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Hydrogeological Investigation & Terrain Analysis
Proposed Residential Subdivision
Emerald Woods Subdivision
Greely, Ontario

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Submitted to:

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Hydrogeological Investigation & Terrain Analysis
Proposed Residential Subdivision
Emerald Woods Subdivision
Greely, Ontario

June 30, 2021
Project: 100554.001

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EXECUTIVE SUMMARY

GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) was retained by ARK Engineering and Development Inc. to carry out a Hydrogeological Investigation and Terrain Analysis for a proposed 74 lot residential subdivision on a 35.0-hectare parcel of land in Greely, Ontario.

The main objectives of the study were as follows: characterize the subsurface conditions to assess the suitability of on-site septic systems and their potential impacts of these systems on the receiving aquifer and nearby surface water features; and, investigate the potential quantity and quality of groundwater available from drilled test wells for potential domestic supply and to assess the long-term impacts on other groundwater users.

In March 2021, GEMTEC coordinated and supervised field investigations, which included: the excavation of 18 test pits across the site (well screens installed in three test pits), drilling of four boreholes with monitoring wells installed in three and drilling of five groundwater test wells; groundwater pumping tests, water sample collection and laboratory analysis; soil sample collection and testing; review of available background documents; and, data analysis, compilation and production of a final report.

A complete description of the methodology and approach, results and conclusions are presented in this report. The executive summary should be read in conjunction with the full text of the report.

Key project findings are summarized as follows:

- The subject site is located in an un-serviced rural setting and the majority of site is currently tree covered. Surrounding land use includes undeveloped residential land, a golf course and residential developments.
- Surficial overburden consists of coarse textured glaciomarine deposits of sand with minor clay and silt, underlain by silty sand and/or silty clay on the western portion of the site and silty-sand till on the eastern portion of the site. The overburden thickness ranges from approximately 1.2 to 8.4 metres, with an average thickness of 5.4 metres. No bedrock outcrops were observed on the site.
- The quantity of groundwater available from the proposed bedrock water supply aquifer is more than sufficient for the proposed development and will sustain repeated pumping at the test rate and duration at 24-hour intervals over the long term;
- Interference between drinking water wells is expected to be acceptable under typical usage for residential developments;
- No negative impacts to the bedrock aquifer are anticipated (nitrate dilution calculations demonstrate that offsite impacts are less than 10 mg/L);

- The water quality available from drilled wells on the subject site is safe for consumption based on the absence of health-related exceedances; however, groundwater treatment for aesthetic parameters will likely be required.
- Recommendations on well construction and septic design are provided in the report.

Based on the results of this hydrogeological investigation and terrain analysis, it is recommended that the Emerald Woods residential subdivision be approved for development.

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1.0 INTRODUCTION

GEMTEC Consulting Engineers and Scientists (GEMTEC) was retained by ARK Engineering and Development to conduct a hydrogeological investigation and terrain evaluation for a proposed 36-hectare subdivision (hereafter referred to as 'the subject site') in Greely, Ontario. The location of the subject site is shown in the attached Site Plan, Figure 1.

The proposed subdivision is currently part of a 35-hectare (86.5 acre) land parcel, Part of Lots 3 and 4, Concession 3, Geographic Township of Osgoode, now in the City of Ottawa. Residential and commercial properties utilizing private services border the site to the north, south and east. Undeveloped and forest covered land border the site to the west.

The proposed development at the subject site will consist of 74 residential lots serviced with on-site septic disposal systems and water supply wells. The proposed lots will be accessed by an internal roadway system and will have a minimum lot size of 0.4 hectares. The proposed layout of the development is shown on the Detailed Site Plan, Figure 2. A copy of the proposed Conceptual Lot Development Plan prepared by Ark Engineering is provided in Appendix A.

1.1 Objectives of Investigation

The objectives of this investigation are as follows:

- To review available background information to assist in characterization of subsurface conditions in the vicinity of the subject site and develop a hydrogeological conceptual model;
- To identify and characterize the shallow subsurface conditions on the subject site as they relate to the suitability of on-site septic sewage disposal systems;
- To assess the potential for impact on the receiving aquifer(s) and any nearby surface water features from on-site septic disposal systems;
- To investigate the potential quantity and quality of groundwater available from drilled test wells on the subject site for potential domestic supply; and,
- To assess the long-term impacts on groundwater supply from existing developments on drilled water supply wells in the vicinity of the subject site.

Following a review of available background information and analysis of the results of the field investigation, conclusions and recommendations for the proposed residential development of the subject site are provided.

2.0 REVIEW OF BACKGROUND INFORMATION

2.1 Land Use

The majority of the subject site is currently undeveloped forest covered land. Land use in the vicinity of the site consists of vacant undeveloped land, a golf course and residential properties on private services. Specific land uses near the subject site boundaries are documented in Table 2.1.

Table 2.1 – Summary of Land Use in Study Area

Site Boundary	Existing Land Use
North	• Residential properties • Golf course
East	• Residential properties
West	• Undeveloped land (future residential subdivision) and forest covered land
South	• Residential properties

Potential impacts to groundwater quality from adjacent lands within 500 metres of the subject site boundary are not anticipated based on the present land uses. A privately-run Golf course is situated approximately 100 metres, at its closest point, from the site boundary to the north.

Two large-scale water takings were identified within 500 metres of the subject site boundary. PTTW number 2420-BCVQ2A is listed as recreational use for the Ottawa-Carleton Ultimate Association. The water taking includes surface and groundwater up to a maximum of 177,692 litres per day. PTTW number 2017-9KTQ6D is listed as commercial use for Greely Glen Golf Course Limited. The water taking includes surface and groundwater up to a maximum of 818,280 litres per day.

2.2 Topography and Drainage

Topographic mapping data indicates that elevations across the site range from about 100 to 105 metres above sea level (Figure 3). A topographic high is located along the southeastern boundary of the subject site and the terrain slopes gently downwards towards the north, west and east. The drainage of the subject site is expected to follow topography and is anticipated to be towards the northeast (Figure 3).

2.3 Regional Surficial and Bedrock Geology

Surficial geology maps (Ontario Geologic Survey, 2010) indicate that the site is primarily underlain by coarse-textured glaciomarine deposits consisting of sand with minor silt and clay, stone-poor silty sand till and organic deposits to the northeast (Figure 4). Drift thickness mapping (Gao, 2006) indicate the overburden soil deposits range from 1 to 15 metres in thickness (Figure5).

Paleozoic bedrock geology maps (Armstrong and Dodge, 2007) indicate the bedrock geology beneath the subject site consists of a limestone unit that is interpreted to be part of the Oxford and March Formations, which are collectively referred to as the Beekmantown Group. The uppermost formation beneath the Site is the Oxford Formation, which is described as a dolostone with shaly and sandy interbeds that are up to 30 cm thick (Williams, 1991). The formation is characterized by light to medium brownish to greenish grey dolostone.

The Oxford Formation is underlain by the March Formation, an interbedded grey quartz sandstone, dolomitic quartz sandstone, and blue-grey sandy dolostone and dolostone. The unit represents a transition zone between the Oxford Formation dolostones above, and the Nepean Formation sandstone below. Dolostones of the March Formation are lithologically similar to the overlying Oxford Formation, making them difficult to distinguish using drill cuttings.

The underlying Nepean Formation is a quartz sandstone that is thinly bedded to massive and well sorted. The sandstone is variable in colour and can be white to light grey, brown, reddish brown and green. It underlies the March Formation beneath the subject site, and the upper Nepean Formation contact is marked by the lowermost unit of (sandy) dolostone.

Available karst mapping (Brunton and Dodge, 2008), does not indicate any areas of any inferred or potential karstic features.

2.4 Ontario Ministry of Environment, Conservation and Parks Water Well Records

The Ministry of Environment, Conservation and Parks (MECP) Water Well Records for existing private wells in the surrounding development were obtained to determine the characteristics of existing private wells in the vicinity of the subject site (500 metre radius). A total of 141 well records were reviewed from the MECP online water well record mapping resource (Appendix B). All of the drinking water well records were for wells completed in bedrock.

Table 2.2 provides a summary of the well characteristics for 141 water well records for depth to water found, static water levels, depth to bedrock, depth into bedrock and total well depth.

Table 2.2 – Summary of Water Well Records Search Results

Parameter	10th Percentile	90th Percentile	Average / Geometric Mean
Depth Water Found (m)	11.0	56.1	28.3 / 23.1
Static Water Level (m)	1.2	10.6	5.1 / 3.7
Depth to Bedrock[1] (m)	0.8	12.8	6.1 / 3.2
Total Well Depth (m)	12.7	60.4	33.5/28.1

Notes: Zero readings set to 0.01 in order to calculate geometric mean.

The MECP Water Well Records for drinking water wells surrounding the subject site indicate that the existing private wells encountered water at depths of 23.1 metres bgs (geometric mean) and the total well depth in existing private wells is 28.1 metres bgs (geometric mean). The geometric mean overburden thickness above the proposed water supply aquifer is 6.1 metres.

2.5 Neighbouring Subdivisions

The report titled: Hydrogeology, Terrain Analysis and Impact Assessment Report, Emerald Links Phase III, Part of Lot 3, Concession 3, Formerly Township of Osgoode, City of Ottawa (Greely), Ontario (2009), prepared by Trow Associates Inc., was reviewed as part of this investigation. The Emerald Links Phase 3 residential subdivision is located west of the subject site.

Shallow groundwater flow in the proposed Emerald Links Phase III Subdivision was reported as being southeast towards Grey's Creek municipal drain that cuts through the western third of the site. The bedrock groundwater flow in the Emerald Links Phase III Subdivision was reported as northward.

Wells draw water from a limestone aquifer (Oxford Formation) or the March/Nepean formation which consists of limestone and sandstone beds. Test well depths ranged from 19.8 to 79 metres and all five test wells were noted to satisfy D-5-5 with respect to water quantity. The bedrock aquifer met all health-related criteria of the ODWQS, except for sodium levels in one test well, which exceed the warning level for persons on sodium restricted diets. Trow (2009) reported aesthetic objective exceedances of the ODWQS for hydrogen sulphide, iron, hardness and colour. Well construction recommendations included complying with Ontario Regulation 903 and extending well casings at least 3 m into competent bedrock.

2.6 Preliminary Site Servicing Report

A preliminary site servicing report for the western portion of the subject site was prepared by the Paterson Group, titled "Preliminary Private Services, Site Suitability Study, Proposed Residential Development, Part of Lot 3, Concession 3, Former Township of Osgoode, Now City of Ottawa,

Ontario" and dated November 1, 2011. Based on the presence of overburden sands identified up to 1.7 metres below ground surface, on-site septic systems are suitable for the proposed residential development. Shallow groundwater was encountered in all 15 test pits advanced on September 8, 2011 at depths ranging from 0.6 to 1.5 metres below ground surface.

3.0 TERRAIN EVALUATION

3.1 Field Procedure

The field work for the terrain evaluation was completed as part of the GEMTEC geotechnical investigation, titled "DRAFT Geotechnical Investigation, Emerald Woods Subdivision, Jack Pine Crescent, Ottawa, Ontario" dated April 27, 2021. A total of 18 test pits (numbered 21-01 to 21-18, inclusive) and four boreholes (numbered 21-101, 21-103, 21-104, and 21-105) were advanced at the site by GEMTEC. Two additional test pits numbered 19 and 20 were advanced at the site by ARK Engineering. The test pits were advanced to depths ranging from about 1.6 to 4.6 metres below the existing ground surface and the boreholes were advanced to depths of about 4.2 to 6.7 metres below the existing ground surface. Well screens were sealed in the overburden at boreholes 21-101, 21-104, and 21-105, to measure the groundwater levels and facilitate groundwater quality sampling.

Descriptions of the subsurface conditions logged in the test pits and boreholes are provided in Appendix C. Selected samples were submitted for grain size distribution testing; the results of the laboratory classification tests on the soil samples are also provided in Appendix C. The locations of the test pits and boreholes are shown on the Detailed Site Plan, Figure 2.

3.2 Soil and Groundwater Conditions

3.2.1 General

The following presents an overview of the subsurface conditions encountered in the test pits and boreholes advanced as part of the geotechnical investigation (GEMTEC, 2021).

3.2.2 Topsoil

A layer of topsoil was encountered at the ground surface at all test hole locations, except borehole 21-103. The thickness of the topsoil ranges from about 50 to 150 millimetres.

3.2.3 Silty Sand to Sand

Native deposits of silty sand to sand with some silt and trace gravel was encountered below the topsoil in all test hole locations. The silty sand to sand deposit was not fully penetrated in all the test holes, but was proven to depths ranging from about 0.2 to 4.6 metres below ground surface.

Two grain size distribution tests were undertaken on samples of the sand from test pits 21-03 and 21-10. The results are provided in Appendix C and are summarized in Table 3.1.

Table 3.1 – Summary of Grain Size Distribution Test (Sand)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
21-03	2	0.9 – 1.0	0	93	6	1
21-10	2	1.2 – 1.4	0	96	2	2

3.2.4 Silty Clay

Native deposits of silty clay were encountered in test pits 21-04 to 21-12 and 21-18, and all of the boreholes.

The full depth of the silty clay in the test holes is grey in colour. The silty clay was not fully penetrated in the test pits, but was proven to depths ranging from about 4.0 to 4.6 metres below ground surface. The silty clay deposits encountered in the boreholes have a thickness ranging from about 0.6 to 1.4 metres and extend to depths ranging from about 3.1 to 4.6 metres below existing ground surface.

3.2.5 Clayey Silt

Native deposits of clayey silt were encountered below the silty clay in the boreholes. The clayey silt has a thickness ranging from about 0.9 to 1.2 metres and extends to depths ranging from about 4.2 to 5.5 metres below ground surface.

3.2.6 Glacial Till

Native deposits of glacial till were encountered below the silty sand and silty clay, where encountered in test pits 21-09, and 21-12 to 21-17 and boreholes 21-101, 21-103, 21-104, and 21-105. The glacial till was not fully penetrated in all the test holes but was proven to depths ranging from about 1.6 to 6.7 metres below ground surface. The glacial till is a heterogeneous mixture of all grain sizes, which at this site, can be described as grey silty sand with trace to some gravel with cobbles and boulders.

One grain size distribution test was undertaken on a select sample of the glacial till from test pit 21-17. The results are provided in Appendix C and are summarized in Table 3.2.

Table 3.2 – Summary of Grain Size Distribution Test (Glacial Till)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
21-17	2	1.0 – 1.2	12	50	33	5

The test pits advanced by Ark Engineering, TP19 and TP20 encountered native deposits of till, with thicknesses of 3.3 and 2.0 metres respectively.

3.2.7 Bedrock

Refusal to excavator advancement was encountered in test pits 21-12, 21-13, 21-14, 21-16, and 21-17 at depths of about 1.6 to 3.4 metres below the existing ground surface. The refusal likely represents the presence of cobbles or boulders within the glacial till deposit or the bedrock surface.

Two additional test pits, numbered 19 and 20, advanced by ARK Engineering on lots 41 and 40, respectively, encountered refusal at depths of about 3.5 and 2.2 metres, respectively.

A summary of the excavator refusal depths and elevations are provided in Table 3.3 below.

Table 3.3 – Summary of Excavator Refusal Depth and Elevation

Borehole/Test Pit Number	Ground Surface Elevation (metres)	Depth to Auger / Excavator Refusal (metres)	Auger / Excavator Refusal Elevation (metres)
21-12	102.7	3.2	99.5
21-13	102.7	3.0	99.7
21-14	102.8	1.6	101.2
21-16	105.0	3.4	101.6
21-17	103.7	3.0	100.7
19	102.7	3.5	99.2
20	102.7	2.2	100.5

3.2.8 Groundwater Conditions

Well screens were installed in the overburden at test pits 21-02, 21-08, and 21-18 and boreholes 21-101, 21-104, and 21-105. The groundwater level in the open test pits were measured at the time of the geotechnical field investigation (GEMTEC, 2021) on March 8 and 9, 2021.

The groundwater levels were measured in the well screens on March 12 and 29, 2021 and are summarized in Table 3.4.

Table 3.4 – Groundwater Depth and Elevation

Test Hole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
21-01	1.1	101.2	March 9, 2021
21-02	1.0	101.5	March 12, 2021
21-03	2.3	100.1	March 8, 2021
21-04	1.4	101.1	March 8, 2021
21-05	Dry (>4.50)	< 98.1	March 8, 2021
21-06	Dry (>4.57)	< 98.3	March 8, 2021
21-07	1.8	100.2	March 8, 2021
21-08	1.9	101.1	March 12, 2021
21-09	Dry (>4.50)	< 98.3	March 8, 2021
21-10	Dry (>4.50)	< 98.4	March 8, 2021
21-11	1.3	101.4	March 8, 2021
21-12	1.5	101.2	March 8, 2021
21-13	Dry (>3.00)	< 99.7	March 8, 2021
21-14	1.4	101.4	March 9, 2021
21-15	Dry (>3.00)	< 100.1	March 9, 2021
21-16	Dry (>3.40)	< 101.6	March 9, 2021
21-17	Dry (>3.00)	< 100.7	March 9, 2021
21-18	0.0	102.3	March 12, 2021
21-101	0.2	102.2	March 29, 2021
21-104	0.0	102.3	March 29, 2021
21-105	0.3	101.9	March 29, 2021

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.0 HYDROGEOLOGICAL CONCEPTUAL MODEL

4.1 Site Specific Geology

Based on the results of the review of MECP water well records, land use observations and available geology maps, the local hydrogeology on the subject site and adjacent lands are characterized by coarse-textured glaciomarine deposits consisting of sand with minor clay and silt, underlain by silty sand and/or silty clay and silty-sand to sandy-silt till. The subject site overburden thickness varies between 1.2 to 8.8 metres, with an average depth to bedrock of 3.9 metres. Based on the Ontario Geologic Survey (OGS) mapping and test wells advanced on-site, the bedrock is characterized as limestone/dolostone of the Oxford and/or March Formation which is underlain by sandstone of the Nepean Formation. The site-specific geology findings are consistent with the findings of the available background information.

4.2 Hydrogeological Conceptual Model

The framework for the hydrogeological conceptual model for the subject site is summarized in Table 4.1 below.

A northwest-southeast hydrogeological cross-section (Figure 6) across the subject site was prepared based information from onsite test wells. Please note that the boundaries between zones indicated on the cross-section have been interpreted based on available information and may differ somewhat from that indicated. Ground surface elevations for each of the test wells were measured by GEMTEC staff using a Trimble R10 global positioning system. The elevations are referenced to geodetic datum.

Table 4.1 – Framework of Hydrogeological Conceptual Model

Stratigraphic Unit	Generalized Composition	Thickness (m)
Overburden	• Topsoil; • Sand and Till • Underlain by silty sand and/or silty clay	1.2 to 8.8 metres (average of 5.4 metres[1])
Bedrock	• Limestone (Oxford and/or March Formation) • Sandstone (Nepean Formation)	• 34.2 to 40.0 metres • > 12 metres

Notes: 1. Average overburden thickness based on five on-site water well records.

The test well bedrock elevation ranges from about 101.25 to 103.00 metres Above Mean Sea Level (AMSL) and the base of the well casings range from 101.7 to 103.4 metres AMSL. The elevation of the water bearing zones (depth water found) ranges from 54.2 to 73.6 metres ASL and the elevation of the bottom of test wells ranged from 48.8 to 71.2 metres AMSL. The cross-section, based on the onsite test well water well records, indicates that the total thickness of the overburden ranges from approximately 1.2 to 8.8 metres and generally consists of sand with gravel, clay and/or boulders.

It is our assessment that the hydrogeological cross section is consistent with available background information and the site-specific geology from the field investigation on the subject site. In general, the site is not considered to be hydrogeologically sensitive based on the absence of significant areas of thin soils, highly permeable soils or karst terrain.

Thin soils, taken to be less than 2.0 metres in thickness were encountered towards the back end of lots 40 and 41 (refer to Conceptual lot Development Plan in Appendix A and Figure 7). The Conceptual lot Development Plan (Appendix A) indicates septic systems will be located in the front of the lots, where the overburden thickness increases to depths greater than 2.0 metres based on site investigation and not likely to be located in a hydrogeologically sensitive area.

5.0 IMPACT ASSESSMENT

The impact on groundwater and surface water resources due to wastewater treatment and disposal by individual onsite sewage disposal systems on the subject site are assessed in the following sections.

5.1 Sewage Disposal Systems

This section discusses the results of the terrain evaluation as they relate to the feasibility of installing sewage disposal systems on the subject site for onsite wastewater treatment and disposal.

It should be noted that the following information is provided for general guidance purposes only and that all septic systems installed on the subject site should be designed on a lot by lot basis using a lot specific investigation involving test holes to determine the actual subsurface conditions at the location of the proposed septic system. In all cases, the septic system design must conform to the Ontario Building Code (OBC) requirements.

5.1.1 Class IV Septic Sewage Disposal Systems

This section discusses the results of the terrain evaluation as they relate to the feasibility of installing Class IV septic sewage disposal systems on the subject site.

The septic system envelope area (septic envelope) represents the area on a lot set aside for the construction of the leaching bed and is for the leaching bed only. It does not include that area

required for the septic tank or the isolation/separation distances required by the Ontario Building Code (OBC). The size of the septic system envelope is a function of the percolation rate of the native soil in the vicinity of the septic envelope (or the fill used for the construction of a septic bed) and the daily effluent loading to the septic bed.

The maximum expected septic system envelope required to service a single-family dwelling at this site is calculated to be 875 m^2, assuming a conservative design flow of 3,500 litres/day and a loading rate of 4 L/m^2/day (high water table).

A 875 m^2 septic envelope corresponds to 21% area cover based on a 4,000 m^2 (0.4 hectare) lot. Typical septic envelope dimensions ions would be 35 metres in length by 25 metres width. The septic system envelope should be readily accommodated on the lot sizes that are proposed. Prior to establishing the actual septic envelope (leaching bed) location on any particular lot, test holes should be excavated to determine the actual subsurface conditions in the area of the proposed leaching bed.

The septic leaching bed design must ensure that the bottom of the absorption trenches is at least 0.9 metres above low permeability soils (such as silty clay), bedrock, and the seasonally high groundwater table. Based on the groundwater levels measured in test pits and boreholes, it is expected that the majority of the septic leaching beds at this site will be partially or fully raised.

5.1.2 Tertiary Septic Systems

Approved septic disposal systems that meet the OBC requirements for tertiary treatment could also be considered for this development in place of conventional Class IV septic systems. The disposal beds for tertiary treatment systems require a smaller area than conventional Class IV septic systems. Furthermore, the required separation distance between the underside of the crushed stone layer in the disposal bed and low permeability soils, bedrock, or the seasonally high groundwater table is less than the required 0.9 metres for conventional septic systems. Some tertiary treatment systems are also effective in reducing contaminants, such as nitrate, prior to disposal to the leaching bed.

5.2 Groundwater Impacts

The potential risk to groundwater resources on and off the subject site was assessed in accordance with Ministry of Environment Procedure D-5-4: Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment. To evaluate the groundwater impacts, the Three-Step Assessment Process outlining in MECP D-5-4 was followed.

5.2.1 Three-Step Assessment: Step 1 - Lot Size Considerations

Lot sizes of 1.0 hectares or larger are assumed to be sufficient for attenuative processes to reduce nitrate-nitrogen to acceptable concentrations in groundwater below adjacent properties. The proposed lot sizes of 0.4 hectares (minimum) do not meet this consideration.

5.2.2 Three-Step Assessment: Step 2 – Isolation

Where proposed lot sizes are less than 1.0 hectares, the risk of sewage effluent contamination must be assessed for the proposed subdivision. As per Procedure D-5-4, it is required to:

- Evaluate the most probable groundwater receiver for sewage effluent; and,
- Define the most probable lower hydraulic or physical boundary of the groundwater receiving the sewage effluent.

Based on the hydrogeological conceptual model and as per the isolation requirements of MECP Procedure D-5-4, the groundwater receiver for the septic effluent is the overburden sands and the upper limestone bedrock aquifer. The result of the hydrogeological conceptual model indicates that the overburden sands and till deposits across the site generally do not meet the above requirements for isolation.

5.2.3 Three-Step Assessment: Step 3 - Nitrate Dilution Calculations

Where it cannot be demonstrated that the effluent is hydrogeologically isolated from the water supply aquifer and the proposed lot sizes are less than 1.0 hectares, the risk of individual on-site septic systems will be assessed using nitrate-nitrogen contaminant loading. The maximum allowable concentration of nitrate in the groundwater at the boundaries of the subject property is 10 mg/L as per the Ministry of the Environment and Climate Change's guideline D-5-4, dated August 1996.

The nitrate concentration at the site boundaries was calculated using the information in Table 5.1, below.

Table 5.1 Nitrate Dilution Assumptions

Parameters	Site Descriptions
Site Area	350,053.1 m^2 (86.5 acres)
Infiltration Area for 74 lots[(1)] *Site area – internal roadway (11,900m^2) – house & driveway footprint (260m^2 per lot)*	318,913.1 m^2
Water Holding Capacity[(2)]	75 mm *Sandy Loam (representative of fine sand, silty sand and silty-sand till encountered on-site)*
Annual Water Surplus[(3)]	Sandy Loam = 378 mm/year *Representative of fine sand, silty-sand till encountered on-site*
Topography Factor (TF)	0.23 *Undeveloped site topography is relatively flat, with topography between flat land – 0.2 and rolling land – 0.3, average of 0.25 (65% lot coverage). Post-development lot*

Parameters	Site Descriptions
	area (35% lot coverage) may include raised septic beds and landscaping with topography represented by rolling lands (0.2). Weighted average topography factor of 0.23.
Soil Factor (SF)	0.4 *Open Sandy Loam*
Cover Factor (CF)	0.165 *Urban Lawns 0.1 (35%) and Woodland 0.2 (65%). Weighted average cover factor of 0.165.*
Site Average Infiltration Factor[4] (TF + SF + CF)	0.795

1. Internal roadway, house and driveway areas provided in the Conceptual Lot Development Plan (Appendix A).
2. Water holding capacity of soils (WHC) based on soil types, which is consistent with the Preliminary Site Servicing Study (Patterson, 2011) and hydrogeological investigations completed for nearby residential subdivisions in the Greely area (Paterson, 2010; Paterson, 2011; Paterson, 2014).
3. Annual water surplus based on Environment Canada Water Surplus Datasheets (Appendix D) for Ottawa International Airport (1984-2006) weather station.
4. Infiltration factors based on information provided in MOEE, 1995.

The predictive assessment is conducted using a mass balance calculation to determine the sewage loading for nitrate at the property boundary (see equation below).

$$C_{Nitrate} = \frac{Mass}{Volume} = \frac{Annual\ Nitrate\ Loading(grams/year)}{Annual\ Dilution\ Volume(cubic\ metres/year)} = \frac{grams}{cubic\ metre} = \frac{mg}{L}$$

The nitrate dilution calculations are provided in Appendix D and summarized in Table 5.2 below.

Table 5.2 Nitrate Dilution Calculations

Parameters	Site Descriptions
Number of Lots	74
Annual Nitrate Loading	1,080,400 grams/year *(74 lots x 40 grams/lot/day *365 days/year)*
Annual Dilution Volume	127,170 m^3/year *[(surplus 0.378 m/year * infiltration factor 0.795 * infiltration area 318,913.1 m^{2-})+ (septic flows of 1 m^3/lot/day * 74 lots * 365 days/year)*
Nitrate Concentration at Property Boundary	8.79 mg/L

Based on the above information, the weighted average nitrate concentration at the site boundaries was calculated to be 8.79 mg/L (refer to the calculation in Appendix D). The nitrate impact assessment meets the acceptable nitrate impact requirement of 10 mg/L established by the

MECP. For reference, the subject site is able to support up to 86 lots, which would have a calculated nitrate concentration of 9.94 mg/L at the site boundary.

5.2.4 Background Overburden Nitrate Concentrations

Groundwater samples were collected from overburden test pits and boreholes advanced as part of the geotechnical investigation (GEMTEC, 2021). Piezometers were installed within the overburden sands, silty sand and silty clay (refer to test pit and borehole logs in Appendix C). Groundwater samples were submitted to an accredited laboratory for analysis of nitrate and nitrite all of which reported non-detectable nitrate and nitrite concentrations (Table 5.3). The Laboratory Certificates of Analyses are provided in Appendix E.

Table 5.3: Overburden Nitrate Sampling

	Test Pit / Monitoring Well Depth (m)	Sampling Date	Nitrate (mg/L)	Nitrite (mg/L)
Test Pit TP21-02	3.0	Mar 9/21	<0.10	<0.05
Test Pit TP21-04	4.5	Mar 8/21	<0.10	<0.05
Test Pit TP21-07	4.0	Mar 8/21	<0.10	<0.05
Test Pit TP21-12	3.2	Mar 8/21	<0.10	<0.05
Test Pit TP21-18	4.0	Mar 9/21	<0.10	<0.05
Monitoring Well BH21-101	5.0	Apr 27/21	<0.10	<0.05
Monitoring Well BH21-104	4.5	Apr 27/21	<0.10	<0.05
Monitoring Well BH21-105	4.5	Apr 27/21	<0.10	<0.05

6.0 GROUNDWATER SUPPLY

A groundwater supply investigation was carried out in accordance with the MECP August 1996 document “Procedure D-5-5, Technical Guideline for Private Wells: Water Supply Assessment”, to determine the quantity and quality of groundwater available for domestic water supply. The results of the groundwater supply investigation are summarized in the following sections.

6.1 Test Well Construction

The MECP Procedure D-5-5 document indicates that a minimum of five test wells are required for sites more than 25 hectares and up to 40 hectares. The total area of the proposed subdivision is 36.0 hectares. A total of five test wells were drilled by Air Rock Drilling Co. Ltd. under Well Contractor License No. 1119. The wells were completed in March 2021; copies of the MECP Water Well Records are provided in Appendix F.

The locations of the new test wells were chosen to provide maximum coverage of the site and with the intent for future use as water supply wells on individual lots (Figure 2).

Well grouting inspections were carried out by GEMTEC staff during the sealing of the well casings in all test wells. The test wells were constructed using a nominal 159 millimetre inside diameter steel casing. The construction details of the test wells are summarized in Table 6.1.

Table 6.1 – Summary of Test Well Construction Details

Test Well	Depth to Bedrock (m BGS)	Depth of Well Casing (m BGS)	Depth Water Found (m BGS)	Total Well Depth (m BGS)
TW 1	8.8	12.2	28.7	30.5
TW 2	5.2	12.2	41.1	43.0
TW 3	5.8	12.2	48.8	50.6
TW4	1.2	12.2	43.9, 45.7	47.5
TW5	5.8	12.2	41.1	43.0

Notes: m BGS - Metres Below Ground Surface

6.2 Pumping Tests Field Procedure

The pumping tests for the onsite test wells were conducted between March 16 and 19, 2021. The pumping tests for test wells TW2 / TW4 and TW1 / TW3 were carried out concurrently on March 18 and March 19 respectively. A six-hour duration constant discharge rate pumping test was conducted in each test well. The pump discharge was directed to the ground surface at a distance ranging from 5 to 10 metres from the test wells and in a manner such that the flow of water on the ground surface was directed away from the test wells.

6.2.1 Water Level Measurements

During the pumping tests, water level measurements were taken at regular intervals in the well being pumped using an electric water level tape and on a continuous basis using electronic data loggers. After the pump was shut off, water level data was collected until a minimum of 95 percent of the drawdown in water level had recovered in the test wells. The water level measurements for the drawdown and recovery data for the pumping tests are provided in Appendix G.

Water level measurements were also taken from other onsite test wells (observation wells) prior to, during and after the pumping of each of the test wells to determine potential interference effects, water level fluctuations and influence from precipitation. Continuous water level measurements were recorded at 30 to 60 second intervals in all test wells from March 16, 2021

to March 30, 2021. Water level measurements taken in the observation wells are provided in Appendix H.

Minimal daily water level fluctuations of less than 0.1 metres were observed in all five test wells. Precipitation data from a nearby weather station (Ottawa Int. Airport, approximately 15 km from site) was compared to the test well water levels during the monitoring period, and the major rainfall events did not appear to have direct impacts on the test well water levels (Appendix H). A gradual increase in water levels, up to approximately 0.5 metres was observed in all test wells during the two-week water level monitoring period but after the pump tests, is attributed to aquifer recharge from the spring freshet.

6.2.2 Flow Rate Measurements

The wells were pumped using an electric submersible pump and portable generator supplied by Air Rock Drilling Ltd. The flow rate of the pump discharge hose was constantly monitored using a timed-volume method. Multiple flow measurements were taken within the first hour of the pumping test and then at 60-minute intervals throughout the remainder of the pumping test to ensure that the discharge rate maintained a constant flow rate (i.e. within 5%). The test wells were pumped at a rate of approximately 68 litres per minute.

6.2.3 Groundwater Sampling

Total chlorine tests were conducted in the field to ensure that chlorine levels were at non-detectable concentrations prior to bacteriological testing. The temperature, conductivity, total dissolved solids, pH, turbidity, colour and total chlorine levels of the groundwater were measured at periodic intervals during the pumping tests and are summarized in Appendix I. The field equipment used during the pumping test is calibrated monthly by GEMTEC and the details of field equipment are provided in Table 6.2.

Table 6.2 – Field Equipment Overview

Field Parameters	Manufacturer	Model No.
Total and Free Chlorine	Hach	DR 900
pH, temperature, Conductivity	Hanna / Horiba[1]	HI 98129 / Horiba U-52[1]
Turbidity	Hanna	HI 98703
Colour	Hach	DR 900

Notes: 1. Rental equipment from Maxim Environmental and Safety Inc.

Groundwater samples for laboratory analysis were collected from the test wells after three and six hours of pumping.

The groundwater samples were collected in laboratory supplied bottles and prepared/preserved in the field in accordance with the industry standard sampling, handling and preservation procedures required by the laboratory. All water samples, including samples for metal analysis, were unfiltered. The groundwater samples were subsequently submitted to Paracel laboratories in Ottawa, Ontario for chemical, physical and bacteriological analyses.

6.3 Test Well Water Quality

The results of the chemical, physical and bacteriological analyses on the water samples from the five test wells are summarized in Appendix I and the laboratory results from Paracel are provided in Appendix J.

6.3.1 Bacteriological Parameters

Total and free chlorine measurements confirmed that total and free chlorine concentrations in the well water was non-detectable (<0.02 mg/L) at the time of bacteriological sampling during the pumping tests (refer to Appendix I).

Based on water samples collected from the on-site test wells, total coliform counts exceeded the Ontario Drinking Water Quality Standards (ODWQS) maximum acceptable concentration of zero in TW 1, TW 2 and TW 4. Low levels of total coliform were detected in the initial 3-hr samples from TW 2 and TW 4, with reported total coliform counts of 1 and 3 CFU/100mL respectively. The samples collected at the end of the six-hour pumping test for TW 2 and TW 4 reported non-detectable total coliform concentrations.

Laboratory results from TW 1 were non-detect for total coliform in the 3-hr sample during the pumping test, but 74 counts/100mL in the 6hr sample. The elevated total coliform was attributed to the elevated turbidity, measured to be 10.3 NTU. Following the pumping test, TW1 was chlorinated and re-pumped on April 6 and 7, 2021. Following additional well development, the turbidity decreased to 0.7 NTU and two samples collected 15 minutes apart had non-detectable total coliform. Upon re-sampling of TW1, the total and free chlorine concentrations were measured to be 0.03 mg/L, just above the method detection limit of 0.02 mg/L. Test well TW1 was pumped for greater than 24 hours at a rate of 68 litres per minute and the residual chlorine detected is likely related to the accuracy of the equipment.

Bacteria indicator species such as e. coli and fecal coliform were not detected in any of the water samples. Based on the bacteriological testing, the water is suitable for consumption.

6.3.2 Other Health Related Parameters

No other maximum acceptable concentration limits of the ODWQS were exceeded (with the exception of total coliforms noted above) in the three- and six-hour water samples collected from the onsite test wells. This includes fluoride, nitrate, nitrite and heavy metals (mercury, aluminum,

antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, manganese, selenium and uranium).

6.3.3 Operational Guideline Exceedances

Operational related exceedances of the ODWQS were noted for hardness (all test well samples) and organic nitrogen (TW 2 and TW 3) and are discussed in the following section:

Hardness

The concentration of hardness in water samples obtained from all five test wells ranged from 164 to 395 mg/L as $CaCO_3$ and was higher than the operational guideline of 80 to 100 mg/L of $CaCO_3$ as specified in the ODWQS.

Water having a hardness level above 80 to 100 mg/L as CaCO3 is often softened for domestic use. The MECP Procedure D-5-5 document states that water having a hardness value more than 300 mg/L is considered "very hard". The Ontario Ministry of the Environment publication entitled "Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines", states that water with hardness in excess of 500 mg/L is considered to be unacceptable for most domestic purposes. There is no upper treatable limit for hardness specified in MECP Procedure D-5-5.

The concentrations of hardness in all the test wells are below the reported threshold of 500 mg/L as CaCO3 as specified in the Technical Support Document for the ODWQS. The concentration of hardness observed in the test wells is considered to be reasonably treatable using a conventional water softener. Based on our experience, most water supply wells within rural eastern Ontario are equipped with water softeners.

Water softening by conventional sodium ion exchange may introduce relatively high concentrations of sodium into the drinking water that may be of concern to persons on a sodium restricted diet. The use of potassium chloride in the water softener (which adds potassium to the water instead of sodium); could be considered as a means of keeping sodium concentrations in the water at background levels. Consideration could also be given to providing a bypass of the water softener for drinking water purposes (for example, a bypass of the softener to the cold-water kitchen tap).

Organic Nitrogen

The organic nitrogen concentration (total kjeldahl nitrogen – ammonia) exceeded the operational guideline of 0.15 mg/L for ODWQS in the 6-hr sample from test well TW 2 and TW 5 and in the 3-hr sample from TW 1. Of the five test wells sampled, only TW 2 and TW 5 slightly exceeded the ODWQS at the end of the pumping tests, with concentrations of 0.2 mg/L.

The ODWQS indicates that levels of organic nitrogen in excess of 0.15 mg/L may be caused by septic tank or sewage effluent contamination and is typically associated with dissolved organic carbon (DOC) contribution of 0.6 mg/L. At the concentrations calculated in TW 2 and TW 5, the organic nitrogen is unlikely associated with septic tank or sewage effluent contamination, given the absence of common septic indicator parameters such as nitrate and nitrite, which were non-detectable (less than 0.1 mg/L).

The DOC in TW 2 and TW 5 was reported to be 3.8 and 1.4 mg/L in the 6-hr samples. Organic nitrogen can react with chlorine and severely reduce its disinfectant power; in addition, taste and odour problems may also occur. It is not expected that ongoing chlorination will be utilized by homeowners in the residential subdivision and, as such, no concerns with the operational objective exceedance for organic nitrogen were identified.

Aluminum

The concentration of aluminum collected from TW1 to TW5, inclusive, at the end of each pumping test ranged from < 0.001 to 0.117 mg/L. The concentrations measured in TW1 and TW2 exceeds the ODWQS operational guideline of 0.1 mg/L. Aluminum in untreated water is found in the form of fine particles of alumino-silicate clay, which are effectively removed in coagulation/filtration. The elevated aluminum concentrations in TW1 and TW2 are attributed to the elevated turbidity, measured to be 10.3 and 10.0 NTU respectively. Following additional well development in TW1 and TW2, the turbidity decreased significantly to 1.1 and 0.7 mg/L respectively and aluminum concentrations in excess of the ODWQS operational guideline are not anticipated. The aluminum concentrations are below the maximum acceptable concentration of 2.9 mg/L (Health Canada, 2021).

6.3.4 Aesthetic Objective Exceedances

Aesthetic objective exceedances of the ODWQS included six drinking water parameters (iron, sulphide, manganese, turbidity, total dissolved solids and colour) as follows: iron (TW 1 and TW 2), sulphide (TW 3, TW 4, TW 5), manganese (TW 1, TW 3), turbidity (TW 1, TW 2), total dissolved solids (TW 3, TW 4, TW 5), and colour (TW 1, TW 2). These exceedances are discussed in the following sections:

Iron

The iron levels in samples recovered from the on-site test wells ranged from 0.1 to 0.8 mg/L. Samples recovered from test wells TW 1 and TW 2 exceed the ODWQS aesthetic objective for iron of 0.3 mg/L. Elevated levels of iron may cause staining to plumbing fixtures and laundry. However, the iron level is well within the maximum reasonably treatable limits of 5.0 mg/L provided in Table 3 of the Appendix in the MECP Guideline D-5-5.

Sulphide

Sulphide levels in samples from three of the five test wells exceed the ODWQS aesthetic objective of 0.05 mg/L. Laboratory samples from TW 3, TW 4 and TW 5 reported sulphide levels of 0.18, 0.58 and 0.92 mg/L respectively. Although the sulphide levels in these test wells exceed the ODWQS aesthetic objectives, low levels of sulphide in drinking water can be effectively removed from most wells by aeration treatment.

Manganese

The manganese levels in samples recovered from the on-site test wells ranged from 0.023 to 0.075 mg/L. Samples recovered from test wells TW 1 and TW 3 exceed the ODWQS aesthetic objective for manganese of 0.05 mg/L. Like iron, manganese may cause staining to plumbing fixtures and laundry. However, the manganese level is well within the maximum reasonably treatable limits (1.0 mg/L) provided in Table 3 of the Appendix in the MECP Guideline D-5-5.

Turbidity

Turbidity levels in samples from two of the five test wells exceed the ODWQS aesthetic objective of 5 NTU. Test wells TW1 and TW2 reported turbidity levels of 10.3 and 10.0 NTU following 6-hours of pumping. The field measured turbidity showed good agreement with the lab results, confirming the exceedance of the ODWQS guidelines for turbidity.

Test wells TW1 and TW2 were both resampled for turbidity on April 7th and April 6th respectively, after pumping for up to 24 hours at a rate of approximately 68 litres per minute. The laboratory results returned turbidity of 1.1 NTU and 0.7 NTU for TW1 and TW2 respectively. Following additional well development, all test wells meet the ODWQS aesthetic objective for turbidity.

Total Dissolved Solids (TDS)

TDS levels in samples from three of the five test wells exceed the ODWQS aesthetic objective of 500 mg/L, with TW 3, TW 4, and TW 5 reporting values of 664 mg/L, 742 mg/L and 520 mg/L respectively. Elevated levels of TDS can lead to problems associated with encrustation and corrosion

To determine the corrosive nature of the groundwater, the Langelier Saturation Index (LSI) was calculated for the samples obtained from the test wells. These values are based on the laboratory measured TDS, pH, alkalinity, and hardness following 6-hours of pumping. The LSI was calculated for TW 3, TW 4 and TW 5 to be 0.76, 0.66 and 0.49 respectively, using an estimated groundwater temperature of 10°C (refer to Appendix K). The test wells have LSI values between 0.5 and 2, which indicates the groundwater scale forming, but non-corrosive.

As per the “Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines”, TDS levels in excess of 500 mg/L may result in excessive hardness, taste, mineral deposition or corrosion. According to the “Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Total Dissolved Solids (TDS)”, published by Health Canada (1991), TDS levels between 600 and 900 mg/L are considered to be ‘fair’. At levels above 1,200 mg/L, the palatability of drinking water is ‘unacceptable’. The palatability of the drinking water is expected to be acceptable, although some taste problems may occur as the palatability is classified as ‘fair’.

Colour

The analytical laboratory results for actual colour (ACU; unfiltered) exceeded the ODWQS aesthetic objective of 5 ACU at all test well locations. The colour in samples from these test wells ranged from 9 – 69 ACU. The true colour (TCU; filtered) was also measured, which ranged from 3 – 38 TCU.

Water having a faint yellow/brown colour can be caused by organic materials and contributed to by iron and manganese. Colour is not generally considered a health issue and the aesthetic objective is set by appearance. The laboratory-measured colour in samples from four of the five test wells exceeded the MECP D-5-5 treatability limit of 7 TCU.

The elevated colour may be the result of high iron concentrations, which can precipitate out of solution and increase the colour levels. Filtered colour (true colour units; TCU) levels were lower than actual colour for all samples. Generally, the test wells with the highest iron concentrations were associated with higher colour.

Given the absence of any elevated organic substances (e.g. dissolved organic carbon, nitrate, nitrite, tannins and lignins and organic nitrogen) exceeding the ODWQS, the colour is likely the result of elevated iron concentrations and can be treated through removal of iron (e.g. manganese greensand treatment systems). As stated in Table 3 of the Appendix in the MECP Guideline D-5-5, higher iron-related colour (exceeding the maximum concentration considered reasonably treatable limit of 7 TCU) may be removed by manganese greensand treatment.

6.3.5 Water Supply Aquifer

The hydrogeological conceptual model completed for the subject site (Table 4.1) identified two distinct water supply aquifers: limestone of the Beekmantown Group (Oxford and March Formations) and sandstone of the Potsdam Group (Nepean Formation). The water well records for the on-site test wells suggest that TW 1 and TW 2 are completed in limestones of the Oxford and/or March Formations and test wells TW 3, TW 4 and TW 5 extend further into the sandstones of the Nepean Formation (refer to geological cross section, Figure 6). Notable differences in water quality encountered from the five on-site test wells are summarized in Table 6.6.

Table 6.6: Test Well Water Quality

	TW 1 and TW 2	TW 3, TW 4, TW 5
Well Depths (m BGS)	30.5, 43.0	50.6, 47.5, 43.0
Lithology – Water Well Record	Grey and black limestone	Grey and black limestone underlain by grey and white sandstone
Notable Water Quality Differences[1]	Chloride = 2 – 3 mg/L TDS = 192 – 336 mg/L Turbidity = 0.7 – 1.1 mg/L[(2)] Hardness = 164 – 192 mg/L Sulphide = ND (0.02 mg/L) Iron = 0.5 to 0.8 mg/L	Chloride = 119 – 148 mg/L TDS = 520 – 742 mg/L Turbidity = 0.4 – 1.6 mg/L Hardness = 331 – 395 mg/L Sulphide = 0.17 – 0.92 mg/L Iron = 0.1 to 0.3 mg/L

Notes:
1. Based on water quality results from 6-hour pumping tests.
2. Initially elevated turbidity levels of 10.0 to 18.6 mg/L which decreased following additional well development.

All on-site test wells meet the ODWQS maximum acceptable concentrations and are within treatable limits. The water quality encountered on future lots may vary, depending on the depths of water bearing fractures encountered at the time of drilling.

6.4 Offsite Domestic Well Water Quality

The offsite domestic well water quality was assessed through a review of the hydrogeological report completed for the Emerald Links Phase 3 residential subdivision (Trow, 2009) located just adjacent to the west and by collecting four groundwater samples (PW1, PW2, PW3 and PW4) from private homes located to the south and east of the subject site. The approximate private well locations are shown in Figure 2. The water quality results are provided in Appendix I and the ODWQS exceedances are summarized in Table 6.7 below.

Table 6.7: Offsite Domestic ODWQS Exceedances

	On-Site	Emerald Links Phase 3 (Trow, 2009)	Offsite Domestic Wells
ODWQS Health-Related Exceedances	-	-	-
ODWQS Aesthetic Exceedances	Iron, manganese, colour, sulphide, total dissolved solids	Iron, manganese, colour, sulphide,	Iron, manganese, colour, sulphide, total dissolved solids
ODWQS Operation Guideline Exceedances	Hardness, organic nitrogen	Hardness	Hardness, organic nitrogen

The groundwater encountered in the on-site test wells is similar to the water quality in off-site test wells (Trow, 2009) and private domestic wells. With the exception of one private well which reported a nitrate concentration of 0.2 mg/L, all other well sampled reported non-detectable (<0.1 mg/L) nitrate concentrations.

6.5 Pumping Test Analysis

6.5.1 Pump Test Analysis Overview

The drawdown and recovery water level data from the five pumping tests conducted on the onsite test wells TW 1 to TW 5, inclusive, are provided in Appendix G. The details of the pumping tests carried out on the test wells are provided in Table 6.8. All depths provided are in metres below ground surface (m BGS).

Table 6.8 – Pumping Tests Details

Parameter	TW 1	TW 2	TW 3	TW 4	TW 5
Duration (minutes)	360	360	360	360	360
Flow Rate (litres per minute)	68	68	68	68	68
Static Water Level (m BGS)	1.6	2.0	5.3	6.2	5.6
Well Depth (m BGS)	31.1	44.2	51.2	50.3	43.9

Parameter	TW 1	TW 2	TW 3	TW 4	TW 5
Available Drawdown (m)	29.5	42.2	45.9	44.1	38.3
Water Level at End of Pumping (m BGS)	6.1	7.4	6.2	8.6	6.6
Observed Drawdown at End of Pumping (m)	4.5	5.4	0.9	2.4	1.0
Percent Drawdown Utilized (%)	15	13	2.0	5.0	3.0
Specific Capacity (L/min/m)	15.1	12.6	75.5	28.3	68.0

As per MECP Procedure D-5-5, each of the test wells was pumped at a flow rate greater than 18.9 litres per minute for 6 hours. The maximum drawdown observed at the end of pumping was 4.5 metres in test well TW 1 which is equivalent to approximately 15 percent of the available drawdown in the test well. The drawdown utilized in the remaining test wells ranged from 2 to 13 percent. Based on these results, all of the onsite test wells are capable of supplying water at a rate significantly greater than 18.9 litres per minute for a period greater than six hours. This is considered more than sufficient for typical domestic use.

6.5.2 Transmissivity and Storativity Analysis

The transmissivity and storativity of the water supply aquifer were estimated from the pump test drawdown data using Aqtesolv version 4.5, a commercially available software program from HydroSOLVE Inc. An analysis of the pumping test data was carried out using the Cooper-Jacob and Theis recovery methods. Drawdown in the observation wells was typically minimal (<0.1 m) and did not produce reasonable transmissivity or storativity values. The results of the Aqtesolv 4.5 analysis are provided in Appendix G.

6.5.2.1 Pumping Test TW 1

Test well TW 1 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 1.5 m following initiation of pumping and then increased to 4.5 m until approximately 360 minutes after pumping started. The water level in the test well fully recovered approximately 60 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown and recovery data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 15.1 L/min/m. An aquifer

transmissivity of 53 and 77 m^2/day was estimated using the drawdown and recovery data, respectively.

6.5.2.2 Pumping Test TW 2

Test well TW 2 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 0.5 m following initiation of pumping and then further increased to 5.4 by the end of the pumping test. The water level in the test well recovered 95% within 4.5 hours after the pump was shut off.

Aquifer parameters were evaluated using drawdown data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 12.6 L/min/m. Aquifer transmissivities of 8.8 m^2/day and 7.6 m^2/day were estimated using the drawdown and recovery data, respectively.

6.5.2.3 Pumping Test TW 3

Test well TW 3 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 0.6 m following initiation of pumping and then decreased to 0.9 by the end of the pumping test. The water level in the test well recovered 95% 20 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 75.5 L/min/m. Aquifer transmissivities of 294 m^2/day and 216 m^2/day were estimated using the drawdown and recovery data, respectively.

6.5.2.4 Pumping Test TW 4

Test well TW 4 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 1.0 m following initiation of pumping and further increased to 2.4 metres approximately 360 minutes after pumping started. The water level in the test well recovered 95% approximately 30 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown and recovery data from the pumping well, and drawdown data in one observation well (TW 3). The specific capacity of the well at the time of maximum drawdown was 28.3 L/min/m. An aquifer transmissivity of 98 and 100 m^2/day was estimated using the drawdown and recovery data, respectively. The data from the observation well produced a transmissivity of 377 m^2/day and storativity of 3×10^{-5}.

6.5.2.5 Pumping Test TW 5

Test well TW 5 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 0.5 m following initiation of pumping and then decreased to 1.1 by the end of the pumping test. The water level in the test well fully recovered 30 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 68.0 L/min/m. Aquifer transmissivities of 156 m^2/day and 129 m^2/day were estimated using the drawdown and recovery data, respectively.

6.5.3 Aquifer Parameters – Transmissivity and Storativity

The transmissivity for each test well was calculated and where sufficient drawdown was observed in the observation wells, the transmissivity and storativity of the bedrock aquifer was calculated. A summary of the aquifer properties is provided in Table 6.8.

Table 6.8 – Summary of Aquifer Parameters

Transmissivity – Drawdown						
		TW 1	TW 2	TW 3	TW 4	TW 5
Observation Wells	TW 1	**53**		-	-	-
	TW 2	-	**8.8**	-	-	-
	TW 3	-	-	**294**	-	-
	TW 4	-	-	-	**98**	-
	TW 5	-	-	-		**156**
Transmissivity – Recovery						
		TW 1	TW 2	TW 3	TW 4	TW 5
Observation Wells	TW 1	**77**	-	-	-	-
	TW 2	-	**7.6**	-	-	-
	TW 3	-	-	**216**	-	-
	TW 4	-	-	-	**100**	-
	TW 5	-	-	-	-	**129**
Geometric Mean Transmissivity		71 m^2/d				

6.6 Hydraulic Interference Effects

During the pumping of the onsite test wells, water level measurements were recorded at the remaining four bedrock observation wells using electric data loggers, recording every 30 seconds to one-minute intervals. The water level measurements in the observation wells are reported in Appendix G and discussed below.

6.6.1 Bedrock Observation Wells

During the pumping tests for test wells TW 1 to TW 5, inclusive, water levels were measured in bedrock observation wells (test wells not being pumped) which are located 250 to 850 metres apart (Figure 2). The observed water level decrease in bedrock observations wells was less than

0.1 metres, including during the pumping tests for TW1 / TW3 on March 19, 2021 and TW2 / TW4 on March 18, 2021 which were carried out concurrently.

Based on the test well pumping rates (68 litres per minute), which are greater than typical domestic use, little to no hydraulic interference effects are anticipated at the subject site. This is supported by long-term water level monitoring of the test wells between March 16 to 30, 2021. The test wells located on proposed lots adjacent to the existing residential development (Figure 2) did not display any significant (less than 0.1 metres) daily water level fluctuations over the 15 day monitoring period.

6.6.2 Computer Model Simulations

A well interference simulation was developed using Aqtesolv version 4.5. One scenario was developed and the well simulation output is provided in Appendix K for discussion purposes. Storativity estimates were not calculated from the pumping test data due to minimal water level drawdowns in the observations wells. Literature values of storativity for confined aquifers typically range from 5×10^{-5} to 5×10^{-3} (Todd, 1980).

6.6.2.1 Scenario 1

Scenario 1 is provided to illustrate the maximum drawdown using the geometric mean aquifer parameters identified in Table 6.8. The following parameter values were utilized in the model:

- Number of pumping wells = 74 wells (well locations approximated by taking the central point on each proposed land parcel);
- Individual well pumping rate = 18.75 litres per minute (minimum peak flow estimate as per MECP Procedure D-5-5);
- Duration of pumping = 120 minutes;
- Analysis model = Theis
- Aquifer thickness = 24.4 m (average of TW 1 to TW 5);
- Aquifer transmissivity, Theis = 71 m^2/day (geometric mean; refer to Table 6.8); and,
- Storativity coefficient = 5×10^{-5} (conservative estimate of storativity based on literature values; Todd, 1980).

The results of Scenario 1 simulation indicate that the maximum drawdown within the site is approximately 4.5 metres and is localized to the pumping well, representing 11% of available drawdown in the wells (calculated using the geometric mean available drawdown in the test wells). Drawdown at the property boundary is conservatively estimated to be less than 4 metres and less than 3 metres at existing neighbouring properties (Figure 8). Based geometric mean available drawdown of offsite wells within 500 m of site, a conservative drawdown of 4 metres would represent approximately 16% of the total available drawdown. The results of the well interference simulation and the average available drawdown in the on-site and neighbouring water wells indicates the interference between drinking water wells is considered acceptable.

7.0 CONCLUSIONS

Based on the results of the hydrogeological investigation, the following conclusions and professional opinions are provided:

- The surficial geology at the subject site generally consists of coarse-textured glaciomarine deposits of sand with minor clay and silt, underlain by silty sand and/or silty clay on the western portion of the site and silty-sand to sandy-silt till on the eastern portion of the site. The subject site overburden thickness ranges from approximately 1.2 to 8.8 metres, with an average thickness of 5.4 metres.

    - The subject site is not considered to be hydrogeologically sensitive based on the absence of significant areas of thin soils, highly permeable soils or karst features. It is noted that thin soils (1.2 to 1.6 metres) were encountered at the southeastern portion of the subject site; however, based on the Conceptual Lot Development Plan (Appendix A), the proposed location of the septic systems is the front yards where overburden thickness generally increases to greater than 2.0 metres.

- The water supply aquifer encountered at the subject site includes limestone of the Oxford and March Formations as well as sandstones of the Nepean Formation.

- The water quality available from drilled wells on the subject site is safe for consumption based on the absence of health-related exceedances; however, groundwater treatment for aesthetic parameters will be required.

    - To note, at the end of the six-hour pumping tests total coliform exceeded the ODWQS in TW 1; however, following well chlorination and additional well development to reduce turbidity levels, the total coliform decreased to non-detectable concentrations.

    - The levels of hardness, colour, iron and manganese are considered to be reasonably treatable using a conventional water softener and/or manganese greensand filters.

    - Total Dissolved Solids levels are in excess of 500 mg/L in three of the five test wells, but are considered “fair”, according to the “Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Total Dissolved Solids (TDS)”, published by Health Canada (1991), and are well below levels of 1,200 mg/L, above which the palatability of drinking water is considered ‘unacceptable’. LSI values indicate the water is considered scale forming, but non-corrosive.

- The water quality from nearby residential subdivisions (Trow, 2009) and private domestic wells sampled are similar to the water quality found in the proposed subdivision. No significant impacts have been identified from the available background reports and water quality sampling.

- The water quality determined in the course of this investigation is representative of long-term water quality from which future lot owners are likely to obtain from their wells constructed in accordance with the well construction recommendations.

- The quantity of groundwater available from the proposed water supply aquifer is more than sufficient for the proposed development and will sustain repeated pumping at the test rate and duration at 24-hour intervals over the long term.

- Interference between drinking water wells is expected to be acceptable under typical usage for residential developments.
    - Drawdown at the site boundary is conservatively estimated to be less than 4.0 metres, which represents 16% available drawdown of average existing domestic water supply wells.
    - Negligible well interference (>0.1 metres) observed during test well pumping tests and long-term test well water level monitoring.

- No negative impacts to the bedrock aquifer are anticipated (based on nitrate dilution calculations which demonstrate that offsite nitrate impacts are less than 10 mg/L).
    - Development can support up to 86 lots with a calculated nitrate concentration of 9.94 mg/L at the Site boundary.
    - Development Plan (Appendix A) indicates 74 lots, which has a calculated nitrate concentration of 8.79 mg/L at the Site boundary.

- The test well construction is typical of wells which will be used in the development in the future.

8.0 RECOMMENDATIONS

The following provides recommendations regarding well construction specifications, water quality and septic systems:

8.1 Well Construction Recommendations

- All wells that are drilled in the subdivision should be constructed in accordance with local and MECP regulations, including, but not limited to, Ontario Reg. 903.

- Well casings should be extended at least 12.2 metres (40 feet) below ground surface and a minimum of 3 metres into competent bedrock. The entire annular space between the steel casing and the overburden/ bedrock should be filled with a suitable cement or bentonite grout;

- A well grouting certification inspection should be conducted during the installation and grouting of the well casing for all future wells installed on the subject site. The well grouting certification inspection should be conducted under the supervision of a professional engineer or professional geoscientist.

- It should be noted that the water bearing fractures in the limestone and sandstone bedrock were encountered at depths ranging from 28.6 to 48.8 metres below ground surface in test wells TW 1 to TW5, inclusive. Water quality below 48.8 metres has not been tested.

- Drinking water wells should be located so that they meet and preferably exceed the minimum setback distances from septic systems, property lines and any other sources of contamination, as required in the Ontario Building Code and/or Ontario Reg. 903. In addition, the well should be situated in a location that allows for future site access for cleaning, treatment, repair, testing or maintenance. Information regarding well access should be included in the subdivision agreement and/or purchase agreement.

- Drinking water wells should be located in general accordance with the Conceptual Lot Development Plan prepared by ARK Engineering (Appendix A).

- It is recommended that newly drilled water wells be developed by the well driller for a minimum of one hour of pumping following completion of the well drilling. This well development can be carried in conjunction with the one hour pumping test that is required for the MECP Water Well Record.

    - Some newly drilled water wells may require extended well development, up to 24 hours in order to decrease turbidity levels.

- It is recommended that newly drilled water wells be chlorinated by the well driller following completion of the well drilling and pumping.

- It should be noted that this study does not address the construction of earth energy systems, which may require approval from the MECP.

8.2 Well Ownership Recommendations

- It is recommended that the property owners construct, maintain and test their drinking water well in accordance with the Ministry of the Environment and Climate Change document “Water Supply Wells - Requirements and Best Management Practices, Revised April 2015”.

- For all newly drilled wells, it is recommended that a raw water sample be collected and analyzed for potability requirements (E. Coli. and total coliform bacteria).

    - If any bacteriological exceedances of the Ontario Drinking Water Quality Standards (ODWQS) are noted in the sampling, then it is recommended that the homeowner take remedial actions (such as chlorination of the well to eliminate bacteria) and retest a raw water sample to confirm that the remedial actions were effective.

- It is recommended that homeowners be informed that some wells may exhibit elevated aesthetic parameters (hardness, iron, manganese, total dissolved solids, sodium, sulphide and/or organic nitrogen) and incrustation, taste, odour and colour can be expected.

- It is recommended that homeowners be informed that hardness levels may exceed the ODWQS operational guideline for hardness. Conventional water softeners may be desired by homeowners to treat minor aesthetic objective and operational guideline exceedances of the ODWS such as hardness. On heating, hard water has a tendency to form scale deposits and can form excessive scum with regular soaps. Conversely, soft water may result in accelerated corrosion of water pipes.

- It is recommended that homeowners and the Local Medical Officer of Health be informed that sodium concentrations exceed 20 mg/L and exceed the warning level for persons on sodium restricted diets.

- It is recommended that homeowners be informed that water softening by conventional sodium ion exchange may introduce relatively high concentrations of sodium into the drinking water which may be of concern to persons on a sodium restricted diet. The use of potassium chloride in the water softener (which adds potassium to the water instead of sodium) could be considered as a means of keeping sodium concentrations in the water at background levels. Consideration could also be given to providing a bypass of the water softener for drinking water purposes.

8.3 Site Phasing and Performance Reviews

- Performance reviews should be conducted in accordance with MECP Procedure D-5-5 Private Wells: Water Supply Assessment, section 4.7 Phased Developments;

- The results of the proposed performance evaluation would be reported prior to the registration of the subsequent phases. The report would include the MECP Water Well Records for the private wells sampled and a site plan showing the sampled well locations as well as any other wells drilled in the subdivision.

- In accordance with the MECP guideline D-5-5, the recommendations and requirements provided in the hydrogeological report and terrain evaluation will be assessed and updated, if required, based on the findings of the investigations for the performance reports and/or a change in the surrounding land use.

8.4 Septic System Construction Recommendations

- Septic systems should be located in general accordance with the Lot Development Plan prepared by ARK Engineering (Appendix A).

- The proposed lots will be serviced by conventional septic sewage disposal systems designed according to the Ontario Building Code. A site-specific investigation should be conducted on each lot for the design of the septic system;
    - Due to the presence of shallow groundwater, septic beds will likely be partially or fully raised.

- Tertiary septic systems could be considered for the proposed development and/or individual property owners. Any tertiary systems should be designed according to the Ontario Building Code. A site-specific investigation should be conducted on each lot for the design of the septic system; and,

- It is recommended that if property owners choose to install tertiary treatment septic systems, then it will be required to enter a maintenance agreement with authorized agents of the system manufacturer for the service life of the system.

8.5 Septic Ownership Recommendations

- It is recommended that the property owners construct, maintain and check their onsite septic system in accordance with the Ontario Building Code.

9.0 LIMITATIONS OF REPORT

This report was prepared for ARK Engineering and Development and is intended for the exclusive use of ARK Engineering and Development. This report may not be relied upon by any other person or entity without the express written consent of GEMTEC and ARK Engineering and Development Nothing in this report is intended to provide a legal opinion.

The investigation undertaken by GEMTEC with respect to this report and any conclusions or recommendations made in this report reflect the best judgments of GEMTEC based on the site conditions observed during the investigations undertaken at the date(s) identified in the report and on the information available at the time the report was prepared. This report has been prepared for the application noted and it is based, in part, on visual observations made at the site, subsurface investigations at discrete locations and depths and laboratory analyses of specific chemical parameters and material during a specific time interval, all as described in the report. Unless otherwise stated, the findings contained in this report cannot be extrapolated or extended to previous or future site conditions, portions of the site that were unavailable for direct investigation, subsurface locations on the site that were not investigated directly, or chemical parameters, materials or analysis which were not addressed.

Should new information become available during future work, including excavations, borings or other studies, GEMTEC should be requested to review the information and, if necessary, re-assess the conclusions presented herein.

We trust that this report is sufficient for your requirements. If you have any questions concerning this information or if we can be of further assistance to you on this project, please call.

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Junior Environmental Scientist

Andrius Paznekas, M.Sc., P.Geo.
Hydrogeologist

Shaun Pelkey, M.Sc.E., P.Eng.
Principal, Environmental Engineer

REFERENCES

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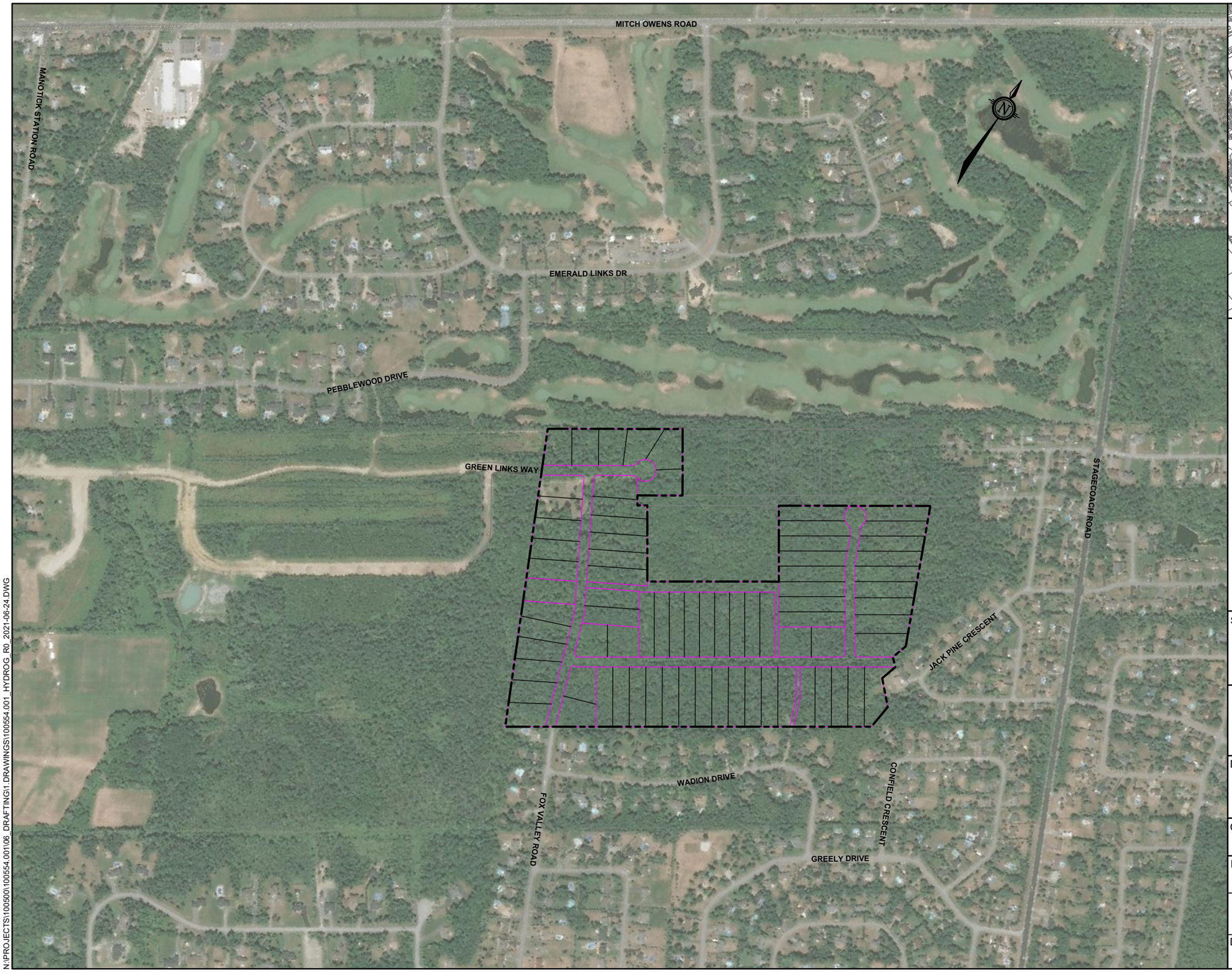

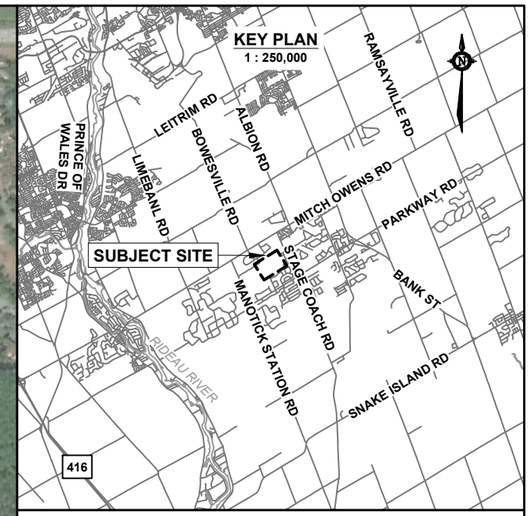

LEGEND

PROPERTY DEVELOPMENT BOUNDARY

Scale
1:7500
0 150 300 450m

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Drawing
SITE PLAN

Client
ARK ENGINEERING AND DEVELOPMENT

Project
100554.001

HYDROGEOLOGICAL INVESTIGATION AND TERRAIN ANALYSIS OF PROPOSED RESIDENTIAL SUBDIVISION - EMERALD WOODS
OTTAWA, ONTARIO

Drwn by	Chkd by
S.L.	A.P.

Date
JUNE, 2021

Rev.
0

FIGURE 1

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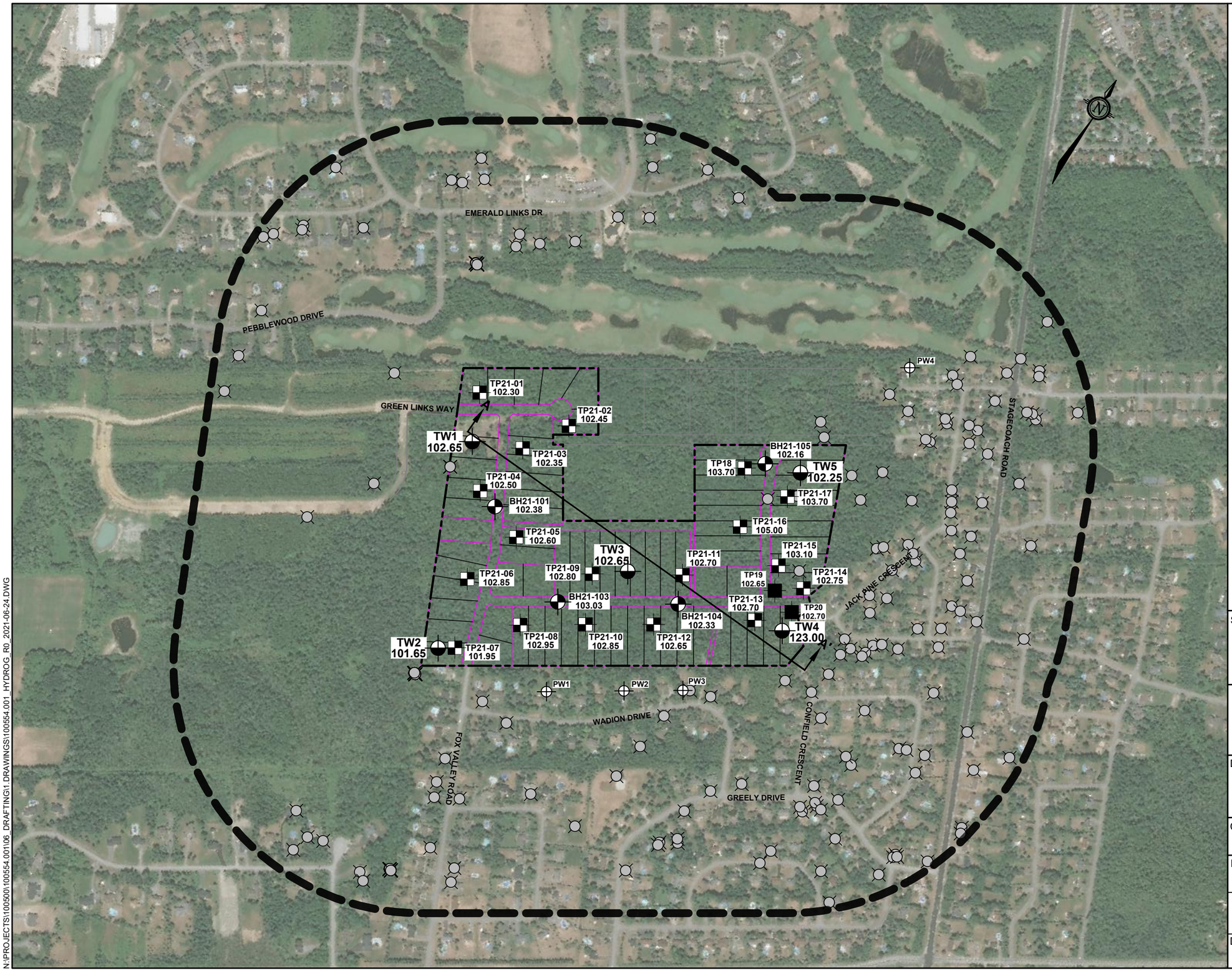

LEGEND

BH/ TW/ TP # ← BOREHOLE/ TEST WELL/ TEST PIT ID

XX.XX ← GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

- **BOREHOLE LOCATION** (current investigation by GEMTEC)
- **TEST WELL LOCATION** (current investigation by GEMTEC)
- **TEST PIT LOCATION** (current investigation by GEMTEC)
- **APPROXIMATE LOCATION OF TEST PIT** (current investigation by ARK ENGINEERING)
- **APPROXIMATE LOCATION OF PRIVATE WELL**
- **MECP WELL**
- **PROPERTY DEVELOPMENT BOUNDARY**
- **STUDY AREA** (500m RADIUS FROM THE PROPERTY BOUNDARY)
- A A' **CROSS-SECTION LOCATION**

Scale 1:7500

0 150 300 450m

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Drawing: DETAILED SITE PLAN

Client: ARK ENGINEERING AND DEVELOPMENT

Project: 100554.001

HYDROGEOLOGICAL INVESTIGATION AND TERRAIN ANALYSIS OF PROPOSED RESIDENTIAL SUBDIVISION - EMERALD WOODS OTTAWA, ONTARIO

Drwn by: S.L. | Chkd by: A.P.

Date: JUNE, 2021 | Rev.: 0

FIGURE 2

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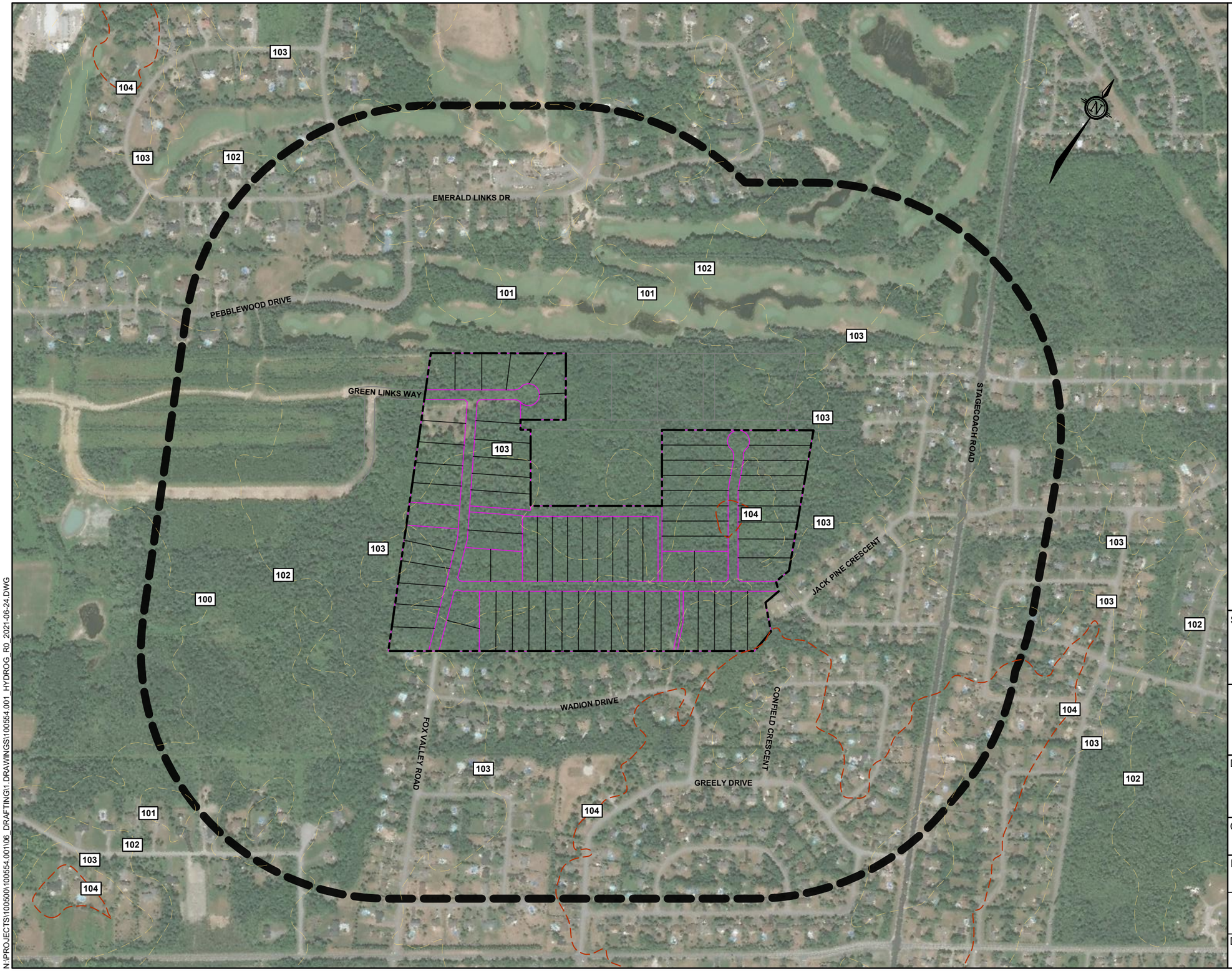

LEGEND

- PROPERTY DEVELOPMENT BOUNDARY
- STUDY AREA (500m RADIUS FROM THE PROPERTY BOUNDARY)
- 100 CONTOUR (MAJOR), IN METRES
- 100 CONTOUR (MINOR), IN METRES

Scale 1:7500

0 150 300 450m

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Drawing: TOPOGRAPHY AND DRAINAGE

Client: ARK ENGINEERING AND DEVELOPMENT

Project: 100554.001

HYDROGEOLOGICAL INVESTIGATION AND TERRAIN ANALYSIS OF PROPOSED RESIDENTIAL SUBDIVISION - EMERALD WOODS OTTAWA, ONTARIO

Drwn by: S.L. | Chkd by: A.P.

Date: JUNE, 2021 | Rev.: 0

FIGURE 3

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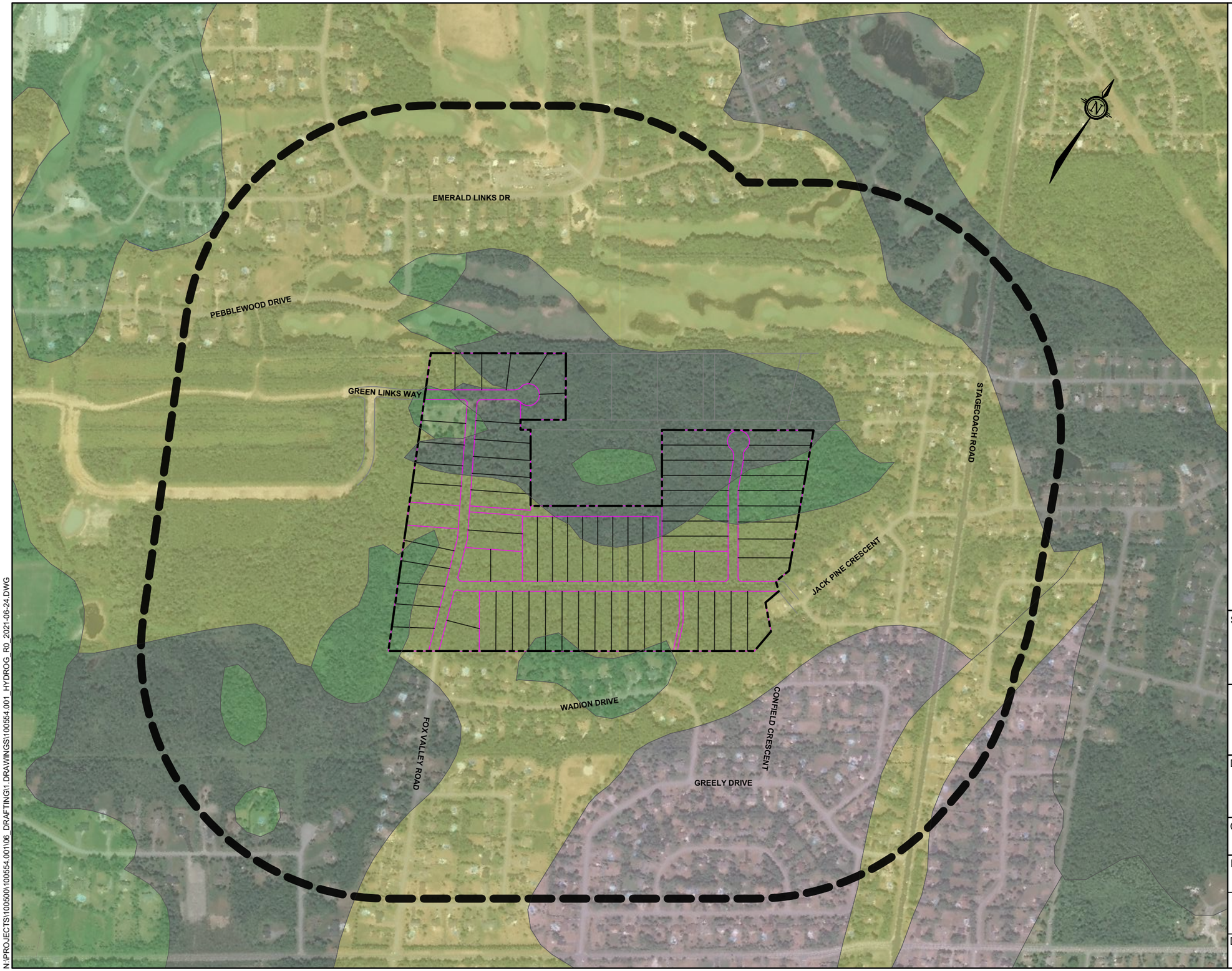

LEGEND

- **PROPERTY DEVELOPMENT BOUNDARY**
- **STUDY AREA** (500m RADIUS FROM THE PROPERTY BOUNDARY)
- **5B** TILL
- **7** GALCIOFLUVIAL DEPOSITS
- **11C** COURSE-TEXTURED GLACIOMARINE DEPOSITE
- **20** ORGANIC DEPOSITS

Reference:

Ontario Geological Survey. 2010. Surficial geology of Southern Ontario. Ontario Geological Survey, Miscellaneous Release-Data 128-Revision 1.

Scale 1:7500

0 150 300 450m

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Drawing: ONTARIO GEOLOGIC SURVEY SURFICIAL GEOLOGY

Client: ARK ENGINEERING AND DEVELOPMENT

Project: 100554.001

HYDROGEOLOGICAL INVESTIGATION AND TERRAIN ANALYSIS OF PROPOSED RESIDENTIAL SUBDIVISION - EMERALD WOODS OTTAWA, ONTARIO

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S.L.	A.P.

Date: JUNE, 2021

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FIGURE 4

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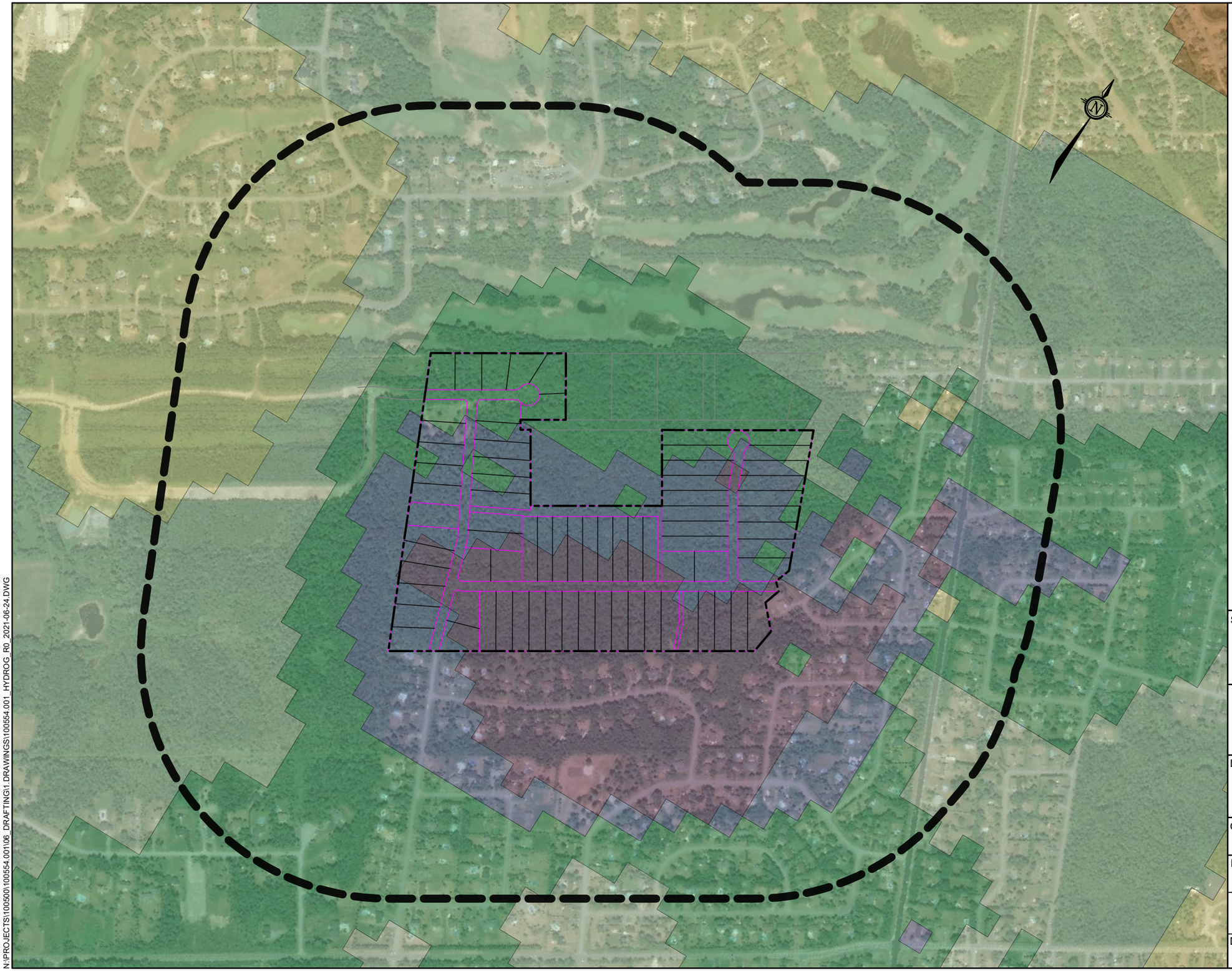

LEGEND

PROPERTY DEVELOPMENT BOUNDARY

STUDY AREA
(500m RADIUS FROM THE PROPERTY BOUNDARY)

OVERBURDEN DRIFT THICKNESS, METRES

- 1 - 2
- 2 - 3
- 3 - 5
- 5 - 10
- 10 - 15
- 15 - 25

Reference:

Gao, C., Shirota, J., Kelly, R.I., Brunton, F.R. and van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 207

Scale

1:7500

0 150 300 450m

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Drawing

ONTARIO GEOLOGIC SURVEY
OVERBURDEN THICKNESS MAP

Client

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100554.001		
Drwn by: S.L.	Chkd by: A.P.	
Date: JUNE, 2021	Rev.: 0	**FIGURE 5**

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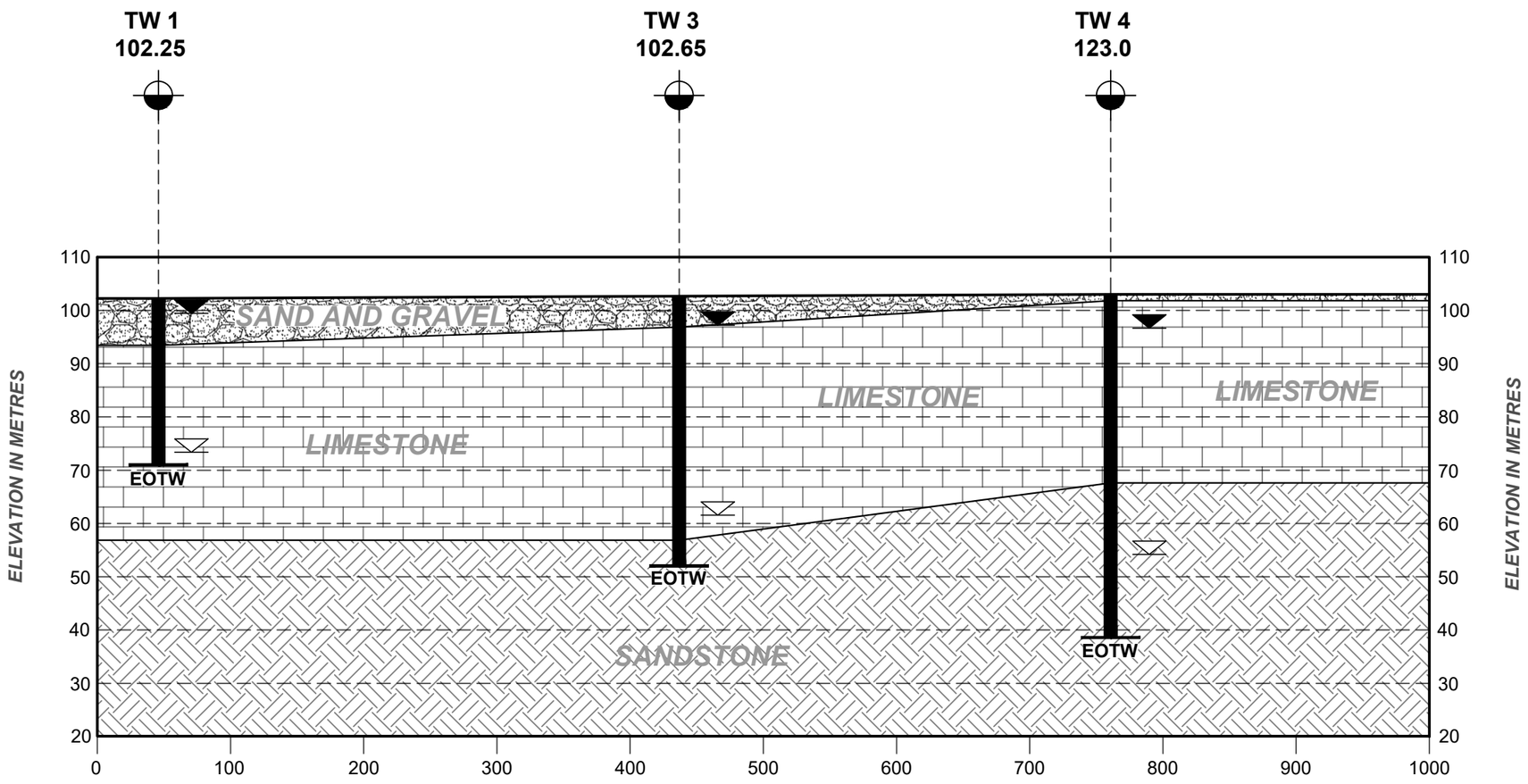
CROSS SECTION A-A'

HORIZTONAL 1:5000
VERTICAL 1:250



LEGEND

- TEST WELL LOCATION (current investigation by GEMTEC)
- SAND AND GRAVEL
- LIMESTONE
- SANDSTONE
- STATIC WATER LEVEL
- WATER-BEARING FRACTURE

Horizontal Scale
1:1000
0 20 40 60m

Vertical Scale
1:250
0 5 10 15m

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Drawing
CROSS-SECTION A-A"

Client
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100554.001		
Drwn by	Chkd by	
S.L.	A.P.	
Date	Rev.	FIGURE 6
JUNE, 2021	0	

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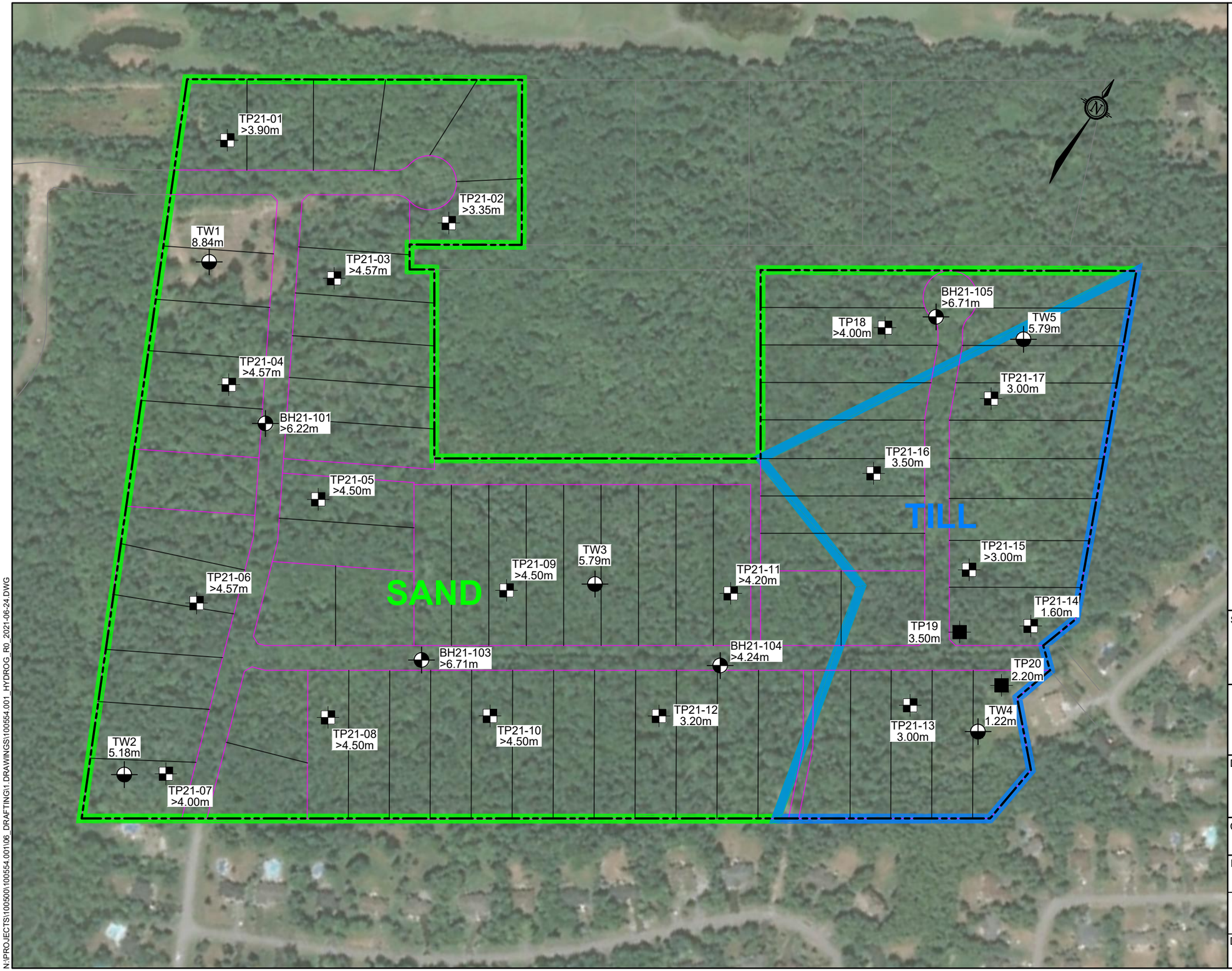

LEGEND

BH/ TW/ TP # — BOREHOLE/ TEST WELL/ TEST PIT ID

XX.XX — GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

BOREHOLE LOCATION
(current investigation by GEMTEC)

TEST WELL LOCATION
(current investigation by GEMTEC)

TEST PIT LOCATION
(current investigation by GEMTEC)

APPROXIMATE LOCATION OF TEST PIT
(current investigation by ARK ENGINEERING)

PROPERTY DEVELOPMENT BOUNDARY

TILL

SAND

Scale
1:3000
0 100 200m

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Drawing
TERRAIN ANALYSIS
SURFICIAL GEOLOGY

Client
ARK ENGINEERING AND DEVELOPMENT

Project
100554.001

HYDROGEOLOGICAL INVESTIGATION AND TERRAIN ANALYSIS OF PROPOSED RESIDENTIAL SUBDIVISION - EMERALD WOODS OTTAWA, ONTARIO

Drwn by	Chkd by
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Date
JUNE, 2021

Rev.
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FIGURE 7

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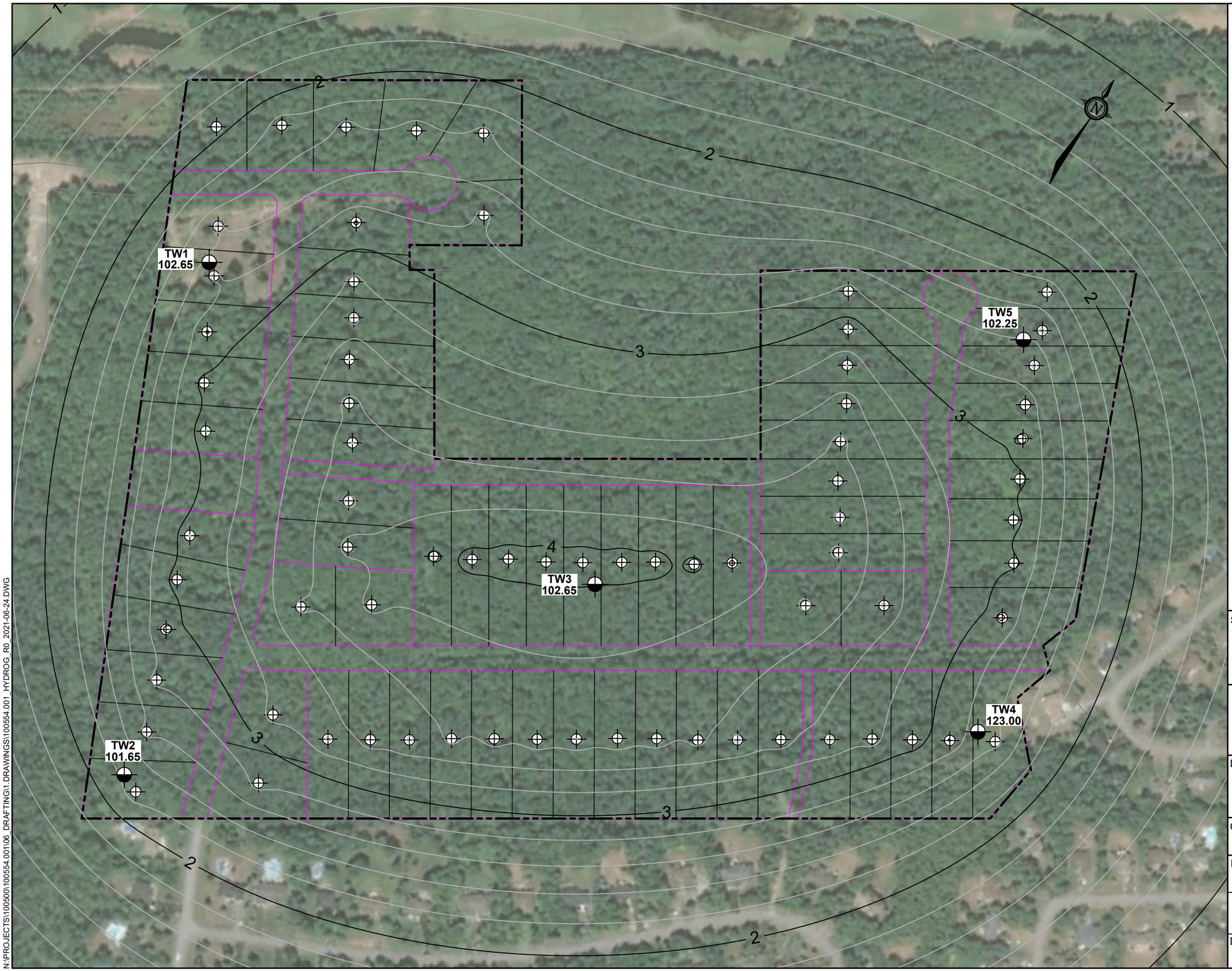

LEGEND

- TW # — TEST WELL ID
- XX.XX — GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM
- TEST WELL LOCATION (current investigation by GEMTEC)
- PROPERTY DEVELOPMENT BOUNDARY
- ASSESSMENT AREA BOUNDARY
- 1.0 — WATER TABLE DRAWDOWN, METRES
- 74 WELLS IN SIMULATION

Scale
1:3000
0 100 200m

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Drawing
WELL INTERFERENCES SIMULATION

Client
ARK ENGINEERING AND DEVELOPMENT

Project
100554.001

HYDROGEOLOGICAL INVESTIGATION AND TERRAIN ANALYSIS OF PROPOSED RESIDENTIAL SUBDIVISION - EMERALD WOODS OTTAWA, ONTARIO

Drwn by	Chkd by
S.L.	A.P.

Date
JUNE, 2021

Rev.
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FIGURE 8

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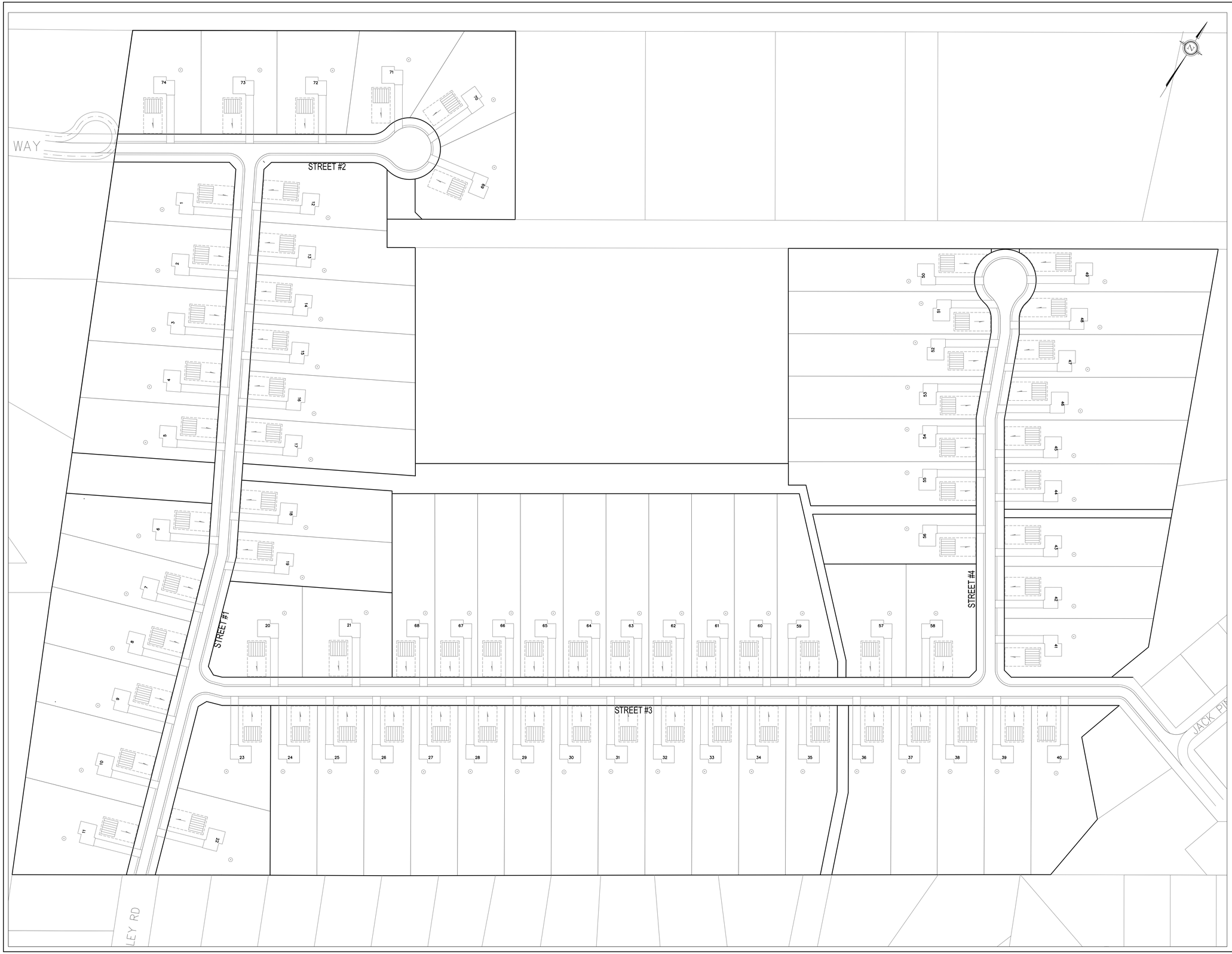
APPENDIX A

Conceptual Lot Development Plan



ARK Engineering and Development

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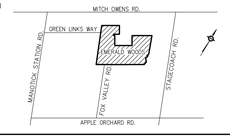
Rockland ON Canada
K4K 1K7
Tel: (613) 858-6443

Legend

- PROPOSED WELL LOCATION
- PROPOSED DISTRIBUTION PIPES
- PROPOSED MANTLE (IF REQUIRED)

General Notes

Key Plan



Revision

0.	SUBMITTED FOR APPROVAL	JUNE/21

Seal

Client / Project

9287043 CANADA CORPORATION

EMERALD WOODS

Drawing Name

LOT DEVELOPMENT PLAN

Scale

1:1200 — 0 12 36 60m

Revision	Sheet	Drawing No.
REV-0	1 of 1	LD-1

APPENDIX B

Background MECP Water Well Records

Background MECP Water Well Records (500 m)

Proposed Emerald Woods Residential Subdivision

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS[1])	Water Found (m BGS)	Water Detail	Well Use
1531226	05-06-00	48.8	5.5	6.1	45.1, 47.5	FR	DO
1507174	07-06-66	12.2		2.1	12.2	FR	DO
1514264	28-08-74	14.6	2.4	1.5	9.1, 13.4	FR	DO
1532953	20-06-02	59.4	1.5	7.9	57.3	UK	DO
1509590	02-07-68	14.6	5.2	0.9	14.6	FR	DO
1527155	29-06-93	29.9	11.6		21, 27.4	UK	DO
7189207	24-09-12					UT	DO
1512180	06-09-72	12.2	0.3	1.2	11.6	FR	DO
1532442	18-09-01	54.9	0.1	4.9	51.5, 53	FR	DO
1528294	16-11-94	42.7	2.7	3	39.6	FR	DO
1535016	05-08-04	18.9	10.7	2.7	16.8		DO
1532600	30-10-01	53.3	0.1	11.6	50, 51.8	UK	DO
1534799	12-07-04	21.3	11.9	4.3	18, 19.8		DO
1532919	26-06-02	22.9	13.1	1.5	18.9	UK	DO
1526593	22-09-92	18.6	4.6	2.7	8.8, 13.4, 16.2	FR	DO
7272943	17-08-16						
1529630	16-09-97	53	7.6	7.9	50	UK	DO
1510959	16-10-70	16.8	7	2.1	16.2	FR	DO
1526464	29-06-92	62.5	0.1	14	59.4	FR	DO
1530360	12-11-98	47.2	8.8	7	47.2	UK	ST
1524519	13-05-90	13.7	11.3	1.8	12.8	UK	DO
1511675	19-11-71	20.1	2.1	0.9	20.1	FR	DO
1511312	20-07-71	12.2	2.1	2.4	11.6	UK	DO
1534774	15-06-04	67.7	1.8	12.4	61, 64.6		DO
1534781	04-06-04	49.4	10.4	8.7	47.2		DO
1532152	27-07-01	22.9	12.2	4.9	18.9	UK	DO
1530359	11-11-98	38.1	7.3	2.1	13.4, 33.8	UK	DO
1517031	05-07-79	11.9	6.4	4	11.3	FR	DO
1534784	21-06-04	19.2	12.5	4.7	16.2, 16.8		DO
1514040	27121	18	1.8	0.6	18	FR	DO
1531342	05-08-00	22.9	12.2	2.7	18.6	UK	DO
1513377	04-06-73	12.5	3	1.2	8.2, 11.9	FR	DO
1531143	04-05-00	22.9	15.2	3.4	19.2	UK	DO
1533041	08-07-02	55.5	12.2	11	53.3	UK	DO
7218233	09-07-13						
1514477	22-11-74	21.3		6.1	21.3	FR	DO
1526544	31-08-92	19.2	0.1	4.6	17.4	FR	DO

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS[1])	Water Found (m BGS)	Water Detail	Well Use
7145838	09-04-10	18.9		3.1	15.8, 16.8, 18	UT	DO
1535181	18-10-04	67	4.6	12.3	64.6		DO
1520088	24-09-85	19.2	7.3	2.4	12.2, 17.7	FR	DO
1533917	17-06-03	31.4	4.6	7.3	29	UK	DO
1511673	17-11-71	17.7	8.2	0.6	17.7	FR	DO
1531440	28-08-00	18.9	6.1	1.8	13.7, 15.5, 16.2	FR	DO
1525808	10-09-91	64	3.7	12.2	54.3, 62.8	FR	DO
1513438	12-07-73	7.6	6.1	0.9	6.7, 7.6	FR	DO
1535313	06-12-04	57.9	1.2	9.1	56.1	UK	DO
1529087	06-07-96	22.9	2.4	4	19.8	UK	DO
1519474	15-10-84	19.2	0.9	3	17.4	FR	DO
1526168	05-05-92	49.7	1.8	3.7	15.2, 48.8	FR	DO
1530312	09-07-98	48.8	8.5	5.5	46.6	FR	DO
1532153	27-07-01	36.6	12.8	5.2	33.8	UK	DO
1535662	23-06-05	52.4	13.7	7.4	50.9		DO
1509836	20-11-68	12.5	8.2	2.1	12.2	FR	DO
1530956	28-09-99	18.3	11.9	0.9	15.2	UK	DO
1525435	10-04-91	15.2	12.2	1.5	14	UK	DO
1517699	27-08-81	29	5.2	6.7	25.9	FR	DO
1534775	17-06-04	49.1	1.8	10.4			DO
7187705	31-07-12	62.8		13.5	60.7	UT	DO
1507176	08-10-65	17.1	0.9	0.6	17.1	FR	DO
1518551	21-02-83	21.3	7.3	3	19.8	UK	DO
7046768	09-05-05						
1530361	12-11-98	18.3	3.4	2.4	10.7, 14.9	UK	ST
1528178	11-08-94	36.9	1.2	6.1	16.2, 31.1	FR	DO
1518847	23-09-83	12.2	1.8	2.1	11	FR	DO
1531973	02-04-01	24.4	13.7	2.1	16.2, 18.3, 22.6	FR	DO
1534905	03-09-04	25	13.7	4.6			DO
1529730	17-10-97	30.5	15.2	2.4	24.4	UK	DO
1511387	18-08-71	9.4	3	1.8	9.4	FR	DO
1533115	13-08-02	64	13.1	7.3	56.7, 62.2	UK	DO
7113132	39717	18.3		0.8	9.1, 14.6, 15.8	UT	DO
1530184	35961	48.8	9.1	7.9	46.6	FR	DO
7187423	41086	82.9		13.4	82.6	UT	DO
1532534	37223	18.3	3.7	2.1	14	UK	DO
1532952	37424	36.6	2.4	15.2	25.9, 34.1	UK	DO
1511946	26413	18.3	2.7	1.5	17.7	FR	DO
1511013	25914	7		0.6	6.1	FR	DO
1531225	36682	24.4	4.6	6.1	14.9, 17.4, 20.4, 21.6	FR	DO

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS[1])	Water Found (m BGS)	Water Detail	Well Use
1514589	27451	48.8	9.1	6.1	48.2	FR	DO
1513842	26823	19.8	5.2	2.4	19.8	FR	DO
1507172	23156	15.5	7	2.1	14.9	FR	DO
1518682	30533	68.6	3.4	6.1	67.1	FR	DO
1514272	27269	14.6	1.8	1.5	13.4	SU	DO
1515730	28061	16.8	9.4	1.2	14.9	FR	DO
1507223	23538	22.6	5.5	5.2	22.6	FR	DO
1529380	35514	62.5	3.7	6.1	59.4	FR	DO
7053821	39385	24.4		2	14.9, 18, 21.3	UK	DO
7134336	40100	79.3		46.9	36, 74.7	UT	DO
1512214	26616	42.7	5.5	4.6	42.4	FR	DO
1507173	23916	11.3	8.2	2.1	10.7	FR	DO
1510099	25366	20.4	2.1	0.3	19.8	FR	DO
1515467	27933	13.4	3	1.8	10.7, 12.5	FR	DO
1534479	37978	55.5	14.6	6.9	51.8	UK	DO
1532090	37041	54.9	1.8	8.2	52.4	FR	DO
1530953	36437	38.1	4.6	5.5	21, 34.7	UK	DO
1534782	38142	55.5	10.4	7.2	48.8, 52.4		DO
7049236	39267	30.5		4.8	#VALUE!		DO
1527700	34344	83.8	61	1.5	76.2, 76.8	UK	
1516711	28759	17.7	1.2	2.1	16.8	FR	DO
1518686	30533	56.4	3.4	6.1	54.9	FR	DO
1531052	36564	25	15.5	7.9	21, 22.3	UK	DO
1535175	38266	54.9	2.4	7.1			DO
1528083	34526	18.3	12.2	2.1	14, 17.1	UK	DO
1507178	24320	15.2	0.1	3	13.7	FR	DO
1531034	36501	46.6	8.5	4.3	23.5, 44.8	UK	DO
1515176	27732	8.5	4.6	1.8	7.3	FR	DO
1533901	37777	38.1	9.1	2.7	37.2	UK	DO
1533613	37660	41.1	4	4.6	37.2, 38.1	UK	NU
1512459	26728	10.7	1.8	0.6	10.1	FR	DO
1529960	35753	18.3	0.1	2.7	11.9, 14.3, 16.2	FR	DO
1535270	38314	19.2	11.9	4.2	16.2		DO
7272966	42598	62.2		13.6	59.7	UT	DO
1525054	33151	57.9	0.1	7.9	31.4, 56.1	FR	DO
1527160	34136	29.9	9.8	2.7	23.8	UK	DO
1533006	37447	16.8	11.9	3.4	14.9	UK	DO
1530533	36300	22.9	12.8	2.4	21	UK	ST
1533360	37566	49.4	0.9	9.1	32.3, 47.5	UK	DO
7218241	41463	82.3		11.4	82	UT	DO
1535666	38537	18.9	5.5	2.8	14.9, 18.3		DO
1510622	25724	17.1	2.7	1.2	17.1	FR	DO

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS[1])	Water Found (m BGS)	Water Detail	Well Use
1515677	27976	12.2	1.8	2.4	9.8, 11.6	FR	DO
1528295	34655	18.3	1.5	3	11.9, 14, 15.8	UK	DO
1510523	25591	15.2	5.5	1.5	14.3	FR	DO
1527109	34078	53.3	3.4	6.1	7.6, 51.8	FR	DO
7230310	41884	30.5		1.9	11.6, 21, 28.7	UT	DO
1533528	37586	19.2	13.4	2.4	15.2, 16.2	UK	DO
1535908	38623	36.6	14.6	4.3	35.1	FR	DO
1518213	30370	44.2	9.1	3	25.9, 42.7	FR	DO
1533371	37561	25	0.9	7.6	21.9	UK	DO
1510100	25350	19.8		0.6	19.2	FR	DO
1532582	37229	62.5	1.2	7.3	60	UK	DO
1512222	26617	10.7	2.7	2.7	10.1	FR	DO
1514273	27269	14.6	1.5	1.5	13.4	SU	DO
1510802	25781	16.5	0.9	1.5	16.5	FR	DO
1528291	34654	18.3	1.8	3	11, 11.9, 15.8	UK	DO
7134334	40099	42.7		5.4	41.1	UT	DO
1528510	34831	22.9	12.8	4	20.1	UK	DO
1530737	36342	30.5	4.3	2.4	19.2, 24.1, 27.7	FR	DO
1527441	34201	54.9	0.9	11.3	28.7, 52.1	SU	DO
1533372	37564	63.4	2.7	8.5	58.2, 61.9	UK	DO
1532339	37146	61	8.8	10.1	52.1	UK	DO
1511505	26233	18.3	5.5	3	16.8	FR	DO
1526130	33568	13.7	11.6	1.5	12.8	UK	DO
1510468	25511	20.4	5.8	2.1	19.8	FR	DO
7324269	43384						
7042546	39150	57.9	10.4	7.1	53.3		DO
1527194	34149	43.6	0.1	3.4	41.8	FR	DO
1527985	34500	16.5	12.2	1.8	15.2	UK	DO
1507180	24381	12.2	1.5	2.4	7.6, 9.1, 11.6	FR	DO
1509930	25146	18.3	0.1	2.1	18.3	FR	DO
1533427	37587	59.1	0.1	7.9	57.6	UK	DO
1534779	38139	55.5	2.7	7.6			DO
1534903	38232	49.7	8.5	9.7	46.6		DO
7126966	40022	19.2		1	14, 16.2, 16.5	UT	DO
7132022	40085					UT	DO
1531439	36766	51.2	8.2	5.5	48.8, 49.4	FR	DO
7272971	42598	59.4		13.9	57.6	UT	DO
7151405	40422	54.9		9.6	25, 52.7	UT	DO
1529959	35751	18.3	8.2	2.7	11.9, 16.8	FR	DO
1531219	36682	18.6	7	5.2	11.3, 14.6, 16.2	FR	DO
1529514	35584	30.5	9.8	2.1	12.8, 29.3	FR	DO

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS[1])	Water Found (m BGS)	Water Detail	Well Use
1507177	24310	15.5	0.1	2.1	15.5	FR	DO
7157195	40457	18.9		4			DO
1534722	38127	61.3	0.3	10.3	8.5, 48.8, 57	UK	DO
1526463	33785	62.5	0.1	14	59.1	FR	DO
1534481	37965	49.1	14.6	6.1	46.9	UK	DO
1507179	24328	20.7	0.1	2.1	20.7	FR	CO
1525053	33156	54.9	0.1	8.8	32, 52.1	FR	DO
1516113	28317	13.4	3	1.8	9.1, 12.2	FR	DO
1512205	26638	14.6	2.1	0.9	14	FR	DO
1532094	37027	24.4	8.5	5.8	18.3, 21.6	FR	DO
1525431	33338	13.1		1.8	13.1	UK	DO
1535185	38287	57.9	0.9	9.6			DO
1533135	37490	44.2	15.2	4.9	39.6	FR	DO
1533352	37526	57.9	1.8	14.6	55.5	UK	DO
1534780	38142	45.7	10.4	7.2			DO
1525388	33289	17.4	8.8	4.6	10.7, 15.2	UK	DO
7187704	41121	61		14.6	58.5	UT	DO
1535973	38614	21.9	12.2	4	18.9		DO
7324275	43375	18.9		3.1	14.6, 15.5, 16.2		#N/A
1518212	30249	12.2	2.1	1.2	11	FR	DO
1512223	26617	12.2	1.5	3	11.6	FR	DO
1531929	37036	61	16.8	6.7	43.6, 57.6	UK	DO
1515123	27673	9.1	0.9	1.2	7.9	FR	DO
1530738	36346	57.3	8.5	8.5	46.3	FR	DO
1533365	37560	49.1	0.9	6.1	46.6	UK	DO
1536034	38644	57.3	3	7.2			MN
1533438	37545	53.3	4.3	11.3	25.9, 51.5	UK	DO
1533364	37557	61.6	1.5	10.7	57.9, 59.7	UK	DO
7132591	40086	18.3		3	16.2	UT	DO
1529744	35678	24.7	2.1	12.5	23.2	FR	DO
7132137	40011	10.7		2.3	8.2	MN	DO
1532592	37203	25	16.1	6.7	18, 21.3, 22.3	UK	DO
1533784	37740	55.2	2.7	5.5	45.7, 53.3	UK	DO
1532581	37228	49.1	9.8	5.5	42.1, 46	UK	DO
1518089	30280	30.5	4	3	29	FR	DO
7272944	42599						
1509833	24950	14.9	1.8	1.2	13.4	FR	DO
1533289	37531	29.9	12.8	4.3	26.2	UK	DO
1532603	37246	55.5	1.8	7.9	53	FR	DO
1525386	33289	24.4	1.2	1.5	9.1, 22.3	UK	DO
1526104	33650	54.9	2.7	4.3	10.4, 46.9	FR	DO
1534991	38147	29.9	14.3	3.1			DO

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS[1])	Water Found (m BGS)	Water Detail	Well Use
7324283	43378	42.7		6.8	12.8, 20.1, 39.3		
1529740	35639	33.5	6.1	7.3	31.4	FR	DO
1528931	35150	18.3	4.6	1.5	7.9, 10.1, 14.9, 15.8	UK	DO
1531821	36896	43.3	7.6	4.9	36.3, 39.6, 40.8	FR	DO
1512181	26548	12.2	1.5	2.4	10.7	FR	DO
1534154	37896	42.7	1.2	3	39.6	UK	DO
1531596	36652	54.9	0.1	8.5	29.6, 51.2	FR	DO
1515995	28238	19.2	9.1	0.6	18.3	FR	DO
1533095	37480	45.1	1.5	11.6	41.8	UK	DO
1512099	26416	20.7	0.1		20.7	FR	DO

Notes. BGS: below ground surface

"Well Use"

DO	Domestic
ST	Livestock
IR	Irrigation
IN	Industrial
CO	Commercial
MN	Municipal
PS	Public
AC	Cooling and A/C
NU	Not Used
OT	Other
TH	Test Hole
DE	Dewatering
MO	Monitoring
MT	Monitoring Test

"Water Detail"

FR	Fresh
SA	Salty
SU	Sulphur
MN	Mineral
UK	Unknown
GS	Gas
IR	Iron

APPENDIX C

Test Pit and Borehole Logs, Grain Size Analyses

RECORD OF BOREHOLE 21-101

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 19 2021

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200 mm DIAMETER HOLLOW STEM	Ground Surface		102.38					10 20 30 40 50 60 70 80 90		
		TOPSOIL		102.25							
		Loose, brown SAND, with rootlets		0.13	1	SS	150	5	●		Bentonite
1					2	SS	305	7	●		
				100.86							Backfill
		Compact, grey SAND some silt		1.52	3	SS	380	10	●		
2											
					4	SS	610	26	●		
3											Bentonite
											Sand
				98.57							
4		Firm, grey SILTY CLAY		3.81	5	SS	305	WH			Screen
				97.81							
		Stiff, grey CLAYEY SILT		4.57	6	SS	610	1	●		
5											
				96.94							
		Very dense, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		5.44							
6					7	SS	100	>50 for 125mm			
				96.16							
		End of Borehole		6.22							
7											
8											
9											
10											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21/03/29	0.2 ▽	102.2

GEMTEC
Consulting Engineers and Scientists

LOGGED: A.S.
CHECKED: W.A.M.

GEO - BOREHOLE LOG 100554.001_EMERLDLINKS_MAR9.2021_BH.GPJ GEMTEC 2018.GDT 26/4/21

RECORD OF BOREHOLE 21-103

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 19 2021

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger 200mm Diameter Hollow Stem	Ground Surface		103.03				
		Very dense, brown SILTY SAND, some gravel (FILL MATERIAL)		102.62	1	SS	455	33
		Compact, brown SAND		0.41				
1					2	SS	455	12
				101.51				
		Compact to dense, grey SILTY SAND, with shells		1.52	3	SS	405	15
2								
					4	SS	455	33
3								
				99.78	5	SS	510	1
		Grey SILTY CLAY		3.25				
				99.07				
4		Stiff, grey CLAYEY SILT		3.96				
					6	SS	305	9
5				97.85				
		Compact to loose, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		5.18	7	SS	355	21
6								
					8	SS	305	10
				96.32				
		End of Borehole		6.71				
7								
8								
9								
10								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Native Backfill

GEO - BOREHOLE LOG 100554.001_EMERLDLINKS_MAR9.2021_BH.GPJ GEMTEC 2018.GDT 26/4/21

GEMTEC
Consulting Engineers and Scientists

LOGGED: A.S.
CHECKED: W.A.M.

RECORD OF BOREHOLE 21-104

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 19 2021

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		102.33							
		TOPSOIL		0.08	1	SS	75	3			
		Very loose to compact, grey brown SAND			2	SS	380	3			
1											
					3	SS	610	12			
2											
				99.84	4	SS	610	2			
		Firm, grey SILTY CLAY		2.49							
3				99.28							
		Stiff, grey CLAYEY SILT		3.05	5	SS	250	12			
					6	SS	250	>50 for 125 mm			
4				98.14							
		Grey, SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		4:24							
		End of Borehole									
5											
6											
7											
8											
9											
10											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

PIEZOMETER OR STANDPIPE INSTALLATION: Bentonite / Backfill / Bentonite / Silica Sand / Screen

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21/03/29	0.0 ▽	102.3

GEMTEC
Consulting Engineers and Scientists

LOGGED: A.S.
CHECKED: W.A.M.

GEO - BOREHOLE LOG 100554.001_EMERLDLINKS_MAR9.2021_BH.GPJ GEMTEC 2018.GDT 26/4/21

RECORD OF BOREHOLE 21-105

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 19 2021

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger 200mm Diameter Hollow Stem	Ground Surface		102.16				
		TOPSOIL		0.08				
		Very loose to loose, grey brown SAND			1	SS	230	3
1					2	SS	355	5
				100.64				
		Compact, grey SAND, some silt		1.52	3	SS	405	14
2				99.87				
		Grey SILTY CLAY		2.29	4	SS	305	2
3					5	ST	610	PM
				98.50				
		Stiff, grey CLAYEY SILT		3.66	6	SS	305	WH
4				97.44				
		Compact, grey SILTY SAND, some gravel with cobbles and boulders (GLACIAL TILL)		4.72	7	SS	203	11
5					8	SS	75	11
6					9	SS	203	13
				95.45				
		End of Borehole		6.71				
7								
8								
9								
10								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Bentonite
Silica Sand
Screen
Silica Sand

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21/03/29	0.3 ▽	101.9

GEMTEC
Consulting Engineers and Scientists

LOGGED: A.S.
CHECKED: W.A.M.

GEO - BOREHOLE LOG 100554.001_EMERLDLINKS_MAR9.2021_BH.GPJ GEMTEC 2018.GDT 26/4/21

RECORD OF TEST PIT 21-01

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL, ⊕ REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.30			10 20 30 40 50 60 70 80 90		Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		0.20					
	Brown SAND			1	GS			
			101.60					
1	Grey SAND		0.70					
				2	GS			
2			100.30					
	Grey SILTY SAND, with shells		2.00					
3								
			98.40					
4	End of Test Pit Sidewalls caving in		3.90					Groundwater level at 1.1 mbgs upon completion
5								
6								
7								
8								
9								
10								

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-09	1.1 ▽	101.2

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-02

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

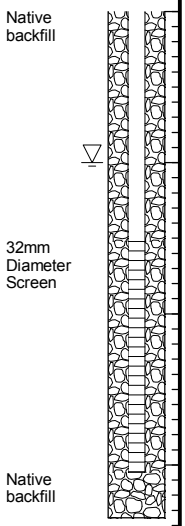
DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE
0	Ground Surface		102.45		
	TOPSOIL		0.10		
	Dark brown SAND, with rootlets		0.30		
	Brown SAND			1	GS
1	Grey SAND		101.45 1.00	2	GS
2	Grey SAND, with shells		100.45 2.00		
3	End of Test Pit Sidewalls caving in		99.10 3.35		
4					
5					
6					
7					
8					
9					
10					

SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
10 20 30 40 50 60 70 80 90

WATER CONTENT, %
W_P — W — W_L

ADDITIONAL LAB. TESTING

WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-12	1.0 ▽	101.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC 2018.GDT 3-31-21

RECORD OF TEST PIT 21-03

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.35					Native backfill
	TOPSOIL		0.05	1	GS			
	Dark brown SAND, with rootlets		101.75					
	Brown SAND, trace silt		0.60	2	GS		MH	
1								
2								
			99.61					
	Grey SILTY SAND, with shells		2.74	3	GS			
3								
4								
			97.78					
	End of Test Pit Sidewalls caving in		4.57					Groundwater level at 2.25 mbgs upon completion
5								
6								
7								
8								
9								
10								

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-08	2.3 ▽	100.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-04

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.50					Native backfill
	TOPSOIL		102.37 / 0.13	1	GS			
	Brown SAND, with rootlets							
	Grey SAND, with shells		101.75 / 0.75	2	GS			
3	Grey SILTY CLAY		99.50 / 3.00	3	GS			
4	End of Test Pit Sidewalls caving in		97.93 / 4.57					Groundwater level at 1.4 mbgs upon completion

10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-08	1.4 ▽	101.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-05

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA ⊣ NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
						10 20 30 40 50 60 70 80 90		
0	Ground Surface		102.60					
	TOPSOIL		0.05	1	GS			Native backfill
	Dark brown SAND, with rootlets		102.20					
	Grey brown SAND		0.40	2	GS			
1								
2			100.50					
	Grey SILTY SAND, with shells		2.10					
3				3	GS			
4			98.60					
	Grey SILTY CLAY		4.00	4	GS			
			98.10					
	End of Test Pit Sidewalls caving in		4.50					Test Pit dry upon completion
5								
6								
7								
8								
9								
10								

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-06

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA ⊢ NATURAL ⊕ REMOULDED / WATER CONTENT, % (W_P W W_L)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.85			10 20 30 40 50 60 70 80 90		Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		0.25	1	GS			
	Red brown SAND		101.95					
1	Grey brown SAND		0.90	2	GS			
2			100.75					
	Grey SILTY SAND, with shells		2.10	3	GS			
3			99.35					
	Grey SILTY CLAY		3.50	4	GS			
4			98.28					
	End of Test Pit Sidewalls caving in		4.57					Test Pit dry upon completion
5								
6								
7								
8								
9								
10								

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

RECORD OF TEST PIT 21-07

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL, ⊕ REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		101.95			10 20 30 40 50 60 70 80 90		Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		0.20	1	GS			
	Brown SAND		0.40					
1	Grey SAND			2	GS			
			100.15					
2	Grey SILTY SAND, with shells		1.80	3	GS			
			99.45					
3	Grey SILTY CLAY		2.50					
4				4	GS			Groundwater level at 1.8 mbgs upon completion
	End of Test Pit Sidewalls caving in		97.95 4.00					
5								
6								
7								
8								
9								
10								

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-08	1.8 ▽	100.2

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-08

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

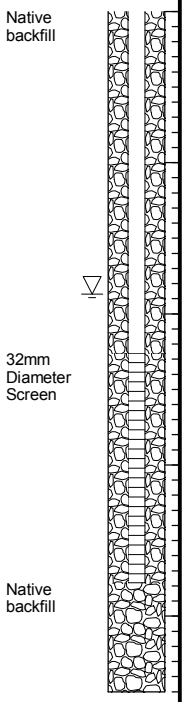
DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE
0	Ground Surface	102.95		
	TOPSOIL	0.05		
	Dark brown SAND, with rootlets	0.20	1	GS
	Red brown SAND	102.35		
	Grey brown SAND	0.60		
1			2	GS
2		100.95		
	Grey SILTY SAND, with shells	2.00	3	GS
3		99.95		
	Grey SILTY CLAY	3.00		
4			4	GS
		98.45		
	End of Test Pit Sidewalls caving in	4.50		
5				
6				
7				
8				
9				
10				

SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
10 20 30 40 50 60 70 80 90

WATER CONTENT, %
W_P — W — W_L

ADDITIONAL LAB. TESTING

WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-12	1.9 ▽	101.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-09

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE
0	Ground Surface		102.80		
	TOPSOIL		0.05		
	Dark brown SAND, with rootlets			1	GS
			102.10		
	Brown SAND		0.70	2	GS
1			101.70		
	Grey SILTY SAND, with shells		1.10		
2			100.50		
	Grey SILTY SAND		2.30	3	GS
3			99.50		
	Grey SILTY CLAY		3.30	4	GS
4			98.80		
	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		4.00		
			98.30		
	End of Test Pit Sidewalls caving in		4.50		
5					
6					
7					
8					
9					
10					

SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
10 20 30 40 50 60 70 80 90

WATER CONTENT, %
W_P — W — W_L

ADDITIONAL LAB. TESTING

WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION

Native backfill

Test Pit dry upon completion

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC 2018.GDT 3-31-21

RECORD OF TEST PIT 21-10

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.85					Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		102.45					
	Brown SAND		0.40	1	GS			
1			101.75					
	Grey brown SAND, trace silt		1.10	2	GS		MH	
2			100.55					
	Grey SILTY SAND, with shells		2.30	3	GS			
3			99.65					
	Grey SILTY CLAY		3.20	4	GS			
4			98.35					
	End of Test Pit Sidewalls caving in		4.50					Test Pit dry upon completion
5								
6								
7								
8								
9								
10								

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-11

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL, ⊕ REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.70			10 20 30 40 50 60 70 80 90		Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		0.30					
	Brown SAND							
1			101.40					
	Grey SAND		1.30					
			101.00					
	Grey SILTY SAND, some gravel, with shells		1.70					
2				1	GS			
			99.90					
	Grey SILTY CLAY		2.80					
3				2	GS			
4								
			98.20					
	End of Test Pit Sidewalls caving in		4.50					Groundwater level at 1.3 mbgs upon completion
5								
6								
7								
8								
9								
10								

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-08	1.3 ▽	101.4

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-12

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

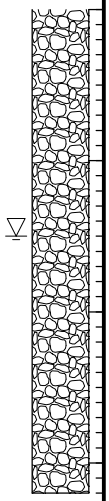
DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE
0	Ground Surface		102.65		
	TOPSOIL		0.05		
	Dark brown SAND, with rootlets		102.35		
			0.30		
	Brown SAND			1	GS
1			101.55		
	Grey SAND		1.10	2	GS
2			100.45		
	Grey SILTY SAND, with shells		2.20	3	GS
			99.85		
	Grey SILTY CLAY		2.80	4	GS
3			99.65		
	Grey SILTY SAND, some gravel with cobbles and boulders (GLACIAL TILL)		3.00		
			99.45		
			3.20		
	End of Test Pit Refusal on boulders in GLACIAL TILL				
4					
5					
6					
7					
8					
9					
10					

SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
10 20 30 40 50 60 70 80 90

WATER CONTENT, %
W_P — W — W_L

ADDITIONAL LAB. TESTING

WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-08	1.5 ▽	101.2

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-13

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 8 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA ⊣ NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
						10 20 30 40 50 60 70 80 90		
0	Ground Surface		102.70					Native backfill
	TOPSOIL		0.10					
	Dark brown SAND, with rootlets		0.30					
	Brown SAND		102.00					
1	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		0.70					
2				1	GS			
3			99.70					
	End of Test Pit Refusal in GLACIAL TILL		3.00					Test Pit dry upon completion
4								
5								
6								
7								
8								
9								
10								

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

RECORD OF TEST PIT 21-14

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL, ⊕ REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		102.75			10 20 30 40 50 60 70 80 90		Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		102.45					
	Brown SAND, trace gravel		0.30	1	GS			
	Grey SILTY SAND, trace gravel, with shells		0.50	2	GS			
1	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		0.65	3	GS			
			101.15					
	End of Test Pit Refusal on bedrock		1.60					Groundwater level at 1.4 mbgs upon completion
2								
3								
4								
5								
6								
7								
8								
9								
10								

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-09	1.4 ▽	101.4

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LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-15

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA ⊣ NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
						10 20 30 40 50 60 70 80 90		
0	Ground Surface		103.10					Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		102.86 0.24					
	Grey brown SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			1	GS			
1								
2			100.80					
	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		2.30	2	GS			
3			100.10					Test Pit dry upon completion
	End of Test Pit		3.00					
4								
5								
6								
7								
8								
9								
10								

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LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-16

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL, ⊕ REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		105.00			10 20 30 40 50 60 70 80 90		Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		0.20					
	Red brown SAND			1	GS			
1			104.00					
	Grey brown SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		1.00					
				2	GS			
2								
3			101.60					
	End of Test Pit Refusal in GLACIAL TILL		3.40					Test Pit dry upon completion
4								
5								
6								
7								
8								
9								
10								

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LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-17

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		103.70					Native backfill
	TOPSOIL		0.05					
	Dark brown SAND, with rootlets		103.40					
	Red brown SAND		0.30	1	GS			
			103.05					
1	Grey brown SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		0.65	2	GS		MH	
2								
3			100.70					
	End of Test Pit Refusal on boulders with GLACIAL TILL		3.00					Test Pit dry upon completion
4								
5								
6								
7								
8								
9								
10								

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LOGGED: M.L.
CHECKED: W.A.M.

GEO - TESTPIT LOG 100554.001_EMERLDLINKS_MAR8.2021_TESTPITS.GPJ GEMTEC.2018.GDT 3-31-21

RECORD OF TEST PIT 21-18

CLIENT: Ark Engineering and Development
PROJECT: Geotechnical Investigation, Proposed Emerald Woods Residential Development
JOB#: 100554.001
LOCATION: See Test Hole Location Plan, Figure 1

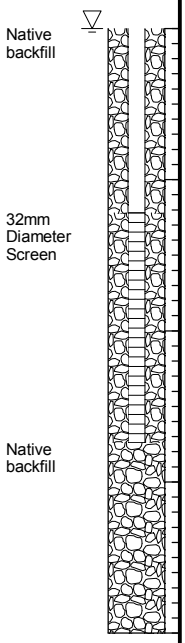
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Mar 9 2021

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE
0	Ground Surface		102.25		
	TOPSOIL		102.10 / 0.15		
	Dark brown SAND, with rootlets		0.30		
	Brown SAND			1	GS
			101.60 / 0.65		
	Grey SAND			2	GS
1					
2			100.25 / 2.00		
	Grey SILTY SAND, some gravel, with shells			3	GS
			99.95 / 2.30		
	Grey SILTY SAND				
3					
				4	GS
4			98.25 / 4.00		
	End of Test Pit Sidewalls caving in				
5					
6					
7					
8					
9					
10					

SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
21-03-12	0.0 ▽	102.25

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LOGGED: M.L.
CHECKED: W.A.M.

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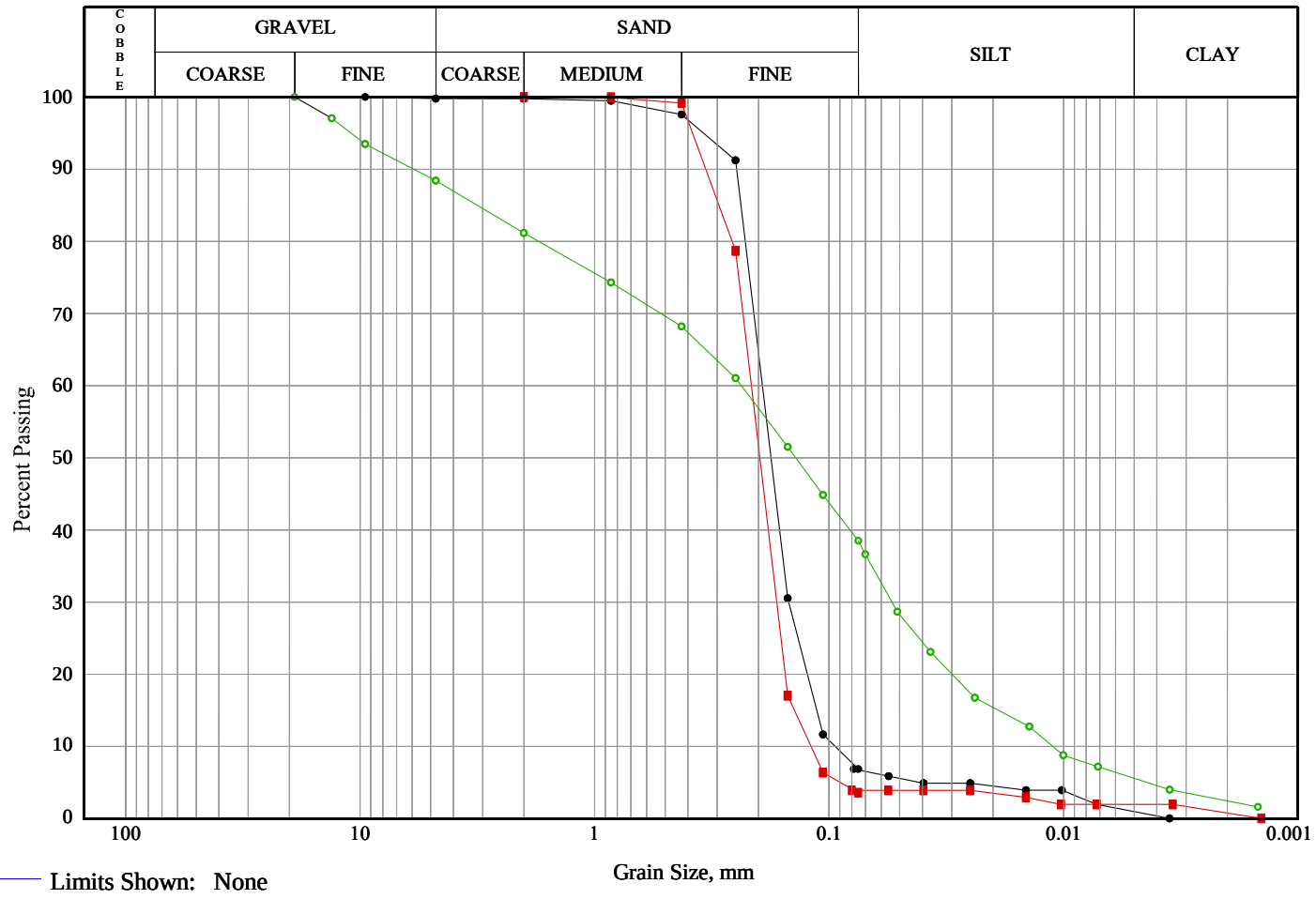
Client:	ARK Engineering
Project:	Geotechnical and Hydrogeological Services, Emerald Wo
Project #:	100554001

Soils Grading Chart



Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
	Sand, trace silt	21-03	GS-2	0.90-1.05	0.2	92.9	5.9	1.0
	Sand	21-10	GS-2	1.20-1.35	0.0	96.4	1.6	1.9
	Glacial Till	21-17	GS2	1.00-1.15	11.6	49.9	32.9	5.6

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
	Sand , trace gravel, trace silt, trace clay	N/A	0.09	0.11	0.15	0.18	0.19	0.24	5.9
	Sand , trace silt, trace clay	SP	0.12	0.14	0.17	0.20	0.21	0.29	1.6
	Silty sand , some gravel , trace clay	N/A	0.01	0.02	0.05	0.14	0.24	3.17	32.9

APPENDIX D

Nitrate Dilution Calculations

Nitrate Dilution Calculation Worksheet

Nitrate Loading

Residential Septic Systems (assumes 1,000 L/day/lot)

Number of lots with untreated septic systems =	74	lots
Nitrate loading from untreated septic system =	40	grams/lot/day
Total annual nitrate loading from untreated systems =	1080400	grams/year
Total Annual Nitrate Loading from all Systems =	**1080400**	**grams/year**

Dilution Volumes

Infiltration Factors

Topography factor =	0.23
Soil factor =	0.4
Cover factor =	0.165
Combined infiltration factor =	0.795

Precipitation Infiltration

Annual water surplus =	0.378	metres/year
Annual infiltration (Water Surplus x Infiltration Factor) =	0.3005	metres/year

Infiltration Area and Infiltration Volumes

Area available for infiltration (Site Area) =	350053.1	square metres
Area available for infiltration (Site Area - Hard Surface Area) =	318913.1	square metres

(assumes 1,700 m2 for interla roadways and 260m2 for each lot house+driveway)

Total Annual Volume of Infiltration (Infiltration x Area) =	95837	cubic metres/year
Annual Flow from Residential Lots (assuming 1000 L/day/lot) =	27010	cubic metres/year
Total Annual Volume Available for Dilution =	**122847**	**cubic metres/year**

Dilution Calculation

$$C_{Nitrate} = \frac{Mass}{Volume} = \frac{Annual\ Nitrate\ Loading(grams/year)}{Annual\ Dilution\ Volume(cubic\ metres/year)} = \frac{grams}{cubic\ metre} = \frac{mg}{L}$$

$$\mathbf{C_{Nitrate} = \frac{1080400\ grams/year}{122847\ cubic\ metres/year} = 8.79\ mg/L}$$

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Nitrate Dilution Calculation Worksheet

Nitrate Loading

Residential Septic Systems (assumes 1,000 L/day/lot)

Number of lots with untreated septic systems =	86	lots
Nitrate loading from untreated septic system =	40	grams/lot/day
Total annual nitrate loading from untreated systems =	1255600	grams/year
Total Annual Nitrate Loading from all Systems =	**1255600**	**grams/year**

Dilution Volumes

Infiltration Factors

Topography factor =	0.23
Soil factor =	0.4
Cover factor =	0.165
Combined infiltration factor =	0.795

Precipitation Infiltration

Annual water surplus =	0.378	metres/year
Annual infiltration (Water Surplus x Infiltration Factor) =	0.3005	metres/year

Infiltration Area and Infiltration Volumes

Area available for infiltration (Site Area) =	350053.1	square metres
Area available for infiltration (Site Area - Hard Surface Area) =	315793.1	square metres

(assumes 1,700 m2 for interla roadways and 260m2 for each lot house+driveway)

Total Annual Volume of Infiltration (Infiltration x Area) =	94899	cubic metres/year
Annual Flow from Residential Lots (assuming 1000 L/day/lot) =	31390	cubic metres/year
Total Annual Volume Available for Dilution =	**126289**	**cubic metres/year**

Dilution Calculation

$$C_{Nitrate} = \frac{Mass}{Volume} = \frac{Annual\ Nitrate\ Loading(grams/year)}{Annual\ Dilution\ Volume(cubic\ metres/year)} = \frac{grams}{cubic\ metre} = \frac{mg}{L}$$

$$\mathbf{C_{Nitrate} = \frac{1255600\ grams/year}{126289\ cubic\ metres/year} = 9.94\ mg/L}$$

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APPENDIX E

Test Pit and Monitoring Well Water Quality Laboratory Results

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 124959

Report Date: 11-Mar-2021
Order Date: 8-Mar-2021

Order #: 2111112

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2111112-01	TP21-04 GW-1
2111112-02	TP21-07 GW-1
2111112-03	TP21-12 GW-1

Approved By:

Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	10-Mar-21	10-Mar-21

Certificate of Analysis

Report Date: 11-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 8-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TP21-04 GW-1	TP21-07 GW-1	TP21-12 GW-1	-
	Sample Date:	08-Mar-21 10:00	08-Mar-21 11:15	08-Mar-21 13:00	-
	Sample ID:	2111112-01	2111112-02	2111112-03	-
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	-
Anions					
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	0.53	0.1	mg/L	0.54			2.0	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.58	0.1	mg/L	0.54	104	79-120			
Nitrite as N	1.01	0.05	mg/L	ND	101	84-117			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 124960

Report Date: 11-Mar-2021
Order Date: 9-Mar-2021

Order #: 2111200

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2111200-01	TP21-02 GW-1
2111200-02	TP21-18 GW-1

Approved By:

Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Report Date: 11-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 9-Mar-2021

Client PO:

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	10-Mar-21	10-Mar-21

Certificate of Analysis

Report Date: 11-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 9-Mar-2021

Client PO:

Project Description: 100554.001

Client ID:		TP21-02 GW-1	TP21-18 GW-1	-	-
Sample Date:		09-Mar-21 11:00	09-Mar-21 11:00	-	-
Sample ID:		2111200-01	2111200-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Anions					
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	-	-

Certificate of Analysis

Report Date: 11-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 9-Mar-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						

Certificate of Analysis

Report Date: 11-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 9-Mar-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	0.53	0.1	mg/L	0.54			2.0	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.58	0.1	mg/L	0.54	104	79-120			
Nitrite as N	1.01	0.05	mg/L	ND	101	84-117			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 13297

Report Date: 29-Apr-2021
Order Date: 27-Apr-2021

Order #: 2118199

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2118199-01	BH21-101
2118199-02	BH21-104
2118199-03	BH21-105

Approved By:

Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Report Date: 29-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 27-Apr-2021

Client PO:

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	28-Apr-21	28-Apr-21

Certificate of Analysis

Report Date: 29-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 27-Apr-2021

Client PO:

Project Description: 100554.001

	Client ID:	BH21-101	BH21-104	BH21-105	-
	Sample Date:	27-Apr-21 12:10	27-Apr-21 12:50	27-Apr-21 12:30	-
	Sample ID:	2118199-01	2118199-02	2118199-03	-
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	-
Anions					
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.67	0.1	mg/L	1.67			0.1	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	2.66	0.1	mg/L	1.67	98.7	79-120			
Nitrite as N	0.979	0.05	mg/L	ND	97.9	84-117			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

APPENDIX F

On-Site Water Well Records

Ontario — Ministry of the Environment, Conservation and Parks

We Tag#:A313160 (Print Below)

A313160

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☐ Metric ☒ Imperial

Page ____ of ____

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	9287043 Canada Corporation (under agreement)		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1705 Old Prescott Road	Greely	ON	K4P 1M8	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Fox Valley Road (No Civic)	Osgoode	P/L 4	3

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Greely	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	452384	5011298	Test Well #1 of 5	S/L 2

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
	Sand	& Gravel & Clay & Boulders		0'	29'
Grey & Black	Limestone			29'	94'
Grey & Black	Limestone			94'	100'

* DO NOT SET PUMP BELOW 80 FT. - BROKEN ROCK *

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/imp gal)
40'	30'	Neat cement	10.9
30'	0'	Bentonite slurry	16.8

Method of Construction

☐ Cable Tool ☐ Diamond ☐ Rotary (Conventional) ☐ Jetting ☐ Rotary (Reverse) ☐ Driving ☐ Boring ☐ Digging ☒ Air percussion ☐ Other, specify ____

Well Use

☐ Public ☐ Commercial ☐ Not used ☒ Domestic ☐ Municipal ☐ Dewatering ☐ Livestock ☐ Test Hole ☐ Monitoring ☐ Irrigation ☐ Cooling & Air Conditioning ☐ Industrial ☐ Other, specify ____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6 1/4"	Steel	.188"	+2'	40'
6"	Open Hole		40'	100'

Status of Well

☒ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ____ ☐ Other, specify ____

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify Not tested

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 80

Pumping rate (l/min / GPM): 20

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 62'

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 80'

Recommended pump rate (l/min/GPM): 20

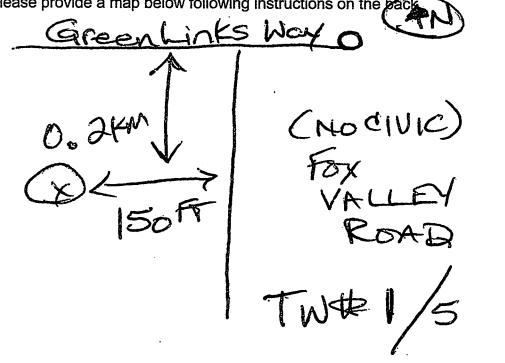
Well production (l/min/GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	7'8"		62'
1	16.1	1	31
2	20.9	2	20.8
3	24.6	3	11.9
4	27.5	4	7.8
5	30	5	7.8
10	38.6	10	7.8
15	44.2	15	7.8
20	48.2	20	7.8
25	50.9	25	7.8
30	52	30	7.8
40	55	40	7.8
50	59.1	50	7.8
60	62'	60	7'8"

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

Water found at Depth (m/ft)	Kind of Water	Gas	Other, specify
94	☐ Fresh ☒ Untested	☐	
	☐ Fresh ☐ Untested	☐	
	☐ Fresh ☐ Untested	☐	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	40'	9 3/4"
40'	100'	6"

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	7681

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
6659 Franktown Road	Richmond	ON	K0A 2Z0	air-rock@sympatico.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)	Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
6138382170	Hanna, Jeremy	T3632		2021 03 31 (Y Y Y Y M M D D)

Comments: 1/2HP-10GPM Set @ 80 FT

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☒ Yes ☐ No	2021 03 12	2021 03 10

Ministry Use Only

Audit No 2355028

Received

Ontario — Ministry of the Environment, Conservation and Parks

Tag#:A305114 (or Print Below)

A305114

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☐ Metric ☒ Imperial

Page ____ of ____

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	9287043 Canada Corporation (under agreement)		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1705 Old Prescott Road	Greely	ON	K4P 1M8	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Fox Valley Road (No Civic)	Osgoode	P/L 4	3

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Greely	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	452543	5010900	Test Well #2 OF 5	S/L 11

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
	Sand & Gravel	& Boulders		0'	17'
Grey & Black	Limestone			17'	135'
Grey & Black	Limestone			135'	141'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft³)
40'	30'	Neat cement	10.9
30'	0'	Bentonite slurry	12.6

Method of Construction

☐ Cable Tool ☐ Diamond ☒ Air percussion
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☒ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6 1/4"	Steel	.188"	+2'	40'
6"	Open Hole		40'	141'

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Status of Well

☒ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Water Details

Water found at Depth (m/ft)	Kind of Water	Hole Depth From (m/ft)	Hole Depth To (m/ft)	Hole Diameter (cm/in)
135 (m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify	0'	40'	9 3/4"
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify	40'	141'	6"
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify			

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft³)
40'	30'	Neat cement	10.9
30'	0'	Bentonite slurry	12.6

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify Not tested

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 120

Pumping rate (l/min / GPM): 20

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 29.9"

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 100'

Recommended pump rate (l/min/GPM): 20

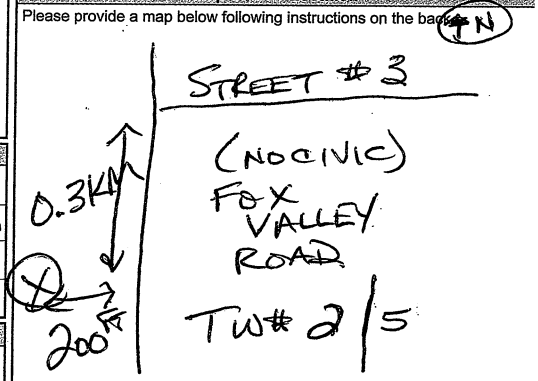
Well production (l/min/GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	11'2"		29.9"
1	15.5	1	23.7
2	17.2	2	17.5
3	18.2	3	12.8
4	19.2	4	11.2
5	20.	5	11'2"
10	22.5	10	
15	24.2	15	
20	25.4	20	
25	26.3	25	
30	27.	30	
40	28.2	40	
50	29.1	50	
60	29.9	60	

Map of Well Location

Please provide a map below following instructions on the back.



Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	7681

Business Address (Street Number/Name)	Municipality
6059 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
ON	K0A 2Z0	air-rock@sympatico.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Hanna, Jeremy

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted (Y Y Y Y M M D D)
T3632		2021 03 31

Comments: 1/2HP-10 GPM Set @ 100 FT

Well owner's information package delivered	Date Package Delivered (Y Y Y Y M M D D)	Ministry Use Only
☒ Yes ☐ No	2021 03 11	Audit No: Z355038

Date Work Completed: 2021 03 10 (Y Y Y Y M M D D)

Received

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Tag#:A313200 (Print Below)

A313200

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☐ Metric ☒ Imperial

Page ____ of ____

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	9287043 Canada Corporation (under agreement)		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1705 Old Prescott Road	Greely	ON	K4P 1M8	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
NO CIVIC - STREET 3	Osgoode	P/L 4	3

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Greely	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	452788	5011237	Test well #3 of 5	S/L 64

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
	Sand	+ Gravel + Boulders		0	19
Grey + Black	Limestone			19	150
Grey & White	Sandstone			150	160
Grey & White	Sandstone			160	166

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
40'	30'	Neat cement	10.9
30'	0'	Bentonite slurry	12.6

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☒ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☒ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6¼"	Steel	.188"	+2'	40'
6"	Open Hole		40'	166'

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water	Other, specify
160	☐	☐ Fresh ☒ Untested	
	☐	☐ Fresh ☐ Untested	
	☐	☐ Fresh ☐ Untested	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	40'	9 3/4"
40'	166'	6"

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	7681

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
6059 Franktown Road	Richmond	ON	K0A 2Z0	air-rock@sympatico.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)	Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted (Y Y Y Y M M D D)
6138382170	Hanna, Jeremy	T3632		2021 03 31

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify **Not tested**

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 150

Pumping rate (l/min / GPM): 20

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 25'8"

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 140'

Recommended pump rate (l/min/GPM): 20

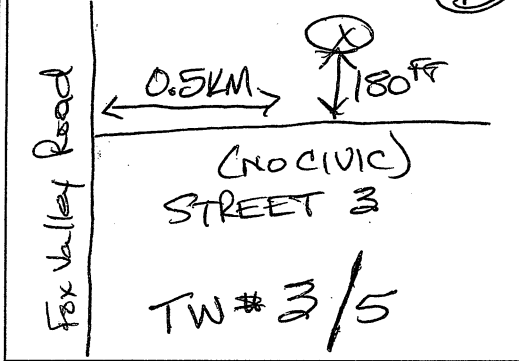
Well production (l/min/GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	21'9"		25'8"
1	24.3	1	22.3
2	24.6	2	21.9
3	24.8	3	21.9
4	24.9	4	21.9
5	25	5	21.9
10	25.2	10	21.9
15	25.2	15	21.9
20	25.4	20	21.9
25	25.5	25	21.9
30	25.6	30	21.9
40	25.7	40	21.9
50	25.8	50	21.9
60	25.8'	60	21'9"

Map of Well Location

Please provide a map below following instructions on the back.



Comments: 1/2HP-10GPM Set @ 140FT

Well owner's information package delivered: ☒ Yes ☐ No

Date Package Delivered: 2021 03 10

Date Work Completed: 2021 03 08

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Audit No: Z355033

Received

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Tag#:A305116 (Print Below)

A305116

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☐ Metric ☒ Imperial

Page ____ of ____

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	9287043 Canada Corporation (under agreement)		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1705 Old Prescott Road	Greely	ON	K4P 1M8	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
NO CIVIC - STREET 3	Osgoode	P/L 4	3

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Greely	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	453096	5011322	Test well 4 of 5	S/L 40

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
	Sand	& Boulders		0'	4'
Grey & Black	Limestone			4'	116'
Grey & White	Sandstone			116'	144'
Grey & White	Sandstone			144'	150'
Grey & White	Sandstone			150'	156'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
40'	30'	Neat cement	10.9
30'	0'	Bentonite slurry	21

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☒ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☒ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6 1/4"	Steel	.188"	+2'	40'
6"	Open Hole		40'	156'

Status of Well

☒ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water: Fresh / Untested	Other, specify
144	☐	☒ Fresh ☐ Untested	
150	☐	☒ Fresh ☐ Untested	
	☐	☐ Fresh ☐ Untested	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	40'	9 3/4"
40'	156'	6"

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify — Not tested

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 140

Pumping rate (l/min/GPM): 20

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 41'9"

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 140'

Recommended pump rate (l/min/GPM): 20

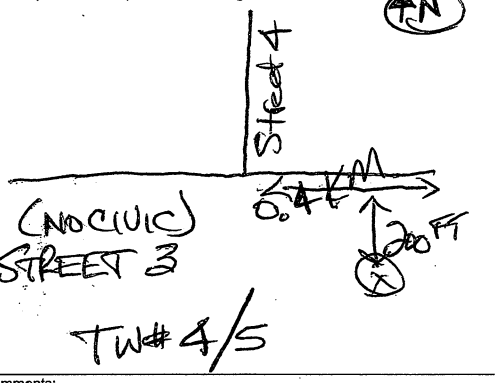
Well production (l/min/GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	23'4"		41'9"
1	30.2	1	37.8
2	33.4	2	34.2
3	35.4	3	30.4
4	36.7	4	26.1
5	37.7	5	23.4
10	40	10	23.4
15	40.8	15	23.4
20	41.2	20	23.4
25	41.4	25	23.4
30	41.6	30	23.4
40	41.8	40	23.4
50	41.9	50	23.4
60	41'9"	60	23'4"

Map of Well Location

Please provide a map below following instructions on the back.



Comments: 1/2 hr. 10 GPM Set @ 140 FT

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
ON	K0A 2Z0	air-rock@sympatico.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Hanna, Jeremy

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted (Y Y Y Y M M D D)
T3632		2021 03 31

Well owner's information package delivered	Date Package Delivered (Y Y Y Y M M D D)	Ministry Use Only
☒ Yes ☐ No	2021 03 05	Audit No Z355030
	Date Work Completed (Y Y Y Y M M D D)	Received
	2021 03 04	

Ministry's Copy

Ontario — Ministry of the Environment, Conservation and Parks

Tag#:A313201 (or Print Below)

A313201

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☐ Metric ☒ Imperial

Page ____ of ____

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	9287043 Canada Corporation (under agreement)		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1705 Old Prescott Road	Greely	ON	K4P 1M8	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
NO CIVIC - STREET 4	Osgoode	P/L 4	3

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Greely	Ontario	

UTM Coordinates Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83 18	452959	5011592	Test Well #5 of 5	S/L 49

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
	Sand & Gravel & Clay		& Boulders	0'	19'
Grey & Black	Limestone			19'	126'
Grey & White	Sandstone			126'	135'
Grey & White	Sandstone			135'	141'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
40'	30'	Neat cement	10.9
30'	0'	Bentonite slurry	12.6

Method of Construction

☐ Cable Tool ☐ Diamond ☐ Rotary (Conventional) ☐ Jetting ☐ Rotary (Reverse) ☐ Driving ☐ Boring ☐ Digging ☒ Air percussion ☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used ☒ Domestic ☐ Municipal ☐ Dewatering ☐ Livestock ☐ Test Hole ☐ Monitoring ☐ Irrigation ☐ Cooling & Air Conditioning ☐ Industrial ☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
6 1/4"	Steel	.188"	+2'	40'
6"	Open Hole		40'	141'

Status of Well

☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water	Other, specify
135	☐	☐ Fresh ☒ Untested	
	☐	☐ Fresh ☐ Untested	
	☐	☐ Fresh ☐ Untested	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	40'	9 3/4"
40'	141'	6"

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
ON	K0A 2Z0	air-rock@sympatico.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Hanna, Jeremy

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632		2021 03 31

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify Not tested

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 130

Pumping rate (l/min / GPM): 20

Duration of pumping: 4 hrs + 0 min

Final water level end of pumping (m/ft): 26.3'

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 100'

Recommended pump rate (l/min/GPM): 20

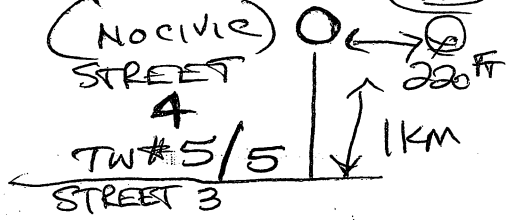
Well production (l/min/GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	21.4'		26.3'
1	24.9	1	22.5
2	25.2	2	21.4
3	25.3	3	21.4
4	25.4	4	21.4
5	25.4	5	21.4
10	25.6	10	21.4
15	25.8	15	21.4
20	25.9	20	21.4
25	26	25	21.4
30	26.1	30	21.4
40	26.2	40	21.4
50	26.3	50	21.4
60	26.3'	60	21.4'

Map of Well Location

Please provide a map below following instructions on the back.



Comments: 1/2HP - 10GPM SA @ 100 FT

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☒ Yes ☐ No	2021 03 10	2021 03 09

Ministry Use Only

Audit No. Z355031

Received

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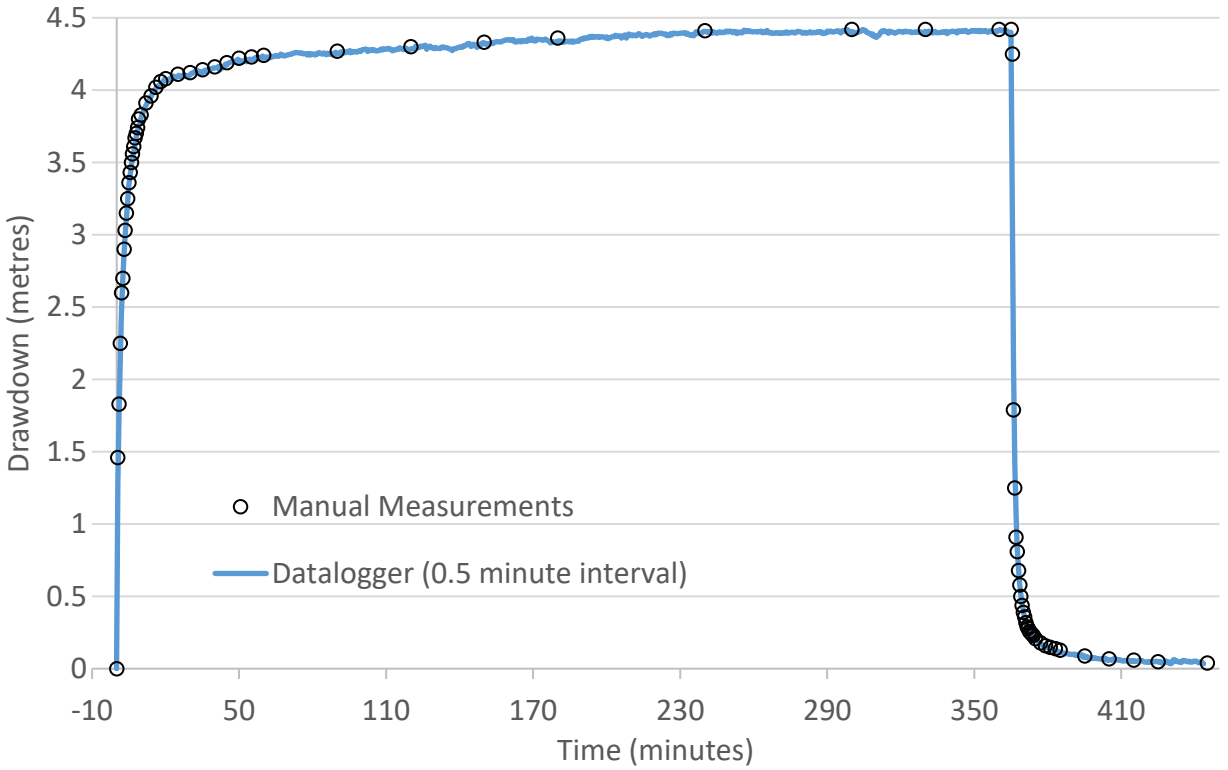
APPENDIX G

Pumping Test Data and Analyses

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RF	Pumping Well: TW-1	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Manual Measurements	Analysis Date: March 29th , 2021
Aquifer Thickness: 29 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Data (TW-1): Drawdown and Recovery

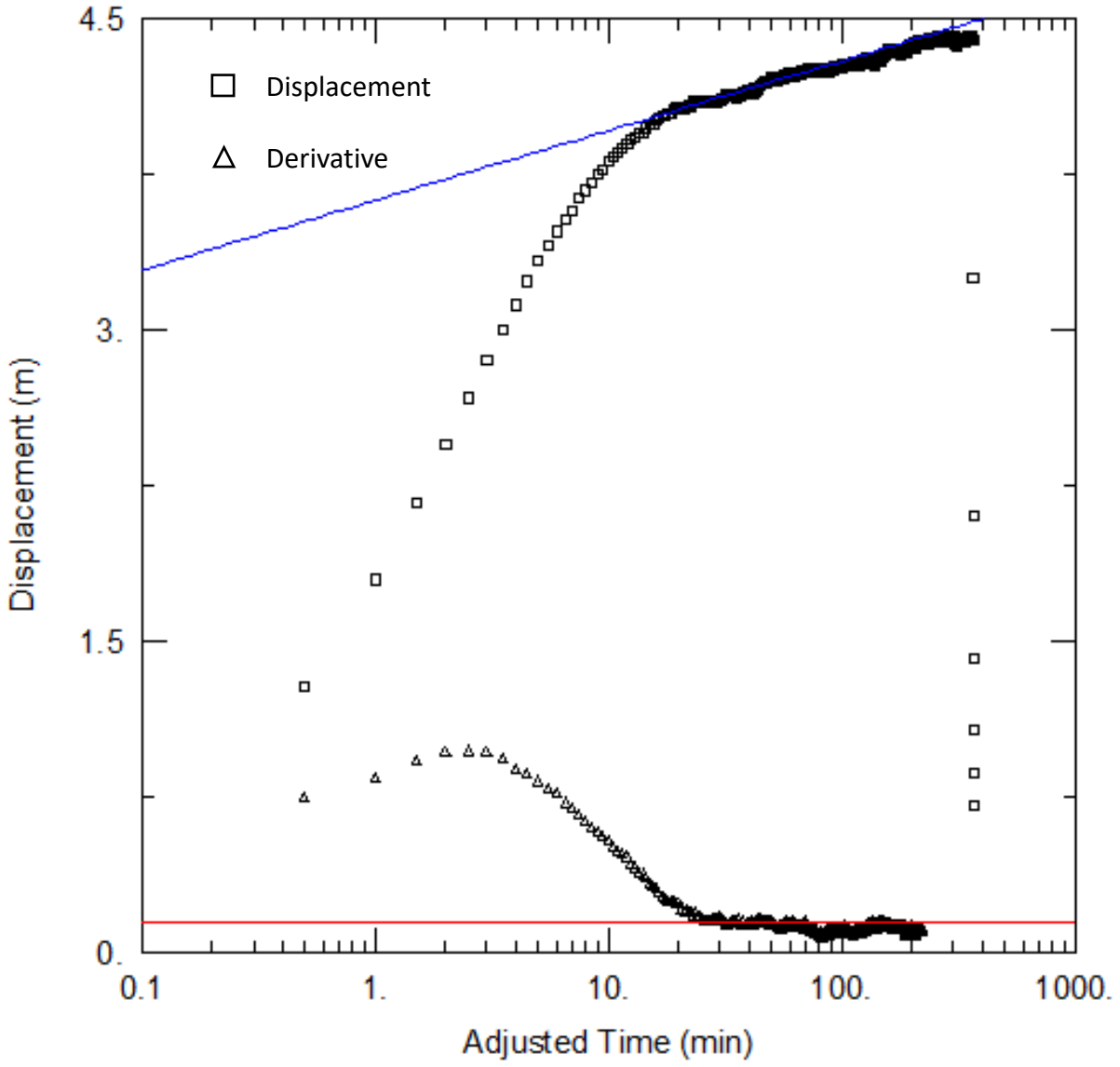


Water Levels TW-1
Static : 2.09 m below top of casing
TOC = 0.45 m above ground surface
End of pump test (6-hours): 6.51 m below top of casing
Following recovery (2 hours): 2.12 m below top of casing

GEMTEC
Consulting Engineers and Scientists

Pumping Test Analysis Report		
Project: Hydrogeological Investigation		
Project Number: 100554.001		
Client: ARK Engineering and Development		
Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RH	Pumping Well: TW-1	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 29 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-1): Cooper-Jacob (Confined Aquifer)

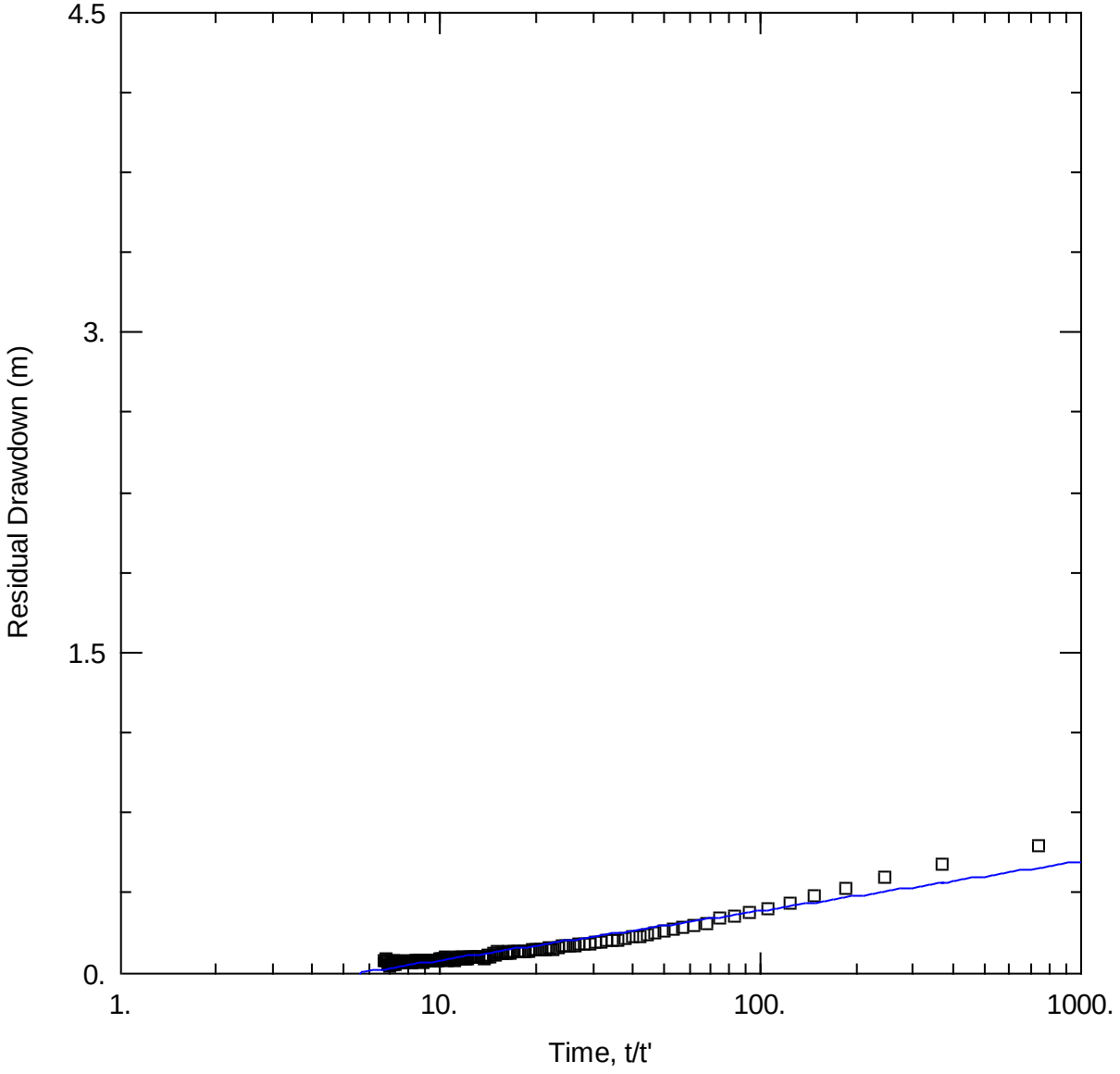


Estimated Transmissivity: 53 m^2/day or 6.2 x 10^{-4} m^2/s

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RH	Pumping Well: TW-1	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 29 m	Discharge: Constant 68 L/min	Duration: 6 hours

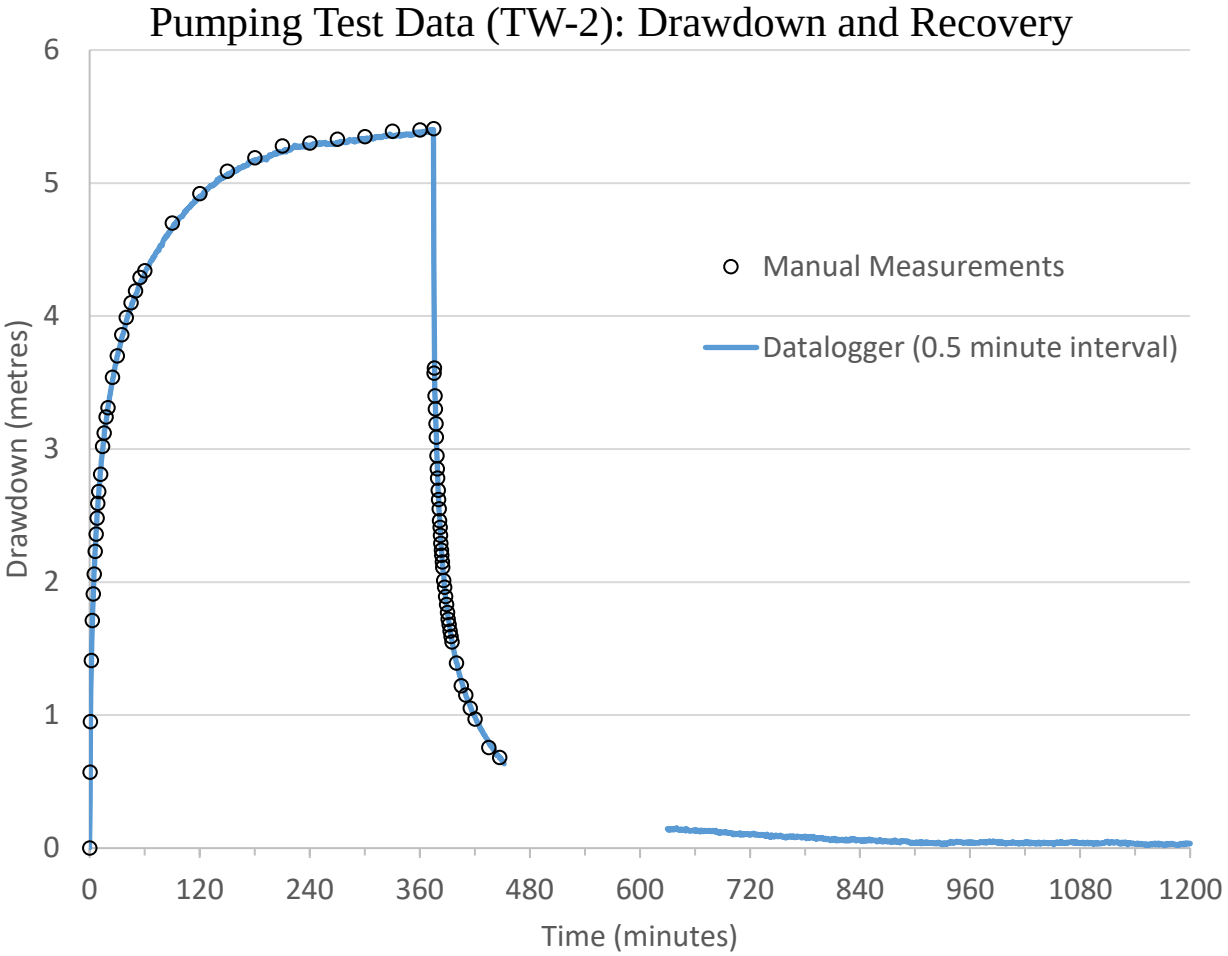
Pumping Test Analysis (TW-1): Theis Recovery (Confined Aquifer)



Estimated Transmissivity: 77 m^2/day or 8.9 x 10^{-4} m^2/s

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RF	Pumping Well: TW-2	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Manual Measurements	Analysis Date: March 29th , 2021
Aquifer Thickness: 42 m	Discharge: Constant 68 L/min	Duration: 6 hours



Water Levels TW-2

Static : 2.59 m below top of casing

TOC = 0.58 m above ground surface

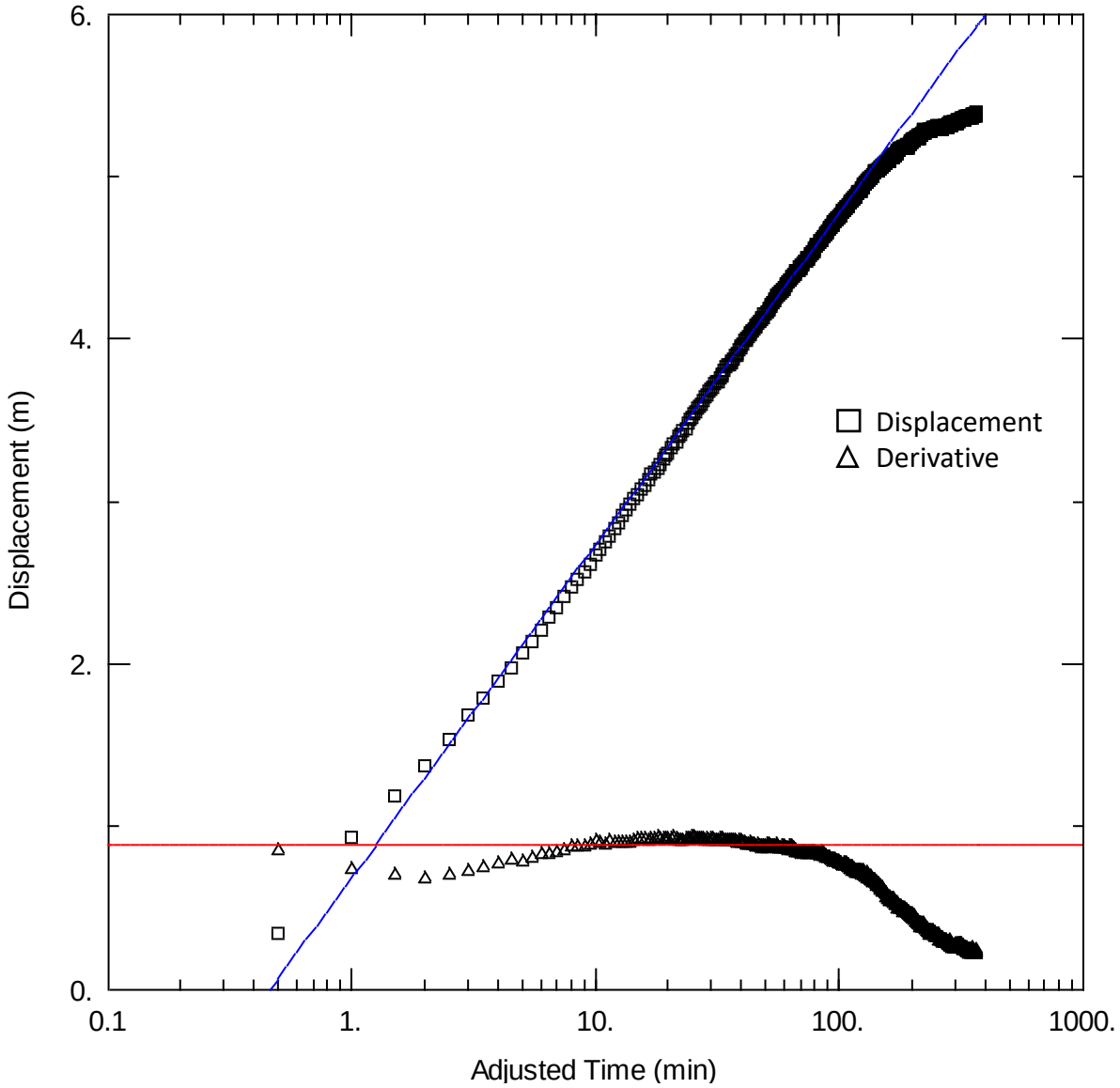
End of pump test (6-hours): 7.97 m below top of casing

Following recovery (2 hours): 3.22 m below top of casing

GEMTEC
Consulting Engineers and Scientists

Pumping Test Analysis Report		
Project: Hydrogeological Investigation		
Project Number: 100554.001		
Client: ARK Engineering and Development		
Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RH	Pumping Well: TW-2	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 42 m	Discharge: Constant 68 L/min	Duration: 6 hours

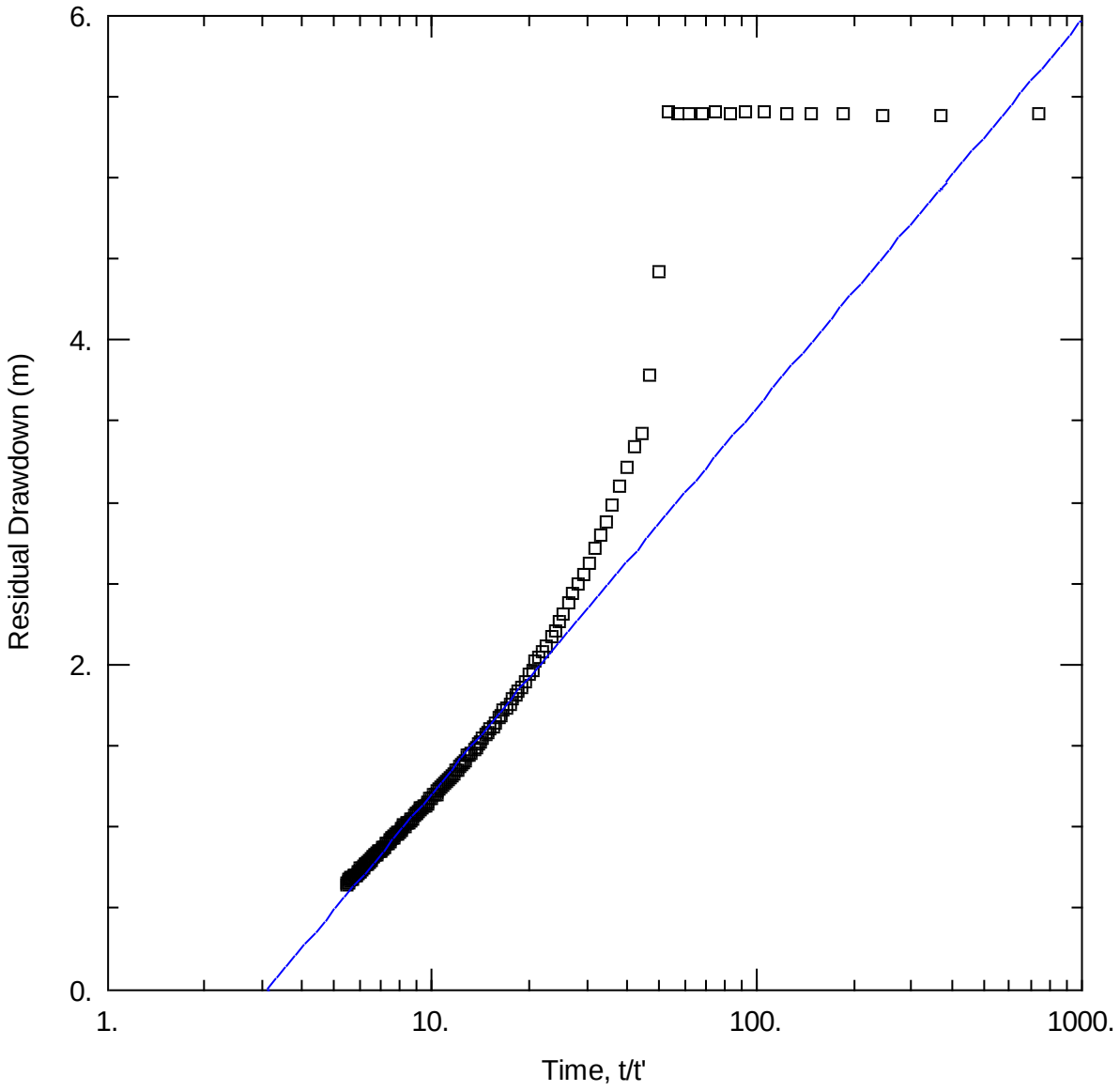
Pumping Test Analysis (TW-2): Cooper-Jacob (Confined Aquifer)



Estimated Transmissivity: 8.8 m^2/day or 1.0 x 10^{-4} m^2/s

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report	
	Project: Hydrogeological Investigation	
	Project Number: 100554.001	
	Client: ARK Engineering and Development	
Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RH	Pumping Well: TW-2	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 42 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-2): Theis Recovery (Confined Aquifer)

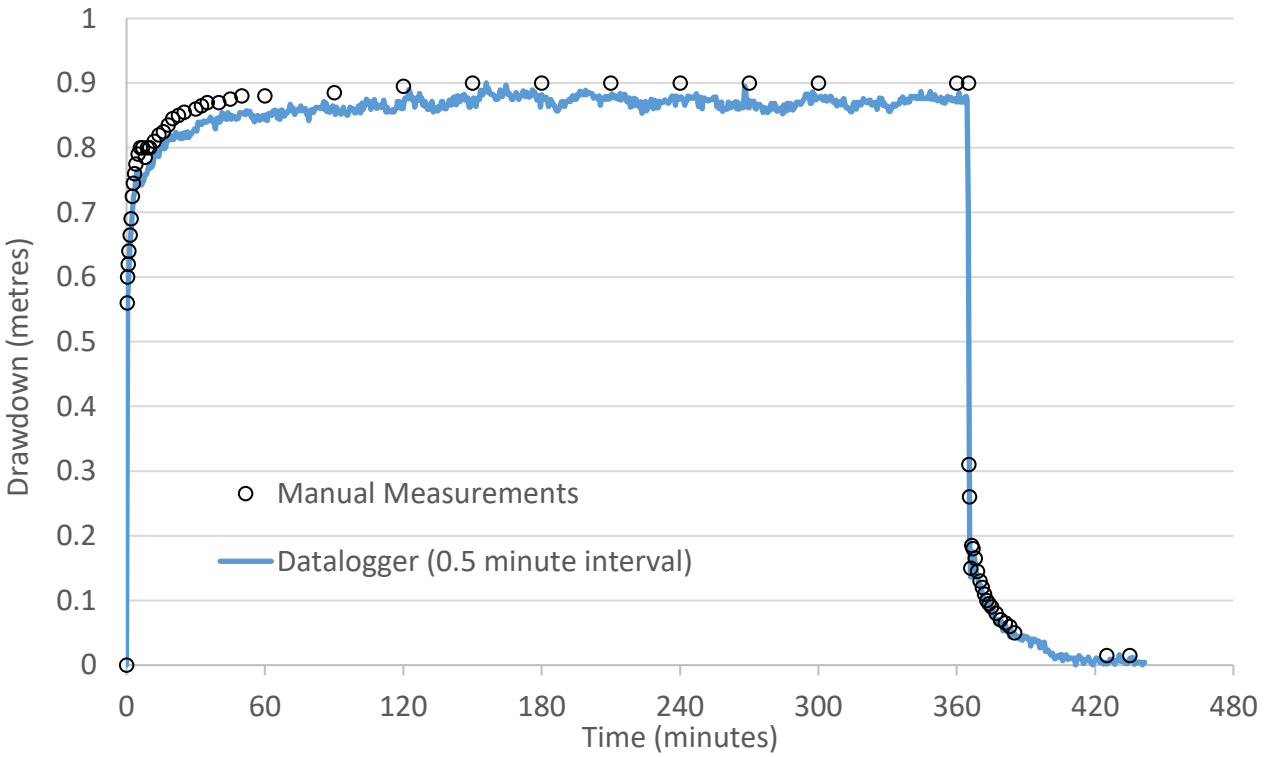


Estimated Transmissivity: 7.6 m^2/day or 8.8 x 10^{-5} m^2/s

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: RF	Pumping Well: TW-3	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Manual Measurements	Analysis Date: March 29th , 2021
Aquifer Thickness: 45 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Data (TW-3): Drawdown and Recovery



Water Levels TW-3

Static : 6.10 m below top of casing

TOC = 0.82 m above ground surface

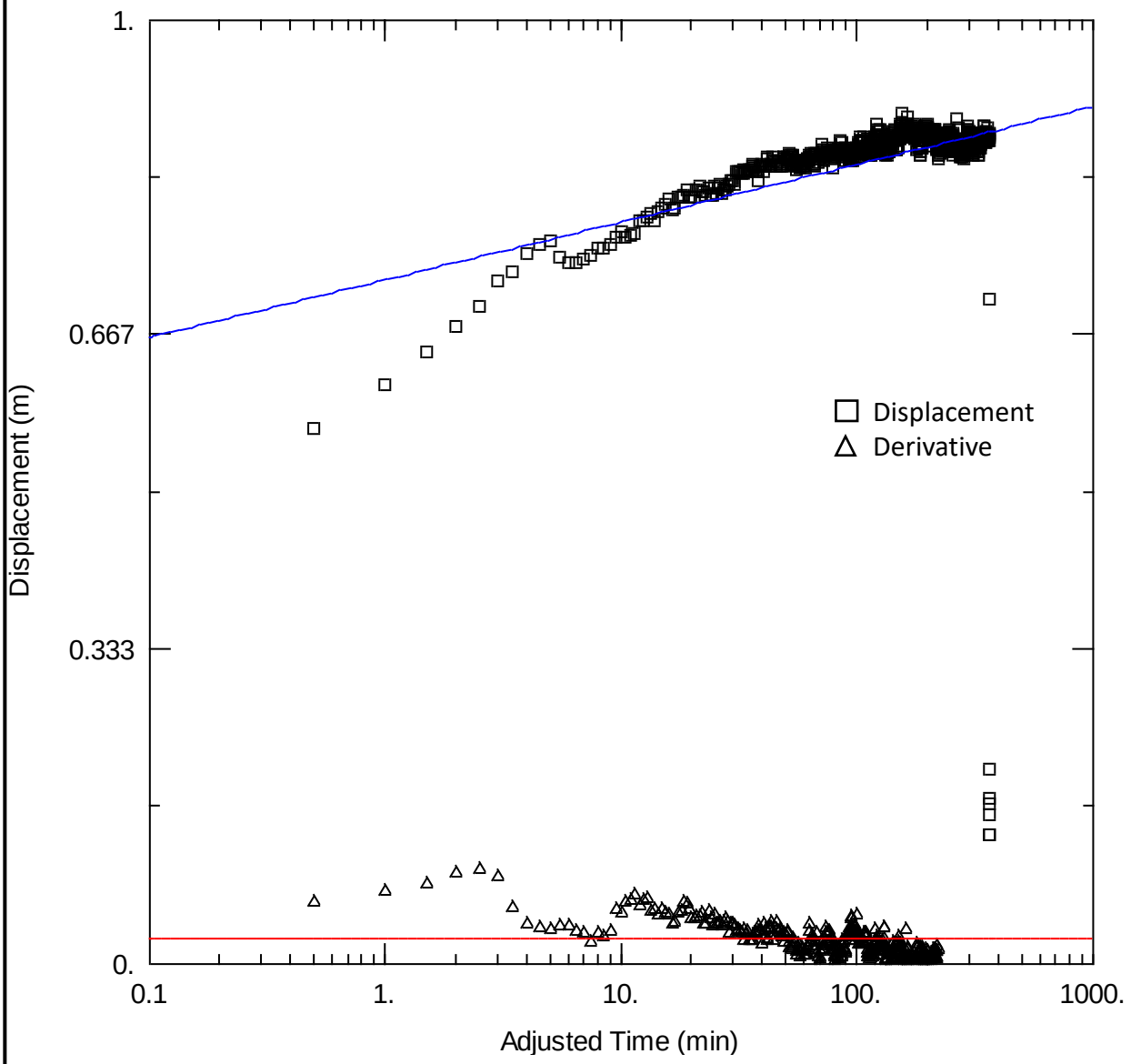
End of pump test (6-hours): 6.99 m below top of casing

Following recovery (2 hours): 6.10 m below top of casing

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-3	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 45 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-3): Cooper-Jacob (Confined Aquifer)



Estimated Transmissivity: 294 m^2/day or 3.4 x 10^{-3} m^2/s

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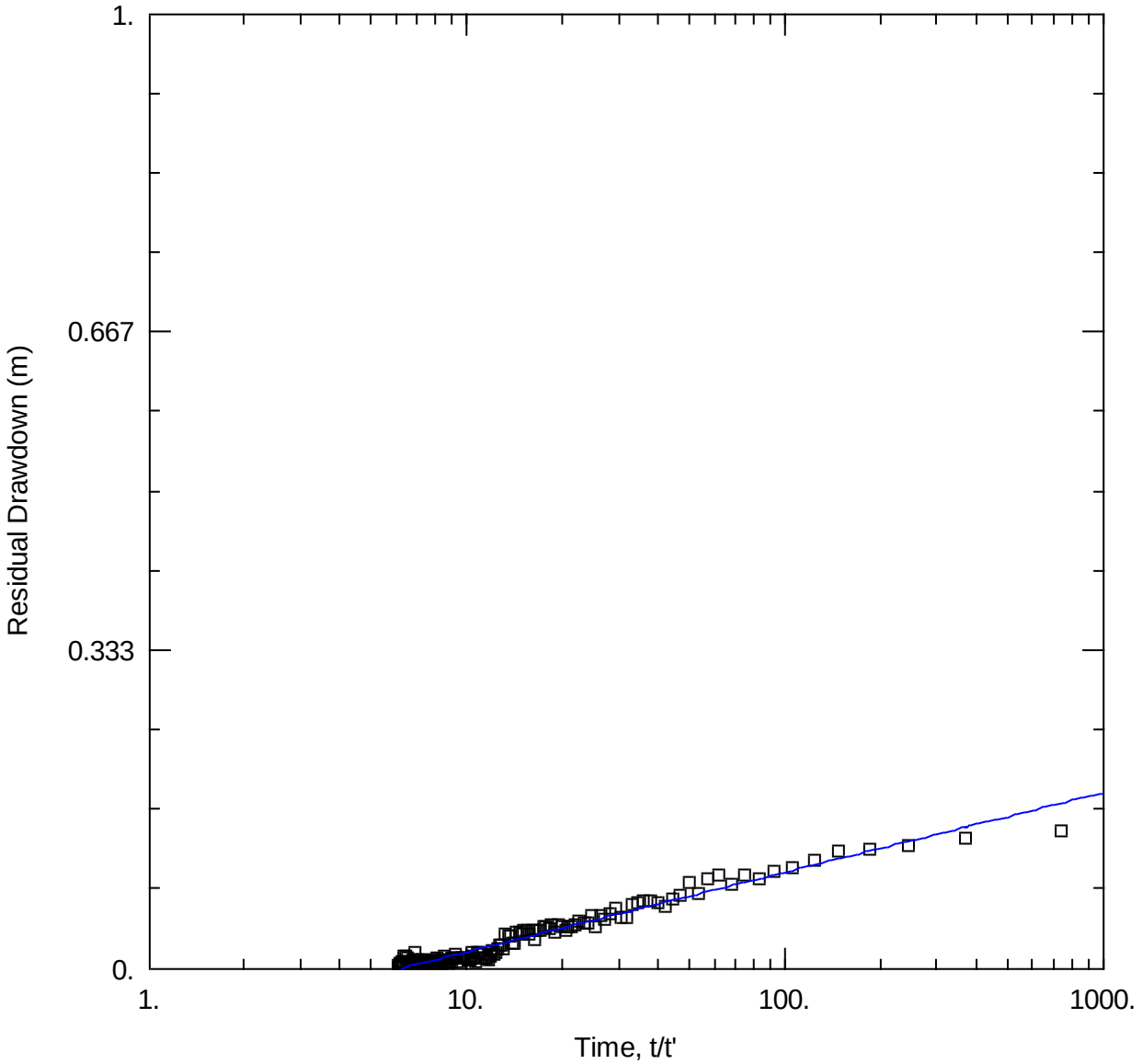
Pumping Test Analysis Report		
Project: Hydrogeological Investigation		
Project Number: 100554.001		
Client: ARK Engineering and Development		
Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-3	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 45 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-3): Theis Recovery (Confined Aquifer)

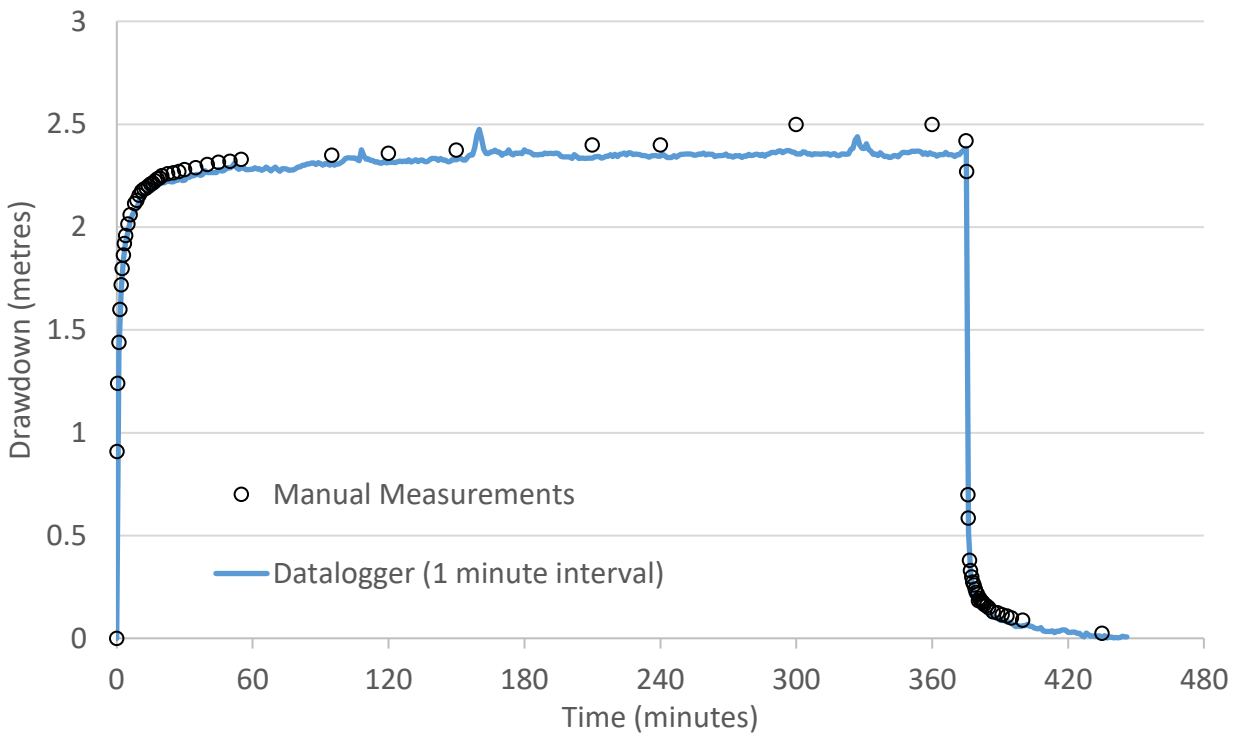


Estimated Transmissivity: 216 m^2/day or 2.5 x 10^{-3} m^2/s

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-4	P-Test Date: March 18th, 2021
Analysis Performed by: BR	Method: Manual Measurements	Analysis Date: March 29th , 2021
Aquifer Thickness: 44 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Data (TW-4): Drawdown and Recovery

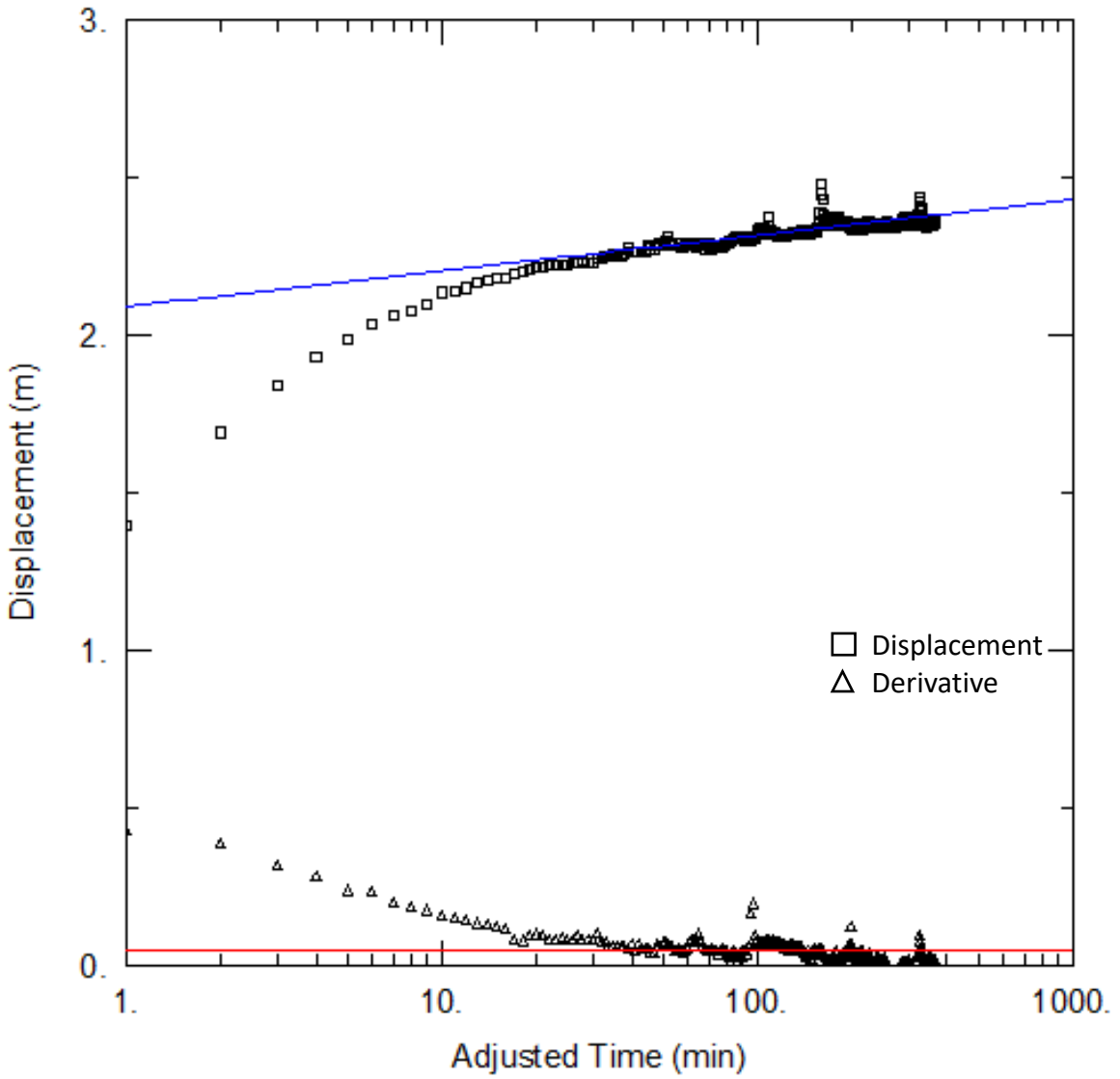


Water Levels TW-4
Static : 6.61 m below top of casing
TOC = 0.42 m above ground surface
End of pump test (6-hours): 9.00 m below top of casing
Following recovery (2 hours): 6.61 m below top of casing

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-4	P-Test Date: March 18th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 44 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-4): Cooper-Jacob (Confined Aquifer)



Estimated Transmissivity: 101 m^2/day or 1.1 x 10^{-3} m^2/s

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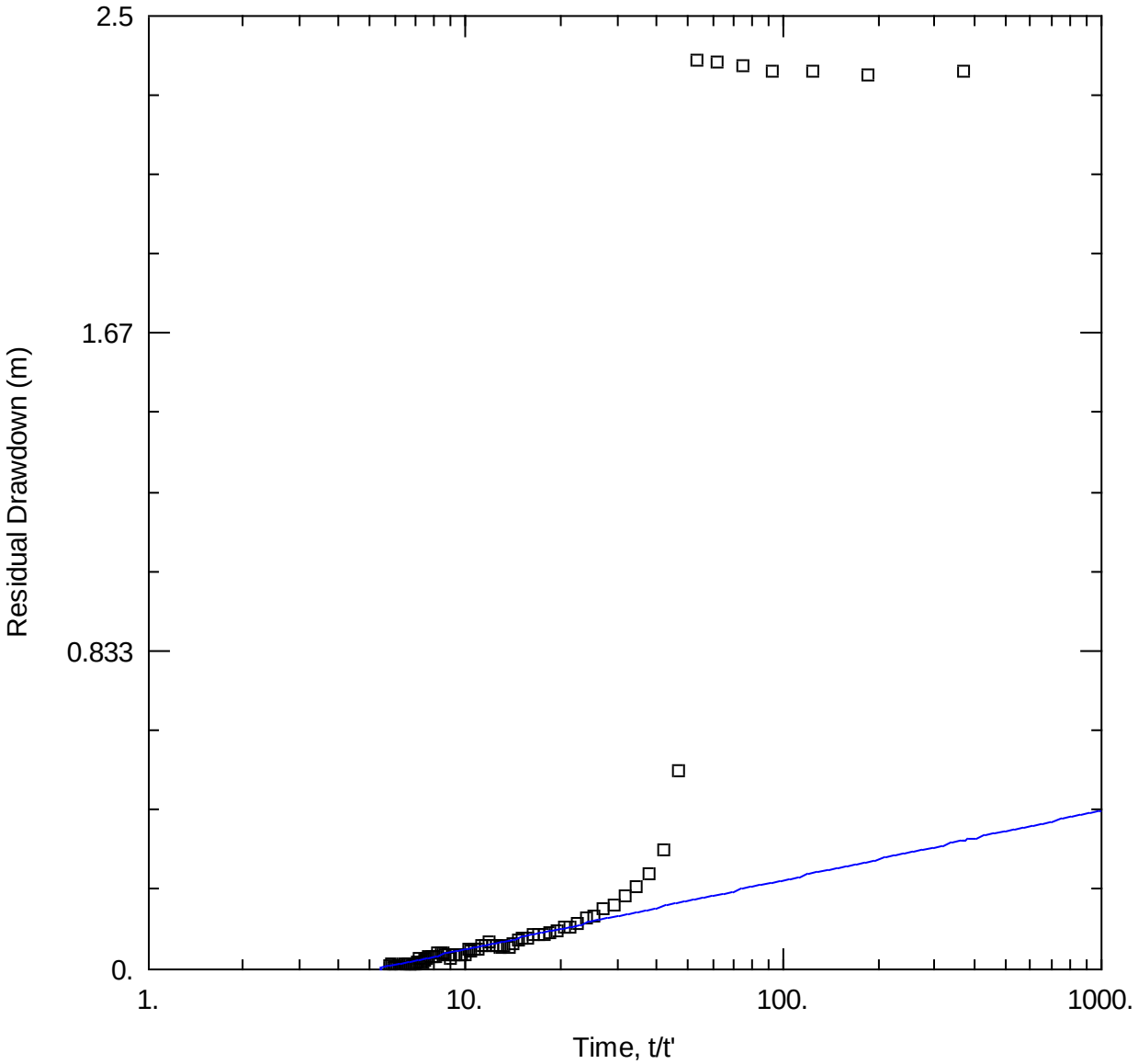
Consulting Engineers and Scientists

Pumping Test Analysis Report		
Project: Hydrogeological Investigation		
Project Number: 100554.001		
Client: ARK Engineering and Development		
Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-4	P-Test Date: March 18th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 44 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-4): Theis Recovery (Confined Aquifer)

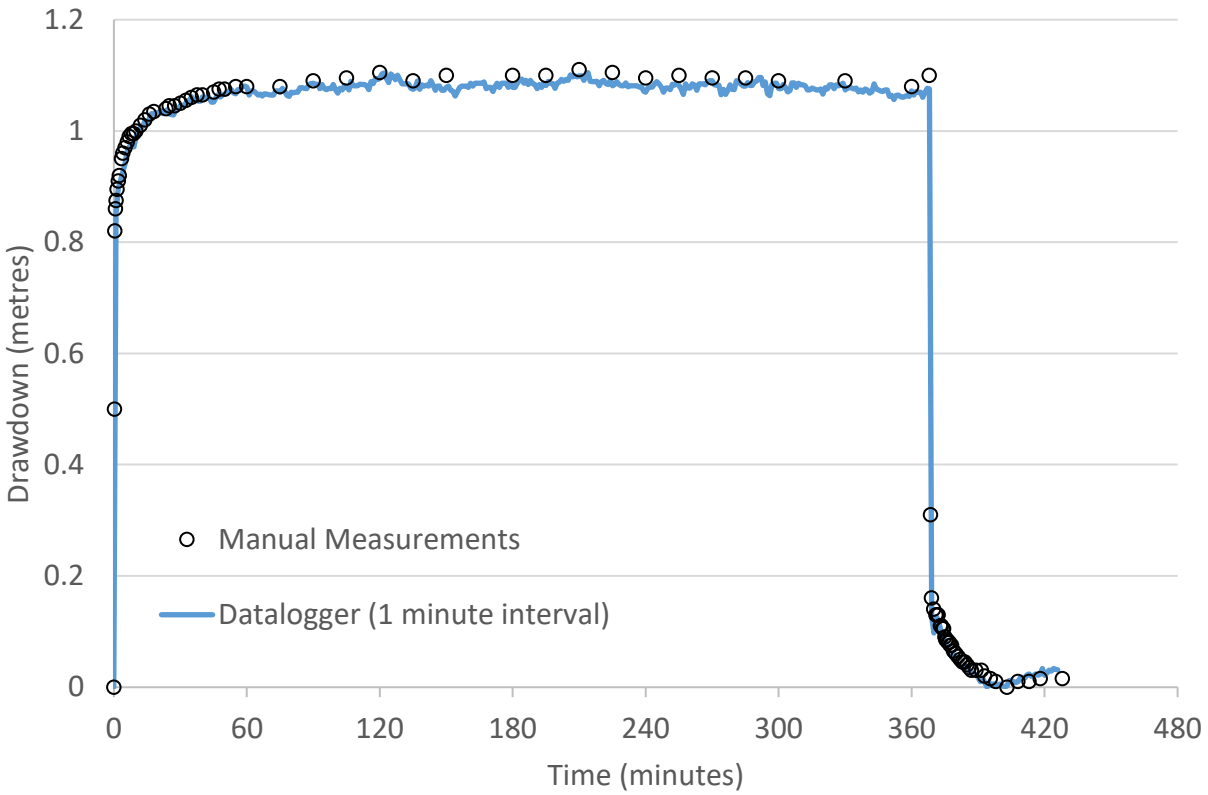


Estimated Transmissivity: 99 m^2/day or 2.5 x 10^{-3} m^2/s

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-5	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Manual Measurements	Analysis Date: March 29th , 2021
Aquifer Thickness: 37 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Data (TW-5): Drawdown and Recovery

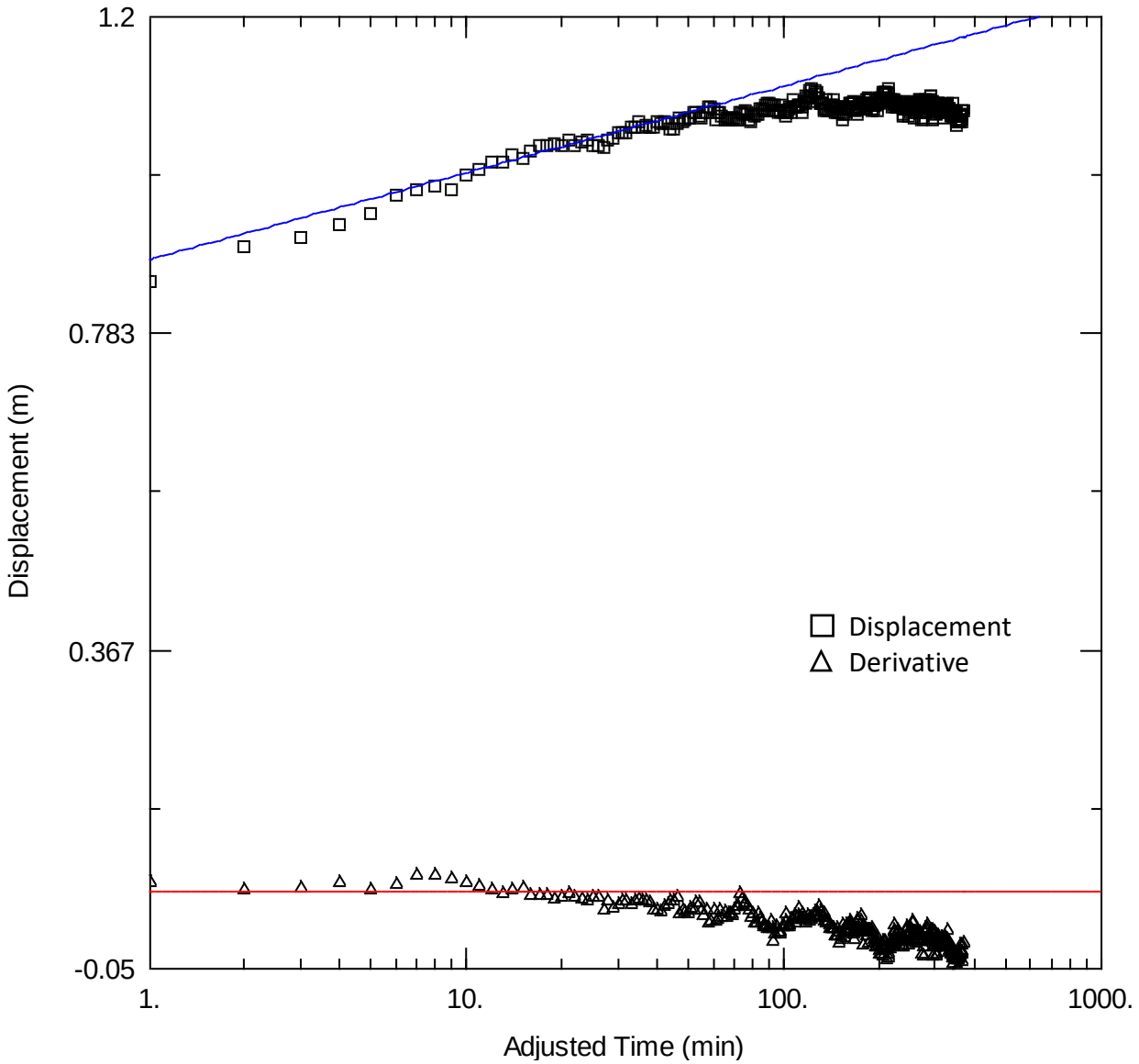


Water Levels TW-5
Static : 6.07 m below top of casing
TOC = 0.51 m above ground surface
End of pump test (6-hours): 7.14 m below top of casing
Following recovery (2 hours): 6.08 m below top of casing

GEMTEC Consulting Engineers and Scientists	Pumping Test Analysis Report
	Project: Hydrogeological Investigation
	Project Number: 100554.001
	Client: ARK Engineering and Development

Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-5	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 37 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-5): Cooper-Jacob (Confined Aquifer)

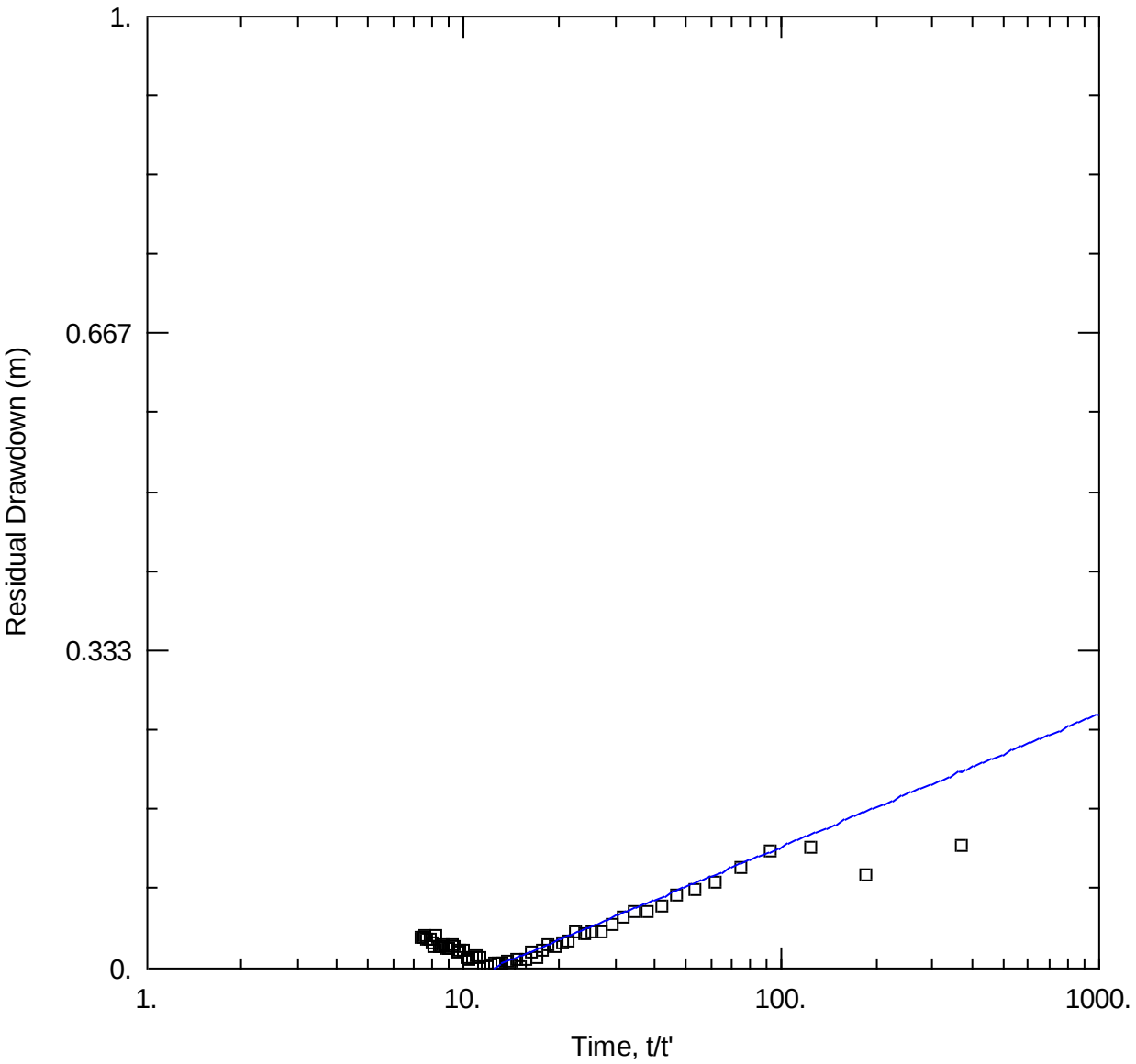


Estimated Transmissivity: 156 m^2/day or 1.8 x 10^{-3} m^2/s

GEMTEC
Consulting Engineers and Scientists

Pumping Test Analysis Report		
Project: Hydrogeological Investigation		
Project Number: 100554.001		
Client: ARK Engineering and Development		
Location: Jack Pine Crescent, Greely, Ontario		
Test Conducted by: BR	Pumping Well: TW-5	P-Test Date: March 19th, 2021
Analysis Performed by: BR	Method: Aqtesolv Analysis	Analysis Date: March 29th , 2021
Aquifer Thickness: 37 m	Discharge: Constant 68 L/min	Duration: 6 hours

Pumping Test Analysis (TW-5): Theis Recovery (Confined Aquifer)

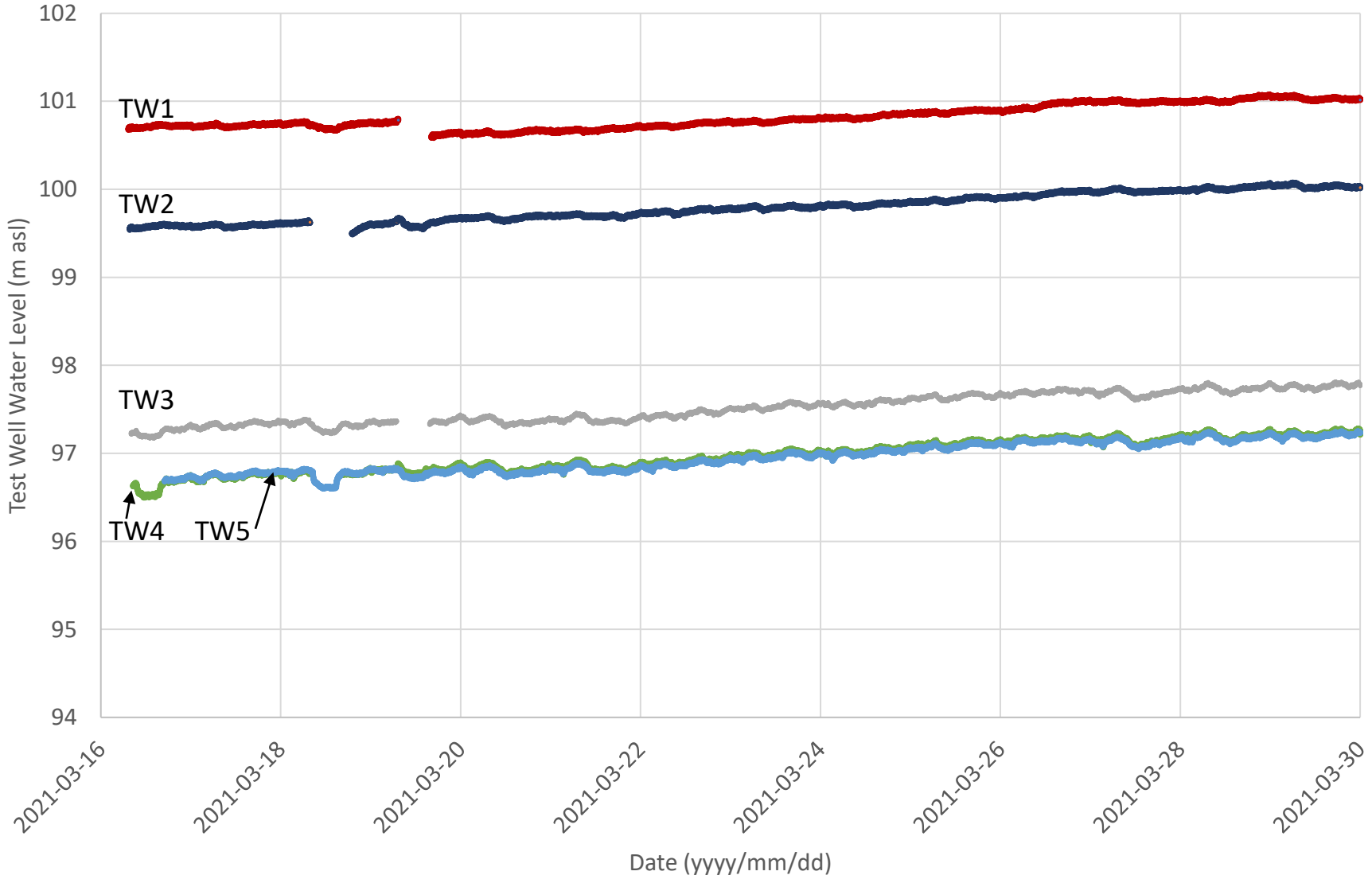


Estimated Transmissivity: 129 m^2/day or 1.5 x 10^{-3} m^2/s

APPENDIX H

Long Term Water Level Monitoring

Long Term Water Level Monitoring
Proposed Emerald Woods Residential Subdivision



GEMTEC
Consulting Engineers and Scientists

Project: 100554.001
Date: June 2021

APPENDIX I

Water Quality Field Measurements and Laboratory Summary

Summary of Field Measured Water Quality

Test Wells

Well	Time Since Pump Start (Hours)	Temp (°C)	EC[1] (µS/cm)	pH (-)	Turbidity[2] (NTU)	TDS[3] (ppm)	Free Chlorine (mg/litre)	Total Chlorine (mg/litre)	Colour (ACU[4])	Colour (TCU[5])
TW 1	1	7.7	331	8.14	13.8	162	-	-	-	-
	2	7.9	318	7.92	21.2	139	-	-	-	-
	3	7.5	320	8.05	12.4	160	<0.02	<0.02	89	42
	4	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-
	6	8.7	327	7.99	12.6	163	<0.02	<0.02	94	<5
TW1[6] (Resample)	-	10.2	323	7.57	1.11	162	0.03	0.03	11	<5
TW 2	1	8.2	380	7.91	11.4	190	-	-	-	-
	2	8.2	381	7.99	26.1	189	-	-	-	-
	3	8.3	380	8	16.7	190	<0.02	<0.02	117	41
	4	8.4	380	7.92	14.4	184	-	-	-	-
	5	8.5	377	7.95	10.2	189	-	-	-	-
	6	8.4	379	7.99	8.98	189	<0.02	<0.02	82	12
TW2[6] (Resample)	-	-	-	-	0.70	-	<0.02	<0.02	<5	<5

Summary of Field Measured Water Quality

Test Wells

Well	Time Since Pump Start (Hours)	Temp (°C)	EC[1] (µS/cm)	pH (-)	Turbidity[2] (NTU)	TDS[3] (ppm)	Free Chlorine (mg/litre)	Total Chlorine (mg/litre)	Colour (ACU[4])	Colour (TCU[5])
TW3	1	7.4	627	7.78	2.4	317	-	-	-	-
	2	7.6	873	7.92	2.1	317	-	-	-	-
	3	7.6	1006	7.75	2.5	506	<0.02	<0.02	14	8
	4	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-
	6	8.4	1126	7.58	2.16	566	<0.02	<0.02	<5	<5
TW4	1	8.3	1140	7.35	2.06	572	-	-	-	-
	2	8.1	1125	7.57	1.80	565	-	-	-	-
	3	8.6	1118	7.83	1.84	563	<0.02	<0.02	24	18
	4	-	-	-	-	-	-	-	-	-
	5	8.6	1120	7.86	1.95	561	-	-	-	-
	6	8.7	1088	7.60	1.61	541	<0.02	<0.02	<5	<5

Summary of Field Measured Water Quality

Test Wells

Well	Time Since Pump Start (Hours)	Temp (°C)	EC[1] (µS/cm)	pH (-)	Turbidity[2] (NTU)	TDS[3] (ppm)	Free Chlorine (mg/litre)	Total Chlorine (mg/litre)	Colour (ACU[4])	Colour (TCU[5])
TW5	1	7.8	1050	7.64	9.13	520	-	-	-	-
	2	7.8	1040	7.78	1.94	519	-	-	-	-
	3	7.6	1052	8.05	2.10	533	<0.02	<0.02	50	40
	4	8.2	1066	7.85	1.46	534	-	-	-	-
	5	7.8	1050	7.76	2.32	528	-	-	-	-
	6	7.9	1060	7.90	2.13	531	<0.02	<0.02	34	<5

Notes:

1. EC: Electrical Conductivity
2. Turbidity is taken to be the average of three consecutive measurements.
3. TDS: Total Dissolved Solids
4. ACU: Actual Colour Units (unfiltered)
5. TCU: True Colour Units (field-filtered using 0.45-micron filter
6. Test well TW1 and TW2 were resampled after an extended pumping duration due to initial high levels of turbidity.

Summary of Field Measured Water Quality

Private Wells

Well	Temp (°C)	EC[1] (µS/cm)	pH (-)	Turbidity[2] (NTU)	TDS[3] (ppm)	Free Chlorine (mg/L)	Total Chlorine (mg/L)	Colour (ACU[4])	Colour (TCU[5])
PW1	9.7	1435	7.45	2.1	714	-	<0.02	0	0
PW2	10.7	633	7.46	1.06	315	-	<0.02	34	31
PW3	10.2	766	7.47	0.96	385	-	<0.02	0	0
PW4	11.0	817	7.42	0.69	411	-	<0.02	8	0

Water Quality Summary
Test Wells

Parameter	Units	MDL	Sample											
			TW1- 3hr	TW1- 6hr	TW1-R1a / TW1-R1b	TW2- 3hr	TW2- 6hr	TW2-R1	TW3- 3hr	TW3- 6hr	TW4- 3hr	TW4- 6hr	TW5 - 3hr	TW5 - 6hr
Sample Date (m/d/y)			**03/19/2021**	**03/19/2021**	**04/07/2021**	**03/18/2021**	**03/18/2021**	**04/05/2021**	**03/19/2021**	**03/19/2021**	**03/18/2021**	**03/18/2021**	**03/16/2021**	**03/16/2021**
Microbiological Parameters														
E. Coli	CFU/100 mL	1	ND (1)	ND (1)	ND (1) / ND (1)	ND (1)	ND (1)	-	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Fecal Coliforms	CFU/100 mL	1	ND (1)	ND (1)	ND (1) / ND(1)	ND (1)	ND (1)	-	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Total Coliforms	CFU/100 mL	1	ND (1)	**74**	ND (1) / ND (1)	1	ND (1)	-	ND (1)	ND (1)	3	ND (1)	ND (1)	ND (1)
Heterotrophic Plate Count	CFU/mL	10	-	-	ND (10) / ND (10)	ND (10)	ND (10)	-	-	-	ND (10)	ND (10)	ND (10)	ND (10)
General Inorganics														
Alkalinity, total	mg/L	5	149	147	-	170	171	-	276	300	293	293	284	286
Ammonia as N	mg/L	0.01	0.09	0.38	-	0.06	0.15	-	0.14	0.17	0.25	0.23	0.25	0.25
Dissolved Organic Carbon	mg/L	0.5	**5.6**	4.9	-	3.3	3.8	-	3.3	2.5	4.1	3.9	1.5	1.4
Colour	TCU	2	**30**	**35**	**18**	**35**	**38**	**16**	**10**	**8**	**8**	7	2	3
Colour, apparent	ACU	2	**67**	**69**	**25**	**99**	**64**	**24**	**17**	**16**	**10**	11	5	9
Conductivity	uS/cm	5	344	321	-	359	368	-	1010	1170	1120	1100	1050	1060
Hardness	mg/L		-	164	-	-	192	-	-	373	-	395	331	339
pH	pH Units	0.1	8.3	8.3	-	8.3	8.3	-	8.2	8.2	8.1	8.1	7.9	8.0
Phenolics	mg/L	0.001	ND (0.001)	ND (0.001)	-	ND (0.001)	ND (0.001)	-	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Total Dissolved Solids	mg/L	10	196	192	-	336	336	-	**572**	**664**	**716**	**742**	**528**	**520**
Sulphide	mg/L	0.02	ND (0.02)	ND (0.02)	-	ND (0.02)	ND (0.02)	-	0.17	0.18	**0.56**	**0.58**	**0.90**	**0.92**
Tannin & Lignin	mg/L	0.1	0.5	0.5	-	0.3	0.3	-	0.1	ND (0.1)	0.2	0.2	ND (0.1)	ND (0.1)
Total Kjeldahl Nitrogen	mg/L	0.1	0.3	0.5	-	0.1	0.3	-	0.1	0.2	0.2	0.3	0.3	0.4
Organic Nitrogen	mg/L		**0.2**	0.1	-	0.0	**0.2**	-	-	0.0	-	0.1	0.1	**0.2**
Turbidity	NTU	0.1	**10.2**	**10.3**	**1.1**	**18.6**	**10.0**	**0.7**	1.2	1.0	0.9	1.0	0.4	1.6
Anions														
Chloride	mg/L	1	2	2	-	3	3	-	119	148	141	135	125	127
Fluoride	mg/L	0.1	ND (0.1)	0.1	-	ND (0.1)	ND (0.1)	-	0.2	0.2	0.3	0.3	0.1	0.1
Nitrate as N	mg/L	0.1	ND (0.1)	ND (0.1)	-	ND (0.1)	ND (0.1)	-	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)
Nitrite as N	mg/L	0.05	ND (0.05)	ND (0.05)	-	ND (0.05)	ND (0.05)	-	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
Sulphate	mg/L	1	16	16	-	18	18	-	66	78	76	74	63	65
Metals														
Mercury	mg/L	0.0001	-	ND (0.0001)	-	-	ND (0.0001)	-	-	ND (0.0001)	-	ND (0.0001)	-	ND (0.0001)
Aluminum	mg/L	0.001	-	0.117	-	-	0.103	-	-	0.002	-	0.002	-	0.001
Antimony	mg/L	0.0005	-	ND (0.0005)	-	-	ND (0.0005)	-	-	ND (0.0005)	-	ND (0.0005)	-	ND (0.0005)
Arsenic	mg/L	0.001	-	ND (0.001)	-	-	ND (0.001)	-	-	ND (0.001)	-	ND (0.001)	-	ND (0.001)
Barium	mg/L	0.001	-	0.170	-	-	0.215	-	-	0.309	-	0.288	-	0.247
Boron	mg/L	0.01	-	0.01	-	-	0.01	-	-	0.09	-	0.15	-	0.23
Cadmium	mg/L	0.0001	-	ND (0.0001)	-	-	ND (0.0001)	-	-	ND (0.0001)	-	ND (0.0001)	-	ND (0.0001)
Calcium	mg/L	0.1	-	44.6	-	49.9	50.0	-	-	89.3	95	91.2	75.0	77.1
Chromium (VI)	mg/L	0.010	-	ND (0.010)	-	-	ND (0.010)	-	-	ND (0.010)	-	ND (0.010)	-	ND (0.010)
Chromium	mg/L	0.001	-	ND (0.001)	-	-	ND (0.001)	-	-	ND (0.001)	-	ND (0.001)	-	ND (0.001)
Copper	mg/L	0.0005	-	0.0006	-	-	0.0005	-	-	0.0013	-	0.0031	-	ND (0.0005)
Iron	mg/L	0.1	-	**0.7**	**0.5**	0.8	**0.8**	**0.529**	-	0.3	0.2	0.2	ND (0.1)	0.1
Lead	mg/L	0.0001	-	0.0007	-	-	0.0007	-	-	ND (0.0001)	-	0.0003	-	ND (0.0001)
Magnesium	mg/L	0.2	-	12.7	-	16.1	16.3	-	-	36.5	41.2	40.7	34.9	35.7
Manganese	mg/L	0.005	-	**0.075**	-	0.051	0.048	-	-	**0.051**	0.023	0.023	0.023	0.025
Potassium	mg/L	0.1	-	1.1	-	1.4	1.4	-	-	5.1	9.0	8.5	8.0	7.9
Selenium	mg/L	0.001	-	ND (0.001)	-	-	ND (0.001)	-	-	ND (0.001)	-	ND (0.001)	-	ND (0.001)
Sodium	mg/L	0.2	-	2.7	-	3.4	3.2	-	-	75.3	64.8	66.9	78.4	78.9
Uranium	mg/L	0.0001	-	0.0002	-	-	0.0002	-	-	0.0001	-	0.0003	-	ND (0.0001)
Zinc	mg/L	0.005	-	ND (0.005)	-	-	ND (0.005)	-	-	0.008	-	0.007	-	ND (0.005)

Bolded Exceeds the Ontario Drinking Water Quality Standards

Water Quality Summary
Private Well Sampling

Parameter	Units	MDL	Sample			
			PW1	PW2	PW3	PW4
Sample Date (m/d/y)			**04/28/2021**	**04/28/2021**	**04/28/2021**	**04/28/2021**
Microbiological Parameters						
E. Coli	CFU/100 mL	1	ND (1)	ND (1)	ND (1)	ND (1)
Fecal Coliforms	CFU/100 mL	1	ND (1)	ND (1)	ND (1)	ND (1)
Total Coliforms	CFU/100 mL	1	ND (1)	ND (1)	ND (1)	ND (1)
Heterotrophic Plate Count	CFU/mL	10	ND (10)	ND (10)	ND (10)	ND (10)
General Inorganics						
Alkalinity, total	mg/L	5	305	229	250	282
Ammonia as N	mg/L	0.01	0.07	0.10	0.20	0.07
Dissolved Organic Carbon	mg/L	0.5	3.0	3.2	4.5	5.0
Colour	TCU	2	2	12	8	12
Colour, apparent	ACU	2	**22**	13	**47**	15
Conductivity	uS/cm	5	1470	614	733	773
Hardness	mg/L		**488**	**263**	**280**	**320**
pH	pH Units	0.1	7.8	8.0	8.0	7.8
Phenolics	mg/L	0.001	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Total Dissolved Solids	mg/L	10	**810**	336	434	412
Sulphide	mg/L	0.02	ND (0.02)	**0.10**	0.04	ND (0.02)
Tannin & Lignin	mg/L	0.1	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)
Total Kjeldahl Nitrogen	mg/L	0.1	0.2	0.2	0.4	0.2
Organic Nitrogen	mg/L	0.1	0.1	0.1	**0.2**	0.1
Turbidity	NTU	0.1	3.6	0.5	2.6	0.2
Anions						
Chloride	mg/L	1	187	33	64	47
Fluoride	mg/L	0.1	ND (0.1)	0.2	ND (0.1)	ND (0.1)
Nitrate as N	mg/L	0.1	0.2	ND (0.1)	ND (0.1)	ND (0.1)
Nitrite as N	mg/L	0.05	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
Sulphate	mg/L	1	124	38	37	59
Metals						
Calcium	mg/L	0.1	115	62.6	70.6	82.3
Iron	mg/L	0.1	**0.5**	0.2	**0.9**	ND (0.1)
Magnesium	mg/L	0.2	48.6	25.8	25.3	27.8
Manganese	mg/L	0.005	**0.119**	0.035	**0.102**	**0.110**
Potassium	mg/L	0.1	1.9	3.2	1.6	1.4
Sodium	mg/L	0.2	**88.6**	**22.2**	**36.4**	**33.4**

Bolded Exceeds the Ontario Drinking Water Quality Standards

GEMTEC
Consulting Engineers and Scientists

Project: 100554.001
Date: June 2021

APPENDIX J

Laboratory Certificates of Analyses

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 143484

Report Date: 25-Mar-2021
Order Date: 19-Mar-2021

Order #: 2112634

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2112634-01	TW1- 3hr
2112634-02	TW1- 6hr
2112634-03	TW3- 3hr
2112634-04	TW3- 6hr

Approved By:

Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	22-Mar-21	23-Mar-21
Ammonia, as N	EPA 351.2 - Auto Colour	22-Mar-21	23-Mar-21
Anions	EPA 300.1 - IC	22-Mar-21	23-Mar-21
Chromium, hexavalent - water	MOE E3056 - colourimetric	23-Mar-21	23-Mar-21
Colour	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Colour, apparent	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Conductivity	EPA 9050A- probe @25 °C	22-Mar-21	23-Mar-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	23-Mar-21	23-Mar-21
E. coli	MOE E3407	19-Mar-21	19-Mar-21
Fecal Coliform	SM 9222D	19-Mar-21	19-Mar-21
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	23-Mar-21	24-Mar-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	22-Mar-21	22-Mar-21
pH	EPA 150.1 - pH probe @25 °C	22-Mar-21	23-Mar-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	22-Mar-21	22-Mar-21
Hardness	Hardness as CaCO3	22-Mar-21	22-Mar-21
Sulphide	SM 4500SE - Colourimetric	23-Mar-21	23-Mar-21
Tannin/Lignin	SM 5550B - Colourimetric	22-Mar-21	22-Mar-21
Total Coliform	MOE E3407	19-Mar-21	19-Mar-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	24-Mar-21	24-Mar-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	22-Mar-21	23-Mar-21
Turbidity	SM 2130B - Turbidity meter	19-Mar-21	19-Mar-21

Certificate of Analysis

Report Date: 25-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 19-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW1- 3hr	TW1- 6hr	TW3- 3hr	TW3- 6hr
	Sample Date:	19-Mar-21 11:00	19-Mar-21 13:30	19-Mar-21 11:00	19-Mar-21 13:30
	Sample ID:	2112634-01	2112634-02	2112634-03	2112634-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Microbiological Parameters					
E. coli	1 CFU/100 mL	ND	ND [1]	ND	ND
Fecal Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Total Coliforms	1 CFU/100 mL	ND	74 [1]	ND	ND
General Inorganics					
Alkalinity, total	5 mg/L	149	147	276	300
Ammonia as N	0.01 mg/L	0.09	0.38	0.14	0.17
Dissolved Organic Carbon	0.5 mg/L	5.6	4.9	3.3	2.5
Colour	2 TCU	30	35	10	8
Colour, apparent	2 ACU	67	69	17	16
Conductivity	5 uS/cm	344	321	1010	1170
Hardness	mg/L	-	164	-	373
pH	0.1 pH Units	8.3	8.3	8.2	8.2
Phenolics	0.001 mg/L	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	10 mg/L	196	192	572	664
Sulphide	0.02 mg/L	<0.02	<0.02	0.17	0.18
Tannin & Lignin	0.1 mg/L	0.5	0.5	0.1	<0.1
Total Kjeldahl Nitrogen	0.1 mg/L	0.3	0.5	0.1	0.2
Turbidity	0.1 NTU	10.2	10.3	1.2	1.0
Anions					
Chloride	1 mg/L	2	2	119	148
Fluoride	0.1 mg/L	<0.1	0.1	0.2	0.2
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Sulphate	1 mg/L	16	16	66	78
Metals					
Mercury	0.0001 mg/L	-	<0.0001	-	<0.0001
Aluminum	0.001 mg/L	-	0.117	-	0.002
Antimony	0.0005 mg/L	-	<0.0005	-	<0.0005
Arsenic	0.001 mg/L	-	<0.001	-	<0.001
Barium	0.001 mg/L	-	0.170	-	0.309
Boron	0.01 mg/L	-	0.01	-	0.09
Cadmium	0.0001 mg/L	-	<0.0001	-	<0.0001
Calcium	0.1 mg/L	-	44.6	-	89.3
Chromium	0.001 mg/L	-	<0.001	-	<0.001
Chromium (VI)	0.010 mg/L	-	<0.010	-	<0.010

Certificate of Analysis

Report Date: 25-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 19-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW1- 3hr	TW1- 6hr	TW3- 3hr	TW3- 6hr
	Sample Date:	19-Mar-21 11:00	19-Mar-21 13:30	19-Mar-21 11:00	19-Mar-21 13:30
	Sample ID:	2112634-01	2112634-02	2112634-03	2112634-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Copper	0.0005 mg/L	-	0.0006	-	0.0013
Iron	0.1 mg/L	-	0.7	-	0.3
Lead	0.0001 mg/L	-	0.0007	-	<0.0001
Magnesium	0.2 mg/L	-	12.7	-	36.5
Manganese	0.005 mg/L	-	0.075	-	0.051
Potassium	0.1 mg/L	1.1	1.1	5.0	5.1
Selenium	0.001 mg/L	-	<0.001	-	<0.001
Sodium	0.2 mg/L	-	2.7	-	75.3
Uranium	0.0001 mg/L	-	0.0002	-	0.0001
Zinc	0.005 mg/L	-	<0.005	-	0.008

Certificate of Analysis

Report Date: 25-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 19-Mar-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Mercury	ND	0.0001	mg/L						
Aluminum	ND	0.001	mg/L						
Antimony	ND	0.0005	mg/L						
Arsenic	ND	0.001	mg/L						
Barium	ND	0.001	mg/L						
Boron	ND	0.01	mg/L						
Cadmium	ND	0.0001	mg/L						
Calcium	ND	0.1	mg/L						
Chromium (VI)	ND	0.010	mg/L						
Chromium	ND	0.001	mg/L						
Copper	ND	0.0005	mg/L						
Iron	ND	0.1	mg/L						
Lead	ND	0.0001	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Selenium	ND	0.001	mg/L						
Sodium	ND	0.2	mg/L						
Uranium	ND	0.0001	mg/L						
Zinc	ND	0.005	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	7.02	1	mg/L	7.12			1.4	10	
Fluoride	0.71	0.1	mg/L	0.73			2.9	10	
Nitrate as N	0.59	0.1	mg/L	0.60			1.6	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	24.6	1	mg/L	24.8			0.9	10	
General Inorganics									
Alkalinity, total	282	5	mg/L	287			1.9	14	
Ammonia as N	0.166	0.01	mg/L	0.168			1.2	17.7	
Dissolved Organic Carbon	4.0	0.5	mg/L	3.3			19.6	37	
Colour	32	2	TCU	30			6.5	12	
Colour, apparent	72	2	ACU	69			4.3	12	
Conductivity	850	5	uS/cm	876			3.0	5	
pH	8.0	0.1	pH Units	8.0			0.5	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	94.0	10	mg/L	98.0			4.2	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11	
Total Kjeldahl Nitrogen	0.18	0.1	mg/L	0.27			NC	16	
Turbidity	10.3	0.1	NTU	10.2			1.0	10	
Metals									
Mercury	ND	0.0001	mg/L	ND			NC	20	
Aluminum	0.086	0.001	mg/L	0.117			29.9	20	QR-05
Antimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	0.168	0.001	mg/L	0.170			1.6	20	
Boron	0.01	0.01	mg/L	0.01			0.6	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	42.5	0.1	mg/L	44.6			4.9	20	
Chromium (VI)	ND	0.010	mg/L	ND			NC	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Copper	0.0005	0.0005	mg/L	0.0006			3.8	20	
Iron	0.6	0.1	mg/L	0.7			7.7	20	
Lead	0.0007	0.0001	mg/L	0.0007			6.0	20	
Magnesium	12.4	0.2	mg/L	12.7			2.1	20	
Manganese	0.075	0.005	mg/L	0.075			0.5	20	
Potassium	1.1	0.1	mg/L	1.1			0.8	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Sodium	2.5	0.2	mg/L	2.7			7.0	20	
Uranium	0.0002	0.0001	mg/L	0.0002			1.7	20	
Zinc	ND	0.005	mg/L	ND			NC	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	16.7	1	mg/L	7.12	95.6	77-123			
Fluoride	1.54	0.1	mg/L	0.73	80.7	79-121			
Nitrate as N	1.60	0.1	mg/L	0.60	100	79-120			
Nitrite as N	0.914	0.05	mg/L	ND	91.4	84-117			
Sulphate	33.2	1	mg/L	24.8	84.1	74-126			
General Inorganics									
Ammonia as N	0.421	0.01	mg/L	0.168	101	81-124			
Dissolved Organic Carbon	13.9	0.5	mg/L	3.3	107	60-133			
Phenolics	0.023	0.001	mg/L	ND	92.5	69-132			
Total Dissolved Solids	100	10	mg/L	ND	100	75-125			
Sulphide	0.52	0.02	mg/L	ND	104	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	106	71-113			
Total Kjeldahl Nitrogen	2.16	0.1	mg/L	0.27	94.5	81-126			
Metals									
Mercury	0.0031	0.0001	mg/L	ND	104	70-130			
Aluminum	44.5	0.001	mg/L	ND	89.1	80-120			
Antimony	45.1	0.0005	mg/L	0.225	89.7	80-120			
Arsenic	50.1	0.001	mg/L	0.480	99.3	80-120			
Barium	210	0.001	mg/L	170	79.1	80-120			QM-07
Boron	55.7	0.01	mg/L	13.0	85.3	80-120			
Cadmium	50.1	0.0001	mg/L	0.0146	100	80-120			
Calcium	11600	0.1	mg/L	ND	116	80-120			
Chromium (VI)	0.205	0.010	mg/L	ND	102	70-130			
Chromium	53.3	0.001	mg/L	0.539	106	80-120			
Copper	48.0	0.0005	mg/L	0.561	94.8	80-120			
Iron	2870	0.1	mg/L	652	88.7	80-120			
Lead	42.8	0.0001	mg/L	0.666	84.2	80-120			
Magnesium	23400	0.2	mg/L	12700	108	80-120			
Manganese	123	0.005	mg/L	74.8	95.6	80-120			
Potassium	12500	0.1	mg/L	1140	113	80-120			
Selenium	48.2	0.001	mg/L	0.128	96.1	80-120			
Sodium	13800	0.2	mg/L	2690	111	80-120			
Uranium	43.9	0.0001	mg/L	0.221	87.3	80-120			
Zinc	48.3	0.005	mg/L	1.17	94.3	80-120			

Qualifier Notes:

Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - sample time reads 14:00

Applies to samples: TW1- 3hr, TW1- 6hr, TW3- 3hr, TW3- 6hr

Sample Qualifiers :

1 : A2C - Background counts greater than 200

QC Qualifiers :

QM-07 : The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

QR-05 : Duplicate RPDs higher than normally accepted. Remaining batch QA\QC was acceptable. May be sample effect.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 13285

Report Date: 24-Mar-2021
Order Date: 18-Mar-2021

Order #: 2112540

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2112540-01	TW2- 3hr
2112540-02	TW2- 6hr
2112540-03	TW4- 3hr
2112540-04	TW4- 6hr

Approved By:

Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	22-Mar-21	23-Mar-21
Ammonia, as N	EPA 351.2 - Auto Colour	22-Mar-21	23-Mar-21
Anions	EPA 300.1 - IC	22-Mar-21	22-Mar-21
Chromium, hexavalent - water	MOE E3056 - colourimetric	19-Mar-21	19-Mar-21
Colour	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Colour, apparent	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Conductivity	EPA 9050A- probe @25 °C	22-Mar-21	23-Mar-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	23-Mar-21	23-Mar-21
E. coli	MOE E3407	19-Mar-21	19-Mar-21
Fecal Coliform	SM 9222D	19-Mar-21	19-Mar-21
Heterotrophic Plate Count	SM 9215C	20-Mar-21	22-Mar-21
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	19-Mar-21	23-Mar-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	19-Mar-21	19-Mar-21
pH	EPA 150.1 - pH probe @25 °C	22-Mar-21	23-Mar-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	19-Mar-21	19-Mar-21
Hardness	Hardness as CaCO3	19-Mar-21	19-Mar-21
Sulphide	SM 4500SE - Colourimetric	23-Mar-21	23-Mar-21
Tannin/Lignin	SM 5550B - Colourimetric	22-Mar-21	22-Mar-21
Total Coliform	MOE E3407	19-Mar-21	19-Mar-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	23-Mar-21	24-Mar-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	19-Mar-21	22-Mar-21
Turbidity	SM 2130B - Turbidity meter	19-Mar-21	19-Mar-21

Certificate of Analysis

Report Date: 24-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 18-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW2- 3hr	TW2- 6hr	TW4- 3hr	TW4- 6hr
	Sample Date:	18-Mar-21 11:30	18-Mar-21 14:30	18-Mar-21 11:30	18-Mar-21 14:30
	Sample ID:	2112540-01	2112540-02	2112540-03	2112540-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Microbiological Parameters					
E. coli	1 CFU/100 mL	ND	ND	ND	ND
Fecal Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Total Coliforms	1 CFU/100 mL	1 [1]	ND	3	ND
Heterotrophic Plate Count	10 CFU/mL	<10	<10	<10	<10
General Inorganics					
Alkalinity, total	5 mg/L	170	171	293	293
Ammonia as N	0.01 mg/L	0.06	0.15	0.25	0.23
Dissolved Organic Carbon	0.5 mg/L	3.3	3.8	4.1	3.9
Colour	2 TCU	35	38	8	7
Colour, apparent	2 ACU	99	64	10	11
Conductivity	5 uS/cm	359	368	1120	1100
Hardness	mg/L	-	192	-	395
pH	0.1 pH Units	8.3	8.3	8.1	8.1
Phenolics	0.001 mg/L	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	10 mg/L	336	336	716	742
Sulphide	0.02 mg/L	<0.02	<0.02	0.56	0.58
Tannin & Lignin	0.1 mg/L	0.3	0.3	0.2	0.2
Total Kjeldahl Nitrogen	0.1 mg/L	0.1	0.3	0.2	0.3
Turbidity	0.1 NTU	18.6	10.0	0.9	1.0
Anions					
Chloride	1 mg/L	3	3	141	135
Fluoride	0.1 mg/L	<0.1	<0.1	0.3	0.3
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Sulphate	1 mg/L	18	18	76	74
Metals					
Mercury	0.0001 mg/L	-	<0.0001	-	<0.0001
Aluminum	0.001 mg/L	-	0.103	-	0.002
Antimony	0.0005 mg/L	-	<0.0005	-	<0.0005
Arsenic	0.001 mg/L	-	<0.001	-	<0.001
Barium	0.001 mg/L	-	0.215	-	0.288
Boron	0.01 mg/L	-	0.01	-	0.15
Cadmium	0.0001 mg/L	-	<0.0001	-	<0.0001
Calcium	0.1 mg/L	-	50.0	-	91.2
Chromium	0.001 mg/L	-	<0.001	-	<0.001

Certificate of Analysis

Report Date: 24-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 18-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW2- 3hr	TW2- 6hr	TW4- 3hr	TW4- 6hr
	Sample Date:	18-Mar-21 11:30	18-Mar-21 14:30	18-Mar-21 11:30	18-Mar-21 14:30
	Sample ID:	2112540-01	2112540-02	2112540-03	2112540-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Chromium (VI)	0.010 mg/L	-	<0.010	-	<0.010
Copper	0.0005 mg/L	-	0.0005	-	0.0031
Iron	0.1 mg/L	-	0.8	-	0.2
Lead	0.0001 mg/L	-	0.0007	-	0.0003
Magnesium	0.2 mg/L	-	16.3	-	40.7
Manganese	0.005 mg/L	-	0.048	-	0.023
Potassium	0.1 mg/L	1.4	1.4	9.0	8.5
Selenium	0.001 mg/L	-	<0.001	-	<0.001
Sodium	0.2 mg/L	-	3.2	-	66.9
Uranium	0.0001 mg/L	-	0.0002	-	0.0003
Zinc	0.005 mg/L	-	<0.005	-	0.007

Certificate of Analysis

Report Date: 24-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 18-Mar-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Mercury	ND	0.0001	mg/L						
Aluminum	ND	0.001	mg/L						
Antimony	ND	0.0005	mg/L						
Arsenic	ND	0.001	mg/L						
Barium	ND	0.001	mg/L						
Boron	ND	0.01	mg/L						
Cadmium	ND	0.0001	mg/L						
Calcium	ND	0.1	mg/L						
Chromium (VI)	ND	0.010	mg/L						
Chromium	ND	0.001	mg/L						
Copper	ND	0.0005	mg/L						
Iron	ND	0.1	mg/L						
Lead	ND	0.0001	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Selenium	ND	0.001	mg/L						
Sodium	ND	0.2	mg/L						
Uranium	ND	0.0001	mg/L						
Zinc	ND	0.005	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	7.02	1	mg/L	7.12			1.4	10	
Fluoride	0.71	0.1	mg/L	0.73			2.9	10	
Nitrate as N	0.59	0.1	mg/L	0.60			1.6	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	24.6	1	mg/L	24.8			0.9	10	
General Inorganics									
Alkalinity, total	282	5	mg/L	287			1.9	14	
Ammonia as N	0.166	0.01	mg/L	0.168			1.2	17.7	
Dissolved Organic Carbon	4.0	0.5	mg/L	3.3			19.6	37	
Colour	8	2	TCU	8			0.0	12	
Colour, apparent	19	2	ACU	19			0.0	12	
Conductivity	850	5	uS/cm	876			3.0	5	
pH	8.0	0.1	pH Units	8.0			0.5	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	306	10	mg/L	336			9.4	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11	
Total Kjeldahl Nitrogen	0.28	0.1	mg/L	0.30			6.8	16	
Turbidity	18.7	0.1	NTU	18.6			0.5	10	
Metals									
Mercury	ND	0.0001	mg/L	ND			NC	20	
Aluminum	ND	0.001	mg/L	ND			NC	20	
Antimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	0.023	0.001	mg/L	0.022			3.2	20	
Boron	0.06	0.01	mg/L	0.06			0.8	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	94.1	0.1	mg/L	93.3			0.9	20	
Chromium (VI)	ND	0.010	mg/L	ND			NC	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Copper	0.0052	0.0005	mg/L	0.0054			3.7	20	
Iron	ND	0.1	mg/L	ND			NC	20	
Lead	0.0004	0.0001	mg/L	0.0005			16.6	20	
Magnesium	26.3	0.2	mg/L	25.9			1.4	20	
Manganese	ND	0.005	mg/L	ND			NC	20	
Potassium	3.2	0.1	mg/L	3.1			2.0	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Sodium	10.7	0.2	mg/L	11.0			3.5	20	
Uranium	ND	0.0001	mg/L	0.0001			NC	20	
Zinc	0.005	0.005	mg/L	0.005			1.1	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	1			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	16.7	1	mg/L	7.12	95.6	77-123			
Fluoride	1.54	0.1	mg/L	0.73	80.7	79-121			
Nitrate as N	1.60	0.1	mg/L	0.60	100	79-120			
Nitrite as N	0.914	0.05	mg/L	ND	91.4	84-117			
Sulphate	33.2	1	mg/L	24.8	84.1	74-126			
General Inorganics									
Ammonia as N	0.421	0.01	mg/L	0.168	101	81-124			
Dissolved Organic Carbon	13.9	0.5	mg/L	3.3	107	60-133			
Phenolics	0.025	0.001	mg/L	ND	99.7	69-132			
Total Dissolved Solids	110	10	mg/L	ND	110	75-125			
Sulphide	0.52	0.02	mg/L	ND	104	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	106	71-113			
Total Kjeldahl Nitrogen	2.00	0.1	mg/L	0.37	81.8	81-126			
Metals									
Mercury	0.0032	0.0001	mg/L	ND	108	70-130			
Aluminum	42.2	0.001	mg/L	ND	84.4	80-120			
Antimony	42.6	0.0005	mg/L	ND	85.1	80-120			
Arsenic	49.9	0.001	mg/L	0.135	99.5	80-120			
Barium	68.3	0.001	mg/L	22.5	91.7	80-120			
Boron	55.4	0.01	mg/L	9.16	92.6	80-120			
Cadmium	45.3	0.0001	mg/L	0.0603	90.5	80-120			
Calcium	20800	0.1	mg/L	9130	117	80-120			
Chromium (VI)	0.209	0.010	mg/L	ND	104	70-130			
Chromium	52.8	0.001	mg/L	0.084	105	80-120			
Copper	51.6	0.0005	mg/L	5.42	92.3	80-120			
Iron	2410	0.1	mg/L	8.3	96.1	80-120			
Lead	42.5	0.0001	mg/L	0.473	84.0	80-120			
Magnesium	36200	0.2	mg/L	25900	103	80-120			
Manganese	55.3	0.005	mg/L	3.83	103	80-120			
Potassium	12500	0.1	mg/L	732	117	80-120			
Selenium	47.7	0.001	mg/L	0.124	95.1	80-120			
Sodium	21700	0.2	mg/L	11000	107	80-120			
Uranium	46.9	0.0001	mg/L	0.128	93.6	80-120			
Zinc	50.3	0.005	mg/L	5.19	90.3	80-120			

Qualifier Notes:

Sample Qualifiers :

1 : Duplicate result for this sample analysis was determined to be ND.

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody:

Report Date: 23-Mar-2021
Order Date: 17-Mar-2021

Order #: 2112298

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2112298-01	TW5 3 hrs
2112298-02	TW5 6 hrs

Approved By:

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 23-Mar-2021

Order Date: 17-Mar-2021

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	17-Mar-21	17-Mar-21
Ammonia, as N	EPA 351.2 - Auto Colour	18-Mar-21	18-Mar-21
Anions	EPA 300.1 - IC	18-Mar-21	18-Mar-21
Chromium, hexavalent - water	MOE E3056 - colourimetric	17-Mar-21	18-Mar-21
Colour	SM2120 - Spectrophotometric	17-Mar-21	17-Mar-21
Colour, apparent	SM2120 - Spectrophotometric	17-Mar-21	17-Mar-21
Conductivity	EPA 9050A- probe @25 °C	17-Mar-21	17-Mar-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	18-Mar-21	18-Mar-21
E. coli	MOE E3407	17-Mar-21	17-Mar-21
Fecal Coliform	SM 9222D	17-Mar-21	17-Mar-21
Heterotrophic Plate Count	SM 9215C	17-Mar-21	17-Mar-21
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	18-Mar-21	18-Mar-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	17-Mar-21	17-Mar-21
pH	EPA 150.1 - pH probe @25 °C	17-Mar-21	17-Mar-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	17-Mar-21	17-Mar-21
Hardness	Hardness as CaCO3	17-Mar-21	17-Mar-21
Sulphide	SM 4500SE - Colourimetric	18-Mar-21	18-Mar-21
Tannin/Lignin	SM 5550B - Colourimetric	22-Mar-21	22-Mar-21
Total Coliform	MOE E3407	17-Mar-21	17-Mar-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	22-Mar-21	22-Mar-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	19-Mar-21	22-Mar-21
Turbidity	SM 2130B - Turbidity meter	17-Mar-21	17-Mar-21

Certificate of Analysis

Report Date: 23-Mar-2021

Client: **GEMTEC Consulting Engineers and Scientists Limited**

Order Date: 17-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW5 3 hrs	TW5 6 hrs	-	-
	Sample Date:	16-Mar-21 09:00	16-Mar-21 00:00	-	-
	Sample ID:	2112298-01	2112298-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Microbiological Parameters					
E. coli	1 CFU/100 mL	ND	ND	-	-
Fecal Coliforms	1 CFU/100 mL	ND	ND	-	-
Total Coliforms	1 CFU/100 mL	ND	ND	-	-
Heterotrophic Plate Count	10 CFU/mL	<10	<10	-	-
General Inorganics					
Alkalinity, total	5 mg/L	284	286	-	-
Ammonia as N	0.01 mg/L	0.25	0.25	-	-
Dissolved Organic Carbon	0.5 mg/L	1.5	1.4	-	-
Colour	2 TCU	2	3	-	-
Colour, apparent	2 ACU	5	9	-	-
Conductivity	5 uS/cm	1050	1060	-	-
Hardness	mg/L	331	339	-	-
pH	0.1 pH Units	7.9	8.0	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Total Dissolved Solids	10 mg/L	528	520	-	-
Sulphide	0.02 mg/L	0.90	0.92	-	-
Tannin & Lignin	0.1 mg/L	<0.1	<0.1	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	0.3	0.4	-	-
Turbidity	0.1 NTU	0.4	1.6	-	-
Anions					
Chloride	1 mg/L	125	127	-	-
Fluoride	0.1 mg/L	0.1	0.1	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	-	-
Sulphate	1 mg/L	63	65	-	-
Metals					
Mercury	0.0001 mg/L	-	<0.0001	-	-
Aluminum	0.001 mg/L	-	0.001	-	-
Antimony	0.0005 mg/L	-	<0.0005	-	-
Arsenic	0.001 mg/L	-	<0.001	-	-
Barium	0.001 mg/L	-	0.247	-	-
Boron	0.01 mg/L	-	0.23	-	-
Cadmium	0.0001 mg/L	-	<0.0001	-	-
Calcium	0.1 mg/L	75.0	77.1	-	-
Chromium	0.001 mg/L	-	<0.001	-	-

Certificate of Analysis

Report Date: 23-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 17-Mar-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW21-04 3hrs	TW21-04 6hrs	-	-
	Sample Date:	16-Mar-21 09:00	16-Mar-21 00:00	-	-
	Sample ID:	2112298-01	2112298-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Chromium (VI)	0.010 mg/L	-	<0.010	-	-
Copper	0.0005 mg/L	-	<0.0005	-	-
Iron	0.1 mg/L	<0.1	0.1	-	-
Lead	0.0001 mg/L	-	<0.0001	-	-
Magnesium	0.2 mg/L	34.9	35.7	-	-
Manganese	0.005 mg/L	0.023	0.025	-	-
Potassium	0.1 mg/L	8.0	7.9	-	-
Selenium	0.001 mg/L	-	<0.001	-	-
Sodium	0.2 mg/L	78.4	78.9	-	-
Uranium	0.0001 mg/L	-	<0.0001	-	-
Zinc	0.005 mg/L	-	<0.005	-	-

Certificate of Analysis

Report Date: 23-Mar-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 17-Mar-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Mercury	ND	0.0001	mg/L						
Aluminum	ND	0.001	mg/L						
Antimony	ND	0.0005	mg/L						
Arsenic	ND	0.001	mg/L						
Barium	ND	0.001	mg/L						
Boron	ND	0.01	mg/L						
Cadmium	ND	0.0001	mg/L						
Calcium	ND	0.1	mg/L						
Chromium (VI)	ND	0.010	mg/L						
Chromium	ND	0.001	mg/L						
Copper	ND	0.0005	mg/L						
Iron	ND	0.1	mg/L						
Lead	ND	0.0001	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Selenium	ND	0.001	mg/L						
Sodium	ND	0.2	mg/L						
Uranium	ND	0.0001	mg/L						
Zinc	ND	0.005	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	94.8	1	mg/L	94.2			0.6	10	
Fluoride	0.22	0.1	mg/L	0.22			0.8	10	
Nitrate as N	ND	0.1	mg/L	ND			NC	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	38.6	1	mg/L	38.3			0.8	10	
General Inorganics									
Alkalinity, total	280	5	mg/L	284			1.4	14	
Ammonia as N	0.258	0.01	mg/L	0.251			2.5	17.7	
Dissolved Organic Carbon	14.7	0.5	mg/L	13.3			9.8	37	
Colour	15	2	TCU	15			0.0	12	
Colour, apparent	9	2	ACU	9			0.0	12	
Conductivity	1030	5	uS/cm	1050			1.5	5	
pH	8.0	0.1	pH Units	7.9			0.9	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	544	10	mg/L	528			3.0	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11	
Total Kjeldahl Nitrogen	0.28	0.1	mg/L	0.30			6.8	16	
Turbidity	1.7	0.1	NTU	1.6			7.2	10	
Metals									
Mercury	ND	0.0001	mg/L	ND			NC	20	
Aluminum	0.003	0.001	mg/L	0.003			0.6	20	
Antimony	0.0008	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	0.023	0.001	mg/L	0.022			3.3	20	
Boron	0.02	0.01	mg/L	0.02			3.2	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	38.4	0.1	mg/L	38.5			0.1	20	
Chromium (VI)	ND	0.010	mg/L	ND			NC	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Copper	0.0077	0.0005	mg/L	0.0079			2.5	20	
Iron	ND	0.1	mg/L	ND			NC	20	
Lead	0.0008	0.0001	mg/L	0.0008			4.1	20	
Magnesium	8.8	0.2	mg/L	9.4			6.8	20	
Manganese	ND	0.005	mg/L	ND			NC	20	
Potassium	2.0	0.1	mg/L	2.0			1.7	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Sodium	18.8	0.2	mg/L	19.5			3.4	20	
Uranium	0.0003	0.0001	mg/L	0.0003			3.7	20	
Zinc	0.039	0.005	mg/L	0.039			0.5	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	9.74	1	mg/L	ND	97.4	85-115			
Fluoride	1.17	0.1	mg/L	0.22	94.7	79-121			
Nitrate as N	1.06	0.1	mg/L	ND	106	79-120			
Nitrite as N	1.03	0.05	mg/L	ND	103	84-117			
Sulphate	47.0	1	mg/L	38.3	86.7	74-126			
General Inorganics									
Ammonia as N	0.503	0.01	mg/L	0.251	101	81-124			
Dissolved Organic Carbon	20.6	0.5	mg/L	13.3	73.3	60-133			
Phenolics	0.028	0.001	mg/L	ND	111	69-132			
Total Dissolved Solids	96.0	10	mg/L	ND	96.0	75-125			
Sulphide	0.51	0.02	mg/L	ND	102	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	106	71-113			
Total Kjeldahl Nitrogen	2.00	0.1	mg/L	0.37	81.8	81-126			
Metals									
Mercury	0.0033	0.0001	mg/L	ND	108	70-130			
Aluminum	46.1	0.001	mg/L	3.42	85.4	80-120			
Antimony	49.2	0.0005	mg/L	0.175	98.1	80-120			
Arsenic	49.2	0.001	mg/L	0.788	96.8	80-120			
Barium	69.7	0.001	mg/L	22.4	94.6	80-120			
Boron	64.9	0.01	mg/L	23.8	82.2	80-120			
Cadmium	46.7	0.0001	mg/L	0.0378	93.3	80-120			
Calcium	47400	0.1	mg/L	38500	89.8	80-120			
Chromium (VI)	0.209	0.010	mg/L	ND	104	70-130			
Chromium	51.5	0.001	mg/L	0.296	102	80-120			
Copper	54.0	0.0005	mg/L	7.90	92.3	80-120			
Iron	2370	0.1	mg/L	28.0	93.7	80-120			
Lead	40.0	0.0001	mg/L	0.833	78.4	80-120			QS-02
Magnesium	19500	0.2	mg/L	9380	101	80-120			
Manganese	50.7	0.005	mg/L	0.652	100	80-120			
Potassium	13700	0.1	mg/L	2000	117	80-120			
Selenium	46.0	0.001	mg/L	0.151	91.8	80-120			
Sodium	29600	0.2	mg/L	19500	101	80-120			
Uranium	41.8	0.0001	mg/L	0.330	83.0	80-120			
Zinc	82.1	0.005	mg/L	39.0	86.1	80-120			

Qualifier Notes:

Login Qualifiers :

Container and COC sample IDs don't match - Containers labelled as TW21-04 (6hrs), chain of custody is missing sample ID.

Applies to samples: TW21-04 3hrs, TW21-04 6hrs

Sample Qualifiers :

QC Qualifiers :

QS-02 : Spike level outside of control limits. Analysis batch accepted based on other QC included in the batch.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 58639

Report Date: 12-Apr-2021
Order Date: 7-Apr-2021

Order #: 2115359

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2115359-01	TW1-R1a
2115359-02	TW1-R1b

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 12-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 7-Apr-2021

Client PO:

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Colour	SM2120 - Spectrophotometric	8-Apr-21	8-Apr-21
Colour, apparent	SM2120 - Spectrophotometric	8-Apr-21	8-Apr-21
E. coli	MOE E3407	8-Apr-21	8-Apr-21
Fecal Coliform	SM 9222D	8-Apr-21	8-Apr-21
Heterotrophic Plate Count	SM 9215C	8-Apr-21	8-Apr-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	8-Apr-21	8-Apr-21
Total Coliform	MOE E3407	8-Apr-21	8-Apr-21
Turbidity	SM 2130B - Turbidity meter	8-Apr-21	8-Apr-21

Certificate of Analysis

Report Date: 12-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 7-Apr-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW1-R1a	TW1-R1b	-	-
	Sample Date:	07-Apr-21 09:15	07-Apr-21 09:15	-	-
	Sample ID:	2115359-01	2115359-02	-	-
	MDL/Units	Water	Water	-	-
Microbiological Parameters					
E. coli	1 CFU/100 mL	ND	ND	-	-
Fecal Coliforms	1 CFU/100 mL	ND	ND	-	-
Total Coliforms	1 CFU/100 mL	ND	ND	-	-
Heterotrophic Plate Count	10 CFU/mL	<10	<10	-	-
General Inorganics					
Colour	2 TCU	18	-	-	-
Colour, apparent	2 ACU	25	-	-	-
Turbidity	0.1 NTU	1.1	-	-	-
Metals					
Iron	100 ug/L	550	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Turbidity	ND	0.1	NTU						
Metals									
Iron	ND	100	ug/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	18	2	TCU	18			0.0	12	
Colour, apparent	25	2	ACU	25			0.0	12	
Turbidity	1.1	0.1	NTU	1.1			3.6	10	
Metals									
Iron	ND	100	ug/L	ND			NC	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Iron	2760	100	ug/L	ND	110	80-120			

Qualifier Notes:

Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - Metals Bottle is not labelled

Applies to samples: TW1-R1a

Container and COC sample IDs don't match - Bacteria bottles labelled as TW-R1a, chain of custody reads TW1 9:30

Applies to samples: TW1-R1b

Container and COC sample IDs don't match - General bottle labelled as TW2-R1, bacteria bottles labelled as TW-R1b chain of custody reads TW1 9:15

Applies to samples: TW1-R1a

Sample Qualifiers :

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 128966

Report Date: 7-Apr-2021
Order Date: 6-Apr-2021

Revised Report

Order #: 2115227

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2115227-01	TW2

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Report Date: 07-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 6-Apr-2021

Client PO:

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Colour	SM2120 - Spectrophotometric	7-Apr-21	7-Apr-21
Colour, apparent	SM2120 - Spectrophotometric	7-Apr-21	7-Apr-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	7-Apr-21	7-Apr-21
Turbidity	SM 2130B - Turbidity meter	7-Apr-21	7-Apr-21

Certificate of Analysis

Report Date: 07-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 6-Apr-2021

Client PO:

Project Description: 100554.001

	Client ID:	TW2	-	-	-
	Sample Date:	05-Apr-21 09:30	-	-	-
	Sample ID:	2115227-01	-	-	-
	MDL/Units	Water	-	-	-
General Inorganics					
Colour	2 TCU	16	-	-	-
Colour, apparent	2 ACU	24	-	-	-
Turbidity	0.1 NTU	0.7	-	-	-
Metals					
Iron	100 ug/L	529	-	-	-

Certificate of Analysis

Report Date: 07-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 6-Apr-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Metals									
Iron	ND	100	ug/L						

Certificate of Analysis

Report Date: 07-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 6-Apr-2021

Client PO:

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	16	2	TCU	16			0.0	12	
Colour, apparent	24	2	ACU	24			0.0	12	
Metals									
Iron	313	100	ug/L	316			0.8	20	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Iron	2520	100	ug/L	ND	101	80-120			

Certificate of Analysis

Report Date: 07-Apr-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 6-Apr-2021

Client PO:

Project Description: 100554.001

Qualifier Notes:

Login Qualifiers :

Container and COC sample IDs don't match - metals bottle missing and ID. Generals bottle read TW2-R1

Applies to samples: TW2

Sample Data Revisions

None

Work Order Revisions / Comments:

REVISION 1: This version contains an amended project number.

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Andrius Paznekas

Client PO:
Project: 100554.001
Custody: 11954

Report Date: 3-May-2021
Order Date: 28-Apr-2021

Order #: 2118321

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2118321-01	[redacted] Relabelled PW1
2118321-02	[redacted] Relabelled PW2
2118321-03	[redacted] Relabelled PW3
2118321-04	[redacted] Relabelled PW4

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Report Date: 03-May-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 28-Apr-2021

Client PO:

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	29-Apr-21	29-Apr-21
Ammonia, as N	EPA 351.2 - Auto Colour	29-Apr-21	29-Apr-21
Anions	EPA 300.1 - IC	29-Apr-21	29-Apr-21
Colour	SM2120 - Spectrophotometric	29-Apr-21	29-Apr-21
Colour, apparent	SM2120 - Spectrophotometric	29-Apr-21	29-Apr-21
Conductivity	EPA 9050A- probe @25 °C	29-Apr-21	29-Apr-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	29-Apr-21	29-Apr-21
E. coli	MOE E3407	29-Apr-21	29-Apr-21
Fecal Coliform	SM 9222D	29-Apr-21	29-Apr-21
Heterotrophic Plate Count	SM 9215C	29-Apr-21	29-Apr-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	29-Apr-21	29-Apr-21
pH	EPA 150.1 - pH probe @25 °C	29-Apr-21	29-Apr-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	30-Apr-21	30-Apr-21
Hardness	Hardness as CaCO3	29-Apr-21	29-Apr-21
Sulphide	SM 4500SE - Colourimetric	29-Apr-21	29-Apr-21
Tannin/Lignin	SM 5550B - Colourimetric	29-Apr-21	30-Apr-21
Total Coliform	MOE E3407	29-Apr-21	29-Apr-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	29-Apr-21	30-Apr-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	29-Apr-21	30-Apr-21
Turbidity	SM 2130B - Turbidity meter	29-Apr-21	29-Apr-21

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Order #: 2118321

Certificate of Analysis

Report Date: 03-May-2021

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 28-Apr-2021

Client PO:

Project Description: 100554.001

	Client ID:	PW1	PW2	PW3	PW4
	Sample Date:	28-Apr-21 16:10	28-Apr-21 12:15	28-Apr-21 13:15	28-Apr-21 14:50
	Sample ID:	2118321-01	2118321-02	2118321-03	2118321-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Microbiological Parameters					
E. coli	1 CFU/100 mL	ND	ND	ND	ND
Fecal Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Total Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Heterotrophic Plate Count	10 CFU/mL	<10	<10	<10	<10
General Inorganics					
Alkalinity, total	5 mg/L	305	229	250	282
Ammonia as N	0.01 mg/L	0.07	0.10	0.20	0.07
Dissolved Organic Carbon	0.5 mg/L	3.0	3.2	4.5	5.0
Colour	2 TCU	2	12	8	12
Colour, apparent	2 ACU	22	13	47	15
Conductivity	5 uS/cm	1470	614	733	773
Hardness	mg/L	488	263	280	320
pH	0.1 pH Units	7.8	8.0	8.0	7.8
Phenolics	0.001 mg/L	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	10 mg/L	810	336	434	412
Sulphide	0.02 mg/L	<0.02	0.10	0.04	<0.02
Tannin & Lignin	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen	0.1 mg/L	0.2	0.2	0.4	0.2
Turbidity	0.1 NTU	3.6	0.5	2.6	0.2
Anions					
Chloride	1 mg/L	187	33	64	47
Fluoride	0.1 mg/L	<0.1	0.2	<0.1	<0.1
Nitrate as N	0.1 mg/L	0.2	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Sulphate	1 mg/L	124	38	37	59
Metals					
Calcium	0.1 mg/L	115	62.6	70.6	82.3
Iron	0.1 mg/L	0.5	0.2	0.9	<0.1
Magnesium	0.2 mg/L	48.6	25.8	25.3	27.8
Manganese	0.005 mg/L	0.119	0.035	0.102	0.110
Potassium	0.1 mg/L	1.9	3.2	1.6	1.4
Sodium	0.2 mg/L	88.6	22.2	36.4	33.4

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Calcium	ND	0.1	mg/L						
Iron	ND	0.1	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Sodium	ND	0.2	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	185	1	mg/L	187			1.4	10	
Fluoride	ND	0.1	mg/L	ND			NC	10	
Nitrate as N	0.18	0.1	mg/L	0.18			1.3	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	121	1	mg/L	124			1.8	10	
General Inorganics									
Alkalinity, total	140	5	mg/L	138			1.3	14	
Ammonia as N	3.40	0.10	mg/L	3.31			2.7	17.7	
Dissolved Organic Carbon	0.5	0.5	mg/L	0.6			18.8	37	
Colour	12	2	TCU	12			0.0	12	
Colour, apparent	15	2	ACU	15			0.0	12	
Conductivity	5580	5	uS/cm	5650			1.2	5	
pH	7.6	0.1	pH Units	7.6			0.1	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	748	10	mg/L	810			8.0	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11	
Total Kjeldahl Nitrogen	0.11	0.1	mg/L	0.17			NC	16	
Turbidity	3.8	0.1	NTU	3.6			4.1	10	
Metals									
Calcium	449	0.1	mg/L	453			1.0	20	
Iron	0.3	0.1	mg/L	0.3			2.1	20	
Magnesium	144	0.2	mg/L	147			2.2	20	
Manganese	0.176	0.005	mg/L	0.180			2.3	20	
Potassium	53.2	0.1	mg/L	53.6			0.8	20	
Sodium	667	0.2	mg/L	704			5.3	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	196	1	mg/L	187	93.6	77-123			
Fluoride	0.92	0.1	mg/L	ND	92.3	79-121			
Nitrate as N	1.27	0.1	mg/L	0.18	109	79-120			
Nitrite as N	0.916	0.05	mg/L	ND	91.6	84-117			
Sulphate	132	1	mg/L	124	82.7	74-126			
General Inorganics									
Ammonia as N	0.216	0.01	mg/L	ND	86.2	81-124			
Dissolved Organic Carbon	12.2	0.5	mg/L	0.6	116	60-133			
Phenolics	0.024	0.001	mg/L	ND	94.2	69-132			
Total Dissolved Solids	94.0	10	mg/L	ND	94.0	75-125			
Sulphide	0.52	0.02	mg/L	ND	105	79-115			
Tannin & Lignin	ND	0.1	mg/L	ND		71-113			
Total Kjeldahl Nitrogen	2.11	0.1	mg/L	0.17	96.9	81-126			
Metals									
Calcium	9770	0.1	mg/L	ND	97.7	80-120			
Iron	2950	0.1	mg/L	280	107	80-120			
Magnesium	9980	0.2	mg/L	ND	99.8	80-120			
Manganese	227	0.005	mg/L	180	94.8	80-120			
Potassium	62000	0.1	mg/L	53600	84.2	80-120			
Sodium	9760	0.2	mg/L	ND	97.6	80-120			

Qualifier Notes:

Sample Qualifiers :

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

APPENDIX K

Langelier Saturation Index

Langelier Saturation Index Calculation

Project: 100554.001
Location: Proposed Emerald Woods Residential Subdivision
Sample ID: **TW3 - 6hr**
Well Tag: A313200

Inputs

pH =	8.2	
Total Dissolved Solids =	664	
Calcium (as $CaCO_3$) =	223	Note: Ca (as CaCO3) = 2.5 x Ca
Alkalinity (as $CaCO_3$) =	300	
Temperature (^oC) =	10	Assumed average groundwater temperature

Where Langelier Saturation Index (LSI) is defined as: $LSI = pH - pH_s$

Where: $pH_s = (9.3 + A + B) - (C + D)$

And:

$$A = \frac{(\log_{10}[TDS] - 1)}{10}$$

$$B = -13.12 \cdot \log_{10}[Temp + 273] + 34.55$$

$$C = \log_{10}[Calcium] - 0.4$$

$$D = \log_{10}[Alkalinity]$$

Output:

A =	0.18
B =	2.38
C =	1.95
D =	2.48
pH_s =	7.44

LSI = 0.76

LSI Value	Indication
-2.0 to -0.5	Serious corrosion
-0.5 to 0.0	Slight corrosion but non-scale forming
LSI = 0	Balanced but corrosion possible
0.0 to 0.5	Slightly scale forming and corrosive
0.5 to 2	Scale forming but non corrosive

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Langelier Saturation Index Calculation

Project: 100554.001
Location: Proposed Emerald Woods Residential Subdivision
Sample ID: **TW4 - 6hr**
Well Tag: A305116

Inputs

pH =	8.1	
Total Dissolved Solids =	742	
Calcium (as $CaCO_3$) =	228	Note: Ca (as CaCO3) = 2.5 x Ca
Alkalinity (as $CaCO_3$) =	293	
Temperature (^oC) =	10	Assumed average groundwater temperature

Where Langelier Saturation Index (LSI) is defined as: $LSI = pH - pH_s$

Where: $pH_s = (9.3 + A + B) - (C + D)$

And:

$$A = \frac{(\log_{10}[TDS] - 1)}{10}$$

$$B = -13.12 \cdot \log_{10}[Temp + 273] + 34.55$$

$$C = \log_{10}[Calcium] - 0.4$$

$$D = \log_{10}[Alkalinity]$$

Output:

A =	0.19
B =	2.38
C =	1.96
D =	2.47
pH_s =	7.44

LSI = 0.66

LSI Value	Indication
-2.0 to -0.5	Serious corrosion
-0.5 to 0.0	Slight corrosion but non-scale forming
LSI = 0	Balanced but corrosion possible
0.0 to 0.5	Slightly scale forming and corrosive
0.5 to 2	Scale forming but non corrosive

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Langelier Saturation Index Calculation

Project: 100554.001
Location: Proposed Emerald Woods Residential Subdivision
Sample ID: **TW5 - 6hr**
Well Tag: A313201

Inputs

pH =	8	
Total Dissolved Solids =	520	
Calcium (as $CaCO_3$) =	193	Note: Ca (as CaCO3) = 2.5 x Ca
Alkalinity (as $CaCO_3$) =	286	
Temperature (^oC) =	10	Assumed average groundwater temperature

Where Langelier Saturation Index (LSI) is defined as: $LSI = pH - pH_s$

Where: $pH_s = (9.3 + A + B) - (C + D)$

And:

$$A = \frac{(\log_{10}[TDS] - 1)}{10}$$

$$B = -13.12 \cdot \log_{10}[Temp + 273] + 34.55$$

$$C = \log_{10}[Calcium] - 0.4$$

$$D = \log_{10}[Alkalinity]$$

Output:

A =	0.17
B =	2.38
C =	1.88
D =	2.46
pH_s =	7.51

LSI = 0.49

LSI Value	Indication
-2.0 to -0.5	Serious corrosion
-0.5 to 0.0	Slight corrosion but non-scale forming
LSI = 0	Balanced but corrosion possible
0.0 to 0.5	Slightly scale forming and corrosive
0.5 to 2	Scale forming but non corrosive

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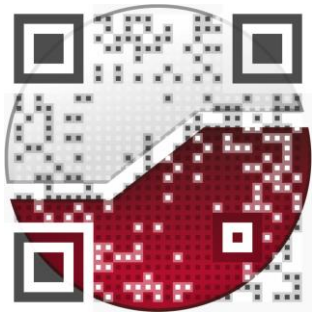

civil	civil
geotechnical	géotechnique
environmental	environnementale
field services	surveillance de chantier
materials testing	service de laboratoire des matériaux

expérience • connaissance • intégrité