January 8, 2019 Reference No. 11155365

Ms. Jessica Ferri
CRH Canada Group Inc.
2300 Steeles Avenue West, 4th Floor
Concord, Ontario
L4K 5X6

Dear Ms. Ferri:

Re: Hydrogeological Assessment – Location of Water Table
Teedon Pit Extension, North 1/2 of Lot 80, Concession 1, W.P.R and Part of the original road allowance between Lot 80 & 81, Concession 1, W.P.R,
Geographic Township of Tiny, County of Simcoe, Ontario

1. Introduction

As requested, GHD has prepared the following hydrogeological assessment with regards to the location of the water table at the Cedarhurst Quarries and Crushing Ltd (Cedarhurst) Teedon Pit Extension located on the North 1/2 of Lot 80, Concession 1, W.P.R and Part of the original road allowance between Lot 80 & 81, Concession 1, W.P.R, Geographic Township of Tiny, County of Simcoe, Ontario. CRH Canada Group Inc. is the owner of the subject lands and has assumed responsibility for the approval of the Teedon Pit Extension on behalf of Cedarhurst.

The purpose of this report is to update the Alpha Environmental Services Inc. (AES) Hydrogeological Assessment dated April 12, 2011 following the installation of eight additional monitoring wells.

2. Background Information

2.1 Water Resources

In March 2012, Cedarhurst Quarries and Crushing Ltd. submitted a Township of Tiny Official Plan Amendment and Zoning By-law Amendment and a Ministry of Natural Resources and Forestry (MNRF) Class A Category 3 pit application to permit an extension to the existing Teedon Pit. The subject lands are located on the North 1/2 of Lot 80, Concession 1, W.P.R and Part of the original road allowance between Lot 80 & 81, Concession 1, W.P.R, Geographic Township of Tiny, County of Simcoe.

The original report to establish the water table was completed by AES. This report was reviewed by R.J. Burnside on behalf of the Township and R.J. Burnside signed-off on the application on November 19, 2014.

In May 2017, CRH Canada Group Inc. acquired the existing Teedon Pit and the Teedon Pit Extension lands. CRH retained GHD to install additional monitoring wells and complete additional site investigations to supplement the water resources information prepared by AES. As part of this work GHD also installed pressure transducers in all the existing Teedon Pit and proposed Teedon Pit Extension monitoring wells.

2.2 Geology and Hydrogeology of the Area

The Teedon Pit Extension is located within the Simcoe Uplands physiographic region where the topography varies significantly. The most common glacial features are sand plains, till plains and clay plains. This is regionally mapped as the Alliston Aquifer Complex.

The topography varies from approximately 260 to about 300 metres (m) above mean sea level (AMSL) (a northwest trending topographic high area) at the centre of the property.

Darby Road and Highway 93 border the east, Stamp Side Road the north, Marshall Road and Carpenter Side Road the west and the existing Teedon Pit is along the south border of the Teedon Pit Extension, as shown on Figure 1.

A small dugout pond is located on the northcentral part of the existing Teedon Pit.

A wetland also occurs to the north (downstream) of the dugout pond and is underlain by fine grained deposits.

In terms of geology and hydrogeology, the most significant deposits are sand deposits of the Upper Aquifer and fine grained deposits (silt and clay) of the Local Aquitard. The geologic and hydrogeologic framework is shown on the hydrogeologic cross-section A-A' (west-east) and cross-section B-B' (south-north) provided on Figures 2 and 3, respectively.

Groundwater flow is generally to the west in the Upper Aquifer from about 238 to 234 m AMSL, as shown on Figure 4.

The Local Aquitard is part of the Thorncliffe silt and clay deposits. The silt and clay deposits are not continuous and occur only on the eastern portion of the existing Teedon Pit and east of the Teedon Pit Extension on additional lands owned by CRH.

The Upper Aquifer is comprised of glacial lake sand with variable amounts of gravel and silt.

The Upper Aquifer is generally the source of water supply for the nearby domestic wells and for the aggregate washing operations within the existing Teedon Pit. There is no aggregate washing proposed within the Teedon Pit Extension.

3. Alpha Environmental Services Inc. Hydrogeological Assessment

The proposed Teedon Pit Extension licence application is for an Aggregate Resources Act (ARA) Class A, Category 3 Pit. Extraction is not proposed within 1.5 m of the established water table.

The original Site Plans for the Teedon Pit Extension included a much larger licensed area and were generated using a letter of opinion/ hydrogeological assessment prepared by Alpha Environmental Services Inc. (AES) dated April 12, 2011. AES determined the following with regards to the water table:

> *The water table is estimated to vary from 236.0 metres a.s.l. in the west portion of the licensed property to 254.8 meters a.s.l. on the central portion and to 252.2 meters a.s.l. in the east portion of the licensed property.*

The AES Assessment was based on four Monitoring wells (MW1-09, 16440 [decommissioned], MW1, and MW4) located at the Teedon Pit and an adjacent domestic well (25425). AES used water table elevation data from these wells to establish the water table for the Teedon Pit Extension lands. Only one monitoring well (MW1-09) was located on the Teedon Pit Extension property at the time.

4. Additional Monitoring Well Installations

Eight additional monitoring wells (MW5-18, MW6R-18, MW6-18, MW7-18, MW8-18, MW9-18, MW10-18S, and MW10-18D) were installed at the Teedon Pit in 2018 to better characterize the subsurface hydrogeological conditions and to allow additional monitoring of the water table. The monitoring well completion details are provided in Table 1.

The new monitoring wells installed on the Teedon Pit Extension property are MW8-18, MW9-18, MW10-18S, and MW10-18D.

The location of all monitoring wells are provided on Figure 1.

5. Proposed Teedon Pit Extension

In accordance with Provincial requirements for a Class A, Category 3 Pit licence extraction will take place 1.5 m above the established water table. The area proposed to be licensed is 15.3 hectares of which 13.5 hectares are proposed to be extracted. The proposed licensed boundary and limit of extraction are illustrated on Figure 1.

6. Water Table Assessment

Currently there are a total of 12 wells that are monitored on the Teedon Pit and Extension properties. There is one pumping well (PW1-09) and 11 monitoring wells (MW1, MW1-09, MW4-10, MW5-18, MW6-18, MW6R-18, MW7-18, MW8-18, MW9-18, MW10-18S, and MW10-18D). In addition, there are three domestic wells (#50632, #25425, and #17709) that have been historically monitored.

Groundwater elevation data has been collected both manually and automatically with pressure transducers/dataloggers at the monitoring well and domestic well locations since approximately 2009 and since 2018 for the newly installed monitoring wells. The manual and pressure transducer data were

reviewed and are very similar. The maximum observed groundwater elevation for each of the monitoring locations is provided in Table 2. In reviewing water levels at the additional monitoring wells installed on the Teedon Pit Extension lands it has been confirmed that the water table in the centre of the subject lands is much lower than originally indicated by AES. Consequently, the water table varies between 236.0 m AMSL on the west side of the proposed licensed boundary to 237.8 m AMSL at the eastern licensed boundary. The maximum observed groundwater elevation is shown on Figure 5.

A local zone of saturation exists above the water table where the relatively impervious Local Aquitard interrupts/intercepts percolation causing groundwater saturation. See Figures 2 and 3 for the location of the local aquitard. This is not considered the water table for the purpose of establishing the on-Site water table due to its isolated nature and limited function. There are no water supply wells drawing water from this unit that may be influenced. The unevaluated wetland area downstream of the dugout pond will not be affected by the proposed extraction of sand and gravel, and it is more than 100 m from the proposed extraction area[1].

7. Assessment

Since extraction will remain 1.5 m above the established groundwater table, there will be no impact to private wells or groundwater resources.

8. Recommendations

1. In order to confirm that the maximum depth of extraction for the Teedon Pit Extension is no closer than 1.5 m above the established ground water table the water levels at monitoring wells MW1-09, MW8-18, MW10D-18, and MW5-18 shall be monitored quarterly and the water level at monitoring well MW9-18 shall be monitored quarterly until it is removed for extraction.
2. The water level measurements shall be compared to the maximum depth of extraction on the site plans. In the event the water level data indicates the maximum depth of extraction is less than 1.5 m above the established groundwater table, the maximum depth of extraction shall be adjusted accordingly to maintain the 1.5-m depth.
3. The operator shall maintain a record of the ground water levels to confirm the maximum depth of extraction remains 1.5 m above the established water table.
4. The ARA site plans shall identify the pit floor as 1.5 m above the established water table elevations based on groundwater contours shown on Figure 5.

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[1] Goodban Ecological Consulting Inc. (GEC). December 2018. Natural Environment Level 1 and 2 Technical Report. Proposed Teedon Pit Extension. Submitted to: CRH Canada Group Inc., 2300 Steeles Avenue West, 4th Floor, Concord, Ontario, L4K 5X6. Prepared by: Goodban Ecological Consulting Inc., 879 Cabot Trail, Milton, Ontario, L9T 3W4.

Should you have any questions, please do not hesitate to contact us.

Sincerely,

GHD

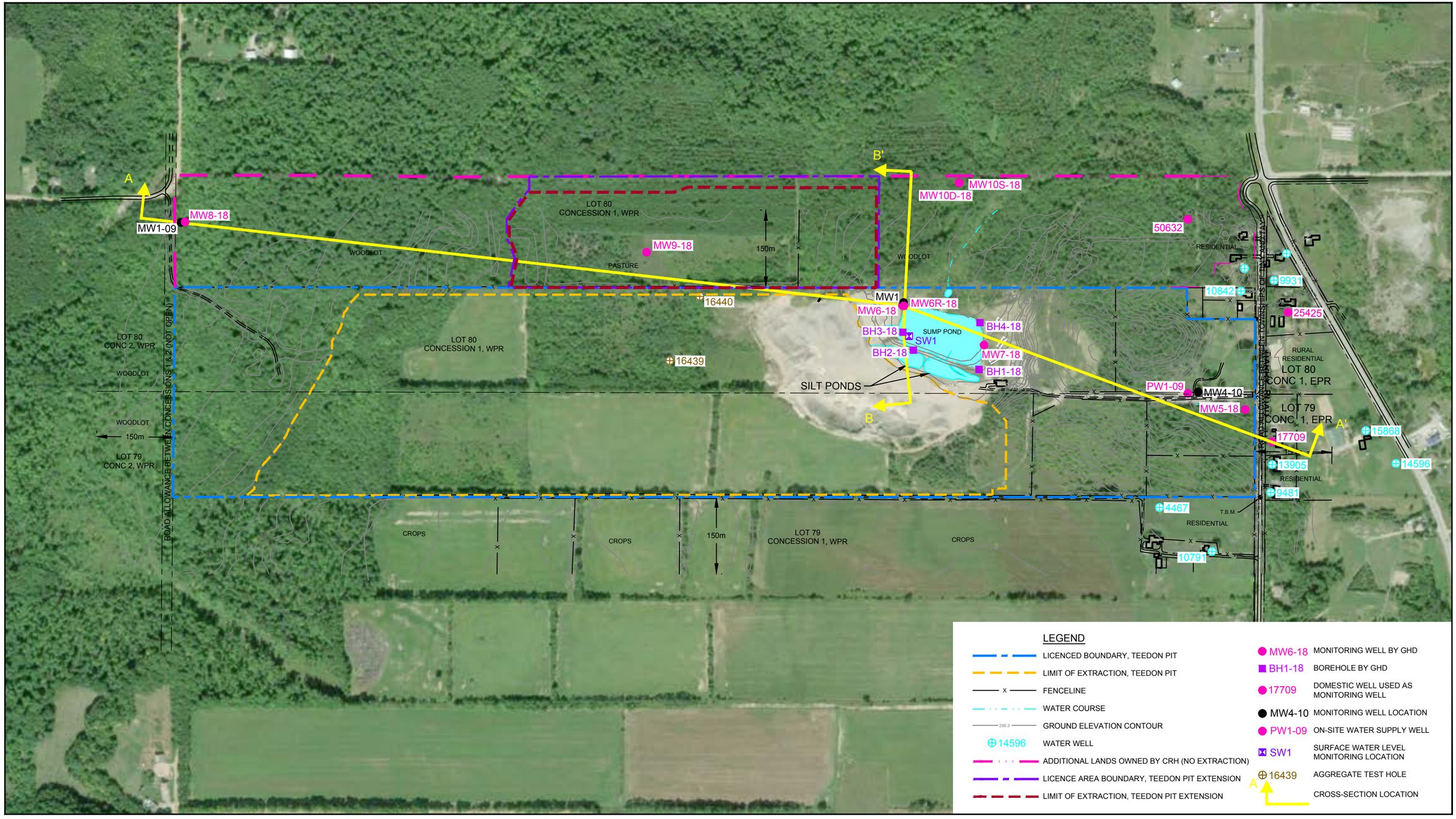
Gary I. Lagos, M.Sc., P. Geo.

J. Richard Murphy, M.A.Sc., P. Eng.

EM/ev/1

Encl.

cc: Brian Zeman, MHBC



Source: Microsoft Product Screen shot Reprinted with permission from Microsoft Corporation, Aquisition Date 2018, Accessed April, 2018

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TEEDON PIT EXTENSION
TOWNSHIP OF TINY, COUNTY OF SIMCOE, ONTARIO

11155365-10

Jan 7, 2019

HYDROGEOLOGIC CROSS-SECTION LOCATIONS

FIGURE 1

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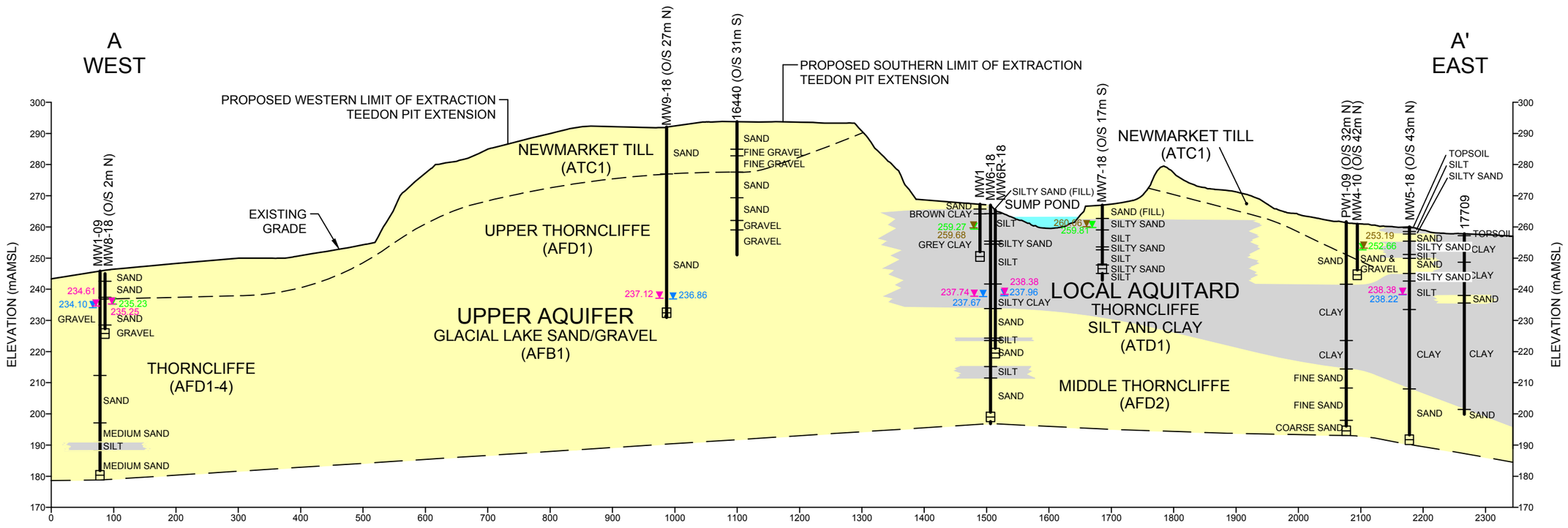

LOCAL STRATIGRAPHY AND HYDROSTRATIGRAPHY OBTAINED BY GHD ON BEHALF OF DUFFERIN WAS CORRELATED WITH THE 2017 WORK BY RILEY P. M. MULLIGAN AND ANDY F. BAJC. "QUATERNARY SEDIMENT ARCHITECTURE OF SIMCOE COUNTY, SOUTHERN ONTARIO"
SUMP POND TOPOGRAPHY BY DELPH & JENKINS LIMITED, MAY 2018.

LEGEND

- COARSE GRAINED DEPOSITS
- FINE GRAINED DEPOSITS
- 252.66 SHALLOW GROUNDWATER ELEVATION OCTOBER 10, 2018
- 234.10 DEEP GROUNDWATER ELEVATION, OCTOBER 10, 2018
- 238.35 MAXIMUM OBSERVED GROUNDWATER ELEVATION
- 253.19 MAXIMUM OBSERVED SHALLOW AQUITARD GROUNDWATER ELEVATION

TEEDON PIT EXTENSION
TOWNSHIP OF TINY, COUNTY OF SIMCOE, ONTARIO

Jan 7, 2019

SITE HYDROGEOLOGIC CROSS-SECTION A-A'

FIGURE 2

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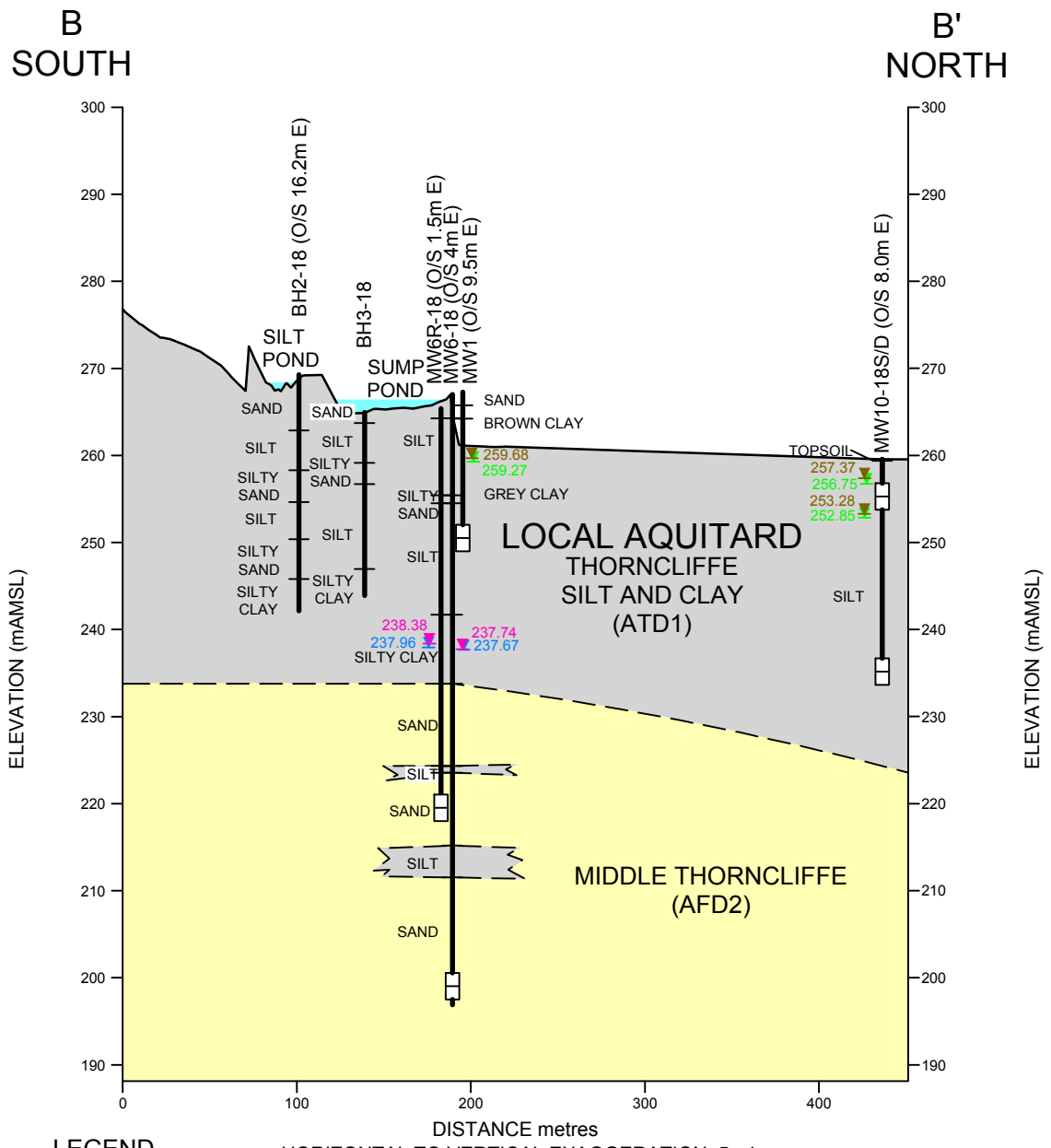

LEGEND

HORIZONTAL TO VERTICAL EXAGGERATION 5 : 1

COARSE GRAINED DEPOSITS

FINE GRAINED DEPOSITS

252.66 SHALLOW GROUNDWATER ELEVATION, OCTOBER 10, 2018

234.10 DEEP GROUNDWATER ELEVATION, OCTOBER 10, 2018

259.68 MAXIMUM OBSERVED GROUNDWATER ELEVATION

259.68 MAXIMUM OBSERVED SHALLOW AQUITARD GROUNDWATER ELEVATION

LOCAL STRATIGRAPHY AND HYDROSTRATIGRAPHY OBTAINED BY GHD ON BEHALF OF DUFFERIN WAS CORRELATED WITH THE 2017 WORK BY RILEY P. M. MULLIGAN AND ANDY F. BAJC. "QUATERNARY SEDIMENT ARCHITECTURE OF SIMCOE COUNTY, SOUTHERN ONTARIO"
SUMP POND TOPOGRAPHY BY DELPH & JENKINS LIMITED, MAY 2018.

TEEDON PIT EXTENSION
TOWNSHIP OF TINY, COUNTY OF SIMCOE, ONTARIO

11155365-10

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SITE HYDROGEOLOGIC CROSS-SECTION B-B'

FIGURE 3

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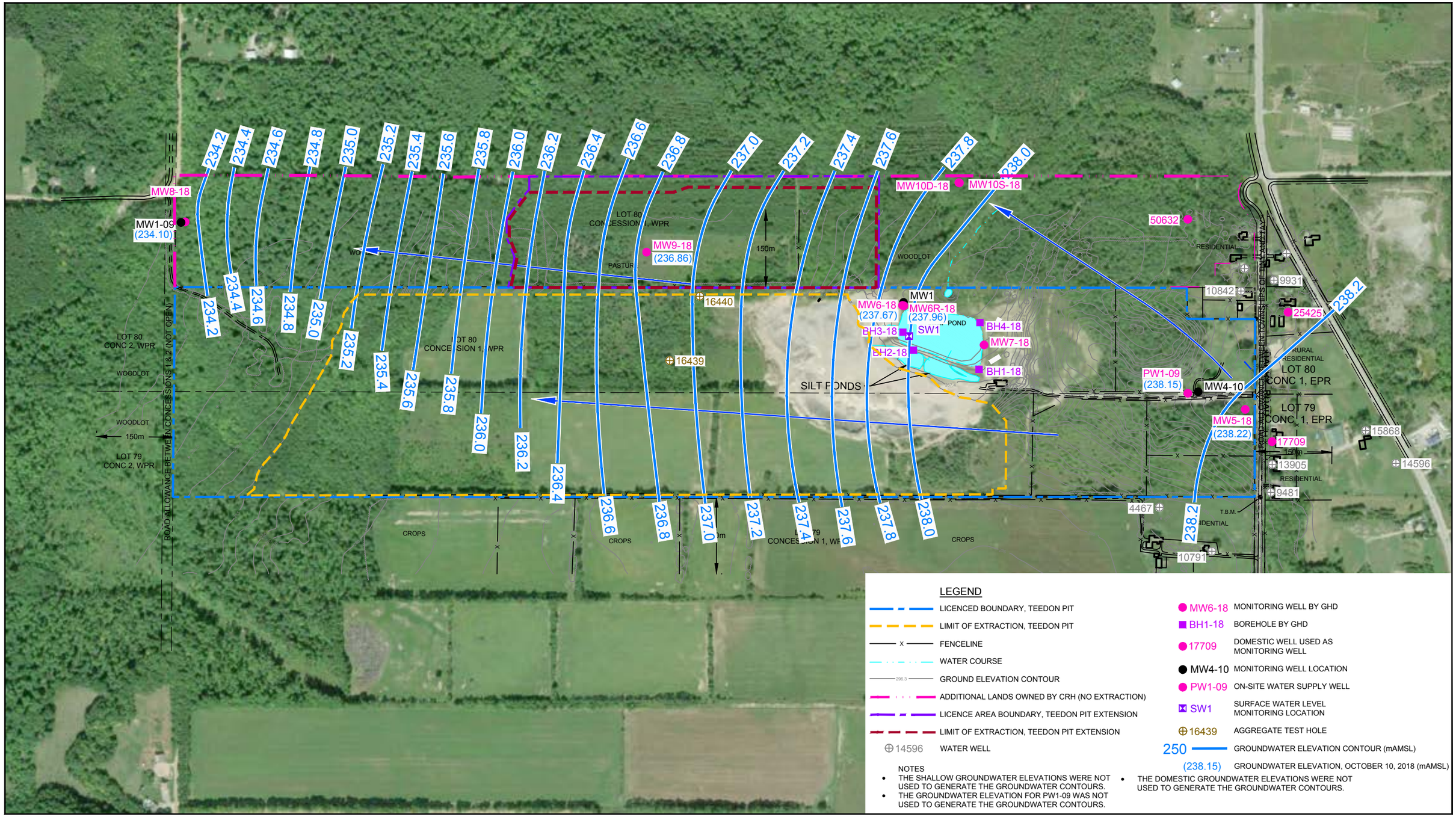

LEGEND

- LICENCED BOUNDARY, TEEDON PIT
- LIMIT OF EXTRACTION, TEEDON PIT
- FENCELINE
- WATER COURSE
- GROUND ELEVATION CONTOUR
- ADDITIONAL LANDS OWNED BY CRH (NO EXTRACTION)
- LICENCE AREA BOUNDARY, TEEDON PIT EXTENSION
- LIMIT OF EXTRACTION, TEEDON PIT EXTENSION
- 14596 WATER WELL
- MW6-18 MONITORING WELL BY GHD
- BH1-18 BOREHOLE BY GHD
- 17709 DOMESTIC WELL USED AS MONITORING WELL
- MW4-10 MONITORING WELL LOCATION
- PW1-09 ON-SITE WATER SUPPLY WELL
- SW1 SURFACE WATER LEVEL MONITORING LOCATION
- 16439 AGGREGATE TEST HOLE
- 250 GROUNDWATER ELEVATION CONTOUR (mAMSL)
- (238.15) GROUNDWATER ELEVATION, OCTOBER 10, 2018 (mAMSL)

NOTES
- THE SHALLOW GROUNDWATER ELEVATIONS WERE NOT USED TO GENERATE THE GROUNDWATER CONTOURS.
- THE GROUNDWATER ELEVATION FOR PW1-09 WAS NOT USED TO GENERATE THE GROUNDWATER CONTOURS.
- THE DOMESTIC GROUNDWATER ELEVATIONS WERE NOT USED TO GENERATE THE GROUNDWATER CONTOURS.

Source: Microsoft Product Screen shot Reprinted with permission from Microsoft Corporation, Aquisition Date 2018, Accessed April, 2018

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TEEDON PIT EXTENSION
TOWNSHIP OF TINY, COUNTY OF SIMCOE, ONTARIO

11155365-10
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GROUNDWATER ELEVATION CONTOURS (mAMSL)

FIGURE 4

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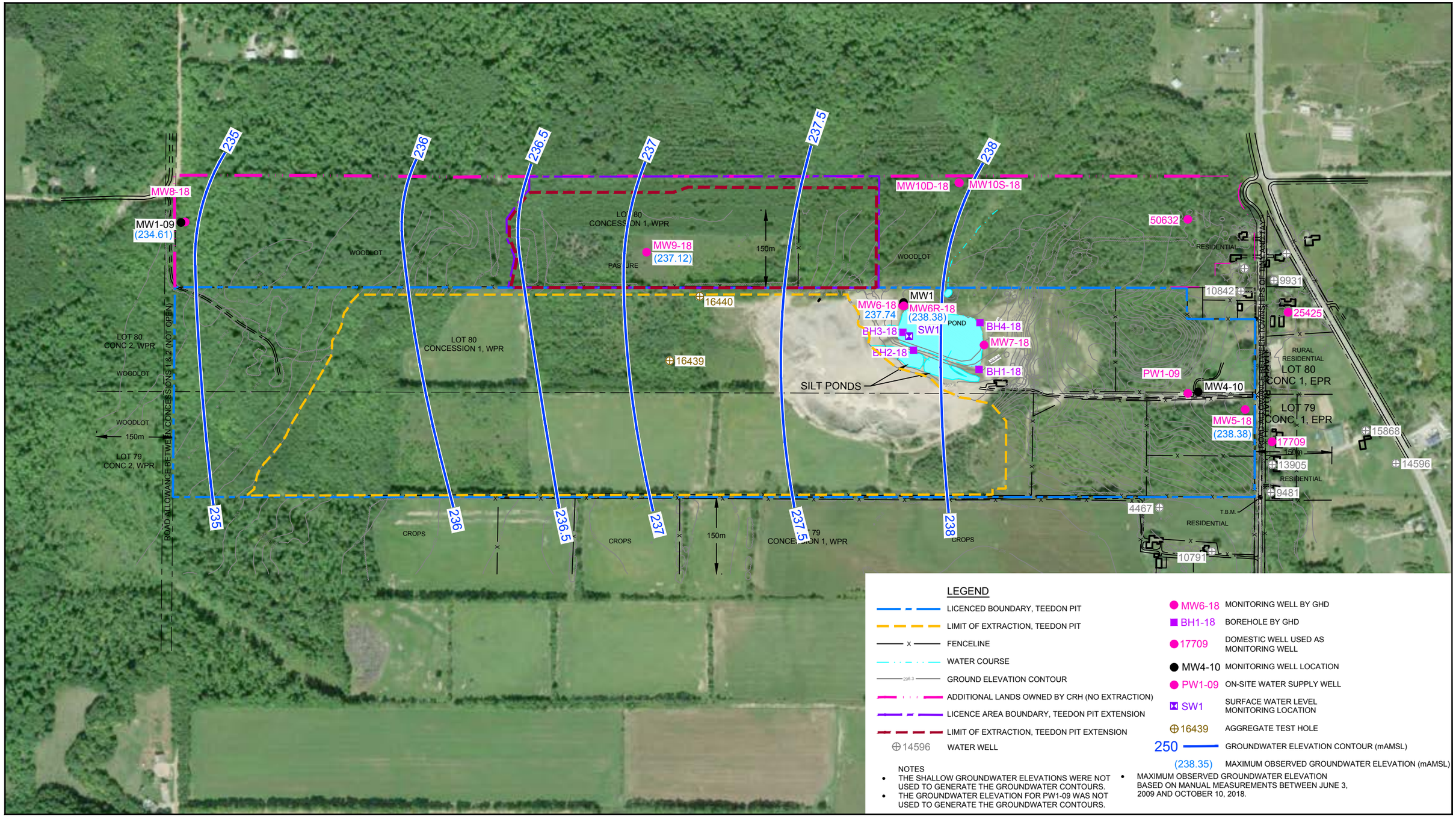

LEGEND

- LICENCED BOUNDARY, TEEDON PIT
- LIMIT OF EXTRACTION, TEEDON PIT
- FENCELINE
- WATER COURSE
- GROUND ELEVATION CONTOUR
- ADDITIONAL LANDS OWNED BY CRH (NO EXTRACTION)
- LICENCE AREA BOUNDARY, TEEDON PIT EXTENSION
- LIMIT OF EXTRACTION, TEEDON PIT EXTENSION
- 14596 WATER WELL
- MW6-18 MONITORING WELL BY GHD
- BH1-18 BOREHOLE BY GHD
- 17709 DOMESTIC WELL USED AS MONITORING WELL
- MW4-10 MONITORING WELL LOCATION
- PW1-09 ON-SITE WATER SUPPLY WELL
- SW1 SURFACE WATER LEVEL MONITORING LOCATION
- 16439 AGGREGATE TEST HOLE
- 250 GROUNDWATER ELEVATION CONTOUR (mAMSL)
- (238.35) MAXIMUM OBSERVED GROUNDWATER ELEVATION (mAMSL)

NOTES
- THE SHALLOW GROUNDWATER ELEVATIONS WERE NOT USED TO GENERATE THE GROUNDWATER CONTOURS.
- THE GROUNDWATER ELEVATION FOR PW1-09 WAS NOT USED TO GENERATE THE GROUNDWATER CONTOURS.
- MAXIMUM OBSERVED GROUNDWATER ELEVATION BASED ON MANUAL MEASUREMENTS BETWEEN JUNE 3, 2009 AND OCTOBER 10, 2018.

Source: Microsoft Product Screen shot Reprinted with permission from Microsoft Corporation, Aquisition Date 2018, Accessed April, 2018

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TEEDON PIT EXTENSION
TOWNSHIP OF TINY, COUNTY OF SIMCOE, ONTARIO

MAXIMUM OBSERVED GROUNDWATER ELEVATION CONTOURS (mAMSL)

11155365-10

Jan 7, 2019

FIGURE 5

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Table 1

Completion Details Summary
Teedon Pit Extension
Township of Tiny, County of Simcoe, Ontario

Location	MOECC Well ID	Completion Date	Easting	Northing	Ground Elevation (m AMSL)	Reference Elevation (m AMSL)	Well Bottom Elevation (m AMSL)	Completion Depth (m bgs)
PW1-09[(1)]	7124734	4/29/2009	592343.75	4945072.04	260.72	261.32	191.4	69.3
MW1[(1)]	7054134	11/8/2007	591776.70	4944920.92	267.45	267.64	245.0	18.3
MW1-09[(4)]	7124729	6/2/2009	590519.95	4944300.96	245.45	246.04	180.4	65.0
MW4-10[(1)]	7150631	8/5/2010	592346.97	4945073.66	260.60	261.31	242.3	17.7
MW5-18[(2)]	Unknown	4/5/2018	592450.79	4945106.20	256.39	257.19	186.6	69.2
MW6-18[(2)]	Unknown	3/29/2018	591778.54	4944916.15	267.60	268.43	197.5	70.1
MW6R-18[(5)]	Unknown	10/2/2018	591780.60	4944916.96	267.57	268.20	218.0	49.6
MW7-18[(2)]	Unknown	4/9/2018	591953.92	4944937.13	266.83	267.56	242.8	24.1
MW8-18[(4)]	Unknown	6/11/2018	590518.91	4944303.17	245.35	245.88	224.6	20.7
MW9-18[(3)]	Unknown	6/6/2018	591302.29	4944734.10	291.58	292.50	230.9	60.7
MW10-18S[(3)]	Unknown	6/6/2018	591743.06	4945177.24	259.44	260.42	248.8	10.7
MW10-18D[(3)]	Unknown	6/6/2018	591741.82	4945176.99	259.55	260.52	233.6	25.9

Notes:

(1) Northing, eastings, ground elevation and reference elevation measured on March 15, 2018.
(2) Northing, eastings, ground elevation and reference elevation measured on April 18, 2018.
(3) Northing, eastings, ground elevation and reference elevation measured on June 13, 2018.
(4) Northing, eastings, ground elevation and reference elevation measured on July 19, 2018.
(5) Northing, eastings, ground elevation and reference elevation measured on October 11, 2018.
m AMSL Metres above mean sea level.
m bgs Metres below ground surface.

Table 2

Maximum Observed Groundwater Elevation - Manual vs. Transducer
Teedon Pit Extension
Township of Tiny, County of Simcoe, Ontario

Location	Ground Elevation (m AMSL)	Reference Elevation (m AMSL)	Manual Maximum Observed Groundwater Elevation[(1)] (m AMSL)	Transducer Maximum Observed Groundwater Elevation[(1)] (m AMSL)
PW1-09	260.72	261.32	238.35	238.73
MW1	267.45	267.64	259.68	259.85
MW1-09	245.45	246.04	234.61	234.66
MW4-10	260.60	261.31	253.19	253.36
MW5-18	256.39	257.19	238.38	238.37
MW6-18	267.60	268.43	237.74	237.96
MW6R-18	267.57	268.20	238.38	237.97
MW7-18	266.83	267.56	260.06	260.03
MW8-18	245.35	245.88	235.25	235.24
MW9-18	291.58	292.50	237.12	237.13
MW10-18S	259.44	260.42	257.37	257.26
MW10-18D	259.55	260.52	253.28	253.25

Notes:

(1) Maximum Observed Groundwater Elevation based on manual measurements recorded between June 3, 2009 and October 10, 2018.
(2) Maximum Observed Groundwater Elevation based on transducer measurements recorded between October 19, 2010 and October 30, 2018.
m AMSL Metres above mean sea level.

Attachment A
Curriculum Vitae for
Gary Lagos and Richard Murphy

Gary I. Lagos
Associate/Senior Hydrogeologist

Qualified: M.Sc., Geology from the University of Windsor, 1989; B.Sc. (Honours), Geology from the University of Windsor, 1986

Connected: Registered Professional Geoscientist: Ontario

Professional Summary: Gary is a senior Hydrogeologist and Associate. Gary is the Associate responsible for the corporate implementation of field training in Canada. Gary has over 27 years of extensive experience in geology, contaminant and physical hydrogeology, groundwater flow, contaminant fate and transport, site characterization, groundwater remediation, and assessment of natural attenuation alternatives. He has been actively involved in over 200 projects in Ontario and over 50 CERCLA and RCRA Sites in the United States with every type of contaminant. Gary has designed soil groundwater investigations and remediation programs in very complex geologic environments.

The list of projects provided below is a representative segment of Gary's projects. Not all projects are listed below.

Aggregate Resources Development Services

Mr. Lagos has been responsible for the evaluation of geology, water resources, hydrogeology, and environmental management matters pertaining to aggregate resource development. The scope of work has included site investigation, impact assessment, and water management for dewatering. Representative projects for CRH include:

- Flamboro Quarry, City of Hamilton, Ontario
- Paris Pit, Paris, Ontario
- Cedar Creek/Alps Pits, North Dumfries, Ontario
- Blair Pit, North Dumfries, Ontario
- Aberfoyle Pit No. 1, Aberfoyle, Ontario
- Teedon Pit, County of Simcoe

Project Manager and Geologist
LDI Superfund Site | LDI Executive Committee | Utica, MI

Gary conducted several hydrogeologic investigations and has prepared numerous reports for the agencies (United States Environmental Protection Agency [USEPA] and Michigan Department of Environmental Quality [MDEQ]) on behalf of the LDI Technical Committee. He has also completed reports for the Institutional Controls work plan and Restrictive Covenant.

Project Coordinator and Geologist/Hydrogeologist
Solvent Savers Superfund Site | Lincklaen, NY

Gary has been active in coordinating all subsurface investigative field programs for delineation of VOC/PCB in soils at the Site, which included the use of hollow-stem augers, direct push technology, and sonic angle drilling. He has been involved with responding to detailed agency comments (USEPA), and in every aspect of the preparation of completion reports. He has been involved with the Site since 1994 designing and implementing of the subsurface investigations.

Geologist/Hydrogeologist
Regional Municipality of Waterloo Landfill | Waterloo, ON

Gary has been responsible for the design and implementation of geological investigations at three of the landfill cells to assess the suitability of the base of the three cells as liners. The geological investigations included a significant amount of logging of soil cores to characterize the fine-grained (clay) content of the base.

Geologist/Hydrogeologist
Green Lane Landfill | London, ON

Gary has been responsible for the design of several geologic and hydrogeologic investigations to assess the environmental suitably of expansion areas for landfilling. Gary was also responsible for the design and implementation for similar geologic and hydrogeologic investigation during the evaluation of other properties near the Green Lane Landfill for their suitability for landfilling.

Project Manager and Hydrogeologist
Ainslie Street | Ministry of the Environment | Cambridge, ON

Gary completed a complicated Hydrogeologic Investigation in the vicinity of a former dry cleaning facility. The purpose was to delineate the horizontal and vertical extent of chlorinated volatile organic compounds (VOCs) in soil and groundwater, and provide recommendations for an appropriate management option and long-term monitoring program.

Project Manager/Hydrogeologist
Former GE Facility | Guelph, ON

Gary was responsible for the design and implementation of several geological and hydrogeological investigations to assess historical impacts of operations in soil and groundwater.

Project Manager/Hydrogeologist
Former GE Facility | Toronto, ON

Gary was responsible for the design and implementation of several geological and hydrogeological investigations to assess historical impact of operations in soil and groundwater.

Project Coordinator and Hydrogeologist
CGC Inc. | Hagersville, ON

Gary has completed hydrogeological investigations as well as annual summaries to the client, and 5-year assessments for the agencies.

Hydrogeologist
Koch Fertilizer Canada | Brandon, MN

Gary has designed and implemented large-scale hydrogeologic investigations to delineate nitrate distribution in groundwater. He has also prepared surface water-groundwater interactions and chloride impact assessments. Gary has also coordinated semi-annual groundwater sampling events with over 100 locations.

Hydrogeologist
Sterling Site 3 | East Greenbush, NY

Gary has completed hydrogeologic investigations for this Site as well as developed a long term monitoring program, associated with active remedial measures.

Hydrogeologist
Buckeye Landfill | Buckeye, OH

Gary has evaluated analytical data with respect to groundwater and surface water quality, and completed various complex evaluations for the Site leading to the approval and use of an engineered wetland to remediate acid mine drainage.

Hydrogeologist
Chloride Impact Assessment | Kitchener, ON

Gary has completed a chloride impact assessment for a proposed subdivision in Kitchener, Ontario. The chloride impact assessment was in response to new guidelines by the Regional Municipality of Waterloo, due to the prevalence and reliance on groundwater supplies.

Project Manager/Hydrogeologist
U. S. Steel Canada | Hamilton, ON

Gary has designed and implemented field investigations to study environmental conditions in soil and groundwater.

Hydrogeologist
Rockwell Automation | Cambridge, ON

Gary has designed and implemented pumping tests at the Site to evaluate the effectiveness of a groundwater extraction system.

Hydrogeologist
GE | Peterborough, ON

Gary was responsible for conducting hydrogeologic investigations to delineate environmental impact within the property and outside the property in a residential area.

Hydrogeologist
Bio-En | Elmira, ON

Gary was the hydrogeologist responsible for the groundwater related activities at one of the first biogas facilities in the Province of Ontario.

Project Manager/Hydrogeologist
Borgwarner | Simcoe, ON

Gary designed and implemented a hydrogeological investigation to assess the environmental impact of the facility on soil and groundwater.

Other related areas of interest

Recognized (Certifications/Trainings)

- OSHA 40-Hour HAZWOPER Training (per 29 CFR 1910.120), Refresher 2015
- Workplace Hazardous Material Information Systems (WHMIS)

Papers Presented and Published in Conference Proceedings

- "The Use of Bench-scale Treatability Studies in the Design of Engineered Wetlands for the Remediation of Acid Mine Drainage (AMD) and Leachate in the Vicinity of Coal Mines – A Case Study in Ohio, United States", 2011. Procedia Earth and Planetary Science 3 (2011) 11-16.

Presentations

- 2011 Xi'an International Conference on Fine Geological Exploration and Groundwater & Gas Hazards Control in Coal Mines.

Work history

1990 – present	Associate, GHD (formerly Conestoga-Rovers & Associates), Waterloo, ON
	Named Associate in 2004
1986 - 1990	Department of Geology, University of Windsor, Windsor, ON

J. Richard Murphy
Principal: Engineer, Hydrogeologist

Qualified: M.A.Sc. Civil Engineering (Water Resources), University of Waterloo, 1991; B.A.Sc. Systems Design Engineering, University of Waterloo, 1989

Connected: Professional Engineers of Ontario (PEO), American Geophysical Union (AGU), National Groundwater Association (NGWA), International Association of Hydrogeologists (IAH), Ontario Stone Sand & Gravel Association (OSSGA)

Professional Summary: Mr. Murphy is a professional engineer specializing in hydrogeology and water resources evaluation and design. Mr. Murphy's project experience over more than 25 years ranges from contaminated site assessment and remediation, numerical and analytical modeling, aggregate resource development, landfills, and water supply; working in both overburden and bedrock environments. Mr. Murphy capably manages/executes all project aspects ranging from technical evaluations, project management, strategic planning, agency and public consultation, to providing expert witness evidence.

Aggregate Resources Development Services

Mr. Murphy has been responsible for the evaluation of water resources, hydrogeology, and environmental management matters pertaining to aggregate resource development. The scope of work has included site investigation, impact assessment, water management design and engineering for dewatering and mitigation systems, stakeholder consultation and approvals, expert witness testimony, and implementation of approved systems. Representative projects include:

- Armbro Pinchin Aggregate Pit, Town of Caledon, Ontario
- Dufferin Milton Quarry, Regional of Halton, Ontario
- Dufferin Acton Quarry, Regional of Halton, Ontario
- Dufferin Flamboro Quarry, City of Hamilton, Ontario
- Dufferin Paris Pit, Paris, Ontario
- Caledon Sand and Gravel Inc. Pit, Town of Caledon, Ontario
- Proposed Rockfort Quarry, Town of Caledon, Ontario
- Armbro Esker Lake Pit, Brampton, Ontario
- Lafarge Ravena Plant and Quarry, Albany County, New York
- Lafarge Woodstock Plant and Quarry, Ontario
- Lafarge Joppa Plant and Quarry, Illinois
- Nelson Quarry, Burlington, Ontario
- Penny's Lawrence Pit, Douglas County, Kansas

Remedial Investigation/Feasibility Studies

Mr. Murphy has been responsible for evaluating hydrogeologic conditions for a number of Remedial Investigation/Feasibility Studies. Duties included hydrogeologic characterization, planning of supplemental investigations, calculation of groundwater flow and contaminant migration rates, prediction of required pumping rates and durations for potential remedial alternatives and recommendation of hydrogeologically suitable remedial alternatives. Evaluation techniques involved both analytical and numerical simulation techniques. Representative projects are listed below:

- Novak Farm Site, Chenango County, New York
- Former Hart Chemical, Guelph, Ontario
- Bristol Aerospace, Winnipeg, Manitoba
- Phelps Dodge Landfill Remediation, Maspeth, New York
- VacAir Alloys Division, Frewsburg, New York
- Fons and Old Wayne Landfills, Ypsilanti Township, Michigan
- Textile Road Site, Ypsilanti Township, Michigan
- Pristine Site, Reading, Ohio
- Henkel Site, Hamilton, Ontario
- Sealand Restoration Site, Lisbon, New York

Remedial Design/Remedial Actions

Mr. Murphy has been responsible for the design of groundwater and soil remediation systems. Duties have included hydrogeologic characterization, planning of supplemental investigations, determination of suitable cleanup objectives, specification of the locations and flow rates for groundwater extraction systems, prediction of performance impacts due to design and operational variations. Evaluation techniques have involved both analytical and numerical simulation methods. Representative projects are listed below:

- Summit National Superfund Site, Deerfield, Ohio
- Spiegelberg Site, Livingston County, Michigan
- Hyde Park Landfill, Niagara Falls, New York
- Buffalo Avenue Plant, Niagara Falls, New York

- S Area Site, Niagara Falls, New York
- Former Hart Chemical, Guelph, Ontario
- Former Uniroyal Chemical, Elmira, Ontario
- G&H Landfill, Macomb County, Michigan
- Pfohl Brothers Landfill, Cheektowaga, New York
- Libbey Glass, Toledo, Ohio
- Caterpillar, East Peoria, Illinois
- Miami County Incinerator Site, Miami County, Ohio
- Fisher Calo Site, Kingsbury, Indiana
- Rockaway Borough Well Field Site, Rockaway Borough, New Jersey
- Schenectady International, Inc. Site, Rotterdam Junction, New York
- Hooker/Rucco Site, Hicksville, New York
- Rocky Hill Municipal Well/Montgomery Township Housing Development Superfund Sites, Somerset County, New Jersey
- JIS Landfill, South Brunswick, New Jersey

Water Supply/Wellhead Protection Studies

Mr. Murphy has been responsible for the evaluation of hydrogeologic impacts and wellhead protection areas for municipal and commercial groundwater supplies. Evaluation of techniques employed include numerical steady state and transient groundwater flow and capture zone simulations, vulnerability assessment, and evaluation of studies by others. Representative projects are listed below:

- Waterloo Landfill Site. Confirmation of findings of Erb Street Well Field Evaluation, Region of Waterloo, Ontario
- Sauble Beach Groundwater Supply Study, Township of Ambel, Ontario
- Fisher Calo Site, Kingsbury, Indiana
- Ontario Source Water Protection Projects:
  - Various client site assessments
  - Saugeen/Grey Sauble Vulnerability Study and Threats Assessment

Solid Waste Management Sites

Mr. Murphy has been responsible for planning and carrying out water quality impact assessments for existing and proposed solid waste management sites. Duties included site characterization, contaminant migration simulation, impact prediction, and recommendations for engineered systems. Simulation techniques range from analytical models to numerical models involving unsaturated and multidimensional solution domains. Representative projects are listed below:

- Waterloo Landfill, Waterloo, Ontario
- Keele Valley Landfill, Toronto, Ontario
- St. Marys Landfill, St. Marys, Ontario
- Valentine Road Landfill, Kincardine, Ontario
- Mid Huron Landfill, Goderich, Ontario
- Greenlane Landfill, Southwold, Ontario
- Sarnia Landfill, Sarnia, Ontario
- Cedartown Municipal Landfill, Cedartown, Georgia
- Wauconda Landfill, Chicago, Illinois
- East Bethel Landfill, East Bethel, Minnesota

Work history

1991 - present	Principal, GHD (formerly Conestoga-Rovers & Associates), Waterloo, ON
	Named Principal, 2002
1990	J.F. Sykes & Associates Limited
1990	Neil Thomson Engineering Services
1989 - 1991	University of Waterloo
1988 - 1989	Conestoga-Rovers & Associates

Other related areas of interest

Recognized (Certifications/Trainings)

- Licensed Professional Engineer: Ontario
- Designated Consulting Engineer: Ontario
- Clayey Barriers for Mitigation of Contaminant Impact, University of Western Ontario, 1992

Expert Testimony

Mr. Murphy has provided expert witness testimony (depositions, Trial, and Hearings) on various aspects of hydrogeology, water resources, site investigation, analysis and remediation, including groundwater flow and contaminant transport issues, water resources, and engineering, for the following projects:

- Royal Oak Site, Royal Oak, Michigan
- Proposed South Quarry Landfill Development, Town of Flamborough, Ontario
- Armbro Pinchin Aggregate Pit Development, Town of Caledon, Ontario
- 217 Fay Avenue, Addison, Illinois
- Rocky Hill Municipal Well/Montgomery Township Housing Development Superfund Sites, Somerset County, New Jersey
- Dufferin Aggregates Milton Quarry Extension, Region of Halton, Ontario
- Proposed Rockfort Quarry Development, Town of Caledon, Ontario
- Proposed Nelson Quarry Extension, Burlington, Ontario
- Halton Regional Official Plan Amendment No. 38, Region of Halton, Ontario
- Dufferin Aggregates Acton Quarry Extension, Town of Halton Hills, Ontario
- Dufferin Paris Pit, Brant County, Ontario

Publications/Presentations

- "Protecting Water Resources with a Groundwater Recharge Well System at the Dufferin Aggregates Milton Quarry", International Association of Hydrogeologists Canadian National Conference, October 27-30, 2015 (with W.T. Armes and N. Fitzpatrick).
- "Safeguarding our future" OSSGA, Avenues, Volume 4, Issue 1 (with Brian Zeman).
- "Adaptive Management Plans in Aggregate Resources: A Good Idea and/or The New Normal?", Ontario Stone Sand and Gravel Association Annual General Meeting February 2012 (with D. Hanratty, J. Buhlman, and B. Clarkson).
- "Predicting Redox Dependent Natural Attenuation at the Plattsburgh Air Force Base", The Fifth International Symposium on In Situ and On Site Bioremediation, San Diego, California, April 19-22, 1999 (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "Visualizing Natural Attenuation Trends", The Fifth International Symposium on In Situ and On Site Bioremediation, San Diego, California, April 19-22, 1999 (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "BIOREDOX MT3DMS: A Coupled Biodegradation Redox Model for Simulating Natural and Enhanced Bioremediation of Organic Pollutants V2.0 User's Guide and Verification Manual", Conestoga-Rovers & Associates, Waterloo, Ontario, Canada, 1999 (with G.R. Carey and P.J. Van Geel).
- "Coupled Biodegradation Redox Modeling to Simulate Natural Attenuation Processes at the Plattsburgh Air Force Base (New York)", MODFLOW'98, Golden, Colorado, October 5-7, 1998 (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "An Efficient Screening Approach for Modeling Natural Attenuation", MODFLOW'98, Golden, Colorado, October 6-8, 1998 (with G.R. Carey, P.J. Van Geel, and E.A. McBean).
- "Full Scale Field Application of a Coupled Biodegradation Redox Model (BIOREDOX)", First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 18-21, 1998, Monterey, California (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "Application of an Innovative Visualization Method for Demonstrating Intrinsic Remediation at a Landfill Superfund Site", Petroleum Hydrocarbons & Organic Chemicals in Ground Water Conference, American Petroleum Institute and National Ground Water Association, Houston, TX, November 1996 (with G.R. Carey, M.G. Mateyk, G.T. Turchan, E.A. McBean, and F.A. Rovers).
- "Two Phase Flow in a Variable Aperture Fracture", Water Resources Research, Vol. 29, No. 10, October 1993 (with N.R. Thomson).