MS	4144512	N/A	2015/08/12	Kevin Comerford

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
4138439	Nitrate (N)	2015/08/07	81	80 - 120	95	80 - 120	<0.10	mg/L	1.4	25
4138439	Nitrite (N)	2015/08/07	98	80 - 120	101	80 - 120	<0.010	mg/L	NC	25
4138919	Total Ammonia-N	2015/08/12	NC	80 - 120	97	85 - 115	<0.050	mg/L	0.65	20
4139372	Alkalinity (Total as CaCO3)	2015/08/10			97	85 - 115	<1.0	mg/L	0.75	25
4139390	Conductivity	2015/08/07			102	85 - 115	<1.0	umho/cm	0	25
4139396	pH	2015/08/07			102	98 - 103			0.31	N/A
4140161	Dissolved Chloride (Cl)	2015/08/10	NC	80 - 120	102	80 - 120	<1.0	mg/L	2.8	20
4140164	Dissolved Sulphate (SO4)	2015/08/10	NC	75 - 125	105	80 - 120	<1.0	mg/L	0.28	20
4140166	Orthophosphate (P)	2015/08/09	111	75 - 125	99	80 - 120	<0.010	mg/L	NC	25
4140209	Dissolved Organic Carbon	2015/08/10	101	80 - 120	103	80 - 120	<0.20	mg/L	2.5	20
4144512	Dissolved Aluminum (Al)	2015/08/12	103	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
4144512	Dissolved Antimony (Sb)	2015/08/12	110	80 - 120	105	80 - 120	0.56, RDL=0.50	ug/L	NC	20
4144512	Dissolved Arsenic (As)	2015/08/12	103	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
4144512	Dissolved Barium (Ba)	2015/08/12	101	80 - 120	99	80 - 120	<2.0	ug/L	1.5	20
4144512	Dissolved Beryllium (Be)	2015/08/12	102	80 - 120	101	80 - 120	<0.50	ug/L	NC	20
4144512	Dissolved Boron (B)	2015/08/12	NC	80 - 120	106	80 - 120	<10	ug/L	0.62	20
4144512	Dissolved Cadmium (Cd)	2015/08/12	107	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
4144512	Dissolved Calcium (Ca)	2015/08/12	NC	80 - 120	98	80 - 120	<200	ug/L	0.47	20
4144512	Dissolved Chromium (Cr)	2015/08/12	103	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
4144512	Dissolved Cobalt (Co)	2015/08/12	102	80 - 120	99	80 - 120	<0.50	ug/L	NC	20
4144512	Dissolved Copper (Cu)	2015/08/12	98	80 - 120	98	80 - 120	<1.0	ug/L	NC	20
4144512	Dissolved Iron (Fe)	2015/08/12	99	80 - 120	97	80 - 120	<100	ug/L	NC	20
4144512	Dissolved Lead (Pb)	2015/08/12	99	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
4144512	Dissolved Magnesium (Mg)	2015/08/12	NC	80 - 120	100	80 - 120	410, RDL=50	ug/L	0.43	20
4144512	Dissolved Manganese (Mn)	2015/08/12	102	80 - 120	102	80 - 120	<2.0	ug/L	0.54	20
4144512	Dissolved Molybdenum (Mo)	2015/08/12	111	80 - 120	103	80 - 120	<0.50	ug/L	5.6	20
4144512	Dissolved Nickel (Ni)	2015/08/12	101	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
4144512	Dissolved Phosphorus (P)	2015/08/12	107	80 - 120	109	80 - 120	340, RDL=100	ug/L	NC	20
4144512	Dissolved Potassium (K)	2015/08/12	NC	80 - 120	100	80 - 120	240, RDL=200	ug/L	0.52	20
4144512	Dissolved Selenium (Se)	2015/08/12	104	80 - 120	100	80 - 120	<2.0	ug/L	NC	20
4144512	Dissolved Silicon (Si)	2015/08/12	99	80 - 120	98	80 - 120	<50	ug/L	0.73	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
4144512	Dissolved Silver (Ag)	2015/08/12	79 (1)	80 - 120	102	80 - 120	<0.10	ug/L	NC	20
4144512	Dissolved Sodium (Na)	2015/08/12	NC	80 - 120	101	80 - 120	510, RDL=100	ug/L	0.80	20
4144512	Dissolved Strontium (Sr)	2015/08/12	NC	80 - 120	101	80 - 120	<1.0	ug/L	0.18	20
4144512	Dissolved Thallium (Tl)	2015/08/12	99	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
4144512	Dissolved Titanium (Ti)	2015/08/12	99	80 - 120	96	80 - 120	<5.0	ug/L	NC	20
4144512	Dissolved Uranium (U)	2015/08/12	104	80 - 120	103	80 - 120	<0.10	ug/L	0.24	20
4144512	Dissolved Vanadium (V)	2015/08/12	105	80 - 120	101	80 - 120	0.76, RDL=0.50	ug/L	NC	20
4144512	Dissolved Zinc (Zn)	2015/08/12	99	80 - 120	98	80 - 120	<5.0	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B5F4677
Report Date: 2015/08/13

AMEC Foster Wheeler Environment & Infrastructure
Client Project #: 5500MKTG.010150
Site Location: FRUITLAND - WINONA
Sampler Initials: MA

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eva P

CHARTERED
Eva Pranjic
CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-Free:800-563-6266 Fax:(905) 817-5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:

Company Name: #10602 AMEC Foster Wheeler Environment & Infrastr
Attention: Michael Anderson
Address: 505 Woodward Ave Unit 1
Hamilton ON L8H 6N6
Tel: (905) 312-0700 Fax: (905) 312-0771
Email: michael.anderson@amecfw.com

REPORT TO:

Company Name: AMEC FOSTER WHEELER
Attention: MICHAEL ANDERSON
Address: 505 WOODWARD AVE UNIT 1
HAMILTON, ON L8H 6N6
Tel: (905)312-0700 Fax: (905)312-0771
Email: michael.anderson@amecfw.com

PROJECT INFORMATION:

Quotation #: B21255
P.O. #:
Project: 5500MKTG.010150
Project Name: FRUITLAND-WINONA
Site #: BLOCK 1
Sampled By: MICHAEL ANDERSON

Laboratory Use Only:

Maxxam Job #:	Bottle Order #:
	521643
COC #:	**Project Manager:**
C#521643-01-01	Marijane Cruz

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ **For RSC**
☐ Table ___

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ________
☑ PWQO
☐ Other ________

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ________

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ________ Time Required: ________ ☐
Rush Confirmation Number: ________ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): [✓ Metals] / Hg / Cr VI	RCAp - Comprehensive	# of Bottles	Comments
1		MW-1	2015/08/04	5:15PM	GW	X	X	4	
2		MW-2	2015/08/04	6:15PM	GW	X	X	4	
3		MW-5	2015/08/04	4:15PM	GW	X	X	4	
4									
5									
6									
7									
8									
9									
10	GOVERNED BY THE TERMS AND CONDITIONS OF THE AGREEMENT 02-32M-71753 (15 APRIL 2014)								

05-Aug-15 17:10
Marijane Cruz
B5F4677
RGN ENV-589

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
/ MICHAEL ANDERSON	2015/08/05	5:07PM	RACHEL DEVLIN	2015/08/05	17:10	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	4/3/2	Present		✓
		Intact		

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

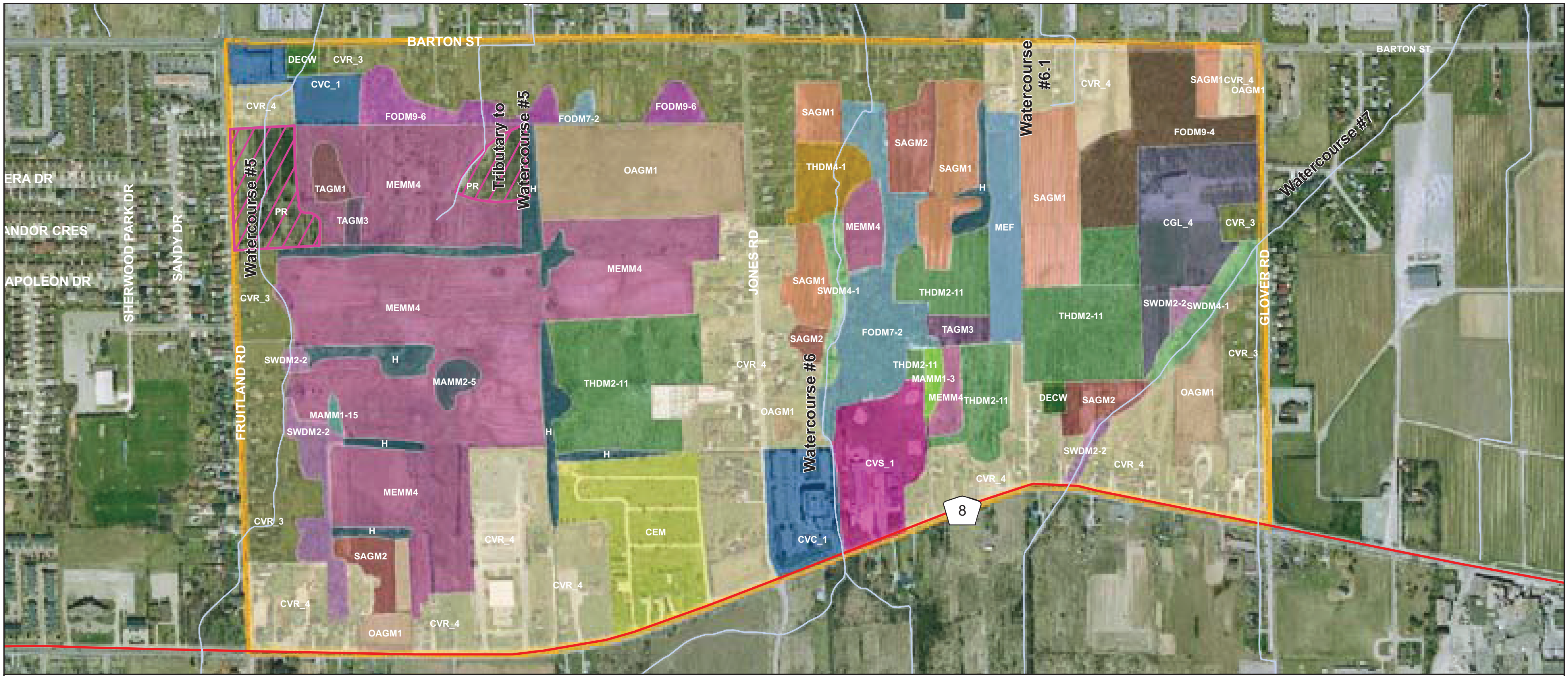
SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Appendix D

Figures by Others



Natural Heritage Assessment of Lands Bounded by Fruitland Road, Glover Road, Barton Street and Highway 8, City of Hamilton

Figure 3.2 Ecological Land Classification

Legend

- 🟨 CEM: Cemetery
- 🟪 CGL_4: Recreational
- 🟦 CVC_1: Business Sector
- 🟫 CVR_3: Single Family Residential
- ⬜ CVR_4: Rural Property
- 🟪 CVS_1: Education
- 🟩 DECW: Deciduous Woodlot
- 🟦 FODM7-2: Green Ash Hardwood Lowland Deciduous Forest
- 🟫 FODM9-4: Fresh Moist Shagbark Hickory Deciduous Forest
- 🟪 FODM9-6: Fresh Moist Oak-Hardwood Deciduous Forest
- 🟦 H: Hedgerow
- 🟦 MAMM1-15: Bulrush Graminoid Mineral Meadow Marsh
- 🟩 MAMM1-3: Reed Canary Grass Graminoid Mineral Meadow Marsh
- 🟪 MAMM2-5: Purple Loosestrife Forb Meadow Marsh
- 🟦 MEF: Forb Meadow
- 🟪 MEMM4: Fresh-Moist Mixed Meadow
- 🟫 OAGM1: Annual Row Crops
- ▨ PR: Plantation Removed
- 🟧 SAGM1: Vineyard
- 🟥 SAGM2: Orchard
- 🟪 SWDM2-2: Green Ash Mineral Deciduous Swamp
- 🟩 SWDM4-1: Willow Mineral Deciduous Swamp
- 🟪 TAGM1: Coniferous Plantation
- 🟪 TAGM3: Deciduous Plantation
- 🟩 THDM2-11: Hawthorn(dogwood/buckthorn) Deciduous Shrub Thicket
- 🟧 THDM4-1: Native Deciduous Regeneration Thicket
- — Highway
- — Watercourse
- ▭ Study Area

N
E
S
W

1:6,500

0 150 300 450 m

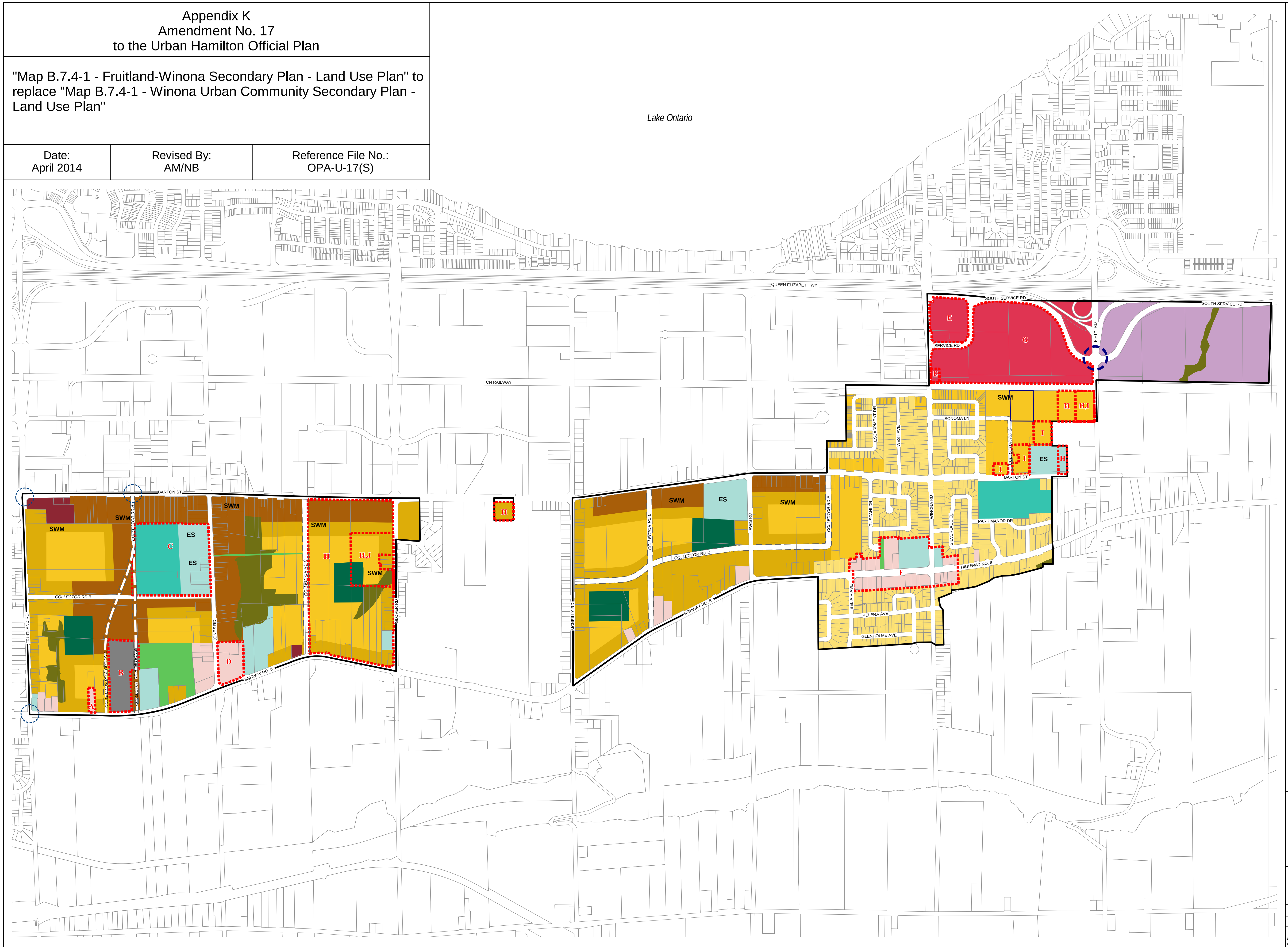
DILLON CONSULTING

Created By: SFG
Checked By: MB
Date Created: 060409
Date Modified: 100209
File Path: I:\GIS\091881 - Fruitland Road\Mappping\Report September 2009\Ecological Land Classification.mxd

Appendix K
Amendment No. 17
to the Urban Hamilton Official Plan

"Map B.7.4-1 - Fruitland-Winona Secondary Plan - Land Use Plan" to replace "Map B.7.4-1 - Winona Urban Community Secondary Plan - Land Use Plan"

Date:	Revised By:	Reference File No.:
April 2014	AM/NB	OPA-U-17(S)



Legend

Residential Designations

- Low Density Residential 1
- Low Density Residential 2
- Low Density Residential 3
- Medium Density Residential 2

Commercial and Mixed Use Designations

- Local Commercial
- District Commercial
- Arterial Commercial

Parks and Open Space Designations

- Neighbourhood Park
- Community Park
- General Open Space
- Natural Open Space

Other Designations

- Employment Area - Business Park
- Institutional
- ES Elementary School
- Utility
- SWM Storm Water Management

Other Features

- Area or Site Specific Policy
- Lands in the Rural Area
- Major Gateway
- Minor Gateway
- Proposed Roads
- Secondary Plan Boundary

Urban Hamilton Official Plan
Fruitland-Winona Secondary Plan
Land Use Plan
Map B.7.4-1

Not To Scale

Date: April 2014

Hamilton

PLANNING & ECONOMIC DEVELOPMENT DEPARTMENT

Appendix E

Limitations

Limitations

1. The work performed in the preparation of this report and the conclusions presented are subject to the following:
    a. The Standard Terms and Conditions which form a part of our Professional Services Contract;
    b. The Scope of Services;
    c. Time and Budgetary limitations as described in our Contract; and
    d. The Limitations stated herein.
2. No other warranties or representations, either expressed or implied, are made as to the professional services provided under the terms of our Contract, or the conclusions presented.
3. The conclusions presented in this report were based, in part, on visual observations of the Site and attendant structures. Our conclusions cannot and are not extended to include those portions of the Site or structures, which are not reasonably available, in WSP's opinion, for direct observation.
4. The environmental conditions at the Site were assessed, within the limitations set out above, having due regard for applicable environmental regulations as of the date of the inspection. A review of compliance by past owners or occupants of the Site with any applicable local, provincial or federal bylaws, orders-in-council, legislative enactments and regulations was not performed.
5. The Site history research included obtaining information from third parties and employees or agents of the owner. No attempt has been made to verify the accuracy of any information provided, unless specifically noted in our report.
6. Where testing was performed, it was carried out in accordance with the terms of our contract providing for testing. Other substances, or different quantities of substances testing for, may be present on-site and may be revealed by different or other testing not provided for in our contract.
7. Because of the limitations referred to above, different environmental conditions from those stated in our report may exist. Should such different conditions be encountered, WSP must be notified in order that it may determine if modifications to the conclusions in the report are necessary.
8. The utilization of WSP's services during the implementation of any remedial measures will allow WSP to observe compliance with the conclusions and recommendations contained in the report. WSP's involvement will also allow for changes to be made as necessary to suit field conditions as they are encountered.
9. This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or contract. Any use which any third party makes of the report, in whole or the part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. WSP accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on the report or anything set out therein.
10. This report is not to be given over to any third party for any purpose whatsoever without the written permission of WSP.
11. Provided that the report is still reliable, and less than 12 months old, WSP will issue a third-party reliance letter to parties that the client identifies in writing, upon payment of the then current fee for such letters. All third parties relying on WSP's report, by such reliance agree to be bound by our proposal and WSP's standard reliance letter. WSP's standard reliance letter indicates that in no event shall WSP be liable for

any damages, howsoever arising, relating to third-party reliance on WSP’s report. No reliance by any party is permitted without such agreement.