Hydrogeology, Terrain Analysis and Impact Assessment Report

Derry Side Road, Township of Beckwith, Ontario

Client:
Steve Smith

Type of Document:
Final

Project Name:
Hydrogeology, Terrain Analysis and Impact Assessment Report
Derry Side Road, Township of Beckwith, Ontario

Project Number:
OTT-00236288-A0

Prepared By: Shawn Doherty, P.Eng.
Reviewed By: Dan McNicoll, P.Geo.

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 7H6
Canada

Date Submitted:
September 18, 2020

Hydrogeology, Terrain Analysis and Impact Assessment

Derry Side Road, Township of Beckwith, Ontario

Prepared For:
Steve Smith

Type of Document:
Final

Project Name:
Hydrogeology, Terrain Analysis and Impact Assessment
Derry Side Road, Township of Beckwith, Ontario

Project Number:
OTT-00236288-A0

Prepared By:
EXP
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
Canada
T: 613 688-1899
F: 613 225-7337
www.exp.com

Shawn Doherty, P.Eng.
Environmental Engineer

Dan McNicoll, M.Sc., P.Geo.
Senior Hydrogeologist

Date Submitted:
September 18, 2020

Executive Summary

An investigation was conducted to assess the suitability of a site located on Derry Side Road and west of Richmond Road in Beckwith, Ontario for a proposed 16 hectare residential subdivision. The site is legally described as Part of Lot 20, Concession 4 in the Township of Beckwith, County of Lanark.

It is proposed that the property, covering an area of 16.158 hectares, be subdivided into 24 residential lots with average lot sizes in the order of 0.47 hectare (1 acre) to 1.17 hectare (2.4 acres). The development will be serviced by individual water wells and Class IV sewage disposal systems. The purpose of the investigation described within was to assess the suitability of the site for development on private services.

However, the client has since revised the lot layout and has reduced the overall size of the proposed development. The revised development covers a total area of 54,452 m^2 (5.4 hectares) and is split into nine (9) residential lots. The proposed lot sizes range in size between 0.4 hectares and 0.62 hectares.

The development will be serviced by individual water wells and Class IV sewage disposal systems. The purpose of the investigation described within was to assess the suitability of the site for development on private services.

The assessment consisted of the following tasks:

- On-site hydrogeologic conditions were investigated through the construction and testing of two domestic water wells. The wells were drilled on the subject property in February / March 2017 by Olympic Drilling in accordance with Ontario Regulation 903. Understanding that MECP Procedure D-5-5 mandates three wells for any subdivision under 15 hectares, it is EXP's opinion that the information gathered from the three wells drilled on site combined with the well drilled off-site (stable property) is sufficient based given that the site is just slightly over 15 hectares (any site between 15 to 20 hectares requires four (4) wells).
- Water quantity was assessed on the basis of six-hour constant-rate pumping tests conducted on the wells and subsequent recovery tests.
- Water quality was evaluated through chemical and bacteriological analysis of samples collected at the beginning and end of each pumping test. Additional pumping and sampling of the wells was conducted as required.

All field and desktop work as part of this hydrogeological investigation was done in accordance with MECP Procedure D-5-5.

- Soil stratigraphy on the site was assessed through the completion of 6 test pits and three (3) boreholes. Select test pits were then outfitted with piezometers. This information was then used to assess the hydrogeological sensitivity of the site and the sizing for the required septic systems.

Based on the above work program, the following are the conclusions:

1. Water well records for wells drilled within 1 km of the site indicate that well yields are in excess of the required 18.75 L/min for 4 bedroom house. The wells extended to depths ranging from 20 to 44 m from surface, with an average well depth of 33 m. Water is generally found at depths of 17 to 42 m. Depth to rock was consistently identified to be beyond 2 m from surface with the exception of one well within the 1km radius of the site.
2. Four water supply wells (including two wells drilled off site: one on the stable property and one southwest near snowmobile trail) were completed in the sandstone and/or limestone/sandstone bedrock formation while intercepting the Oxford Formation (limestone) potentially extending into the March Formation. Six-hour constant rate pumping tests, at rates of 75 L/min, followed by

recovery tests conducted on each of these wells indicate well yields at or in excess of the 75 L/min. Some of the wells did not sustain any drawdown at these rates. These rates are more than adequate to supply the MECP recommended 18.75 L/min flow rate for a 4-bedroom residence. It is our professional opinion that the wells tested as part of this program display sufficient well yields that future wells (drilled as recommended) would produce sufficient yield.

3. The wells drilled within the subject property are drawing the majority of the water from water bearing fractures within the March Formation (dolomite and sandstone).
4. The pumping tests did not identify any well interference between the respective test wells drilled on the subject site. The impacts within the monitoring wells approximately 110 to 120 m away from the respective production wells were in the order of <1% (18 to 21 cm respectively) of the available drawdown as a result of 6 hrs of pumping at high flow rates. The pumping tests were conducted at flow rates well above the anticipated household flow rates to assess the well yield. A conservative evaluation of the cumulative well interference at the site predicts a cumulative drawdown ranging of 0.53 m at the center of the property based on standard water usage over 30 years, which is not considered a concern.
5. Groundwater quality in the bedrock aquifer met all health related criteria of the Ontario Drinking Water Standards for those parameters tested after all testing was complete.
    a. Turbidity levels were noted to be above the applicable aesthetic objective guidelines (1 NTU) at the end of the test in each of the test wells. These levels decreased during testing and should continue to decrease with continued pumping at lower rates.
    b. Test Well #3 was shock chlorinated following initial water testing to establish good water quality. Subsequent to the second well shock, total coliform was no longer detected.
    c. Hardness levels were consistently elevated within all the wells suggesting hard water. The hard water can lead to potential scaling within the piping.
    d. Elevated colour is present within some of the wells (i.e. TW3 and the neighbouring barn well). All on-site test wells were within the D-5-5 Treatability limit and colour levels were identified to be lower from TW1 during low rate pumping than the higher rate pumping test program.
    e. Although within acceptable criteria, nitrate was observed within the groundwater in the southern portion of the property and at higher levels within the neighbouring property to the south (horse stable/barn). An old dug well with drilled well inside is present within that property and suspected to be the source of the nitrate impact. The nitrate appears to be limited to the southern limits of the property based on the results from all the wells. Note that the old barn well has since been upgraded and sampled,
    f. Based on the known “Beckwith plume”, EXP collected TVOCs from TW3 on the property at which no VOCs were detected. There are no concerns with the Beckwith plume on th subject site.
6. Neighbourhood well sampling was completed in 2017 at three (3) wells and did not identify any regional groundwater concerns. The water from four neighbouring wells was generally considered to be hard. Groundwater concentrations from the neighbouring wells were similar to on-site wells with slightly higher turbidity, iron and organic nitrogen. The client collected a water sample from his upgraded barn well in 2020 to assess surficial impacts. Nitrate levels from the barn well were well below criteria and do not suggest any surficial related impacts since the barn well was upgraded.

7. The construction of test pits revealed that overburden materials is described as a “till” material consisting of sand and gravel with traces of silt. Sporadic locations were also determined to contain “some” silt at depth. The overburden soils on the site are predominantly 2 m thick with an isolated area (proposed lots 1, 2 and 3) with soils determined to be between 1 to 2 m thick and the southern portions of the site with soils exceeding 5 m in thickness. No bedrock was observed at surface at the subject property. The overburden groundwater is noted to be shallow throughout the property (poorly drained) during the spring melt conditions previously identified. This would necessitate the need for partial to fully raised field beds and potential use of fill material and/or storm water management solutions.
8. The average lot size is 0.4-0.62 hectare and the site is not deemed hydrogeologically sensitive. As such, nitrate dilution calculations on the site were conducted and display theoretical nitrate levels from the installation of 9 septic systems would be 8.2 mg/L. Although existing nitrate levels were presented within a single on-site well and the neighbouring well in 2017 (but lower in 2020 based on updated testing), the installation of the new septic systems is not considered a concern since the suspected source of the nitrate appears to have been resolved since the upgrading of a neighbouring old barn well.

Based on the results of the hydrogeological, terrain and impact assessment evaluation, it is recommended that the proposed residential subdivision be approved for development.

Table of Contents

List of Tables

List of Appendices

1.0 Introduction

1.1. General

EXP Services Inc. (EXP) was retained by Steve Smith. to conduct a hydrogeological investigation, terrain analysis and impact assessment for a proposed residential subdivision on the southeast side of the intersection between Derry Side Road and Ferguson Road. The site is legally described as part of Lot 20, Concession 4, Township of Beckwith in the County of Lanark. Refer to Figures 1 & 2 in Appendix A for the site location and surrounding area.

It was originally proposed that the property, covering an area of 16.158 hectares, be subdivided into 24 residential lots with average lots sizes of the order of 0.6 hectare (1.4 acre). The hydrogeological assessment associated with this proposed development was dated June 22, 2017.

However, the client has since revised the lot layout and has reduced the overall size of the proposed development. The revised development covers a total area of 54,452 m^2 (5.4 hectares) and is split into nine (9) residential lots. The proposed lot sizes range in size between 0.4 hectares and 0.62 hectares.

The development will be serviced by individual water wells and Class IV sewage disposal systems. The purpose of the investigation described within was to assess the suitability of the site for development on private services.

1.2. Methodology

It is understood that the work program was completed in two stages:

- Phase 1: Original development program in 2017 including well drilling, water sampling programs, for the originally proposed 24 lot development.
- Phase 2: Additional test pits and revision of original report for proposed nine (9) lot development.

The following describes the work programs and associated methodology for each work phase.

Phase 1: Original Development

Background information relating to local geology and hydrogeology was obtained from published maps and reports, and Ontario Ministry of Environment, Conservation and Parks (MECP) Water Well Records.

On-site hydrogeologic conditions were investigated through the construction and testing of four domestic water wells. As per Procedure D-5-5, four (4) wells are generally required for properties larger than 15 hectares but smaller than 20 hectares. Given that the proposed development is only 1.1 hectare in size above the 15 hectare maximum for the drilling of three (3) wells, one of the wells was drilled 250 m outside of the property boundary but still serves as an indicator of well performance and chemistry for the development. In summary, a total of four (4) wells were drilled with three off the wells drilled on the subject property and the fourth well drilled on the property to the south (but still within 200 m of the subject property). In addition, the well locations were drilled within accessible locations while still providing good site coverage. Access was not available to the western portions of the property due to the heavy forest and poorly drained conditions. The wells were drilled on the subject property in February / March 2017 by Olympic Drilling Company in accordance with Ontario Regulation 903. The Water Well Records for the four new water wells are included in Appendix B.

Water quantity of the site was assessed on the basis of six-hour constant-rate pumping tests conducted on the two wells. The recovery of the wells subsequent to pump shut down was monitored for 24 hours or until

95 % recovery was noted. The non-pumping wells were monitored during the tests to identify potential well interference.

Water quality, was evaluated through chemical and bacteriological analysis of samples collected at the beginning and end of each pumping test. Both samples were collected for a suite of parameters identified as a detailed "private well" package consisting of major anions, inorganics, organics and bacteriological parameters. Turbidity was periodically monitored in the field during the tests. Three water samples were also collected from residences nearby for analyses of water quality parameters.

All field and desktop work as part of this hydrogeological investigation was done in general accordance with MECP Procedure D-5-5.

Overburden soil conditions at the subject site were investigated through the completion of six (6) test pits and three (3) boreholes in March 2017. Each test pit and/or borehole was logged for depth, soil characteristics and groundwater conditions. Three of the test pits were subsequently outfitted with slotted standpipes to determine the overburden static water elevation and to allow for monitoring of the overburden during the pumping program.

Phase 2: Smaller Subdivision

Following the original submission, it was decided that the size of the development be reduced.to nine lots to meet the new proposed plan.

As part of this program, EXP excavated six additional test pits to better characterize the soil conditions and depth to bedrock within the newly proposed lots.

In addition, EXP also reviewed and updated the previously submitted 2017 report to reflect the updated work plan and updated report submission. On the basis of the information obtained, recommendations for the construction of water wells and on-site sewage disposal systems are presented.

1.3. Site Location and Physiography

The site consists of approximately 4.3 hectares of land approximately 10 km west of the Town of Carleton Place and 14 km southeast of the Village of Richmond. The site is accessed via Derry Side Road and located to the southwest of the intersection between Derry Side road and Ferguson Road approximately 1km north of Richmond Road, (see Figure 2). The site is bounded to the northwest by Ferguson Road, to the northeast by Derry Side Road, to the east by a stable and to the south by forested land.

The subject site is relatively flat with some site influences associated with the municipal drain that traverses the centre of the property and borders the northwest as well as other swales throughout the property. No visible bedrock outcrops were observed throughout the property and/or significant grade changes that would suggest a notable change in the site conditions. There are no major water bodies that are within the vicinity of the subject site whereas the Goodwood Marsh is located approximately 1km northwest of the site.

Poorly drained lands are located to the west / northwest of the subject site and south of the residential dwelling on Ferguson Road that borders the property to the northwest.

1.3.1. Environmental Impacts

The neighbouring properties are described as follows (assuming Ferguson Road is to the north):

- North: Ferguson Road including some sparsely populated residential properties followed by agricultural properties to the north. A large pond, likely associated with a former Quarry, is located approximately 900 m from the site.
- East: Derry Side Road followed by sparsely populated residential dwellings. Some smaller agricultural lands are located to the southeast.
- South: A small woodlot followed by a horse stable, owned by the owner of the same land. The stable houses horses and a residential property. This is followed by agricultural lands.
- West: Woodlot including (poorly drained land) and agricultural lands. It is noted that the lands to the immediate west of the subject site consist of the lands that were part of the original submission in 2017 but have since been excluded as part of this 2020 submission.

Based on a review of the neighbouring properties, the only concern stemmed from potential nutrients associated with the stable property to the south. A well was installed at the stable to assess for water quality concerns stemming from the stable (i.e. nutrients), which also served as the fourth well associated with the assessment.

In addition, it is understood that a plume of dry cleaner fluid is being monitored within the Township of Beckwith. It is our understanding that the plume extends from an old landfill near Carleton Place in a southeastern fashion. However, based on a mapping / implementation strategy from JL Richards (2006), the monitoring program of the plume extends to the north of the site and Ferguson Road approximately 500 m to the east of the site. As such, the plume does not come into contact or within the immediate vicinity of the subject site. The southern limits of the plume monitoring is identified on Figure 1.

2.0 Geology

2.1. Surficial Geology

Surficial geology, as mapped by the Ontario Geological Survey (2003), indicates that the central portions of the site consist of a thin layer of organic materials that consist a variety of peat, much and marine deposits. These deposits are reportedly thinner at the northern corner of the property. The southern half of the site is reported to consist of till material with a sand deposit to the immediate southern corner of the site.

Based on the information collected from the test-pit program at the site, the soils on site consistently consist of a thin layer of topsoil over a mix of sand and gravel to depths of approximately 1.5m with a small area that displays thinner soil veneer in the order of 0.6 to 1 m thick in the northern section of the property. The overburden thickness increased towards the southern / southeastern portions of the property where till formations were observed below layers of sand. Overburden thickness extended beyond 5m within the southeastern portions of the property.

2.2. Bedrock Geology

The bedrock geology, as mapped by the Ontario Geological Survey (2003), indicates that the site consists of the Oxford Formation (dolostone with minor shale layers). The Oxford formation is described as having greyish dolostone beds of 30 cm in thickness. This formation can produce some well yields from its fractures. This formation overlies the March Formation, which consists primarily of a brown / reddish sandstone rock and noted to produced elevated yields of water. This formation is relatively thin an in the order of 15m thick in the western portions of Ottawa. Good well yields are commonly reported from this formation.

A review of MECP well records indicates that most of the wells in proximity to the site are completed within the sandstone formation with nearly half of the wells penetrating through layers of limestone ranging between 10 to 20 m thick. However, it appears that the majority of the wells do draw the majority of their water from the sandstone formation.

2.3. Desktop Hydrogeology

A detailed review of 10 MECP Water Well Records within a 1 km radius of the site were reviewed as part of the work program. These are predominantly well records from wells drilled from 1950 to 2010.The wells extended to depths ranging from 20 to 44 m from surface, with an average well depth of 33 m. Water was found in fractures at depths in the range of 16.7 to 42 m. The recommended well yields were reported to range from 2 gpm (from one well) to upwards of 60 gpm. The majority of the well yields were in the order of 5-10 gpm (17 to 34 L/min). The majority of the wells draw water from the sandstone. The MECP Water Well Records are shown in Appendix B.

2.4. Preliminary Conceptual Hydrogeological Model Summary

The site consists of forested parcel of land to the southeast of Derry Side Road and Ferguson Road within the Township of Beckwith. This parcel is located within a sparsely populated portion of Beckwith with a mix of single unit residential dwellings and some smaller agricultural lands (no large scale farming activities). The property to the southeast, under same ownership, is operated as a horse stable. The horse stable is located approximately 200 to 250 m to the south of the subject site. Due to the proximity of the stable to the site, a test well (TW 4) was also installed within the stable property to identify any potential surficial concerns

stemming from those activities and to act as a neighbouring sampling location to help assess groundwater at the site.

The subject property and general area are relatively flat with smaller swales and gentle grades. There are no notable outcrops and/or steep slopes within the area. A variety of small creeks and drainage ditches are located throughout the area with the Leach Drain traversing the central portions of the property. Some additional swales are located within the southern portion of the site (i.e. near the snowmobile trails associated with Lot 9) which can hold standing water in the spring.

A provincially significant wetland (Goodwood Marsh) is located approximately 1km to the northwest of the property and approximately 2km directly west.

It is anticipated that the majority of the surface water flow is directed to the municipal drain but it does appear that the northern portions of the site are poorly drained as evidenced by standing water in the spring of 2017 (during drilling / borehole drilling programs). This may be stem from snowmelt not infiltrating rapidly and resting on the bedrock surface. No notable slopes are present on the site to suggest a prominent overburden groundwater flow in any direction.

Overburden material in the area is slightly variable with soil thickness ranging from 0.6 m to 1 m on the northern corners of the property to over 2.5 m on the southern portions of the property. The soils consist of a range of sand and gravel with some cobbles throughout the entire property whereas a till formation was more predominantly observed to underlie those sandy soils to the south. The till was described as a sand and gravel till with some silt.

It is anticipated that surficial water flow in the area is controlled primarily from the Leach Drain that traverses the centre of the property and continues to move westward approximately 100m and then extends northward towards Ferguson Road. It is noted that the drainage on the site was considered to be relatively poor during the spring of 2017 during the snow melt. It is anticipated that the regional groundwater flow is westward towards the Goodwood Marsh.

3.0 Hydrogeology

3.1. Well Construction

In February and March of 2017, four 152-mm diameter test wells were constructed using air rotary drilling techniques. Although four wells are generally required to satisfy requirements of Procedure D-5-5, it was deemed that three wells on the subject site and a fourth well on a neighbouring site would be considered sufficient, since the property is only slightly over 15 hectares. All of the wells are completed in limestone/sandstone bedrock and in accordance with Ontario Regulation 903. The wells both extend 60 cm beyond ground surface and are capped. Well records are included in Appendix B.

Table 1: Well Construction Summary

EXP Well No.	Completion Depth (m)	Depth to Rock (m)	Water Found (m)	Casing Depth (m)	Grout Pumped in Annular Space	Stratigraphy
On-Site Wells						
Bush Trail TW3	145	6	90, 138, 145	40	12 bags of cement 3 bags of grout	Limestone 6-75 Limestone/sandstone 75-95 Sandstone 95-135
Field TW2	145	6	105,135,145	40	12 bags of cement 3 bags of grout	Limestone 4-40 Limestone / sandstone 40-80 Sandstone 80-145
Neighbouring / Off-Site Wells						
Barn Well TW4	135	18	65,95, 125	40	14 bags cement 4 bags of grout	Limestone 16-65 Limestone / sandstone 65-85 Sandstone 85 - 135
Snowmobile TW1	143	17	75, 100,142	40	12 bags of cement 2 bags of qrout	17-68 limestone Limestone/sandstone 68-90 Sandstone 90-143

Following the drilling to a depth of 12.2m (40 ft), to ensure a strong seal into the bedrock, the 152 mm diameter steel well casing was installed into the 200 mm well annulus. Once the casing was welded and set to the required depth, Olympic drilling commenced with the grouting process. Olympic staff fastened a “PVC Tremie Line” to the well casing during its installation, which provides a conduit for the grout to be pumped to the bottom of the well casing. The grouting consisted of the pumping of cement at the bottom of the well followed by the pumping of quick-gel to bring the grout to the top of the well. EXP staff were on-site for the grouting of each well casing.

Once the well was grouted, Olympic allowed the grout to sit overnight prior to returning to drill the following day. EXP advised the driller to drill the well to a depth whereupon a minimum of 5 gpm (19 L/min) following completion of the grouting procedure. Once the driller obtained water, each well was developed with air pressure to clean out the well. Subsequently, water flowed from the well for approximately 20 minutes to

remove mud and rock fragments and to estimate the well yield for the pumping test. It is noted that access could not be provided to the western limits of the property as the area was heavily forested and poorly drained.

Based on the test well construction, it is evident that the bedrock is fairly uniform on the site. A uniform limestone formation is underlain by a sandstone formation. The depth to bedrock is generally within 2 to 5 m from surface, consistently through 15 to 30 m of limestone prior to intersecting 10 m of limestone / sandstone mix followed by limestone. A cross section has been provided in Figure 3.

It is recommended that future bedrock wells on this property be cased to at least 12 m from surface or a minimum of 3 m into bedrock (whichever is greater). Casing the wells 3 m into rock will ensure that the casing extends beyond any surficial weathered bedrock. All wells must be constructed in accordance with Ontario Regulation 903. It is recommended that the installation and grouting of the well casing be observed by a qualified professional. The professional should either be a professional engineer, a professional geoscientist, or a suitably trained inspector.

3.2. Water Quantity

3.2.1. Well Yields

Information on groundwater quality at the site was determined by completing six-hour pumping tests followed by recovery tests on the four newly installed test wells. Interpretation of the well yield characteristics of the test wells was conducted by calculating the transmissivity of the well and assessing the well yield. The transmissivity of an aquifer is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. The calculation of the transmissivity for the pumping test was conducted using the Cooper-Jacob method which is based on the following assumptions: 1) the aquifer is confined; 2) water was discharged at a constant rate; 3) the well fully penetrates the bedrock aquifer; 4) discharge from the well is derived exclusively from storage in the aquifer. These assumptions and methods were used in determining the transmissivity values in this section. Based on the pump test results, the calculation of transmissivity and storativity was feasible for only two (2) of the wells. Two of the four wells were pumped to the maximum allowed by the pump and by the MECP Permit To Take Water requirements (i.e. above 50,000L/day requires a permit). Tabular and graphical representations of the data collected from these pump tests are presented in Appendix C. In addition, the pumping test programs were designed to identify whether the wells could supply the MECP recommended 18.75 L/min flow rate for the proposed subdivision development that might consist of 4-bedroom luxury dwellings.

Standpipes were installed within the property (i.e. near each bedrock test well). The water levels were measured periodically during the pumping test to establish potential connections between the bedrock aquifer and the overburden formation. It is understood that the pumping test programs were completed at the end of the winter / beginning of spring at a time of year when the snow started to melt.

3.2.1.1. On-Site Wells

Test Well #2 (Field Well)

Test Well #2 was pumped at a constant rate of 75 L/min for 6 hours on April 6, 2017. Drawdown at the end of the test was 2.64 m, which represents 3 % of the total available drawdown based on a static water level of 1.54 m. The well recovered to within 100% of the observed drawdown within 5 minutes of the end of the pump test.

It is understood that over 60% of the drawdown occurred within the first minute into the 6 hour pump test. The drawdown then slowed down/stabilized but continued gradually through the remainder of the test.

An aquifer transmissivity of 123 m^2/day was calculated from the pumping well drawdown using the Cooper-Jacob. Due to the speed in which the well recovered, a transmissivity could not be feasibly calculated for the recovery test. The storage coefficient using the Cooper-Jacob method was shown to be $7.5x10^{-13}$. It is understood that the storage coefficient is not representative as it is calculated using the production well, which saw a rapid drawdown in the first few minutes only.

Based on the observed drawdown/recovery relationships from the test well, the long-term yield of Test Well #2 is at or in excess of the tested rate of 75 L/min, and more than sufficient to supply the needs of a single-family home. This rate exceeds the MECP minimum yield of 18.75 L for a 4-bedroom dwelling to supply a single-family residence.

Test Well #3 (Bush Well)

Test Well #3 was pumped at a constant rate of 75 L/min for 6 hours on April 5, 2017. Drawdown at the end of the test was 0.38 m, which represents less than 1 % of the total available drawdown based on a static water level of 0.46 m. The well recovered to within 95% of the observed drawdown within 25 minutes of the end of the pump test. The majority of the well recovery occurred within the first 25 seconds and to within 90% (within 5 cm of full recovery) within the first minute.

It is understood that over 90% of the drawdown occurred within the first minute into the 6 hr pump test. The drawdown than slowed down/stabilized but continued gradually through the remainder of the test.

Based on the quick drawdown of the well within the first minute of the test and only 5 cm of drawdown within the remaining 359 minutes, a useable drawdown curve and transmissivity calculation could not be feasibly calculated. Due to the speed in which the well recovered, a transmissivity could not be feasibly calculated for the recovery test.

Since no discernable drawdown occurred after the 1st minute of the pumping test, the long-term yield of Test Well #3 is at or in excess of the tested rate of 75 L/min, and more than sufficient to supply the needs of a single-family home. This rate exceeds the MECP minimum yield of 18.75 L for a 4-bedroom dwelling to supply a single-family residence.

Summary

Based on a review of the pump tests from Test Well #2 and Test Well #3, it is evident that the well yield exceeds the required well yield of 18.75 L/min. Although only two wells were drilled within the proposed development (below the minimum number of three wells for a development of less than 15 hectares), it is EXP's opinion that the high well yield within the two on-site wells combined with the additional information collected from the neighbouring wells (discussed in Section 3.2.1.2) provides sufficient information to be suitable for the Procedure D-5-5 requirements.

3.2.1.2. Neighbouring Wells

Test Well #1 (Snowmobile Trail)

Test Well #1 was pumped for six hours at a constant rate of 75 L/min on April 4, 2017. There was no discernable drawdown at the end of the test. The static water level measured 3.37 m from top of casing and decreased immediately to 3.4 m after 1 minute of pumping and eventually to 3.41 m after 5 minutes of pumping. The water level then remained stagnant for 3 hours at which the water levels returned to 3.37m from top of casing.

Following the pump shut off, the water level increased to 3.32 m from top of casing. Given that no drawdown curve can be plotted, it is not feasible to calculate a transmissivity and/or storage coefficient for the well.

Since no discernable drawdown occurred after 6 hours, it is concluded that the long-term yield of Test Well #1 is in excess of the tested rate of 75 L/min, and more than sufficient to supply the requirements of a single-family house. This rate exceeds the MECP minimum yield of 18.75 L/min for a 4-bedroom dwelling to supply a single-family residence.

Test Well #4 (Off-site – Stable Property)

Test Well #4 was pumped at a constant rate of 75 L/min for 6 hours on April 3, 2017. Drawdown at the end of the test was 2.24 m, which represents less than 5 % of the total available drawdown based on a static water level of 2.63 m. Following the 6-hr pump test, the well recovered to within 95% of the observed drawdown within 25 minutes of the end of the pump test. The well recovered within 10 min of the end of the pumping test with 95% of the recovery occurring within the first two minutes.

It is understood that over 70% of the drawdown occurred within the first minute into the 6 hour pump test. The drawdown then slowed down/stabilized but continued gradually through the remainder of the test.

An aquifer transmissivity of 121 m^2/day was calculated from the pumping well drawdown using the Cooper-Jacob. Due to the speed in which the well recovered, a transmissivity could not be feasibly be calculated for the recovery test. The storage coefficient using the Cooper-Jacob method was shown to be $1/13x10^{-10}$

Based on the observed drawdown/recovery relationships from the test well, the long-term yield of Test Well #4 is at or in excess of the tested rate of 75 L/min, and more than sufficient to supply the needs of a single-family home. This rate exceeds the MECP minimum yield of 18.75 L for a 4-bedroom dwelling to supply a single-family residence.

Summary

Based on the water quantity from Test Well 1 and Test Well 4, the neighbouring wells display a consistent quantity of water throughout the general area. Sufficient water quantity information has been collected to confirm the well yields exceed MECP's minimum well yield.

3.2.2. Well Interference

During each pumping test program, each non-pumping test well was used as a monitoring well to determine potential well interference at the site and the overall impact on the aquifer with increased groundwater usage. Therefore, as an example, while Test Well #1 was being pumped, the monitoring well consisted of Test Well #2. The water levels were measured periodically at the monitoring wells during the pumping test. All data is shown in Appendix C. The actual total drawdown from the monitoring wells and the distances from the pumping well are identified in the following table.

Table 2: Well Interference Measurements

Pumping Well	Monitoring Wells							
	Test Well #1		Test Well #2		Test Well #3		Test Well #4	
	Drawdown (m)	Distance (m)	Drawdown (m)	Distance (m)				
Test Well #1	-	-	-0.05	240	-0.05	540	-0.05	240
Test Well #2	-0.04	240	-	-	-0.01	325	-0.02	720
Test Well #3	0.03	540	0.02	325			0.02	400
Test Well #4	0.03	240	0.01	720	0.01	400		

Note: Distance indicates the total horizontal distance between the pumping well and the monitoring well.

Based on the above, it is difficult to state whether the wells are hydraulically connected or not. Some wells displayed drawdowns in the order of 1 to 3 cm whereas other monitoring wells were observed to have increases in the static water levels during pumping. The increases in the static water levels could have been due to changes in barometric pressure during the tests as significant rainfalls were occurring at the time of the pumping tests. In addition, although the wells may be hydraulically connected, the well yields are very high and the pumping rates during the pumping tests may not have resulted in drawdown of the monitoring wells.

When assessing these well interferences, it is understood that over 27,000 L of water was pumped for a single well within a 6 hr timeframe with little to no discernable impact to the wells. Given that some of the monitoring wells showed increasing water levels during the pumping program, it is anticipated that weather conditions and barometric pressure had a larger impact on the static water levels than the pumping of the other wells.

Since the pumping rates used for these pump tests are well in excess of the required 18.75 L for a larger house and provide a worst-case scenario, it is our opinion that the impacts of well interference should be minimal when conducting standard residential water withdrawal.

3.2.3. Cumulative Well Impact

Based on the various data from the on-site pumping tests, an evaluation was conducted to determine the potential impact that may be associated with pumping several wells at once on the subject property. This is based on measured transmissivity data and storage data collected from the site. EXP also assumes anticipated water withdrawal rates, proposed well locations and well separation distances based the proposed development. All this data may have an impact on the results.

The evaluation was conducted by assuming an average daily flow rate of 2000 L/day (4-bedroom dwelling) and by using the average transmissivity value of 121 m^2/day determined through the pumping tests of TW2 and TW4 (transmissivity could not be calculated from other wells as drawdown was not encountered).

It was assumed that nine wells would be drilled on the subject property (i.e. nine residential building lots). In addition, approximately five neighbouring wells are present within over a distance of 300 m from the central portion of the site. Based on the pump test data collected (average pump test transmissivity), it was determined that each well would have a transmissivity of 121 m^2/day. The storage coefficient from these wells, as determined from the limited well data, was valued at 1 x 10^{-10}, based on average storage coefficient data which is the value that was determined for the production wells. It is understood that the storage

coefficient is often best calculated from monitoring well data but not drawdown was observed in the monitoring wells. This data was then inputted into a cumulative well analysis calculation to assess the drawdown per well and the cumulative well drawdown.

Based on the above-noted assumptions, it was determined that the 30 year average drawdown on the site is 0.04 m on a per well basis, with the largest drawdown occurring in the central portion of the property and the smallest drawdown at the property boundary.

If one were to determine the cumulative drawdown over 30 years from combining all of the drawdown per well, the cumulative drawdown would be in the order of 0.51 m and would account for less than 1% of the available drawdown of the wells.

It is understood that several assumptions are made when determining the cumulative drawdown such as:

- The aquifer is homogeneous throughout the entire property;
- That the aquifer will recharge (note that rain water will replenish the aquifer over time);
- Constant dewatering over the period (period of water use fluctuate); and,
- The similar well depths/water bearing fractures throughout the site is similar (note that this is not the case as the water bearing fractures were variable throughout the site).

As a result, it is anticipated that the theoretical drawdown determined via the mutual well interference calculation is considered to be likely more elevated that will actually occur. As such, the cumulative well interference is not considered to be a concern.

3.2.4. Summary

Based on the above-noted information, all of the newly drilled wells at the subject site (and on the neighbouring barn well site) provides the required yield of 18.5 L/min for a 4-bedroom luxury home. Well yields from the newly drilled Test Wells were all in excess of 75 L/min, and after extended pumping at these flow rates, total drawdowns ranged from 0 to <2% of the available drawdowns from the wells. The low impact to the available drawdown is not considered a concern, considering that the pumping rate was well over what is required for a residential dwelling. It is EXP's opinion that a sufficient number of wells were constructed and tested to assess well yields at the site.

Water levels measured within the monitoring wells did not account for any notable drawdown during the pumping test. Cumulative well impact assessments conducted for the site were shown to produce drawdowns of 0.03 to 0.04 m/well based on the expected usage of 2000 L of water. This impact is considered to be minimal. Therefore, there are no concerns regarding well yields on the subject site.

Based on the above, EXP has no concerns with the completed well constructions and recommends that future on-site wells be constructed in a similar fashion. As a result, wells should be drilled to depths between 40 to 50 m from surface and with steel casings extending a minimum of 3 m into competent bedrock.

3.3. Water Quality

3.3.1. General

The water quality in the bedrock aquifer was assessed through chemical, physical, and bacteriological analyses of samples collected at the beginning and end of the pumping tests. Two samples were collected during each pump test, the first sample being collected within the first 60 minutes of the test and the second sample being collected after 300 minutes of pumping. Each sample was submitted to Caduceon

Environmental Laboratories in Ottawa, Ontario. The samples were analysed for a "private well" water quality package, which includes bacteriological parameters, general inorganic parameters, metals and organics. For the purpose of this report, samples collected at the beginning of the test are identified by "A" and samples collected near the end of the test are identified by "B". Based on the presence of the "Beckwith Plume" to the northeast of the site, EXP collected a sample of Total Volatile Organic Compounds from one of the on-site wells. Pesticides and herbicides were not collected as farming activities are not abundant on the site. All the results of the chemical analyses are shown in Appendix D.

Prior to collecting samples for bacteria, free and total chlorine were measured in the field to be 0 mg/L, thus indicating that no residual chlorine remained in the well. No colour change was observed in the vials during field measurements. Turbidity was also measured periodically in the field during each pumping test. Turbidity levels generally decreased as the pump tests progressed. The field readings are included within the pump test data (Appendix C) as field readings are generally considered to be more reliable if elevated iron and/or other materials that precipitate are found.

The results of the tests, presented in Appendix D, indicate that the groundwater available from the bedrock aquifer is of good quality, and meets all health related criteria of the Ontario Drinking Water Standards (ODWS) and Procedure D-5-5 treatability limits for those parameters tested following the required shocking and re-sampling/pumping.

The water quality from each well tested as part of this program is discussed in the ensuing sections:

3.3.2. On-site Wells

3.3.2.1. Test Well #2

The analytical results from the groundwater sample collected on April 6, 2017 are shown to be hard and mineralized but did not exceed health-related criteria outlined in the ODWS. No bacteriological parameters were detected. Total coliform and E.Coli. were determined to be 0 cts/100 ml at the start and the end of the pump test. In addition, fluoride, nitrite and nitrate levels are all shown to be below the applicable criteria. Nitrate levels were determined to be 0.2 mg/L. Sodium levels were noted to be below 20 mg/L and therefore not considered a concern.

Several aesthetic parameter exceedances were observed from the pump test for turbidity, iron, hardness and organic nitrogen. Turbidity levels were initially observed to have concentrations of 6.2 NTU at the start of the pumping test but decrease to levels of 2.0 NTU at the end of the pumping test. As such, there are no concerns with turbidity.

Iron levels were shown to decrease from 0.427 mg/L to 0.172 mg/L and organic nitrogen levels were shown to decrease from 0.2 to 0.13 mg/L. Therefore, these parameters are not considered a concern.

Hardness levels were notably high with concentrations of 355 to 346 mg/L. These levels are indicative a hard water. Given that the levels are below 500 mg/L, they are considered potable and within the D-5-5 treatability limits.

Surficial related parameters were not found to be elevated. At the end of the pumping test, parameters such as TKN, DOC, ammonia, tannin and lignin were all found to be low or non detectable. This combined with no bacteria suggests that the well is fully sealed and there is no connection to the surface.

3.3.2.2. Test Well #3

The analytical results from the groundwater sample collected on April 4, 2017 are shown to be hard and did exceed health-related criteria outlined in the Ontario Drinking Water Standards (ODWS). Total coliform

was determined to be 1 cts/100 ml at the start and the end of the pump test whereas no E.Coli. was detected. It is understood that total coliform bacteria should not be present in the well. As such, the well was shocked with chlorine, mixed and pumped for an additional 4 hours until the chlorine was no longer detected. Subsequently, EXP staff collected an additional bacteria sample for total coliform and E.Coli., which were both determined to be 0 cts/100ml. No other health related parameters were determined to be elevated at the time of the sampling since fluoride, nitrite and nitrate levels are all shown to be well below the applicable criteria.

Several aesthetic parameter exceedances were observed from the pump test including turbidity, iron, hardness, colour and organic nitrogen. Turbidity levels were initially observed to have concentrations of 5.2 NTU at the start of the pumping test but decrease to levels of 4.5 NTU at the end of the pumping test. As such, there are no concerns with turbidity and it assumed these levels would continue to decrease and would be lower with lower pumping rates.

Iron levels were shown to decrease from 0.43 mg/L to 0.29 mg/L and organic nitrogen levels were shown to decrease from 0.46 to 0.09 mg/L. Therefore, these parameters are not considered a concern.

Hardness levels were notably high with concentrations of 330 to 335 mg/L. these levels are indicative of hard water. Given that the levels are below 500 mg/L, they are considered potable and within the D-5-5 treatability limits.

Colour levels were observed to be elevated and consistent at 7 TCU within both of the samples (start and end of pump test). Although the colour exceeds the ODWS aesthetic objective, it is observed to be within the D-5-5 treatability limit. As seen with TW1, the levels increased from 3 to 7 TCU when pumped at higher rates but decreased to 2 TCU at a lower pumping rates. As such, EXP does not anticipate that the colour concentrations would increase.

Surficial related parameters were not found to be elevated. At the end of the pumping test, parameters such as TKN, DOC, ammonia, tannin and lignin were all found to be low or non detectable. This combined with no bacteria suggests that the well is fully sealed and there is no connection to the surface.

In addition, this well was also sampled for total volatile organic compounds (TVOC) to assess whether TCE is present in the well stemming from the known Beckwith plume. No measurable VOCs were observed within the well, which is the well closest to the anticipated plume. As such, there are no existing concerns stemming from the Beckwith Plume at this time.

3.3.3. Off-Site Wells

3.3.3.1. Test Well #1 (Snowmobile trail - Southwest)

The analytical results from the groundwater sample collected on April 4, 2017 are shown to be hard and mineralized but did not exceed health-related criteria outlined in the ODWS. No detectable bacteriological parameters were detected. Total coliform and E.Coli. were determined to be 0 cts/100 ml at the start and the end of the pump test. In addition, fluoride, nitrite and nitrate levels are all shown to be below the applicable criteria. Although the nitrate levels are within the acceptable criteria, they are slightly elevated within the groundwater supply with levels of 2.9 and 3mg/L. Nitrate levels are not commonly observed within the groundwater, especially within the sandstone formations. As such, there is a potential source of nitrate which is discussed further in upcoming discussions. Sodium levels were noted to be below 20 mg/L and therefore not considered a concern.

Turbidity levels were shown to decrease from 5.9 NTU at 30 min of pumping to 3.2 NTU at 330 minutes of pumping. It is our opinion that turbidity levels are within acceptable levels.

A limited number of aesthetic parameters exceeded the applicable criteria within this well including iron, organic nitrogen, colour and hardness. The iron levels were shown to decrease during the test from 0.36 mg/L to 0.07 mg/L and therefore is not considered a concern. Conversely, colour levels increased from 3 to 7 TCU and organic nitrogen increase from 0.14 to 0.18 mg/L. In response to these increases, EXP requested additional pumping of the well on April 19, 2017 at a lower flow rate (18 L/min) to assess whether these increases would continue. Following the pumping for approximately 5 hours, samples were collected and colour levels were identified at 2 TCU and organic nitrogen decreased to 0.07 mg/L.

Hardness levels were shown to be between 359 and 353 mg/L. These levels are indicative a hard water. Given that the levels are below 500 mg/L, they are considered potable and within the D-5-5 treatability limits.

Surficial related parameters were observed but not at elevated levels. Concentrations of DOC, tannin and lignin, total kjeldahl nitrogen, ammonia were observed at low concentrations. In addition, none of these parameters show increasing trends that would suggest surface water impact. Increases in organic nitrogen were related to the high pumping rates as they were observed to be substantially lower during the 2nd test. However, as discussed, the aforementioned nitrate levels do lead to a potential concern (i.e. a potential source of contamination).

Following the pumping test and subsequent purging of the wells, the water was then determined to be acceptable for consumption and no further development of the well is necessary.

3.3.3.2. Test Well #4 (Stable Property - Off-Site Well)

The analytical results from the groundwater sample collected on April 3, 2017 are shown to be hard and did not exceed health-related criteria outlined in the ODWS. No bacteriological parameters were detected. Total coliform and E.Coli. were determined to be 0 cts/100 ml at the start and the end of the pump test. In addition, fluoride, nitrite and nitrate levels are all shown to be below the applicable criteria. Although the nitrate levels are within the acceptable criteria, they are slightly elevated within the groundwater supply with levels of 3.8 and 4.3 mg/L. Nitrate levels are not commonly observed within the groundwater, especially within the sandstone formations. As such, there is a potential source of nitrate which is discussed further in upcoming discussions. Sodium levels were noted to be below 20 mg/L and therefore not considered a concern.

Aesthetic parameter exceedances were observed from the pump test were limited to colour, organic nitrogen and hardness. Organic nitrogen levels were shown to decrease from 0.22 mg/L to 0.05 mg/L and therefore is not considered a concern.

Hardness levels were notably high with concentrations of 313 to 314 mg/L. These levels are indicative of hard water. Given that the levels are below 500 mg/L, they are considered potable and within the D-5-5 treatability limits.

Colour levels were observed to be elevated with concentrations of 11 and 12 TCU within both of the samples (start and end of pump test). Although the colour exceeds the ODWS and the D-5-5 treatability limit, it is anticipated that some of the colour related issues do results from the high pumping rates (i.e. higher pumping rates can stir up material within the aquifer).

With the exception of the nitrate, other surficial related parameters were not found to be elevated. At the end of the pumping test, parameters such as TKN, DOC, ammonia, tannin and lignin were all found to be low or non detectable. This combined with no bacteria suggests that the well is fully sealed and there is no direct connection to the surface. As such, it is suspected that the nitrate is being drawn in from the aquifer and/or another source (i.e. old barn well) and not via infiltration through the overburden.

It is EXP's understanding that the "old barn well" to the southeast of the site (50-75 m from TW4) has been grouted and outfitted (in 2019) with a new casing to prevent infiltration of surface water and/or shallow groundwater to the underlying aquifer.

In response to the old barn grouting program to limit surface water infiltration, EXP requested that confirmatory sampling be completed for surficial related parameters from the newly drilled barn well to establish impacts from the grouting/well improvement. It is our understand that the client collected samples from TW4 on July 31, 2020 and submitted the results to Caduceon Laboratories. Based on a review of the results, there is no elevated colour, nitrate/nitrite or tannin and lignin. Therefore, the water quality from TW4 appears to be improved since the old barn well has been upgraded.

3.3.4. Summary

Based on a review of the analytical results, it appears the water quality from the two on-site wells display similar water characteristics. The mineral content of the water as well as the aesthetic quality of the water is similar in both wells. Both on-site wells (Test Well #2 and Test Well #3) displayed higher iron, organic nitrogen, turbidity at the start of the test and decreased to acceptable levels at the end of pumping. Colour was observed to be present within the water quality test and showed some increasing trends at higher pumping rates, but lower values at lower pumping rates. This was evidence by the pumping of off-site well Test Well #1 when additional pumping programs showed lower colour levels. Although colour remains above ODWS in Test Well #3, it is not considered to be a concern at lower pumping rates.

It is noted that no health related exceedances are present within the water supply of Test Well #2 and Test Well #3. Although on-site nitrate levels did not pose a concern, it is understood that nitrate was detected at levels of 2.9 and 3 mg/L in off-site well TW1 (snowmobile trail) and 3.8 and 4.3 mg/L at the off-site barn well. Nitrate levels were detected to be between 0.1 to 0.3 mg/L from TW2 and TW3, further to the northwest. The higher nitrate levels within the neighbouring drilled wells to the south (although still within the applicable criteria) appear to be centered around the horse stable property to the southeast. It is our understanding that older drilled well is present on that property and there are concerns that this well may be providing a pathway for nitrates to enter the aquifer. This well was reported to be a drilled well within a suspected former dug well and there are concerns regarding surface water infiltration into this well.

In 2017, EXP recommended that the older drilled well be sealed and that the newer barn well be used as the new well for the horse stable. It is our opinion that the nitrate is manageable since: 1) to be limited to the southern portion of the property, 2) is still well below the applicable criteria even after pumping over 100,000L of water in the area over a 4-day period; 3) is not present in any of the northern portion property; 4) the older well on the stable property is to be abandoned in accordance with O.Reg. 903.

EXP understands that the well was not abandoned but instead was upgraded in 2019. The well was upgraded by Olympic Drilling and included the installation of new grout and new casing within the existing well. EXP understands that the former "barn well" is now operational and currently used for residential purposes. It is noted that sampling of TW4 in 2020 provided identified improved water quality with no detectable nitrate/nitrate levels. The water from the old barn well was sampled by the client on July 31, 2020 and is described in Section 3.3.5.

The following summarizes the aesthetic objectives for the wells within the subject property:

- Hardness: Hardness levels are above the ODWS and were noted to be hard. Elevated hardness can be easily treated with the use of a softener and are not considered to be a concern.
- Turbidity: Turbidity levels are above 1 NTU, which is an operational guideline for the operation of ultraviolet treatment systems designed to remove bacteria. Therefore, turbidity above 1 NTU is not

a concern given that total coliform and E.coli are not present. Nonetheless, as per D-5-5, the treatability limit for turbidity is 5 NTU and all turbidity levels were below 5 NTU.

- Colour: Colour was observed above the ODWS in Test Well #3 with levels of 7 TCU but within the D-5-5 treatability limits within the entire property. The colour was observed to be above D-5-5 treatability limits from Test Well #4 (the barn well), which is off-site. The colour was consistent within this well and can be treated with organic filter systems, if desired. In addition, pumping at lower rates may also allow for lower colour as well.
- The other elevated aesthetic parameters were all shown to decrease during the pumping test.

3.3.5. Neighbourhood Wells / Property

It is understood that Procedure D-5-5 allows for the sampling of residential water wells within a 500 m radius of the subject site. As per industry standard and our previous practice on similar subdivisions, not all of the wells are sampled as per such a program, and three (3) houses are included in the sampling program. EXP attempted to collect water and interview well owners that would be representative of the site conditions based on type of septic system, upgradient vs. downgradient of the wells, similar site conditions and well information (if previously observed). However, it is understood that due to site access, homeowner availability and confidentiality reasons, the optimal residences are not always selected. The information collected from the neighbourhood well assessment is then used to predict and/or assess potential impacts from development on the aquifer moving forward.

As part of the assessment program, interviews and water sampling were conducted at selected residential dwellings neighbouring the subject property (Figure 2 in Appendix A). A summary of the residential information is as follows.

Derry Side Road (East of Site)

- The residential property has a single bedrock well with stick-up casing
- The Owner did not report any concerns with the water;
- No evident treatment systems in the house.
- Septic system is located behind the house and is below grade. The owner has not reported any concerns.
- The analytical results from the water collected were noted to be hard but the mineral content was considered to be low. No observed nitrate and/or nitrite was observed within the well. Organic nitrogen was observed above the applicable aesthetic objective but no other aesthetic exceedances were observed. There are no concerns regarding the water quality and the water appeared to be relatively similar to the newly drilled on site wells.
- The owner did not report any concerns regarding their septic system.

Derry Side Road (North of Site)

- The property has a bedrock well that is buried and reported to have 75 mm dia (3”) casing (older well). The well was re-drilled from 33 to 45 m (110 to 150’) deep. E.Coli. was formerly present in their supply prior to the well upgrade.
- Owner reports a sulfur smell to the water and suggests a high iron content in the water supply.
- Well owner operates a water softener and a charcoal filtration system.

- The water quality was noted to be hard with additional aesthetic exceedances. Elevated turbidity, iron and organic nitrogen is present within the well. The hydrogen sulphide levels are also within the acceptable aesthetic criteria. Although there are some aesthetic exceedances, no health related concerns are noted from the water quality test.

Richmond Road (South of Site)

- The property has a single bedrock drilled well to which the depth is unknown.
- No concerns regarding water quantity were reported by the homeowner.
- The owners operate a softener to reduce hardness levels.
- The water quality was noted to be hard. In addition to the hardness levels, the only aesthetic objective is manganese. No evident bacteria, nitrate/nitrite or other health related parameters were identified and/or indication of impacts from the stables. Low levels of hydrogen sulphide were observed that may present a slight odour. There are no concerns regarding the water quality from this well.

Old Barn Well (approximately 50 – 75m south of TW4)

- The old barn is located at the property to the south of the proposed development;
- The well is described as an old barn well that was recently upgraded with a steel casing and pressure grouted (completed by Olympic Drilling in 2019) based on previous recommendations to abandon or upgrade.
- The water was tested for surficial related parameters. No detectable bacteriological parameters, nitrate levels were well below criteria (1.5m mg/L) and no detectable colour / tannins and lignins.

Summary

The water quality was determined to be hard but not heavily mineralized as levels of TDS, conductivity and other metals was considered quite low. There are no existing health related exceedances from the subject wells on the site as fluoride, sodium, E.Coli and total coliform levels are all within the acceptable criteria. One of the wells had to be shocked but total coliform levels were acceptable after being shocked.

It is noted that slightly elevated nitrate levels were observed off-site from the well on the stable property as well the off-site snowmobile trail (i.e. nearest the stable property) but has not been shown to extend to the proposed nine lot proposed development. The on-site wells Test Well #2 and Test Well #3 did not show impact and there it is suspected that the nitrate levels are limited to the south of the property. The original submission of this report in 2017 had recommended that any older wells on site be abandoned and sealed in accordance with O.Reg. 903 minimize short circuiting into the aquifer. EXP understands that the older barn well has been upgraded with new casing and grout to mitigate the potential for short-circuiting.

Various aesthetic object exceedances were observed from the water supply but either decreased during the pumping test and/or showed improved concentrations following low level pumping. Iron, organic nitrogen, turbidity all decreased with continue pumping. Colour levels are still present within Test Well #3 but remained below the D-5-5 treatability limits.

The water quality from the neighbouring wells did not identify any health related exceedances and were similar in nature to the water quality from the on-site wells. Some slightly higher iron, organic nitrogen and turbidity were present but sporadic between the houses. The water from the neighbouring wells was also hard but the nitrate levels were observed to be low.

It is our opinion that the water quality from local sampled wells is of a good water quality and does not suggest any widespread poor water quality issues. It is also our opinion that the combination of the existing three wells combined with the well at the stable as well as the four neighbouring wells provides sufficient information to assess the water quality.

3.3.6. Treatment Systems

Based on the above-noted water quality data, sporadic aesthetic related exceedances were identified in the groundwater samples collected from the on-site test wells. Even though the aesthetic exceedances will not cause any health-related concerns, they can still hamper the colour and taste of the water. The aesthetic objectives exceedances at the site consisted of hardness. It is noted that elevated turbidity and iron was also observed in neighbouring wells.

- Cartridge Filter:
  - Lowers the turbidity to acceptable levels below 1 NTU, if required for treatment;
  - Used as pre-treatment for the use of UV units to ensure that turbidity levels are below 1 NTU, if UV systems are to be installed;
- Activated Carbon Filter
  - An activated carbon filter can be installed to help reduce colour that is caused from organic matter, which is the suspected cause of colour from Test Well #3.
- Softener:
  - Lowers water hardness to acceptable levels.
  - Can also lend to lowering iron and manganese;
- Chemical-free Iron Filter:
  - Lowers elevated iron concentrations to aesthetic levels, if not sufficiently reduced by softener. The iron levels were within criteria but shown to be elevated from neighbouring wells.
  - These systems can also reduce colour levels that are impacted by iron, manganese and other metals.
- Nitrate Removal Systems
  - Helps lower nitrate levels for residential sized water consumption. Nitrate levels are well below the criteria and this is provided to identify that nitrate removal systems can be used, if desired.

It is understood that the use of treatment systems does provide some increase to the septic loading. However, such loading would be in the order of 200 to 400 L/day. Given that the size of the septic systems (as discussed later in Section 4) is based on the flow of 3,000 L/day but the average consumption of water for a luxury residence (4 bedroom) is less than 2,000 L/day, it is our opinion that this additional loading would not cause undue impact to the field bed.

4.0 Sewage Disposal

4.1. Site Sensitivity

4.1.1. Background

The current Procedure D-5-4 – *Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Assessment*, Revised August 1996 indicates that subdivision approval will not be permitted for any development on exposed bedrock, highly conductive soils (cobbles, gravel, coarse sand) and in areas with thin soil cover. It is considered that such a site would be characterized as being hydrogeologically sensitive. However, a specific soil thickness and/or maximum hydraulic conductivity is not specified and it is up to the proponent to establish the appropriate soil cover characteristics to accommodate a private residential development.

To establish the thickness of sufficient soil on a site in deeming it is not sensitive, EXP refers back to prior discussions with local health units and our professional experience. Based on prior discussions with the various health units on other similar developments, it was determined that a soil thickness of 30 cm of native soil is required to accommodate a septic system to 1) provide a proper buffer below the underlying field bed and 2) provide sufficient soil for downgradient nitrate dilution prior to entering the bedrock and/or migrating off property. Conversely, the regulatory authorities has also been referring to a required soil thickness of 2 m based on O.Reg. 511/09 and O.Reg. 153/04 when representing municipalities on similar investigations. However, EXP does not consider it to be directly applicable as the regulation is intended for the classification of contaminated sites and not to assess the use of a site for septic system installation and/or hydrogeological assessments.

The soil thickness within the proposed nine-lot site plan generally ranges between 1.5 m to 2.5 m thick. A small section to the northern corner (Lot 1 and 2) has soil in the order of 1m thick but is very limited in nature and further away from the “stable” property to the south. Soil thickness to the southwest of the property (i.e. near Test Well #1 on the snowmobile trail) extend beyond 5 m in thickness.

Once one has established that sufficient soil thickness is present, a review of the soils is required to ensure that the overburden is suitable for septic systems.

4.1.2. Work Program

Original work plans consisted of assessing the nature and distribution of overburden materials on the originally proposed 24 lot site through the construction of six (6) test pits and three (3) boreholes on the previous 2017 proposed site plan,

Based on the revised nine lot site layout (2020 proposed plan), additional six test pits were excavated in March 2020. Combining the two soil investigation programs, a total of nine (9) test-pits and one borehole are located on the new nine lot site plan.

The test pits excavated across the subject site to determine the general soil conditions at the site as part of the geotechnical assessments. Samples were collected from the different soil stratigraphy for further laboratory grain size analysis. All soils were logged for soil type, colour, moisture, and sample number. The locations of the boreholes and test pits are shown on Figure 2 (Appendix A) and descriptions of the materials encountered are presented in Appendix E.

4.1.3. Soil Results / Terrain Analysis

To proceed with the development, the case has to be made to determine whether the site is sensitive. To assess the sensitivity of the proposed nine lot site, EXP conducted the following:

- Assessed the soil stratigraphy from nine test pits and one borehole on the site;
- Collected select samples from the various soil layers on the site;
- Submitted soil samples from the various defining soil layers/types on the site for grain size analysis;
- Determined a hydraulic conductivity of the various soil type layers (samples of sand with traces of clay and gravel, silty sand with traces of clay and gravel, and clay formations);

The majority of the site is described as having 0.2 m to 0.3 m of topsoil. Below the layer of topsoil, the next layer is described as a sand and gravel layer with traces of silt as described in TP2-2020, TP3-2020 whereas ta more sand / sand and gravel mix is below the top soil to the south in TP5-2020 and TP4. This layer is generally only 0.3m – 0.6 m thick. The sand/silt or sand / sand gravel layers are then underline by a thin layer of till material that extends to bedrock.

Grain size analysis was conducted on the soils to determine the properties of the soil to determine the potential for short circuiting of septic effluent into the bedrock formation and with the goal of establishing suitability for septic systems. Grain size analysis was not completed on the topsoil but it was consistently identified to be 0.2 m thick. It is noted that the hydraulic conductivities were shown to range from $6.2x10^{-2}$ cm/s to 4 $x10^{-6}$ cm/s. Based on a review of all of the grain size analysis, the general hydraulic conductivity for the site appears to be in the order of 10^{-3} cm/s.

Nevertheless, all of the soils contain some level of silty material which provides some isolating properties to the soil that will prevent immediate short circuiting and extend a minimum of 1.5 - 2 m deep throughout the majority of the property with small section with soils as shallow as 1m on Lot 1 In addition, all soils are overlain with a layer of topsoil that also provides additional protection.

In addition to the above, water bearing fractures were not observed within the top 15 / 20 m of the underlying bedrock formation. As such, there is no direct connection between the surface of the site and the underlying aquifer.

Based on the information above (i.e. hydraulic conductivity, thickness of the soil, the lack of drawdown in the piezometers during the pumping tests, the lack of surficial impact in the wells), it is our opinion that the site is not hydrogeologically sensitive.

Understanding that the soils and site conditions do not provide a concern for infiltration / short circuiting of septic effluent, one can proceed to assess the septic sizing. Understanding the soils through the site are generally a mix of sand, with varying levels of silt and gravels, a “consistent” soil classification can be used across the site for the purpose of provide generic septic system sizing.

Septic System Sizing – Class IV

Based on the information collected from the test pits and boreholes, the dominant soils on the site are described as a “till” material beneath the surficial topsoil. The till consists primarily of sand and gravel with some to traces of silt.

It is also noted that traces of clay (<5%) were sporadically identified throughout the site. The hydraulic conductivity of the soils is variable throughout the site based on the varying levels of silt. Therefore,

hydraulic conductivities on the site range from 6.2 x 10^{-2} cm/s to 4 x10^{-6} cm/s. This would result in a T-time ranging from 6 min/cm to 20 min/cm.

The septic system size for a conventional Class IV septic system is then determined via the calculation below at which the length pipe is initially determined. For the sizing of the septic systems, it is assumed that a worst-case flow rate for a large scale luxury residential dwelling is in the order of 3000 L/day. Based on the aforementioned flow rates, it is assumed that the pipe length is as follows for a conventional Class IV septic bed: It is understood that this may vary at the time of construction based on the specific location of the field bed, specific design of field bed and actual water consumption within a built house

$$L = QT/200$$

- L= length of pipe
- Q = daily flow rate
- T = percolation time

Assuming a best case T-time of 8 min/cm (i.e. higher permeability), the length of pipe would be in the order of 120 m, resulting in a field bed area of 198 m^2 (12 pipes at a length of 10 m per pipe). This is assuming that the beds would be constructed as an “in ground”. There is the potential for slightly larger beds in some areas if the silt content is slightly higher in specific locations.

The specific location of the larger and/or smaller beds would be determined at the time of construction dependant on the specific field bed location to be determined at the time of construction as well as more accurate permeability testing at that time.

Partially to Fully Raised Beds

Based on the potential for poorly drained soils / shallow groundwater tables primarily in Lot 1 to Lot 3, there is the potential for partially to fully raised beds on the site, depending on the specific lot and the high water table at the select location.

It is assumed that imported soil, required to raise a field bed would have a hydraulic conductivity in the order of 8 to 12 min/cm. As such, assuming a septic size of (198m^2), as per above, a fully raised field bed assuming a side sloping of 4:1 and a 15 m long mantle would account for a fully raised field bed in the order of 800 m^2.

It is understood that existing soils on the site and/or the use of imported soils for re-grading would allow for the use of a partially raised bed (i.e. portions of the field bed could be installed to a certain depth within the ground, to a suitable level). Nevertheless, for the purpose of demonstrating sufficient size to accommodate a fully raised bed, EXP has allotted for the fully raised bed on Figure 4. It is noted that field beds are all located more than 15 m from any proposed drinking water wells and are not located on bedrock.

A single lot layout depicting the proposed well, house and septic locations has been prepared and is displayed on Figure 4, Appendix A for the worst case raised bed situation. The goal of this figure is to display that there is sufficient room for the above-noted wells, houses and septic systems while maintaining required distances and set-backs.

Septic System Locations

The field beds are orientated to flow away from the proposed well locations. All field beds are proposed in areas:

- with sufficient soil,
- more than 30 m from ditch/surface water body

- 15 m from a proposed well locations. It is noted that field beds are directed to minimize any flow towards proposed wells.

The proposed layout is identified within Figure 4***.***

New Technology

It is understood that the field beds for a Class IV sewage system required to handle the sewage from a luxury home occupy substantial portions of the property. Based on the information collected from the site, the field beds within select lots would likely require raised beds based on shallow water tables. However, there are new technologies available that could reduce the size of the septic system footprint for each property such as class VII septic systems. If these septic systems are to be incorporated into the design of the properties at the time of design/construction stage, it is recommended that the systems be installed as per the Ontario Building Code.

5.0 Impact Assessment

Prior to conducting the nitrate impact assessment, EXP staff reviewed the piezometers and ground conditions to assess the sampling for nitrate sampling. The piezometer sampling locations were collected to address potential on site sources of background nitrate as well as provide spatial representation of the site conditions.

Overburden groundwater was consistently identified at the site as well as standing water, likely due to poor drainage during the spring snow melt. Bedrock was not observed at surface within the developments but described to be within 1.5 m on northern portions of the site.

Groundwater was sampled from three of the piezometers to establish whether nitrate impact is currently present within the overburden groundwater regime. The groundwater collected from the piezometers was determined to contain no nitrate / nitrite levels within piezometers TP2 and TP3. Conversely, 0.4 mg/L of nitrate was observed from within piezometer TP1.was determined to be 0.4 mg/L. Current practices have surficial material being deposited on the snowmobile trail area, which in turn may be impacting the overburden groundwater conditions in that area.

Nevertheless, a review of the bedrock groundwater (on-site and neighbouring wells) was conducted at which background nitrate levels were not elevated and therefore do not suggest long term impacts from septic usage.

5.1. Nitrate Impact Assessment

The MECP Procedure D-5-4 presents a methodology for assessing the potential impact of on-site sewage disposal systems to groundwater resources. The procedure employs a three step process, with the need to proceed to a step dependent upon the conditions determined by the previous step.

Step One considers lot sizes. If the proposed development has a minimum lot size of 1.0 hectares or larger, no further evaluation is necessary. Since the average lot size proposed for this development is less than 1 hectare, the condition required for Step One is not fulfilled, and the assessment proceeds to Step Two.

Step Two considers system isolation. In areas where the underlying water supply aquifer(s) are protected by upward gradients or deposits of low permeability materials, the minimum lot size will not be determined by potential impact. Given that the overburden material at the site does not comprise of a consistent layer of low permeability clay or till that could serve as isolation, Step Two is not fulfilled and the assessment must proceed to Step Three.

Step Three considers contaminant attenuation and a study is required to determine the risk of exceeding the allowable nitrate concentration of 10 mg/L at property boundaries based on the proposed septic systems. The following method used to determine the risk is the predictive method at which contaminant attenuation is based.

For the purposes of this calculation, it is assumed that each lot will produce 1,000 L/day of sewage effluent containing 40 mg/L nitrate. The 1,000 L/day value is less than the design flow, but is recognized as a representative *average* value for subdivision lots. The calculation can be conducted for areas where there is sufficient soil for nitrate dilution (i.e. locations where there is more than 30 cm of soil) and also must exclude other non-permeable surfaces such as roadways, driveway and rooftops.

5.1.1. Total Infiltration Area

For the purpose of the dilution calculation, dilution of the septic system effluent occurs though interaction with surface water / rain water infiltration. Therefore, impervious materials used for the development including asphalt roadways, driveways and roof tops, generally diminish the infiltration capacity of the site.

Taking into consideration the size of the roadway, approximate size of proposed roof tops and driveway within the proposed subdivision, the site area used in the calculation was determined to be in the order of (54,452 m^2 m^2) - (9* 200 m^2) – (9*250 m^2) = 50.402 m^2.

5.1.2. Infiltration Factor

The infiltration factor (I_f) was determined by considering site factors such as topography, soils, and vegetative cover, which are identified during previous works conducted on the site. Coefficient factors, provided by the MECP, are determined for each site factor and the summation of the coefficient factors provide the infiltration factor. For this site, the following site factors were determined:

- Based on available topographical information for the site, the property consists primarily of rolling land as assumed elevations changes within the property are predominantly in the range of 2.8 to 3.8 m / km. With the exception of a limited number of swales throughout the property, there is no notable elevation changes to suggest that the site is hilly land (i.e. 28 m to 47 m/km). As such, the land is described as rolling (coefficient factor of 0.2) with slight swales (25% of the property with a coefficient of 0.1) for a coefficient factor of 0.175.
- The vegetative cover at the site is predominantly woodland (80%) with some cultivated lands (20%). The coefficient factor for woodlot is 0.2 and 0.1 for cultivated lands. It is assumed that post development conditions would likely equate to 50% woodland and 50% low vegetation (grass). As such, a coefficient factor of 0.15 is attributed.
- Based on test pits excavated at the site, the majority of the soils consist of fine to medium grained sand with gravel with traces of silt (i.e. suspected till material). It is noted that the silty materials would generally account for less than 10% of the soils on the site. As such, the soils are primarily sand and with some silt. The infiltration factor for open sandy loam is 0.4.

Based on the above coefficient factors, the calculated infiltration factor for the site would be **0.725.**

5.1.3. Water Surplus

A value for water surplus of 0.345 m was attributed to the site based on information collected from the Ottawa International Airport weather station (2008). The data was collected for a period of 1939 to 2008 and is attached in Appendix F.

Based on information provided by the Ottawa weather station, the water surplus is deemed to be 0.359 m/year for a 100 mm column of sand, which is considered to be relatively representative of the soil conditions at the site (especially within the surficial soils). Some silt levels were identified at depths of deeper than 2.5 m and thus does not impact the infiltration of the septic systems.

For the purposes of this calculation, it is assumed that each lot will produce 1,000 L/day of sewage effluent containing 40-mg/L nitrate. The 1,000 L/day value is less than the design flow, but is recognized as a representative *average* value for subdivision lots.

5.1.4. Nitrate Dilution Calculation

The following equation arrives at the given nitrate content:

$$[NO_3^-]_{gw} = \frac{[NO_3^-]_{effluent} \times (\#\ Lots) \times (Daily\ Flow) \times (365\ days/year)}{D_w + Volume\ of\ Sewage}$$

$[NO_3^-]_{gw}$ = average nitrate content of groundwater on-site following development with infiltration as the only attenuating mechanism.

$[NO_3^-]_{effluent}$ = 40 mg/L = 40 g/m^3

D_w = Annual volume of precipitation infiltration available for dilution
= A x W_s x I_f

A = downgradient area available for infiltration
= 50,402 m^2 (excludes area of roads and other non-permeable surfaces)

W_s = water surplus from Ottawa Airport (to 2008)
= 0.345 m

I_f = infiltration factor
= 0.725

Therefore D_w = 12,606 m^3

$$\text{Therefore } [NO_3^-] = \frac{40\ g/m^3 \times 9\ units \times 1\ m^3/day \times 365\ days/yr}{12{,}606\ m^3 + 365\ days\ (9\ units)}$$

= 8.2 mg/L

Based on the above, a nitrate level of 8.2 mg/L would be present at the property boundary. The theoretical nitrate levels at the property boundary are to be 10 mg/L and the above nitrate loading is well below the criteria. In addition, the above theoretical loading is based on septic technologies from years ago and newer technologies can minimize the loading.

It is understood that an existing nitrate loading already exists within the bedrock aquifer to the south of the site as evidence by off-site Test Well #1 and Test Well #4. Conversely, nitrate levels within the proposed nine-lot development are near the laboratory detection limit and not a concern on the subject site. At this time, it is our opinion that there may be a direct source for snowmelt / spring runoff (mixed with horse droppings) to get into the aquifer through the older drilled well. It is not anticipated that the source of nitrate is due to the natural site characteristics. Since the 2017 field program, it is our understand that the “older barn well” has since been upgraded with a new casing and grout to meet current O.Reg. 903 standards.

Nitrate levels were also measured from the overburden groundwater from the piezometers installed at offsite BH1, off-site BH2 and BH3 installed in proposed Lot 2, and were all determined to be non detect to low (0.4 mg/L). The only measurable nitrate concentrations within the overburden groundwater was from TP1, which is nearest the neighbouring horse stable. It is also noted that the property owner deposits horse droppings throughout the snowmobile trail, which may have impacted the slightly higher nitrate levels at TP1/BH1.

5.2. Surface water Setback

Based on a review of the site conditions and topographic mapping, the Leach Drain traverses the central portion of the property and then borders the western portions of the property. This does not appear to be a seasonal ditch but rather more of a permanent ditch / water body.

It is understood that septic systems and field beds direct septic effluent and associated phosphate loading to downgradient receptors. As such, the septic systems and associated field beds cannot directly flow to the Leach Drain thus a buffer is needed. Therefore, a 30 m buffer zone as per industry standards has been allotted between the surface water and any development. It is also noted that the buffer zone is applicable to the mantle of the field bed, as such, no field tiles are within 45 m of the surface water.

6.0 Conclusions

An investigation was conducted to assess the suitability of a site located on Derry Side Road and west of Richmond Road in Beckwith, Ontario. It was originally proposed that the property, covering an area of 16.158 hectares, be subdivided into 24 residential lots with average lots sizes of the order of 0.6 hectare (1.4 acre). The hydrogeological assessment associated with this proposed development was dated June 22, 2017.

However, the client has since revised the lot layout and has reduced the overall size of the proposed development. The revised development covers a total area of 54,452 m^2 (5.4 hectares) and is split into nine (9) residential lots. The proposed lot sizes range in size between 0.4 hectares and 0.62 hectares.

Based on the results of this investigation, the following conclusions are presented:

1. Water well records for wells drilled within 1 km of the site indicate that well yields are in excess of the required 18.75 L/min for 4 bedroom house. The wells extended to depths ranging from 20 to 44 m from surface, with an average well depth of 33 m. Water is generally found at depths of 17 to 42 m. Depth to rock was consistently identified to be beyond 2 m from surface with the exception of one well within the 1km radius of the site.
2. Four water supply wells (including two wells drilled off site: one on the stable property and one southwest near snowmobile trail) were completed in the sandstone and/or limestone/sandstone bedrock formation while intercepting the Oxford Formation (limestone) potentially extending into the March Formation. Six-hour constant rate pumping tests, at rates of 75 L/min, followed by recovery tests conducted on each of these wells indicate well yields at or in excess of the 75 L/min. Some of the wells did not sustain any drawdown at these rates. These rates are more than adequate to supply the MECP recommended 18.75 L/min flow rate for a 4-bedroom residence. It is our professional opinion that the wells tested as part of this program display sufficient well yields that future wells (drilled as recommended) would produce sufficient yield.
3. The wells drilled within the subject property are drawing the majority of the water from water bearing fractures within the March Formation (dolomite and sandstone).
4. The pumping tests did not identify any well interference between the respective test wells drilled on the subject site. The impacts within the monitoring wells approximately 110 to 120 m away from the respective production wells were in the order of <1% (18 to 21 cm respectively) of the available drawdown as a result of 6 hrs of pumping at high flow rates. The pumping tests were conducted at flow rates well above the anticipated household flow rates to assess the well yield. A conservative evaluation of the cumulative well interference at the site predicts a cumulative drawdown ranging of 0.53 m at the center of the property based on standard water usage over 30 years, which is not considered a concern.
5. Groundwater quality in the bedrock aquifer met all health related criteria of the Ontario Drinking Water Standards for those parameters tested after all testing was complete.
    a. Turbidity levels were noted to be above the applicable aesthetic objective guidelines (1 NTU) at the end of the test in each of the test wells. These levels decreased during testing and should continue to decrease with continued pumping at lower rates.
    b. Test Well #3 was shock chlorinated following initial water testing to establish good water quality. Subsequent to the second well shock, total coliform was no longer detected.

c. Hardness levels were consistently elevated within all the wells suggesting hard water. The hard water can lead to potential scaling within the piping.

d. Elevated colour is present within some of the wells (i.e. TW3 and the neighbouring barn well). All on-site test wells were within the D-5-5 Treatability limit and colour levels were identified to be lower from TW1 during low rate pumping than the higher rate pumping test program.

e. Although within acceptable criteria, nitrate was observed within the groundwater in the southern portion of the property and at higher levels within the neighbouring property to the south (horse stable/barn). An old dug well with drilled well inside is present within that property and suspected to be the source of the nitrate impact. The nitrate appears to be limited to the southern limits of the property based on the results from all the wells. Note that the old well has since been upgraded and sampled,

f. Based on the known “Beckwith plume”, EXP collected TVOCs from TW3 on the property at which no VOCs were detected. There are no concerns with the Beckwith plume on th subject site.

6. Neighbourhood well sampling was completed in 2017 at three (3) wells and did not identify any regional groundwater concerns. The water from four neighbouring wells was generally considered to be hard. Groundwater concentrations from the neighbouring wells were similar to on-site wells with slightly higher turbidity, iron and organic nitrogen. The client collected a water sample from his upgraded barn well in 2020 to assess surficial impacts. Nitrate levels from the barn well were well below criteria and do not suggest any surficial related impacts since the barn well was upgraded. No health related concerns were observed within any of the sampled wells and nitrate levels were low to non-detectable from these wells.

7. The construction of test pits revealed that overburden materials is described as a “till” material consisting of sand and gravel with traces of silt. Sporadic locations were also determined to contain “some” silt at depth. The overburden soils on the site are predominantly 2 m thick with an isolated area (proposed lots 1, 2 and 3) with soils determined to be between 1 to 2 m thick and the southern portions of the site with soils exceeding 5 m in thickness. No bedrock was observed at surface at the subject property. The overburden groundwater is noted to be shallow throughout the property (poorly drained) during the spring melt conditions previously identified. This would necessitate the need for partial to fully raised field beds and potential use of fill material and/or storm water management solutions.

8. The average lot size is 0.4-0.62 hectare and the site is not deemed hydrogeologically sensitive. As such, nitrate dilution calculations on the site were conducted and display theoretical nitrate levels from the installation of 9 septic systems would be 8.2 mg/L. Although existing nitrate levels were presented within a single on-site well and the neighbouring well in 2017 (but lower in 2020 based on updated testing), the installation of the new septic systems is not considered a concern since the suspected source of the nitrate appears to have been resolved since the upgrading of a neighbouring old barn well.

Based on the results of the hydrogeological, terrain and impact assessment evaluation, it is recommended that the proposed residential subdivision be approved for development.

7.0 Recommendations

Based on the findings of this assessment, the following recommendations are made:

- All wells drilled on this property should be constructed in accordance with Ontario Regulation 903. The casing of bedrock wells should extend at least 3 m into competent bedrock while ensuring the casing maintains the minimum 12 m length from surface. Grouting procedures and the installation of the casing are to be supervised by a Professional Engineer.
- It is recommended that drinking water wells be drilled to depths of approximately 40 m to 60 m, based on the depths of wells sampled/tested as part of this program. Any well that would extend much beyond that depth would have to undergo additional chemical analysis (similar to that conducted as part of this report) prior to commissioning.
- It is recommended that Test Well #2 be abandoned in accordance with O.Reg. 903 if the building footprint and/or septic system location interfere with building code (i.e. less than 15m separation distance).
- It is recommended that the separation distance between drinking water wells and the proposed septic systems/field beds be a minimum of 15 m. Any additional buffer that can be created between the well and septic system is beneficial in reducing any potential risks of contamination.
- Aesthetic objective exceedances were observed from the test wells. Based on aesthetic objective exceedances, the following recommendations apply:
    - Elevated hardness levels are present within the groundwater supply. It is recommended that softeners be used to treat hardness, if desired.
    - Elevated colour can be reduced with the use of the chemical free iron filters and/or organic treatment systems.
    - Although nitrate levels are within criteria, nitrate removal systems can be installed to further decrease nitrate levels.
- It is recommended that well users pump their well for a minimum of 24 hrs to reduce turbidity levels in the water supply and collect water samples for bacteriological analysis prior to using their well for consumption purposes. Well users should collect water samples on a semi-annual basis.
- It is noted that field beds may require partial to partially to fully raised field beds due to poor drainage, in accordance with the Ontario Building Code.
- Standard septic systems and field beds on the site are to be installed as Class IV septic systems. Newer technology Class VII systems can assist in minimizing impacts on the site.
- The locations of the well and the septic system are to remain in the same general locations as that shown on Figure 4.
- It is recommended that a buffer of 30 m be maintained between septic systems and the Leach Drain.
- Based on the results of the hydrogeological, terrain analysis and impact assessment, it is recommended that the proposed residential development be approved for development while ensuring that the wells and septic system are completed as per the existing Ontario Building Code.

8.0 References

1. Cooper, H.H. and Jacob, C.E., 1946: A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-Field History. Trans, *Amer. Geophys. Union, Vol. 27*, No IV, pp 526-534.
2. Freeze, R.A. and Cherry, J.A., 1979: *Groundwater: Prentice Hall.*
3. Hantush, M.S. and Jacob, C.E. (1955), Non-steady radial flow in an infinite leaky aquifer, *Am. Geophys. Union Trans*., v. 36, p. 95-100.
4. Harrison, 1976: Ottawa-Hull: 1: 125,000: Map 1508A, *Generalized Bedrock Geology, Geological Survey of Canada*.
5. Johnson Division, 1986: *Groundwater and Wells, 2nd Edition*; F.G. Driscoll, Principal Author.
6. Ministry of the Environment: *Water Well Records*.
7. Ministry of the Environment 1995: *MOEE Hydrogeological Technical Information Requirements for Land Development Applications*.
8. Ministry of the Environment, 1982: Excerpt from *MOE Policy, Procedures, and Guidelines for Private Sewage Disposal Systems*.
9. Ministry of the Environment, *D-5-5 Technical Guideline for Private Wells: Water Supply Assessment*, August 1996 (revision).
10. Ministry of the Environment, Ontario Drinking Water Standards, 2004
11. Ontario Building Code, 1997: *Regulation 403/97, Code & Guide for Sewage Systems 1997*. Ministry of Municipal Affairs and Housing.
12. Richard S.H. et al., 1974: *Surficial Materials and Terrain Features (Ottawa-Hull), Map 1425A, Scale 1: 125,000 Geological Survey of Canada*.
13. Theis, C.V., 1935: The relation between the lowering of the piezometric surface and the rate, and the duration of discharge of a well using groundwater storage. *Trans, Amer, Geophys. Union, 2*, pp. 519-524.

9.0 Limitation of Liability, Scope of Report, and Third Party Reliance

This report has been prepared for and is intended for the exclusive use of the client. The contents of this report should not be relied upon by any other party without the express written consent of EXP.. The findings are relevant for the dates of our site visits and should not be relied upon to represent conditions at later dates.

Our conclusions regarding the site are based on observations of existing site conditions, our interpretation of site history and site usage information, and the results of a limited subsurface exploration, sample screening, and chemical testing program. The results of this evaluation are qualified by the fact that only limited borings, soil and groundwater sampling and chemical testing were conducted at the site. The concentrations of parameters measured may not be representative of conditions at locations intermediate to those locations sampled. Further, conditions may change at any particular location as a function of time in response to natural conditions, chemical reactions and other events.

Conclusions regarding the condition of the site do not represent a warranty that all areas within the site and beneath structures are of the same quality as those sampled. Further, contamination could also exist in forms not indicated by the limited investigations conducted. Additionally, the scope contained herein is based, in part, on rules and regulations which we understand to be current or expected at the time of the proposal. Changes in regulations, interpretations and/or enforcement policies may occur at any time in the future. Such changes could be reflected in the degree of remediation actually required at the time of the action. If additional information becomes available concerning this site, such information should be provided to EXP so that our recommendations may be reviewed and modified as necessary.

Appendix A: Figures

Base Maps | 2014

Derry Branch 6 Drain
Derry Drain
Derry Branch 2 Drain
Derry Branch 1 Drain
Derry Branch 7 Drain
Goodwood Marsh
Goodwood Marsh
McCoy Drain
Leach Branch 1 Drain
Leach Drain
LOT 1
LOT 2
LOT 3
LOT 4
LOT 5
LOT 6
LOT 7
LOT 8
LOT 9
FERGUSON ROAD
Leach Drain
DERRY SIDE ROAD
Goodwood Drain
McCoy Drain
500 m
2000 ft
© 2017 - City Of [illegible] Enterprises Inc

LEGEND

LIMITS OF BECKWITH PLUME

NEIGHBOURHOOD WELL SAMPLES

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
www.exp.com

DESIGN	S.D.
DRAWN	M.N.
DATE	APRIL ~~2020~~
FILE NO	236288–A0

HYDROGEOLOGY TERRAIN ANALYSIS AND IMPACT ASSESSMENT

SITE PLAN AND SURFACE WATER PLAN

SCALE 1:7500

SKETCH NO FIG 1

Filename: R:\230000\236000\236288-A0 Derry Side Road, Lanark\2020 - Revised Lots\236288 Fig 1.dwg
Last Saved: May 14, 2020 4:50 PM Last Plotted: May 14, 2020 4:52 PM Plotted by: NugentM

DERRY SIDE ROAD

EDGE/PAVEMENT

DRAINAGE DITCH

UP AN

LOT 1 | LOT 2 | LOT 3 | LOT 4 | LOT 5 | LOT 6 | LOT 7 | LOT 8 | LOT 9

A
FIG 3

TP1-2020
0.3
0.6
0.9

BH3
0.3
1.0

WELL 2

TP2-20
0.3
0.9
1.2

TP3-2020
0.3
0.9
1.5

TP4-2020
0.3
0.6
1.5

TP6
0.3
2.0

TP5-2020
1.5
0.5
1.5

TP6-2020
0.3
1.5

TP4
0.2
2.0
2.6

WELL 3

TP3
0.2
0.9
1.5

TP5
0.3
2.6

BH2

WELL 4

A'
FIG 3

BH1
0.2
2.5
5

WELL 1

MUNICIPAL DRAIN

FERGUSON ROAD

LEGEND

TP5-2020	TESTHOLE LOCATION & NUMBER - 2020
TP5	TESTHOLE LOCATION & NUMBER - 2017
BH3	BOREHOLE LOCATION & NUMBER - 2017
WELL 1	DRILLED WELL LOCATION & NUMBER
	HYDROGEOLOGY CROSS-SECTION

	TOPSOIL
	SAND & GRAVEL / SANDY GRAVEL
	TILL
	FILL
	SAND
	SAND/CLAY
	SAND/SILT

30 × 15 HOUSE

BASE DRAWING FROM Stantec Geomatics Ltd.

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
www.exp.com

DESIGN	S.D.
DRAWN	M.N.
DATE	APRIL 2020
FILE NO	236288-A0

HYDROGEOLOGY TERRAIN ANALYSIS AND IMPACT ASSESSMENT

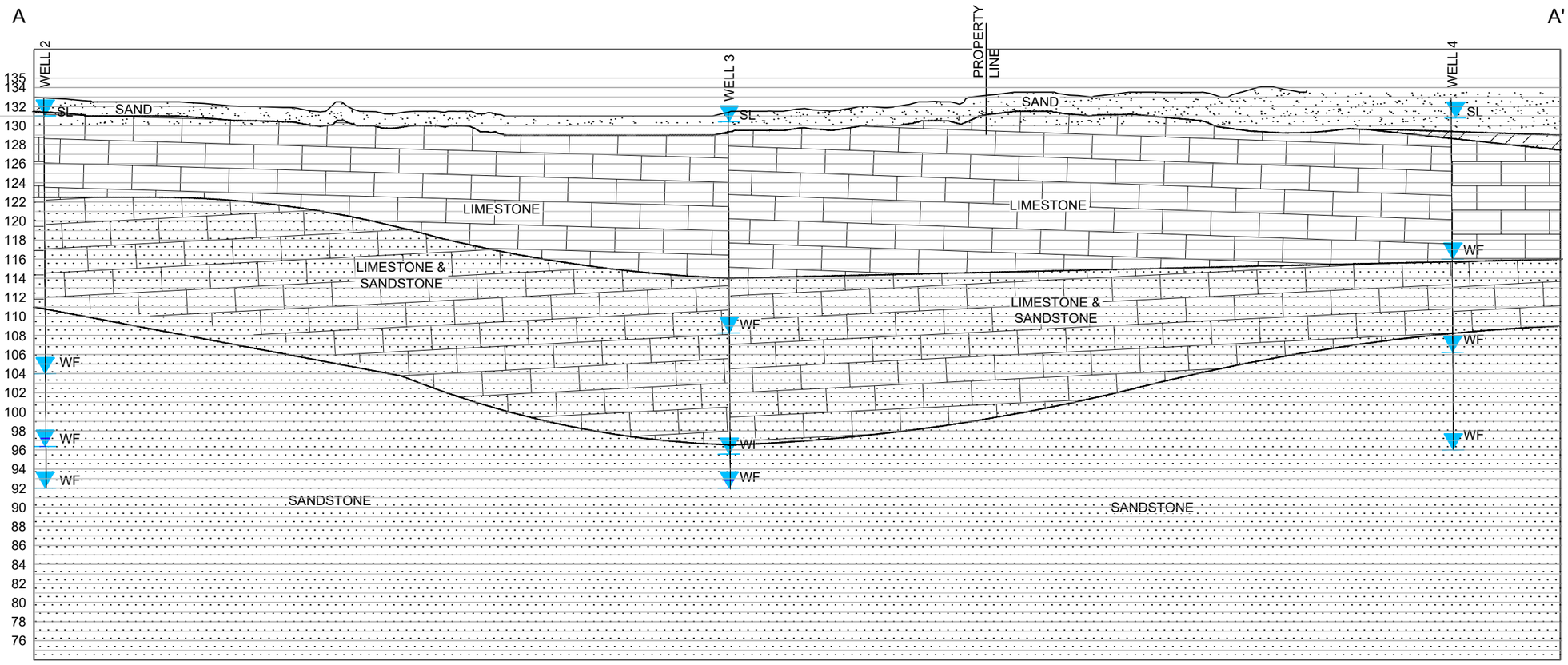
SOIL STRATIGRAPHY AND BOREHOLE LOCATION PLAN

DERRYSIDE, BECKWITH, ON

SCALE 1:2500

SKETCH NO FIG 2

Filename: R:\230000\236000\236288-A0 Derry Side Road, Lanark\2020 - Revised Lots\236288-XSEC.0-Fig 2.dwg
Last Saved: Jul 22, 2020 3:24 PM Last Plotted: Jul 22, 2020 3:33 PM Plotted by: NugentM



LEGEND

SL STATIC WATER LEVEL

WF WATER FOUND

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
www.exp.com

DESIGN	
DRAWN	J.R.
DATE	APRIL 2020
FILE NO	236288-A0

HYDROGEOLOGY TERRAIN ANALYSIS AND IMPACT ASSESSMENT

CROSS SECTION A–A'

SCALE 1:2,500

SKETCH NO FIG 3

Filename: R:\230000\236000\236288-A0 Derry Side Road, Lanark\2020 - Revised Lots\236288 Fig 1.dwg
Last Saved: Apr 7, 2020 4:45 PM Last Plotted: May 14, 2020 4:36 PM Plotted by: NugentM

DERRY SIDE ROAD

FERGUSON ROAD

EDGE/PAVEMENT

DRAINAGE DITCH

MUNICIPAL DRAIN

LOT 1 | LOT 2 | LOT 3 | LOT 4 | LOT 5 | LOT 6 | LOT 7 | LOT 8

TP1-2020

TP2-20

TP3-2020

TP4-2020

TP5-2020

TP6-2020

TP6

TP3

TP4

TP5

WELL 2

WELL 3

WELL 4

WELL 1

BH1

BH2

BH3

A

A'

FIG 3

UP

AN

LEGEND

- PROPOSED POTABLE WATER WELL
- MUTUAL WELL INTERFERENCE RADIUS
- BUFFER ZONE FROM DRAIN
- WELL — EXISTING POTABLE WATER WELL
- WELL #2 — WELL TO BE ABANDONED

SEPTIC BED

30 × 15

HOUSE

BASE DRAWING FROM Stantec Geomatics Ltd.

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
www.exp.com

DESIGN	S.D.
DRAWN	J.R./M.N.
DATE	APRIL 2020
FILE NO	236288-A0

HYDROGEOLOGY TERRAIN ANALYSIS AND IMPACT ASSESSMENT

SEPTIC PLAN WITH INTERFERENCE RADIUS

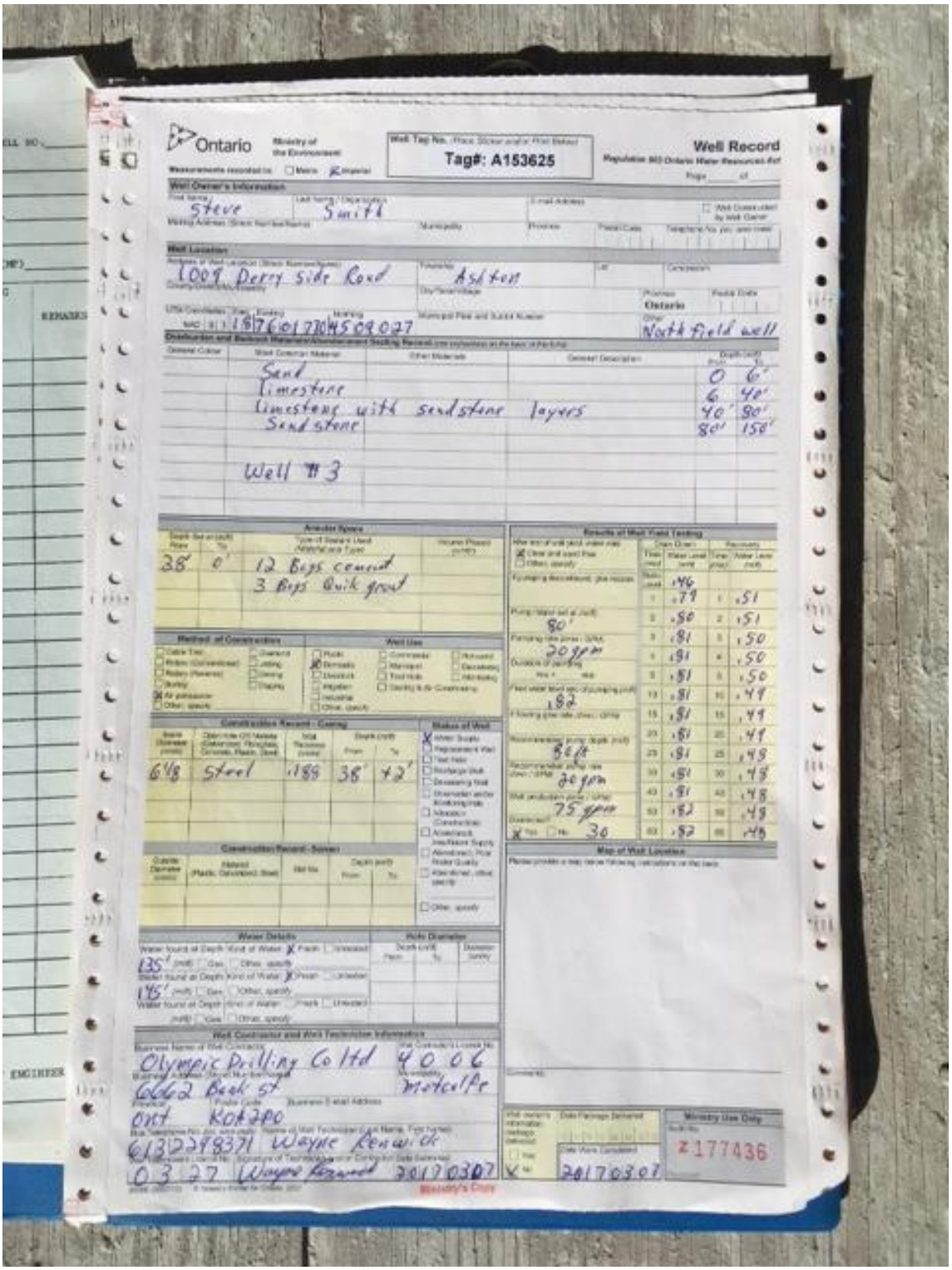
DERRYSIDE, BECKWITH, ON

SCALE 1:2500

SKETCH NO FIG 4

Filename: R:\230000\236000\236288-A0 Derry Side Road, Lanark\2020 - Revised Lots\236288-XSEC.0-Fig 4.dwg
Last Saved: Sep 18, 2020 10:51 AM Last Plotted:Sep 18, 2020 10:52 AM Plotted by:NugentM

Appendix B:
MECP Well Records



Ontario Ministry of the Environment

Well Tag No. (Place Sticker and/or Print Below) Tag#: A153625

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☐ Metric ☒ Imperial

Well Owner's Information

First Name: Steve | Last Name/Organization: Smith

Well Location

Address of Well Location (Street Number/Name): 1009 Derry side Road | Township: Ashton | Province: Ontario

UTM Coordinates: Zone: 18 | Easting: 361701 | Northing: 7045090 27

Municipal Plan and Lot(s): | Other: North field well

Overburden and Bedrock Materials/Abandonment Sealing Record

General Colour	Most Common Material	Other Materials	General Description	Depth (ft) From	To
	Sand			0	6'
	Limestone			6	40'
	Limestone with sandstone layers			40'	80'
	Sand stone			80'	158'

Well #3

Annular Space

Depth Set at (ft) From	To	Type of Sealant Used (Abandonment Type)	Volume Placed (cm³)
38	0'	12 Bags cement 3 Bags Quik grout	

Method of Construction: ☒ Air percussion

Well Use: ☒ Domestic

Construction Record - Casing

Inside Diameter (mm)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (mm)	Depth (ft) From	To
6 1/8	Steel	.188	38	42'

Status of Well: ☒ Water Supply

Construction Record - Screen

Outside Diameter (mm)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (ft) From	To

Water Details

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

Hole Diameter

Depth (ft) From	To	Diameter (inches)

Results of Well Yield Testing

After test of well yield, water was: ☒ Clear and sand free ☐ Other, specify

How was drawdown obtained and by what method? Pumping rate (l/min / GPM): 20 gpm

Duration of pumping: hrs 1 min 82

Final water level end of pumping (ft): 81

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

Recommended pump depth (ft): 80 ft

Recommended pump rate: 20 gpm

Well production (l/min / GPM): 75 gpm

Disinfected? ☒ Yes ☐ No: 36

Time (min)	Water Level (ft)	Time (min)	Water Level (ft)
Static level	146		
1	179	1	151
2	180	2	151
3	181	3	150
4	181	4	150
5	181	5	150
10	181	10	149
15	181	15	149
20	181	20	149
25	181	25	149
30	181	30	149
40	181	40	148
50	182	50	149
60	182	60	148

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: Olympic Drilling Co ltd | Well Contractor's Licence No.: 4006

Business Address (Street Number/Name): 6662 Bank St | City/Town: Metcalfe

Province: Ont | Postal Code: K0A2P0 | Business E-mail Address:

Business Telephone No. (inc. area code): 6132298371 | Name of Well Technician (Last Name, First Name): Wayne Renwick

Well Technician's Licence No.: | Signature of Technician and/or Contractor: Wayne Renwick | Date Submitted: 20170307

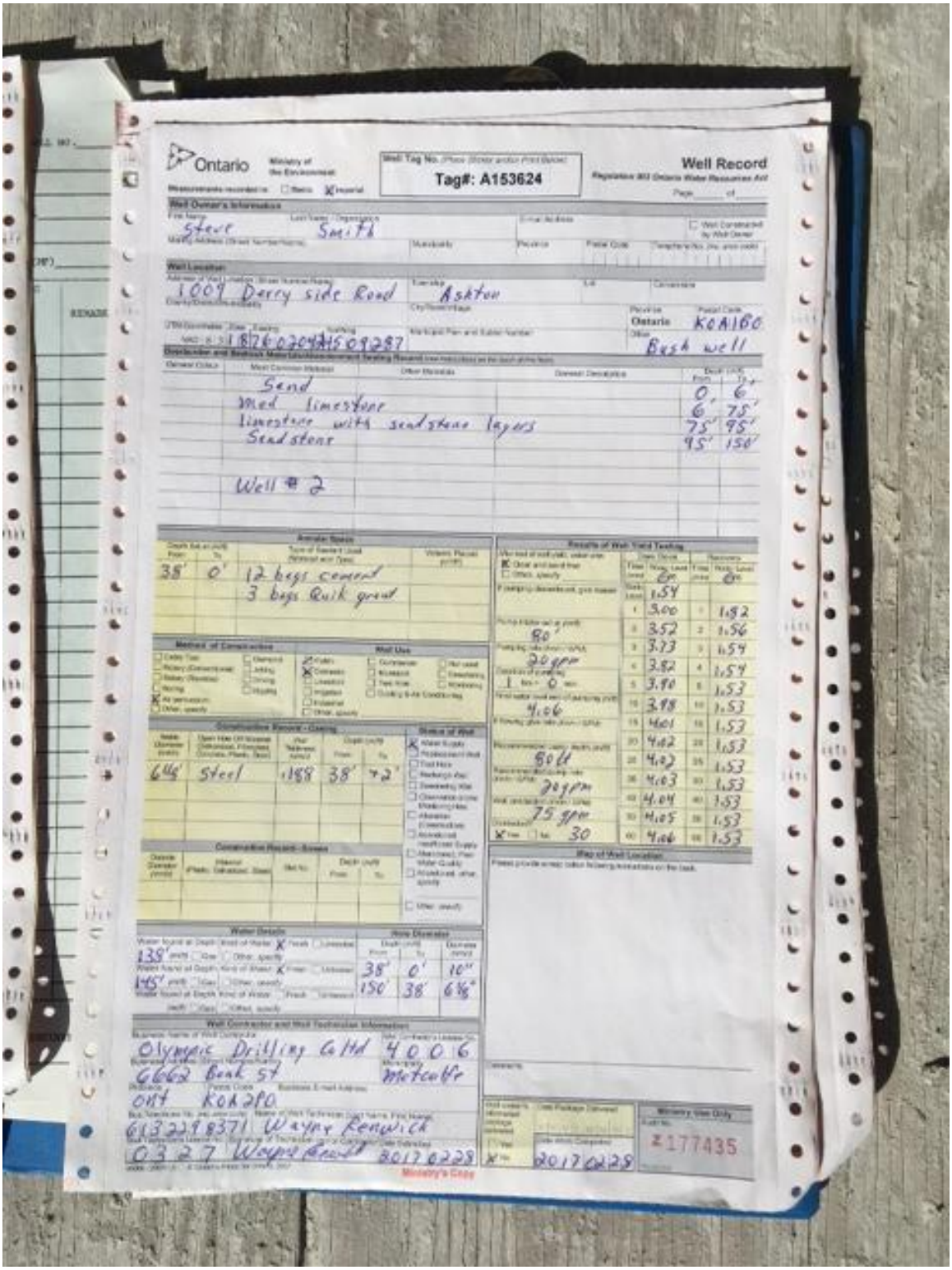
03 27

Ministry's Copy

Ministry Use Only

Z177436

Date Received: 20170307



Ontario Ministry of the Environment

Well Tag No. Tag#: A153624

Well Record

Well Owner's Information
First Name: Steve Last Name: Smith

Well Location
3009 Derry side Road Township: Ashton
Province: Ontario Postal Code: K0A1B0
Other: Bush well

Overburden and Bedrock Materials/Abandonment and Testing Record

Depth From	Depth To	General Colour	Most Common Material	Other Materials	General Description
			Sand		
			Med limestone		
			limestone with sandstone layers		
			Sandstone		
0'	6'				
6'	75'				
75'	95'				
95'	150'				

Well # 2

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Neat cement, Bentonite)	Volume Placed (m³/ft³)
38'	0'	12 bags cement 3 bags Quik grout	

Method of Construction: As permanent

Well Use: Domestic

Construction Record - Casing

Inside Diameter	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (mm/in)	Depth (m/ft) From	To
6¼"	Steel	.188	38'	+2'

Status of Well: Water Supply

Construction Record - Screen

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

Water Details

Water found at Depth (m/ft)	Kind of Water (Fresh, Untested, Salty, Sulphur, Gas, Other)	Hole Diameter Depth From	To	Diameter (cm/in)
138'	Fresh	38'	0'	10"
145'	Fresh	150'	38'	6¼"

Well Contractor and Well Technician Information

Business Name of Well Contractor: Olympic Drilling Co Ltd — Well Contractor's Licence No.: 4006
Business Address: 6662 Bank St — Municipality: Metcalfe
Province: ONT — Postal Code: K0A2P0
Well Technician's Licence No.: 0327 — Signature of Technician and Contractor: Wayne Renwick — Date Submitted: 20170228

Ministry's Copy

Results of Well Yield Testing

Time	Water Level (m/ft)	Time	Water Level (m/ft)
Static Level	1.54		
1	3.00	15	1.82
2	3.52	20	1.56
3	3.73	25	1.54
4	3.82	30	1.54
5	3.90	35	1.53
10	3.98	40	1.53
15	4.01	45	1.53
20	4.02	50	1.53
25	4.02	55	1.53
30	4.03	60	1.53
40	4.04	90	1.53
50	4.05	90	1.53
60	4.06	120	1.53

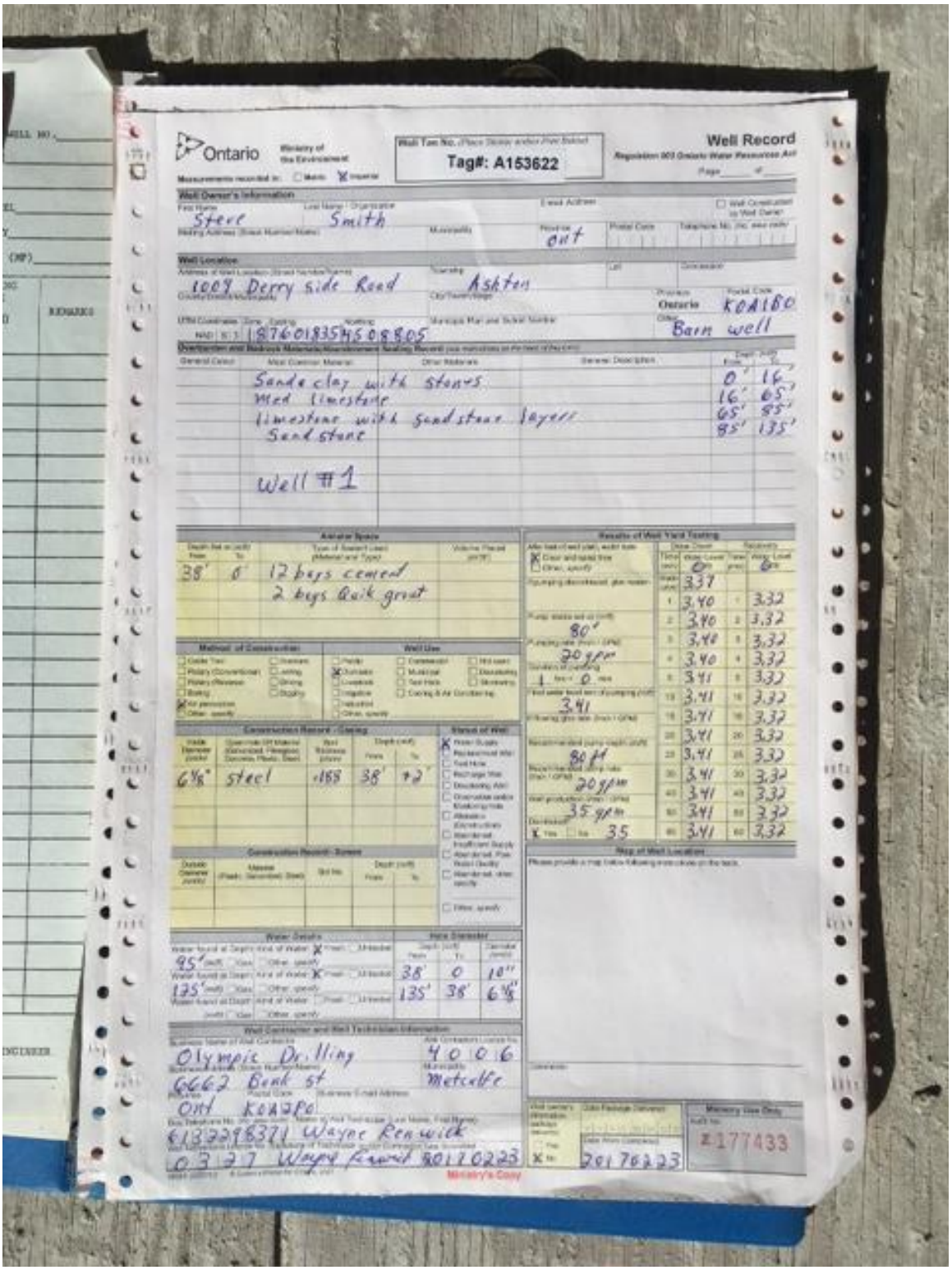
Pumping Rate: 80
Duration of Pumping: 1 hrs + 0 min
Final water level: 4.06
Recommended pump depth: 80'
Recommended pump rate: 20 gpm
Well water level: 75 gpm
Clear: 30

Map of Well Location

Comments

Date Package Delivered
Date Work Completed: 20170228

Ministry Use Only: Z177435



Ontario Ministry of the Environment

Tag#: A153622

Well Record

Regulation 903 Ontario Water Resources Act

Well Owner's Information

First Name: Steve | Last Name / Organization: Smith | Province: Ont

Well Location

Address of Well Location: 1009 Derry side Road | Township: Ashton | Province: Ontario | Postal Code: K0A1B0

UTM Coordinates: 18 760183 5045080 5 | Other: Barn well

Overburden and Bedrock Materials/Abandonment Sealing Record

General Colour	Most Common Material	Other Materials	General Description	Depth From	Depth To
	Sand clay with stones			0'	16'
	Med limestone			16'	65'
	limestone with sandstone layers			65'	85'
	Sandstone			85'	135'

Well #1

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
38'	0'	12 bags cement 2 bags Quik grout	

Method of Construction: Air percussion

Well Use: Domestic

Construction Record - Casing

Inside Diameter	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (inches)	Depth (m/ft) From	To
6 5/8"	steel	.188	38'	+2'

Status of Well: Water Supply

Construction Record - Screen

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

Water Details

Water found at Depth	Kind of Water	Other specify	Hole Diameter Depth From	To	Diameter
95' (ft)	Fresh		38'	0	10"
135' (ft)	Fresh		135'	38'	6 5/8"

Well Contractor and Well Technician Information

Business Name of Well Contractor: Olympic Drilling | Well Contractor's Licence No.: 4006

Address: 6662 Bank st | Municipality: Metcalfe | Province: Ont | Postal Code: K0A2P0

Business Telephone No.: 6132978371 | Name of Well Technician: Last Name, First Name: Wayne Renwick

Well Technician's Licence No.: 0377 | Signature of Technician and Contractor: Wayne Renwick | Date Submitted: 20170223

Ministry's Copy

Results of Well Yield Testing

Clear and sand free

Time (min)	Water Level (m/ft)	Time (min)	Water Level (m/ft)
0	3.37		
1	3.40	1	3.32
2	3.40	2	3.32
3	3.40	3	3.32
4	3.40	4	3.32
5	3.41	5	3.32
10	3.41	10	3.32
15	3.41	15	3.32
20	3.41	20	3.32
25	3.41	25	3.32
30	3.41	30	3.32
40	3.41	40	3.32
50	3.41	50	3.32
60	3.41	60	3.32

Static water level: 80'

Pumping rate: 20 gpm

Duration of pumping: 1 hrs 0 mins

Final water level end of pumping: 341

If flowing give rate:

Recommended pump depth: 80 ft

Recommended pump rate: 20 gpm

Well production: 35 gpm

Disinfected? Yes: X | No: | 35

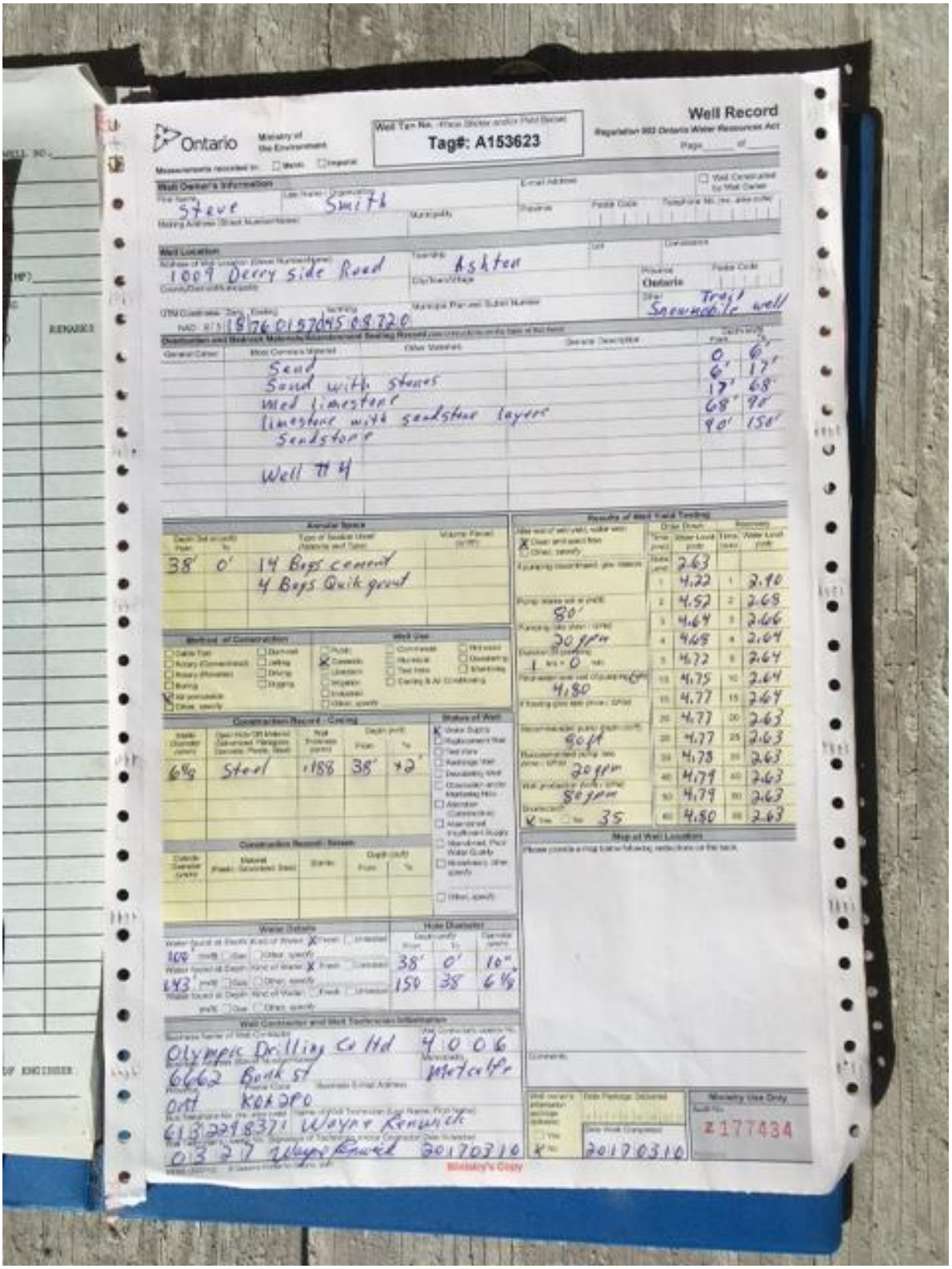
Map of Well Location

Please provide a map below following instructions on the back.

Comments:

Date Package Delivered: Yes: | No: X | Date Work Completed: 20170223

Ministry Use Only: Audit No. #177433



Ontario Ministry of the Environment

Well Record

Tag#: A153623

Well Owner's Information
First Name: Steve
Last Name: Smith

Well Location
1009 Derry side Road
Township: Ashton
Province: Ontario
Site: Trail Snowmobile well
UTM Coordinates: NAD 83 18 76 01 97045 08720

Overburden and Bedrock Materials/Abandonment Sealing Record

General Colour	Most Common Material	Other Materials	General Description	Depth From	Depth To
	Sand			0	6'
	Sand with stones			6'	17'
	Med limestone			17'	68'
	limestone with sandstone layers			68'	90'
	Sandstone			90'	150'

Well # 4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Abandoned Holes)	Volume Placed (cu.m)
38'	0'	14 Bags cement 4 Bags Quik grout	

Method of Construction: Air percussion
Well Use: Domestic
Status of Well: Water Supply

Construction Record - Casing

Inside Diameter	Material	Wall Thickness	Depth From	Depth To
6⅝	Steel	.188	38'	+2'

Construction Record - Screen

Outside Diameter	Material	Slot	Depth From	Depth To

Water Details

Water found at Depth	Kind of Water	Hole Diameter Depth From	Depth To	Diameter
108'	Fresh	38'	0'	10"
643'	Fresh	150	38	6⅛

Results of Well Yield Testing

Time (min)	Water Level (ft)	Time (min)	Water Level (ft)
Static	2.63		
1	4.22	1	2.90
2	4.52	2	2.68
3	4.64	3	2.66
4	4.68	4	2.64
5	4.72	5	2.64
10	4.75	10	2.64
15	4.77	15	2.64
20	4.77	20	2.63
25	4.77	25	2.63
30	4.78	30	2.63
40	4.79	40	2.63
50	4.79	50	2.63
60	4.80	60	2.63

Pump set at: 80'
Pumping rate: 30 gpm
Duration of pumping: 1 hrs + 0 min
Final water level: 4.80
If flowing give rate: GPM
Recommended pump depth: 80 ft
Recommended pump rate: 20 gpm
Well production: 80 gpm
Disinfected: Yes — 35

Map of Well Location
Please provide a map below following instructions on the back.

Comments:

Well Contractor and Well Technician Information
Business Name of Well Contractor: Olympic Drilling Co Ltd
Well Contractor's Licence No.: 4006
Business Address: 6662 Bank St
Municipality: Metcalfe
Province: Ont
Postal Code: K0A 2P0
Business E-mail Address:
Name of Well Technician: Wayne Renwick
Date Package Delivered: 20170310
Date Work Completed: 20170310

Ministry Use Only
Audit No: Z177434

Ministry's Copy

Appendix C:
Pump Test Data

OTT-00236288-A0
Pumping Test on Well 1 - Off Site Well (Southeast)
Pump Testing conducted on April 4, 2017

Flow Rate	**75.7 L/min**
Pump Depth	**18.29 m**

Pumping Test		
Running Time (min)	Water Levels (m)	Drawdown (m)
0	3.37	0
1	3.40	0.03
2	3.40	0.03
3	3.40	0.03
4	3.40	0.03
5	3.41	0.04
6	3.41	0.04
8	3.41	0.04
10	3.41	0.04
15	3.41	0.04
20	3.41	0.04
25	3.41	0.04
30	3.41	0.04
40	3.41	0.04
50	3.41	0.04
60	3.41	0.04
75	3.41	0.04
90	3.41	0.04
105	3.41	0.04
120	3.41	0.04
150	3.40	0.03
180	3.40	0.03
210	3.40	0.03
240	3.40	0.03
270	3.39	0.02
300	3.38	0.01
330	3.37	0
360	3.37	0

Recovery Test			
Recovery Time (min)	Running Time (min)	Water Levels (m)	Residual Drawdown (m)
0	360	3.37	0.00
0.5	360.5	3.32	-0.05
1	361	3.32	-0.05
2	362	3.32	-0.05
5	365	3.32	-0.05

Time	**Parameters**		
	Free Chlorine	Total Chlorine	Turbidity (NTU)
10	0 - 0.5		28.5
30			6.24
330	0		3.40

Monitoring Well Data

Time (min)	House Well	Well 2	Well 3	Well 4	Piezometer
Pumping Test					
0	2.40	1.72	0.64	2.50	2.70
120	2.38	1.70	0.63	2.50	2.10
180					2.51
240					2.52
330	2.34	1.67	0.59	2.45	2.50

OTT-00236288-A0
Pumping Test on Well 2
Pump Testing conducted on April 6, 2017

Flow Rate	**75.7 L/min**
Pump Depth	**18.29 m**

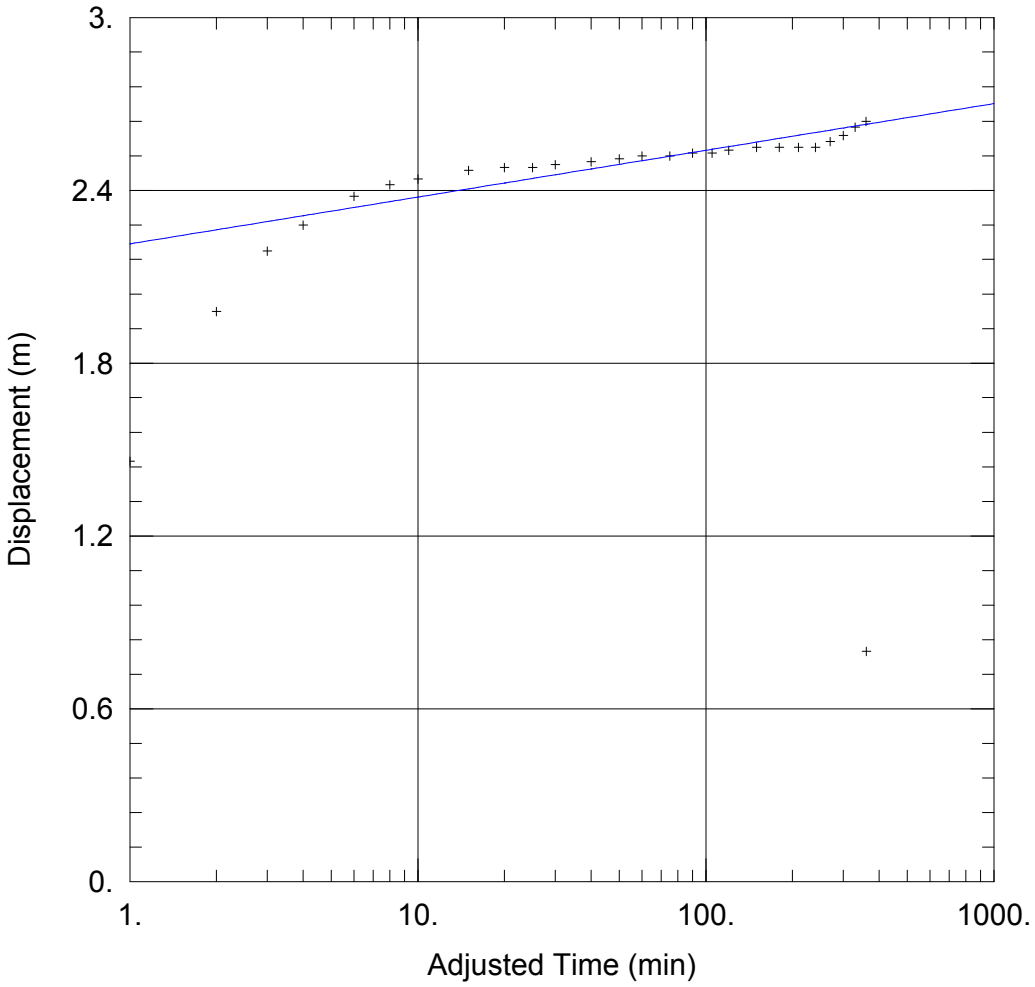
Pumping Test		
Running Time (min)	Water Levels (m)	Drawdown (m)
0	1.54	0
1	3.00	1.46
2	3.52	1.98
3	3.73	2.19
4	3.82	2.28
6	3.92	2.38
8	3.96	2.42
10	3.98	2.44
15	4.01	2.47
20	4.02	2.48
25	4.02	2.48
30	4.03	2.49
40	4.04	2.5
50	4.05	2.51
60	4.06	2.52
75	4.06	2.52
90	4.07	2.53
105	4.07	2.53
120	4.08	2.54
150	4.09	2.55
180	4.09	2.55
210	4.09	2.55
240	4.09	2.55
270	4.11	2.57
300	4.13	2.59
330	4.16	2.62
360	4.18	2.64

Recovery Test			
Recovery Time (min)	Running Time (min)	Water Levels (m)	Residual Drawdown (m)
0	360	4.18	2.64
0.5	360.5	2.34	0.80
1	361	1.82	0.28
1.5	361.5	1.60	0.06
2	362	1.56	0.02
3	363	1.54	0.00
4	364	1.54	0.00
5	365	1.53	-0.01

Time	**Parameters**		
	Free Chlorine	Total Chlorine	Turbidity (NTU)
15	0 - 0.5		20.2
120			2.22
330	0		1.10

Monitoring Well Data

Time (min)	House Well	Well 1	Well 3	Well 4	Piezometer
Pumping Test					
0		3.20	0.46	2.31	0.95
50			0.46		0.94
90		3.18	0.46	2.32	0.94
120	3.70				
240	2.17	3.16	0.45	2.29	
330					0.95



WELL TEST ANALYSIS

Data Set: P:\...\Well 2.aqt
Date: 04/21/17 Time: 11:05:05

PROJECT INFORMATION

Company: exp Services Inc.
Client: Steve Smith
Project: OTT-00236288-A0
Location: 1009 Derry Side Road
Test Well: Well 2
Test Date: April 4, 2017

AQUIFER DATA

Saturated Thickness: 61. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Well 2	0	0

Observation Wells

Well Name	X (m)	Y (m)
+ Well 2	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 123.1 m^2/day S = 7.556E-13

OTT-00236288-A0
Pumping Test on Well 3
Pump Testing conducted on April 5, 2017

Flow Rate	**75.7 L/min**
Pump Depth	**18.29 m**

Pumping Test

Running Time (min)	Water Levels (m)	Drawdown (m)
0	0.46	0
1	0.79	0.33
2	0.80	0.34
3	0.81	0.35
4	0.81	0.35
6	0.81	0.35
8	0.81	0.35
10	0.81	0.35
15	0.81	0.35
20	0.81	0.35
25	0.81	0.35
30	0.81	0.35
40	0.81	0.35
50	0.82	0.36
60	0.82	0.36
75	0.83	0.37
90	0.83	0.37
105	0.83	0.37
180	0.84	0.38
210	0.84	0.38
240	0.84	0.38
270	0.84	0.38
300	0.84	0.38

Recovery Test

Recovery Time (min)	Running Time (min)	Water Levels (m)	Residual Drawdown (m)
0	360	0.84	0.38
0.25	360.25	0.52	0.06
0.5	360.5	0.51	0.05
0.75	360.75	0.51	0.05
1	361	0.51	0.05
2	362	0.51	0.05
3	363	0.50	0.04
4	364	0.50	0.04
6	366	0.50	0.04
8	368	0.50	0.04
10	370	0.49	0.03
25	385	0.48	0.02

Time	**Parameters**		
	Free Chlorine	Total Chlorine	Turbidity (NTU)
4	0 - 0.5		13.0
240	0		2.83

Monitoring Well Data

Time (min)	House Well	Well 1	Well 2	Well 4	Piezometer
Pumping Test					
0	2.20	3.18	1.54	2.31	0.82
40					0.78
60	2.21	3.20	1.55	2.33	0.77
75					0.78
180					0.77
240	2.22	3.22	1.56	2.34	0.77
280	2.21	3.21	1.56	2.33	0.78
320					0.78

OTT-00236288-A0
Pumping Test on Well 4 - off-site well
Pump Testing conducted on April 3, 2017

Flow Rate	**75.7 L/min**
Pump Depth	**18.29 m**

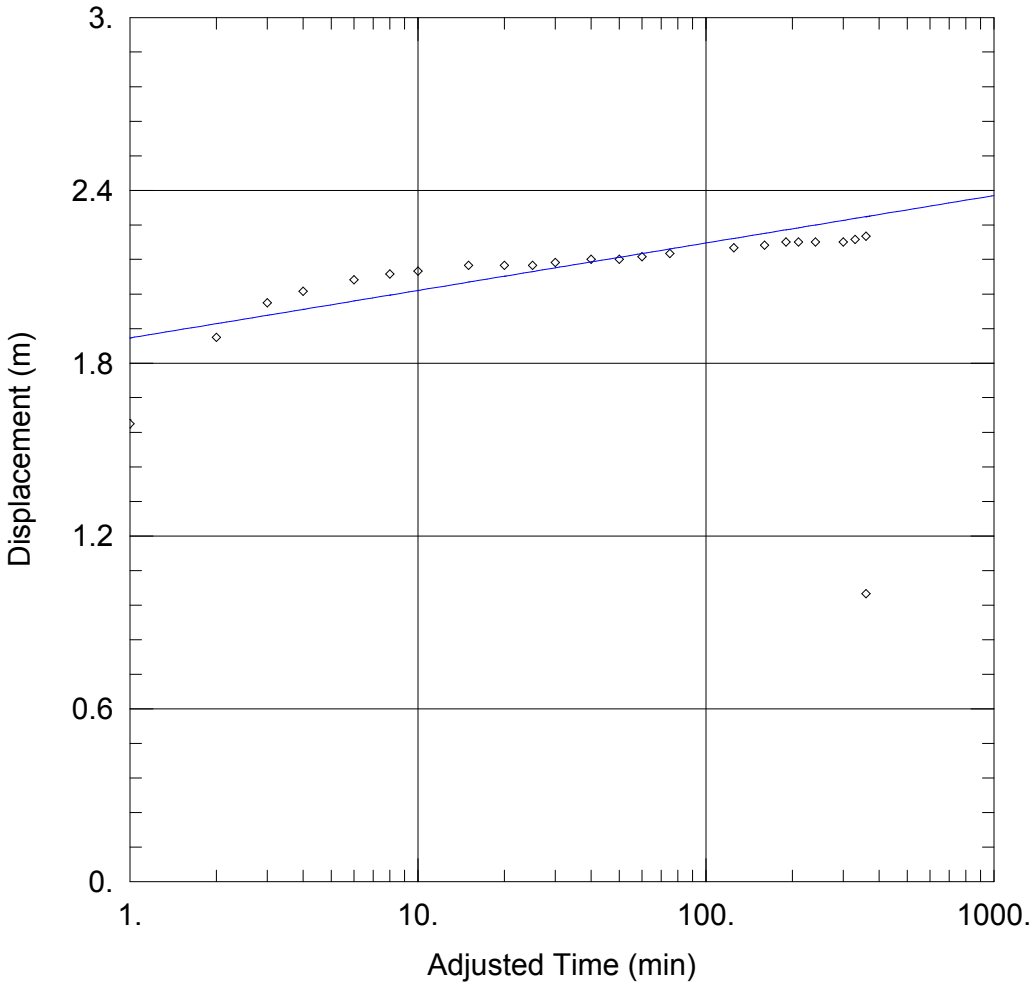
Pumping Test		
Running Time (min)	Water Levels (m)	Drawdown (m)
0	2.63	0
1	4.22	1.59
2	4.52	1.89
3	4.64	2.01
4	4.68	2.05
6	4.72	2.09
8	4.74	2.11
10	4.75	2.12
15	4.77	2.14
20	4.77	2.14
25	4.77	2.14
30	4.78	2.15
40	4.79	2.16
50	4.79	2.16
60	4.80	2.17
75	4.81	2.18
125	4.83	2.2
160	4.84	2.21
190	4.85	2.22
210	4.85	2.22
240	4.85	2.22
300	4.85	2.22
330	4.86	2.23
360	4.87	2.24

Recovery Test			
Recovery Time (min)	Running Time (min)	Water Levels (m)	Residual Drawdown (m)
0	360	4.87	2.24
0.3	360.3	3.63	1.00
0.7	360.7	3.19	0.56
1	361	2.90	0.27
1.5	361.5	2.72	0.09
2	362	2.68	0.05
3	363	2.66	0.03
4	364	2.64	0.01
5	365	2.64	0.01
7.5	367.5	2.64	0.01
10	370	2.64	0.01

Time	**Parameters**		
	Free Chlorine	Total Chlorine	Turbidity (NTU)
8	0 - 0.5		6.34
75			2.35
360			

Monitoring Well Data

Time (min)	House Well	Well 1	Well 2	Well 3	Piezometer
Pumping Test					
0	3.00	3.48	1.82	0.75	n/a
70	2.55				
80		3.51	1.83	0.76	
180		3.52	1.83	0.76	
330	2.55	3.51	1.83	0.76	



WELL TEST ANALYSIS

Data Set: P:\...\Well 4.aqt
Date: 04/21/17 Time: 11:01:40

PROJECT INFORMATION

Company: exp Services Inc.
Client: Steve Smith
Project: OTT-00236288-A0
Location: 1009 Derry Side Road
Test Well: Well 4
Test Date: April 3, 2017

AQUIFER DATA

Saturated Thickness: 61. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Well 4	0	0

Observation Wells

Well Name	X (m)	Y (m)
◇ Well 4	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 121.2 m^2/day S = 1.138E-10

Appendix D:
Groundwater Chemistry

Table #1 (OTT-00236288-A0)
Groundwater Analytical Results - Derry Side Road
General Water Chemistry

					Well 1			**Well 2**		**Well 3**			**Well 4**			**Neighbouring Residential Wells**			
PARAMETER	**UNITS**	**Type of Criteria**	**ODWS Criteria**	**D-5-5 Treatability**	**0.5hr**	**5.5 hr**	**5 hr**	**0.5hr**	**5.5 hr**	**0.5 hr**	**1.5 hr**	**4 hr**	**0.5**	**5.5**	**client sample**	**1056 Richmond**	**1088 Derry Side**	**Well #3**	**Barn Well client sample**
Well Description																South	East	West / North	southeast
Date					**04-Apr-17**	**04-Apr-17**	**19-Apr-17**	**06-Apr-17**	**06-Apr-17**	**04-Apr-17**	**04-Apr-17**	**18-Apr-17**	**03-Apr-17**	**03-Apr-17**	**31-Jul-20**	**10-Apr-17**	**04-Apr-17**	**May 8/17**	**31-Jul-20**
Total Coliform	ct/100ml	MAC	1 ; 5[7]	-	0.00	0.00		0	0	1.00	**1.00**	0	0.00	0.00	0.00	0	0	0	0
E. Coli	ct/100ml	MAC	1	-	0.00	0.00		0	0	0.00	0.00	0	0.00	0.00	0.00	0	0	0	0
Background	ct/1ml	MAC	200	-	2.00	6.00		0	1	2.00	2.00		0.00	0.00	0.00	0	0	0	0
Alkalinity as $CaCO_3$	mg/L	OG	30 to 500	-	281.00	304.00		286.000	280.000	261.00	268.00		305.00	285.00		251	269	247	
Chloride	mg/L	OG	250	250	10.90	10.10		16.500	16.800	12.20	12.10		8.20	8.00		8	12	15	
Colour	TCU	AO	5	7	3.00	**7.00**	<2	<2	<2	**7.00**	**7.00**		**11.00**	**12.00**	**<2**	<2	5	5	<2
Conductivity	umho/cm	n/v	n/v	-	576.00	579.00		583.000	574.000	539.00	533.00		611.00	597.00		549	571	549	
Dissolved Organic Carbon	mg/L	AO	5.0	10	2.30	2.30		2.000	2.200	1.40	1.40		2.30	2.60		1.6	1.5	1.3	
Fluoride[8]	mg/L	MAC	1.5 - 2.4	-	<0.1	0.20		0.400	0.400	0.30	0.30		<0.1	<0.1		0.1	0.2	0.6	
Hydrogen Sulphide	mg/L	AO	0.05	-	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		0.20	0.02	<0.01	
N-NH_3 (Ammonia)	mg/L	n/v	n/v	-	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		0.03	<0.001	0.04	
N-NO_2 (Nitrite)	mg/L	MAC	1.0	-	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1		0.30	0.30	<0.1	<0.1	<0.1	<0.1	<0.1
N-NO_3 (Nitrate)	mg/L	MAC	10.0	-	2.90	3.00		0.200	0.200	0.10	0.30		3.80	4.30	<0.1	<0.1	<0.1	<0.1	1.5
pH	$-\log_{10}[H+]$	AO	6.5-8.5	-	7.98	8.00		7.970	7.980	7.99	8.00		8.05	8.07		8.05	8.00	8.00	
Phenols	mg/L	n/v	n/v	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001		<0.001	<0.001		<0.001	<0.001	<0.001	
Sulphate	mg/L	AO	500	500	25.00	25.00		33.000	34.000	31.00	31.00		25.00	24.00		31	31	35	
Tannin & Lignin	mg/L	n/v	n/v	-	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.5
Organic Nitrogen	mg/L	AO	0.15		0.14	**0.18**	0.1	**0.200**	0.130	**0.46**	0.09		**0.22**	0.05	<0.1	0.12	**0.23**	**0.17**	<0.1
Total Dissolved Solids	mg/L	AO	500	-	346.00	356.00		356.000	350.000	324.00	330.00		346.00	335.00		297	323	317	
Total Kjeldahl Nitrogen	mg/L	n/v	n/v	-	0.14	0.19		0.200	0.130	0.46	0.09		0.22	0.05		0.15	0.23	0.17	
Turbidity	NTU	AO/OG	5	5	**5.90**	**3.20**		**6.200**	2.000	**5.20**	4.50		2.10	0.40		0.2	1.3	**9.8**	
Hardness as $CaCO_3$	mg/L	OG	100	500[9]	**359.00**	**353.00**		**355.000**	**346.000**	**330.00**	**335.00**		**313.00**	**314.00**		**296**	**319**	**301**	
Calcium	mg/L	n/v	n/v	-	86.40	84.60		86.600	84.000	81.00	82.30		74.30	75.00		69.8	77.2	75.0	
Magnesium	mg/L	n/v	n/v	-	34.90	34.20		33.600	33.200	31.10	31.50		30.80	30.80		29.6	30.7	27.6	
Potassium	mg/L	n/v	n/v	-	1.90	1.90		2.800	2.900	2.70	2.80		1.70	1.60		2.4	2.7	2.6	
Sodium	mg/L	AO	20[6] ; 200	200	5.40	5.00		10.400	10.500	8.50	7.90		4.10	4.00		5.7	7.8	12.7	
Iron	mg/L	AO	0.30	5	**0.36**	0.07		**0.427**	0.172	**0.43**	0.29		0.07	0.01		0.005	0.207	**0.803**	
Manganese	mg/L	AO	0.05	1	0.01	0.00		0.018	0.014	0.02	0.01		0.002	<0.001		**0.256**	0.008	0.025	

Notes : AO= aesthetic objective, OG = operational guideline, MAC = maximum allowable concentration

1. Ontario Drinking Water Standards - 2004 is used as the health related criteria
2. **Bold** - concentration exceeds appropriate ODWS criteria

shade - exceeds D-5-5 criteria

3. OG (operational guideline) criteria are for treated drinking water systems .
4. n/a - not analysed
5. N/v - no value
6. Sodium value is a health related criteria for people with low salt diets.
7. D-5-5 criteria for raw water
8. Where supplies contain naturally occurring fluoride at levels higher than 1.5 mg/L but less than 2.4 mg/L, the Ministry of Health and Long-Term Care recommends an approach through local boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources.
9. Under D-5-5, hardness is accepted at values below 500 mg/L.

* - Field readings collected.at end of test

Note:July 21, 2020 samples collected by client

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88397 **REPORT No. B17-08177**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 04-Apr-17
DATE REPORTED: 12-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well 4 - Initial	Well 4 - Final	ODWS	
			Sample I.D.:		B17-08177-1	B17-08177-2	Objective	Type of Objective
			Date Collected:		03-Apr-17	03-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	10-Apr-17/O	**312**	**314**	80-100	OG
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	04-Apr-17/O	305	285	30-500	OG
Conductivity @25°C	µmho/cm	1	SM 2510B	04-Apr-17/O	611	597		
pH @25°C	pH Units		SM 4500H	04-Apr-17/O	8.05	8.07	6.5-8.5	OG
Colour	TCU	2	SM 2120C	05-Apr-17/O	**11**	**12**	5	AO
Turbidity	NTU	0.1	SM 2130	05-Apr-17/O	**2.1**	0.4	5,1.0	AO,MAC
Fluoride	mg/L	0.1	SM4110C	04-Apr-17/O	< 0.1	< 0.1	1.5	MAC
Chloride	mg/L	0.5	SM4110C	04-Apr-17/O	8.2	8.0	250	AO
Nitrite (N)	mg/L	0.1	SM4110C	04-Apr-17/O	0.3	0.3	1	MAC
Nitrate (N)	mg/L	0.1	SM4110C	04-Apr-17/O	3.8	4.3	10	MAC
Sulphate	mg/L	1	SM4110C	04-Apr-17/O	25	24	500	AO
Calcium	mg/L	0.02	SM 3120	10-Apr-17/O	74.3	75.0		
Magnesium	mg/L	0.01	SM 3120	10-Apr-17/O	30.8	30.8		
Sodium	mg/L	0.2	SM 3120	10-Apr-17/O	4.1	4.0	200,20	AO,MAC
Potassium	mg/L	0.1	SM 3120	10-Apr-17/O	1.7	1.6		
Copper	mg/L	0.002	SM 3120	10-Apr-17/O	< 0.002	< 0.002	1	AO
Iron	mg/L	0.005	SM 3120	10-Apr-17/O	0.066	0.006	0.3	AO
Manganese	mg/L	0.001	SM 3120	10-Apr-17/O	0.002	< 0.001	0.05	AO
Silica	mg/L	0.02	SM 3120	12-Apr-17/O	9.48	9.42		
Zinc	mg/L	0.005	SM 3120	10-Apr-17/O	< 0.005	< 0.005	5	AO
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	05-Apr-17/O	< 0.01	< 0.01		
Total Kjeldahl Nitrogen	mg/L	0.05	MOEE 3367	06-Apr-17/O	0.22	0.05		
Organic Nitrogen	mg/L	0.05	MOEE 3367	07-Apr-17/O	**0.22**	0.05	0.15	OG
Dissolved Organic Carbon	mg/L	0.2	EPA 415.1	06-Apr-17/O	2.3	2.6	5	AO
Phenolics	mg/L	0.001	MOEE 3179	07-Apr-17/O	< 0.001	< 0.001		
Tannins and Lignins	mg/L	0.1	SM5550B	07-Apr-17	< 0.1 [1]	< 0.1 [1]		
Sulphide	mg/L	0.01	SM4500-S2	06-Apr-17/K	< 0.01	< 0.01	0.05	AO
Total Coliform	cfu/100mL	1	MOE E3407	04-Apr-17/O	0	0	0	MAC

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88397 **REPORT No. B17-08177**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 04-Apr-17
DATE REPORTED: 12-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well 4 - Initial	Well 4 - Final	ODWS	
			Sample I.D.:		B17-08177-1	B17-08177-2	Objective	Type of Objective
			Date Collected:		03-Apr-17	03-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
E coli	cfu/100mL	1	MOE E3407	04-Apr-17/O	0	0	0	MAC
Background	cfu/100mL	1	MOE E3407	04-Apr-17/O	0	0		
Anion Sum	meq/L		Calc.	10-Apr-17/O	7.15	6.76		
Cation Sum	meq/L		Calc.	10-Apr-17/O	6.47	6.50		
% Difference	%		Calc.	10-Apr-17/O	5.01	2.02		
Ion Ratio	AS/CS		Calc.	10-Apr-17/O	1.11	1.04		
Sodium Adsorption Ratio	-		Calc.	10-Apr-17/O	0.101	0.0981		
TDS(ion sum calc.)	mg/L		Calc.	10-Apr-17/O	346	335	500	AO
Conductivity (calc.)	µmho/cm		Calc.	10-Apr-17/O	616	604		
TDS(calc.)/EC(actual)	-		Calc.	10-Apr-17/O	0.565	0.561		
EC(calc.)/EC(actual)	-		Calc.	10-Apr-17/O	1.01	1.01		
Langelier Index(25°C)	S.I.		Calc.	10-Apr-17/O	0.953	0.948		

1 . Subcontracted to Paracel Labs

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G63499 **REPORT No. B17-08407**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 05-Apr-17
DATE REPORTED: 12-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.		Well 1 - Initial	Well 1 - Final		
			Sample I.D.		B17-08407-1	B17-08407-2		
			Date Collected		04-Apr-17	04-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Apr-17/O	359	352		
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	05-Apr-17/O	281	304		
Conductivity @25°C	µmho/cm	1	SM 2510B	05-Apr-17/O	576	579		
pH @25°C	pH Units		SM 4500H	05-Apr-17/O	7.98	8.00		
Colour	TCU	2	SM 2120C	07-Apr-17/O	3	7		
Turbidity	NTU	0.1	SM 2130	07-Apr-17/O	5.9	3.2		
Fluoride	mg/L	0.1	SM4110C	05-Apr-17/O	< 0.1	0.2		
Chloride	mg/L	0.5	SM4110C	05-Apr-17/O	10.9	10.1		
Nitrite (N)	mg/L	0.1	SM4110C	05-Apr-17/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	05-Apr-17/O	2.9	3.0		
Sulphate	mg/L	1	SM4110C	05-Apr-17/O	25	25		
Calcium	mg/L	0.02	SM 3120	11-Apr-17/O	86.4	84.6		
Magnesium	mg/L	0.01	SM 3120	11-Apr-17/O	34.9	34.2		
Sodium	mg/L	0.2	SM 3120	11-Apr-17/O	5.4	5.0		
Potassium	mg/L	0.1	SM 3120	11-Apr-17/O	1.9	1.9		
Copper	mg/L	0.002	SM 3120	11-Apr-17/O	< 0.002	< 0.002		
Iron	mg/L	0.005	SM 3120	11-Apr-17/O	0.362	0.065		
Manganese	mg/L	0.001	SM 3120	11-Apr-17/O	0.005	0.001		
Silica	mg/L	0.02	SM 3120	11-Apr-17/O	9.69	9.50		
Zinc	mg/L	0.005	SM 3120	11-Apr-17/O	< 0.005	< 0.005		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	10-Apr-17/O	< 0.01	< 0.01		
Total Kjeldahl Nitrogen	mg/L	0.05	MOEE 3367	10-Apr-17/O	0.14	0.18		
Organic Nitrogen	mg/L	0.05	MOEE 3367	11-Apr-17/O	0.14	0.18		
Dissolved Organic Carbon	mg/L	0.2	EPA 415.1	06-Apr-17/O	2.3	2.3		
Sulphide	mg/L	0.01	SM4500-S2	06-Apr-17/K	< 0.01	< 0.01		
Phenolics	mg/L	0.001	MOEE 3179	07-Apr-17/O	< 0.001	< 0.001		
Tannins and Lignins	mg/L	0.1	SM5550B	07-Apr-17	< 0.1 [1]	< 0.1 [1]		

Gord Murphy
Lab Supervisor

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G63499 **REPORT No. B17-08407**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

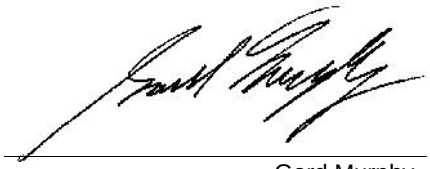
Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 05-Apr-17
DATE REPORTED: 12-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.		Well 1 - Initial	Well 1 - Final		
			Sample I.D.		B17-08407-1	B17-08407-2		
			Date Collected		04-Apr-17	04-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Total Coliform	cfu/100mL	1	MOE E3407	05-Apr-17/O	0	0		
E coli	cfu/100mL	1	MOE E3407	05-Apr-17/O	0	0		
Background	cfu/100mL	1	MOE E3407	05-Apr-17/O	2	6		
Anion Sum	meq/L		Calc.	12-Apr-17/O	6.65	7.09		
Cation Sum	meq/L		Calc.	12-Apr-17/O	7.49	7.30		
% Difference	%		Calc.	12-Apr-17/O	5.92	1.48		
Ion Ratio	AS/CS		Calc.	12-Apr-17/O	0.888	0.971		
Sodium Adsorption Ratio	-		Calc.	12-Apr-17/O	0.124	0.116		
TDS(ion sum calc.)	mg/L		Calc.	12-Apr-17/O	346	356		
Conductivity (calc.)	µmho/cm		Calc.	12-Apr-17/O	645	653		
TDS(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	0.601	0.615		
EC(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	1.12	1.13		
Langelier Index(25°C)	S.I.		Calc.	12-Apr-17/O	0.913	0.957		

1 . Subcontracted to Paracel Labs



Gord Murphy
Lab Supervisor

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 08561 **REPORT No. B17-08561**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 06-Apr-17
DATE REPORTED: 13-Apr-17
SAMPLE MATRIX: Drinking Water

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well 3 - Initial	Well 3 - Final	ODWS	
			Sample I.D.:		B17-08561-1	B17-08561-2	Objective	Type of Objective
			Date Collected:		04-Apr-17	04-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Apr-17/O	**330**	**335**	80-100	OG
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	06-Apr-17/O	261	268	30-500	OG
Conductivity @25°C	µmho/cm	1	SM 2510B	06-Apr-17/O	539	533		
pH @25°C	pH Units		SM 4500H	06-Apr-17/O	7.99	8.00	6.5-8.5	OG
Colour	TCU	2	SM 2120C	07-Apr-17/O	**7**	**7**	5	AO
Turbidity	NTU	0.1	SM 2130	07-Apr-17/O	**5.2**	**4.5**	5,1.0	AO,MAC
Fluoride	mg/L	0.1	SM4110C	06-Apr-17/O	0.3	0.3	1.5	MAC
Chloride	mg/L	0.5	SM4110C	06-Apr-17/O	12.2	12.1	250	AO
Nitrite (N)	mg/L	0.1	SM4110C	06-Apr-17/O	< 0.1	< 0.1	1	MAC
Nitrate (N)	mg/L	0.1	SM4110C	06-Apr-17/O	0.1	0.3	10	MAC
Sulphate	mg/L	1	SM4110C	06-Apr-17/O	31	31	500	AO
Calcium	mg/L	0.02	SM 3120	11-Apr-17/O	81.0	82.3		
Magnesium	mg/L	0.01	SM 3120	11-Apr-17/O	31.1	31.5		
Sodium	mg/L	0.2	SM 3120	11-Apr-17/O	8.5	7.9	200,20	AO,MAC
Potassium	mg/L	0.1	SM 3120	11-Apr-17/O	2.7	2.8		
Copper	mg/L	0.002	SM 3120	11-Apr-17/O	< 0.002	< 0.002	1	AO
Iron	mg/L	0.005	SM 3120	11-Apr-17/O	**0.433**	0.290	0.3	AO
Manganese	mg/L	0.001	SM 3120	11-Apr-17/O	0.016	0.013	0.05	AO
Silica	mg/L	0.02	SM 3120	11-Apr-17/O	9.67	9.61		
Zinc	mg/L	0.005	SM 3120	11-Apr-17/O	< 0.005	< 0.005	5	AO
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	11-Apr-17/O	< 0.01	< 0.01		
Total Kjeldahl Nitrogen	mg/L	0.05	MOEE 3367	11-Apr-17/O	0.46	0.09		
Organic Nitrogen	mg/L	0.05	MOEE 3367	12-Apr-17/O	**0.46**	0.09	0.15	OG
Dissolved Organic Carbon	mg/L	0.2	EPA 415.1	10-Apr-17/O	1.4	1.4	5	AO
Sulphide	mg/L	0.01	SM4500-S2	06-Apr-17/K	< 0.01	< 0.01	0.05	AO
Phenolics	mg/L	0.001	MOEE 3179	07-Apr-17/O	< 0.001	< 0.001		
Tannins and Lignins	mg/L	0.1	SM5550B	07-Apr-17	< 0.1 [1]	< 0.1 [1]		
Total Coliform	cfu/100mL	1	MOE E3407	06-Apr-17/O	**1**	**1**	0	MAC

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 08561 **REPORT No. B17-08561**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 06-Apr-17
DATE REPORTED: 13-Apr-17
SAMPLE MATRIX: Drinking Water

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well 3 - Initial	Well 3 - Final	ODWS	
			Sample I.D.:		B17-08561-1	B17-08561-2	Objective	Type of Objective
			Date Collected:		04-Apr-17	04-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
E coli	cfu/100mL	1	MOE E3407	06-Apr-17/O	0	0	0	MAC
Background	cfu/100mL	1	MOE E3407	06-Apr-17/O	2	2		
Anion Sum	meq/L		Calc.	12-Apr-17/O	6.22	6.38		
Cation Sum	meq/L		Calc.	12-Apr-17/O	7.06	7.13		
% Difference	%		Calc.	12-Apr-17/O	6.37	5.58		
Ion Ratio	AS/CS		Calc.	12-Apr-17/O	0.880	0.894		
Sodium Adsorption Ratio	-		Calc.	12-Apr-17/O	0.203	0.189		
TDS(ion sum calc.)	mg/L		Calc.	12-Apr-17/O	324	330	500	AO
Conductivity (calc.)	µmho/cm		Calc.	12-Apr-17/O	608	618		
TDS(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	0.601	0.619		
EC(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	1.13	1.16		
Langelier Index(25°C)	S.I.		Calc.	12-Apr-17/O	0.872	0.902		

1 . Subcontracted to Paracel Labs

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 08561 **REPORT No. B17-08561**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 06-Apr-17
DATE REPORTED: 13-Apr-17
SAMPLE MATRIX: Drinking Water

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well - 1088 Derry	Well - 1283 Derry	ODWS	
			Sample I.D.:		B17-08561-3	B17-08561-4	Objective	Type of Objective
			Date Collected:		04-Apr-17	04-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Apr-17/O	**319**	**301**	80-100	OG
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	06-Apr-17/O	269	247	30-500	OG
Conductivity @25°C	µmho/cm	1	SM 2510B	06-Apr-17/O	571	549		
pH @25°C	pH Units		SM 4500H	06-Apr-17/O	8.00	8.00	6.5-8.5	OG
Colour	TCU	2	SM 2120C	07-Apr-17/O	5	5	5	AO
Turbidity	NTU	0.1	SM 2130	07-Apr-17/O	**1.3**	**9.8**	5,1.0	AO,MAC
Fluoride	mg/L	0.1	SM4110C	06-Apr-17/O	0.2	0.6	1.5	MAC
Chloride	mg/L	0.5	SM4110C	06-Apr-17/O	11.5	15.2	250	AO
Nitrite (N)	mg/L	0.1	SM4110C	06-Apr-17/O	< 0.1	< 0.1	1	MAC
Nitrate (N)	mg/L	0.1	SM4110C	06-Apr-17/O	< 0.1	< 0.1	10	MAC
Sulphate	mg/L	1	SM4110C	06-Apr-17/O	31	35	500	AO
Calcium	mg/L	0.02	SM 3120	11-Apr-17/O	77.2	75.0		
Magnesium	mg/L	0.01	SM 3120	11-Apr-17/O	30.7	27.6		
Sodium	mg/L	0.2	SM 3120	11-Apr-17/O	7.8	12.7	200,20	AO,MAC
Potassium	mg/L	0.1	SM 3120	11-Apr-17/O	2.7	2.6		
Copper	mg/L	0.002	SM 3120	11-Apr-17/O	0.007	0.003	1	AO
Iron	mg/L	0.005	SM 3120	11-Apr-17/O	0.027	**0.803**	0.3	AO
Manganese	mg/L	0.001	SM 3120	11-Apr-17/O	0.008	0.025	0.05	AO
Silica	mg/L	0.02	SM 3120	11-Apr-17/O	9.89	8.71		
Zinc	mg/L	0.005	SM 3120	11-Apr-17/O	0.013	0.011	5	AO
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	11-Apr-17/O	< 0.01	0.04		
Total Kjeldahl Nitrogen	mg/L	0.05	MOEE 3367	11-Apr-17/O	0.23	0.17		
Organic Nitrogen	mg/L	0.05	MOEE 3367	12-Apr-17/O	**0.23**	0.13	0.15	OG
Dissolved Organic Carbon	mg/L	0.2	EPA 415.1	10-Apr-17/O	1.5	1.3	5	AO
Sulphide	mg/L	0.01	SM4500-S2	06-Apr-17/K	0.02	< 0.01	0.05	AO
Phenolics	mg/L	0.001	MOEE 3179	07-Apr-17/O	< 0.001	< 0.001		
Tannins and Lignins	mg/L	0.1	SM5550B	07-Apr-17	< 0.1 [1]	< 0.1 [1]		

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 08561 **REPORT No. B17-08561**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 06-Apr-17
DATE REPORTED: 13-Apr-17
SAMPLE MATRIX: Drinking Water

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well - 1088 Derry	Well - 1283 Derry	ODWS	
			Sample I.D.:		B17-08561-3	B17-08561-4	Objective	Type of Objective
			Date Collected:		04-Apr-17	04-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Total Coliform	cfu/100mL	1	MOE E3407	06-Apr-17/O	0	0	0	MAC
E coli	cfu/100mL	1	MOE E3407	06-Apr-17/O	0	0	0	MAC
Background	cfu/100mL	1	MOE E3407	06-Apr-17/O	0	0		
Anion Sum	meq/L		Calc.	12-Apr-17/O	6.35	6.11		
Cation Sum	meq/L		Calc.	12-Apr-17/O	6.79	6.68		
% Difference	%		Calc.	12-Apr-17/O	3.31	4.42		
Ion Ratio	AS/CS		Calc.	12-Apr-17/O	0.936	0.915		
Sodium Adsorption Ratio	-		Calc.	12-Apr-17/O	0.190	0.319		
TDS(ion sum calc.)	mg/L		Calc.	12-Apr-17/O	323	317	500	AO
Conductivity (calc.)	µmho/cm		Calc.	12-Apr-17/O	601	589		
TDS(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	0.565	0.578		
EC(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	1.05	1.07		
Langelier Index(25°C)	S.I.		Calc.	12-Apr-17/O	0.874	0.825		

1 . Subcontracted to Paracel Labs

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88420 **REPORT No. B17-08677**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 07-Apr-17
DATE REPORTED: 12-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well 2 - Initial	Well 2 - Final	ODWS	
			Sample I.D.:		B17-08677-1	B17-08677-2	Objective	Type of Objective
			Date Collected:		06-Apr-17	06-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	11-Apr-17/O	**355**	**346**	80-100	OG
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	10-Apr-17/O	286	280	30-500	OG
Conductivity @25°C	µmho/cm	1	SM 2510B	07-Apr-17/O	583	574		
pH @25°C	pH Units		SM 4500H	07-Apr-17/O	7.97	7.98	6.5-8.5	OG
Colour	TCU	2	SM 2120C	11-Apr-17/O	< 2	< 2	5	AO
Turbidity	NTU	0.1	SM 2130	11-Apr-17/O	**6.2**	**2.0**	5,1.0	AO,MAC
Fluoride	mg/L	0.1	SM4110C	07-Apr-17/O	0.4	0.4	1.5	MAC
Chloride	mg/L	0.5	SM4110C	07-Apr-17/O	16.5	16.8	250	AO
Nitrite (N)	mg/L	0.1	SM4110C	07-Apr-17/O	< 0.1	< 0.1	1	MAC
Nitrate (N)	mg/L	0.1	SM4110C	07-Apr-17/O	0.2	0.2	10	MAC
Sulphate	mg/L	1	SM4110C	07-Apr-17/O	33	34	500	AO
Calcium	mg/L	0.02	SM 3120	11-Apr-17/O	86.6	84.0		
Magnesium	mg/L	0.01	SM 3120	11-Apr-17/O	33.6	33.2		
Sodium	mg/L	0.2	SM 3120	11-Apr-17/O	10.4	10.5	200,20	AO,MAC
Potassium	mg/L	0.1	SM 3120	11-Apr-17/O	2.8	2.9		
Copper	mg/L	0.002	SM 3120	11-Apr-17/O	< 0.002	< 0.002	1	AO
Iron	mg/L	0.005	SM 3120	11-Apr-17/O	**0.427**	0.172	0.3	AO
Manganese	mg/L	0.001	SM 3120	11-Apr-17/O	0.018	0.014	0.05	AO
Silica	mg/L	0.02	SM 3120	11-Apr-17/O	8.71	8.69		
Zinc	mg/L	0.005	SM 3120	11-Apr-17/O	< 0.005	< 0.005	5	AO
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	11-Apr-17/O	< 0.01	< 0.01		
Total Kjeldahl Nitrogen	mg/L	0.05	MOEE 3367	12-Apr-17/O	0.20	0.13		
Organic Nitrogen	mg/L	0.05	MOEE 3367	12-Apr-17/O	**0.20**	0.13	0.15	OG
Dissolved Organic Carbon	mg/L	0.2	EPA 415.1	11-Apr-17/O	2.0	2.2	5	AO
Sulphide	mg/L	0.01	SM4500-S2	10-Apr-17/K	< 0.01	< 0.01	0.05	AO
Phenolics	mg/L	0.001	MOEE 3179	07-Apr-17/O	< 0.001	< 0.001		
Tannins and Lignins	mg/L	0.1	SM5550B	11-Apr-17	< 0.1 [1]	< 0.1 [1]		
Total Coliform	cfu/100mL	1	MOE E3407	07-Apr-17/O	0	0	0	MAC

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88420 **REPORT No. B17-08677**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 07-Apr-17
DATE REPORTED: 12-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-AO
WATERWORKS NO.

			Client I.D.:		Well 2 - Initial	Well 2 - Final	ODWS	
			Sample I.D.:		B17-08677-1	B17-08677-2	Objective	Type of Objective
			Date Collected:		06-Apr-17	06-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
E coli	cfu/100mL	1	MOE E3407	07-Apr-17/O	0	0	0	MAC
Background	cfu/100mL	1	MOE E3407	07-Apr-17/O	0	1		
Anion Sum	meq/L		Calc.	12-Apr-17/O	6.91	6.80		
Cation Sum	meq/L		Calc.	12-Apr-17/O	7.63	7.46		
% Difference	%		Calc.	12-Apr-17/O	4.98	4.67		
Ion Ratio	AS/CS		Calc.	12-Apr-17/O	0.905	0.911		
Sodium Adsorption Ratio	-		Calc.	12-Apr-17/O	0.240	0.245		
TDS(ion sum calc.)	mg/L		Calc.	12-Apr-17/O	356	350	500	AO
Conductivity (calc.)	µmho/cm		Calc.	12-Apr-17/O	662	652		
TDS(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	0.611	0.610		
EC(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	1.14	1.14		
Langelier Index(25°C)	S.I.		Calc.	12-Apr-17/O	0.912	0.899		

1 . Subcontracted to Paracel Labs

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88525 **REPORT No. B17-08966**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 11-Apr-17
DATE REPORTED: 19-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-A
WATERWORKS NO.

			Client I.D.:		Well - 1056 Richmond		ODWS	
			Sample I.D.:		B17-08966-1		Objective	Type of Objective
			Date Collected:		10-Apr-17			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Hardness (as CaCO3)	mg/L	1	SM 3120	12-Apr-17/O	**296**		80-100	OG
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	11-Apr-17/O	251		30-500	OG
Conductivity @25°C	µmho/cm	1	SM 2510B	11-Apr-17/O	549			
pH @25°C	pH Units		SM 4500H	11-Apr-17/O	8.05		6.5-8.5	OG
Colour	TCU	2	SM 2120C	11-Apr-17/O	< 2		5	AO
Turbidity	NTU	0.1	SM 2130	11-Apr-17/O	0.2		5	AO
Fluoride	mg/L	0.1	SM4110C	11-Apr-17/O	0.1		1.5	MAC
Chloride	mg/L	0.5	SM4110C	11-Apr-17/O	8.0		250	AO
Nitrite (N)	mg/L	0.1	SM4110C	11-Apr-17/O	< 0.1		1	MAC
Nitrate (N)	mg/L	0.1	SM4110C	11-Apr-17/O	< 0.1		10	MAC
Sulphate	mg/L	1	SM4110C	11-Apr-17/O	31		500	AO
Calcium	mg/L	0.02	SM 3120	12-Apr-17/O	69.8			
Magnesium	mg/L	0.01	SM 3120	12-Apr-17/O	29.6			
Sodium	mg/L	0.2	SM 3120	12-Apr-17/O	5.7		200,20	AO,MAC
Potassium	mg/L	0.1	SM 3120	12-Apr-17/O	2.4			
Copper	mg/L	0.002	SM 3120	12-Apr-17/O	0.007		1	AO
Iron	mg/L	0.005	SM 3120	12-Apr-17/O	0.005		0.3	AO
Manganese	mg/L	0.001	SM 3120	12-Apr-17/O	**0.256**		0.05	AO
Silica	mg/L	0.02	SM 3120	12-Apr-17/O	10.8			
Zinc	mg/L	0.005	SM 3120	12-Apr-17/O	< 0.005		5	AO
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	13-Apr-17/O	0.03			
Total Kjeldahl Nitrogen	mg/L	0.05	MOEE 3367	18-Apr-17/O	0.15			
Organic Nitrogen	mg/L	0.05	MOEE 3367	19-Apr-17/O	0.12		0.15	OG
Dissolved Organic Carbon	mg/L	0.2	EPA 415.1	12-Apr-17/O	1.6		5	AO
Sulphide	mg/L	0.01	SM4500-S2	17-Apr-17/K	< 0.01		0.05	AO
Phenolics	mg/L	0.001	MOEE 3179	12-Apr-17/O	< 0.001			
Tannins and Lignins	mg/L	0.1	SM5550B	13-Apr-17	< 0.1	1		

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88525 **REPORT No. B17-08966**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 11-Apr-17
DATE REPORTED: 19-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-A
WATERWORKS NO.

			Client I.D.:		Well - 1056 Richmond		ODWS	
			Sample I.D.:		B17-08966-1		Objective	Type of Objective
			Date Collected:		10-Apr-17			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Total Coliform	cfu/100mL	1	MOE E3407	11-Apr-17/O	0		0	MAC
E coli	cfu/100mL	1	MOE E3407	11-Apr-17/O	0		0	MAC
Background	cfu/100mL	1	MOE E3407	11-Apr-17/O	0			
Anion Sum	meq/L		Calc.	12-Apr-17/O	5.89			
Cation Sum	meq/L		Calc.	12-Apr-17/O	6.24			
% Difference	%		Calc.	12-Apr-17/O	2.89			
Ion Ratio	AS/CS		Calc.	12-Apr-17/O	0.944			
Sodium Adsorption Ratio	-		Calc.	12-Apr-17/O	0.143			
TDS(ion sum calc.)	mg/L		Calc.	12-Apr-17/O	297		500	AO
Conductivity (calc.)	µmho/cm		Calc.	12-Apr-17/O	556			
TDS(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	0.541			
EC(calc.)/EC(actual)	-		Calc.	12-Apr-17/O	1.01			
Langelier Index(25°C)	S.I.		Calc.	12-Apr-17/O	0.851			

1 . Subcontracted to Paracel Labs

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88437 **REPORT No. B17-09847**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 19-Apr-17
DATE REPORTED: 26-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-A
WATERWORKS NO.

			Client I.D.		Well 3	Well 1		
			Sample I.D.		B17-09847-1	B17-09847-2		
			Date Collected		18-Apr-17	19-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Total Coliform	cfu/100mL	1	MOE E3407	19-Apr-17/O	0			
E coli	cfu/100mL	1	MOE E3407	19-Apr-17/O	0			
Organic Nitrogen	mg/L	0.05	MOEE 3367	26-Apr-17/O		0.07		
Colour	TCU	2	SM 2120C	20-Apr-17/O		< 2		
Acetone	µg/L	2	EPA 8260	20-Apr-17/O	< 2			
Benzene	µg/L	0.5	EPA 8260	20-Apr-17/O	< 0.5			
Bromodichloromethane	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Bromoform	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Bromomethane	µg/L	0.3	EPA 8260	20-Apr-17/O	< 0.3			
Carbon Tetrachloride	µg/L	0.2	EPA 8260	20-Apr-17/O	< 0.2			
Monochlorobenzene (Chlorobenzene)	µg/L	0.2	EPA 8260	20-Apr-17/O	< 0.2			
Chloroform	µg/L	0.3	EPA 8260	20-Apr-17/O	< 0.3			
Dibromochloromethane	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dibromoethane,1,2- (Ethylene Dibromide)	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichlorobenzene,1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichlorobenzene,1,3-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichlorobenzene,1,4-	µg/L	0.2	EPA 8260	20-Apr-17/O	< 0.2			
Dichlorodifluoromethane	µg/L	1	EPA 8260	20-Apr-17/O	< 1			
Dichloroethane,1,1-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloroethane,1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloroethene, 1,1-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloroethene, cis-1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloroethene, trans-1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloropropane,1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloropropene, cis-1,3-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Dichloropropene, trans-1,3-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			

Gord Murphy
Lab Supervisor

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 88437 **REPORT No. B17-09847**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 19-Apr-17
DATE REPORTED: 26-Apr-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-A
WATERWORKS NO.

			Client I.D.		Well 3	Well 1		
			Sample I.D.		B17-09847-1	B17-09847-2		
			Date Collected		18-Apr-17	19-Apr-17		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Dichloropropene 1,3-cis+trans	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Ethylbenzene	µg/L	0.5	EPA 8260	20-Apr-17/O	< 0.5			
Hexane	µg/L	1	EPA 8260	20-Apr-17/O	< 1			
Dichloromethane (Methylene Chloride)	µg/L	0.3	EPA 8260	20-Apr-17/O	< 0.3			
Methyl Ethyl Ketone	µg/L	1	EPA 8260	20-Apr-17/O	< 1			
Methyl Isobutyl Ketone	µg/L	1	EPA 8260	20-Apr-17/O	< 1			
Methyl-t-butyl Ether	µg/L	1	EPA 8260	20-Apr-17/O	< 1			
Styrene	µg/L	0.5	EPA 8260	20-Apr-17/O	< 0.5			
Tetrachloroethane,1,1,1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Tetrachloroethane,1,1,2,2-	µg/L	0.4	EPA 8260	20-Apr-17/O	< 0.4			
Tetrachloroethylene	µg/L	0.2	EPA 8260	20-Apr-17/O	< 0.2			
Toluene	µg/L	0.5	EPA 8260	20-Apr-17/O	< 0.5			
Trichloroethane,1,1,1-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Trichloroethane,1,1,2-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Trichloroethylene	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Trichlorofluoromethane	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Vinyl Chloride	µg/L	0.2	EPA 8260	20-Apr-17/O	< 0.2			
Xylene, m,p-	µg/L	0.4	EPA 8260	20-Apr-17/O	< 0.4			
Xylene, o-	µg/L	0.1	EPA 8260	20-Apr-17/O	< 0.1			
Xylene, m,p,o-	µg/L	0.4	EPA 8260	20-Apr-17/O	< 0.4			
Dichloroethane-d4,1,2-(SS)	%		EPA 8260	20-Apr-17/O	104			
Toluene-d8 (SS)	%		EPA 8260	20-Apr-17/O	106			
Bromofluorobenzene,4(SS)	%		EPA 8260	20-Apr-17/O	96.0			

Gord Murphy
Lab Supervisor

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G68283 **REPORT No. B17-11037**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Mark Devlin

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 28-Apr-17
DATE REPORTED: 02-May-17
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Derry Side Rd
P.O. NUMBER: OTT-00236288-A
WATERWORKS NO.

	Parameter		Nitrite (N)	Nitrate (N)			
	Units		mg/L	mg/L			
	R.L.		0.1	0.1			
	Reference Method		SM4110C	SM4110C			
	Date Analyzed/Site		01-May-17/O	01-May-17/O			
Client I.D.	**Sample I.D.**	**Date Collected**					
Well 1- TP	B17-11037-1	27-Apr-17	< 0.1	0.4			
Well 2- TP	B17-11037-2	27-Apr-17	< 0.1	< 0.1			
Well 3- TP	B17-11037-3	27-Apr-17	< 0.1	< 0.1			

K. Pipin

Krystyna Pipin , M. Sc.
Lab Supervisor

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

CADUCEON™ ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: DW 106898 **REPORT No. B20-22374**

Report To:
Private - Ottawa

Attention: Steve Smith

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 31-Jul-20
DATE REPORTED: 13-Aug-20
SAMPLE MATRIX: Drinking Water

JOB/PROJECT NO.:
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.:		Old Well	New Well	ODWS	
			Sample I.D.:		B20-22374-1	B20-22374-2	Objective	Type of Objective
			Date Collected:		31-Jul-20	31-Jul-20		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Total Coliform	cfu/100mL	1	MOE E3407	31-Jul-20/O	0	0	0	MAC
E coli	cfu/100mL	1	MOE E3407	31-Jul-20/O	0	0	0	MAC
Background	cfu/100mL	1	MOE E3407	31-Jul-20/O	0	0		
Colour	TCU	2	SM 2120C	04-Aug-20/O	< 2	< 2	5	AO
Nitrite (N)	mg/L	0.1	SM4110C	31-Jul-20/O	< 0.1	< 0.1	1	MAC
Nitrate (N)	mg/L	0.1	SM4110C	31-Jul-20/O	1.5	< 0.1	10	MAC
Organic Nitrogen	mg/L	0.1	E3199A.1	11-Aug-20/K	< 0.1	< 0.1	0.15	OG
Tannins and Lignins	mg/L	0.5	SM5500B	05-Aug-20/K	< 0.5	< 0.5		

ODWS - Ontario Drinking Water Standards
AO - Aesthetic Objectives
IMAC - Interim Maximum Acceptable Concentration
MAC - Maximum Acceptable Concentration
OG - Operational Guidelines

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

Appendix E:
Test Pit Logs, Grain Size Analyses and Water Surplus Data

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

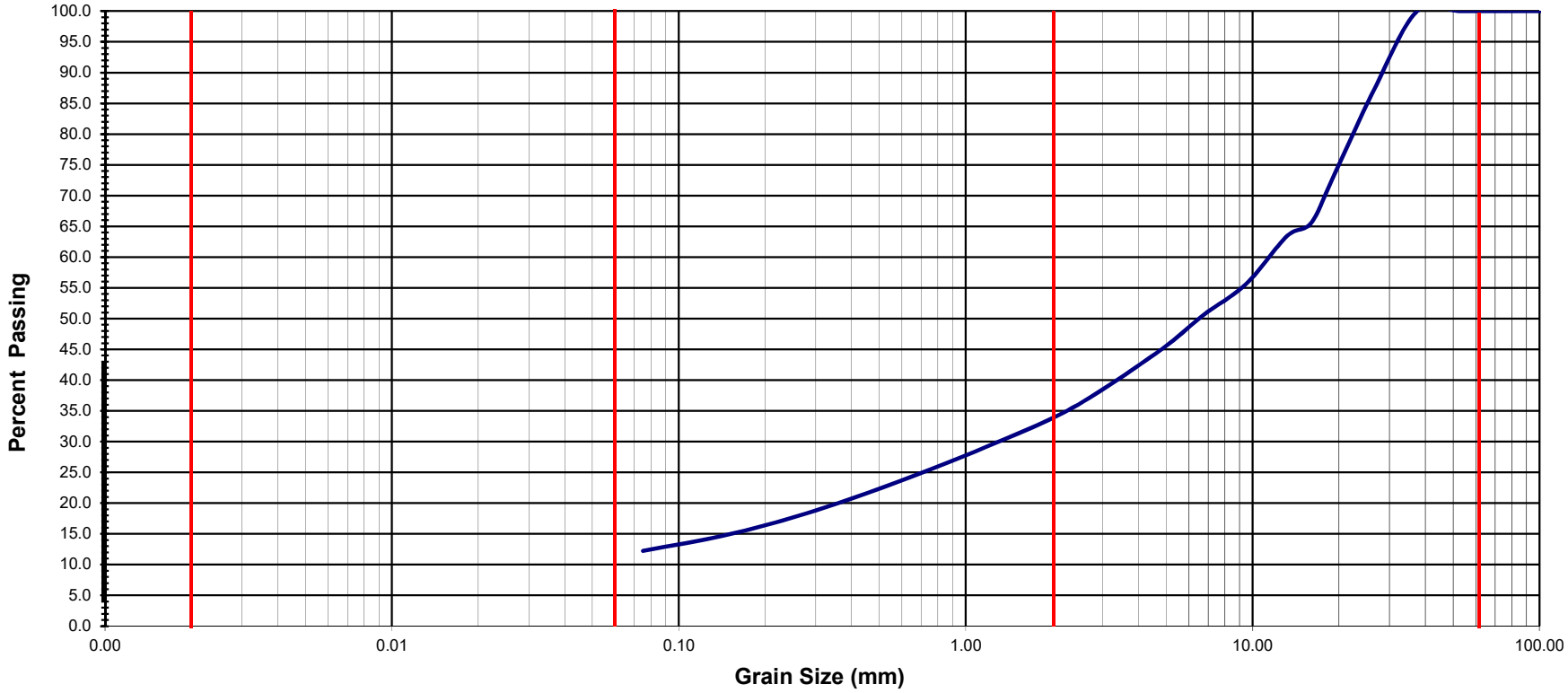
Grain-Size Distribution Curve

Method of Test for Sieve Analysis of Aggregate

ASTM C-136 (LS-602)

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL		
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse



Exp Project No.:	**OTT-00236288-A0**	**Project Name :**	**Geotechnical Investigation, Proposed Residential Subdivision**				
Client :	**Mr Steve Smith**	**Project Location :**	**1009 Derry Road, Beckwith, ON**				
Date Sampled :	**April 11, 2017**	**Borehole:**	**BH-1**	**Sample:**	**SS3**	**Depth (m) :**	**1.5-2.1**
Sample Description :		**Sandy Gravel, Some Silt**				**Figure :**	**12**

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

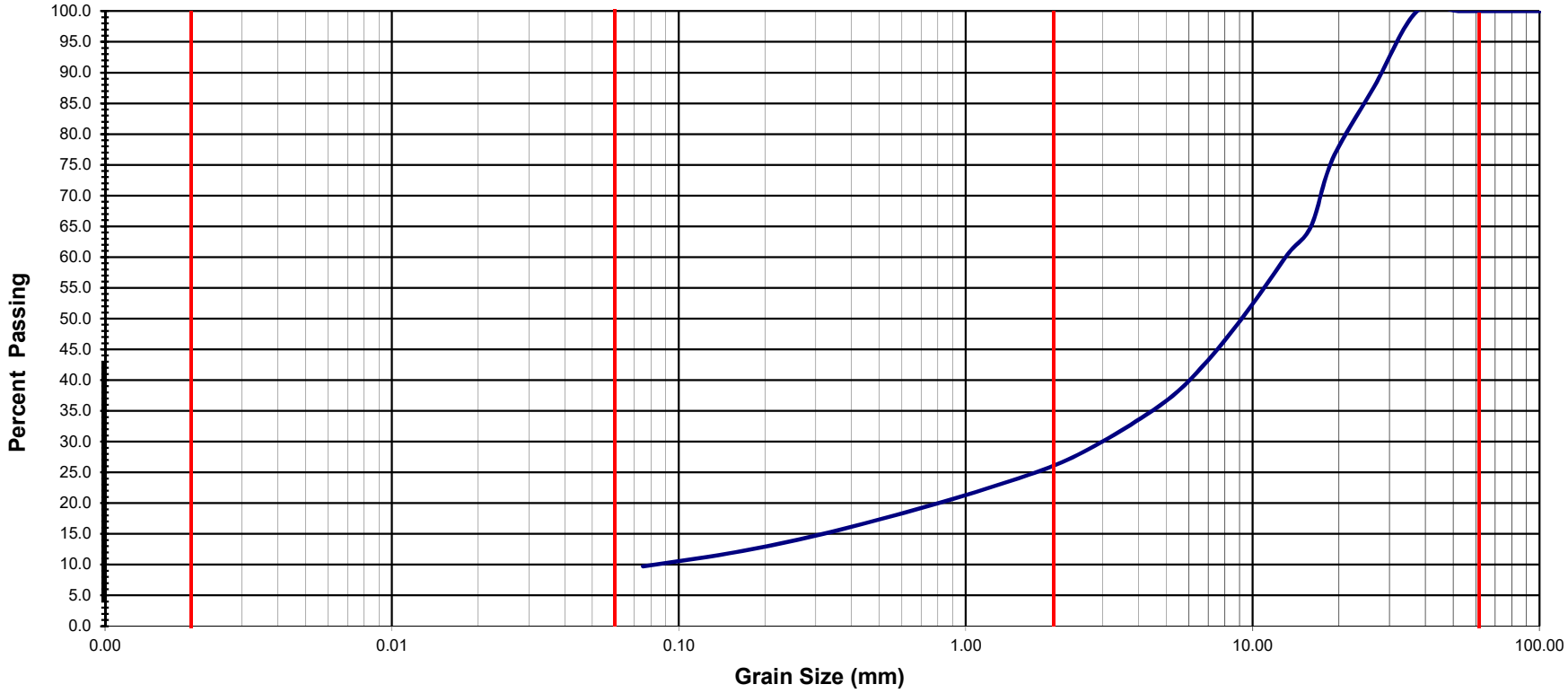
Grain-Size Distribution Curve

Method of Test for Sieve Analysis of Aggregate

ASTM C-136 (LS-602)

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL		
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse



Exp Project No.:	**OTT-00236288-A**	**Project Name :**	**Geotechnical Investigation, Proposed Residential Subdivision**				
Client :	**Mr Steve Smith**	**Project Location :**	**1009 Derry Road, Beckwith, ON**				
Date Sampled :	**April 11, 2017**	**Borehole:**	**1**	**Sample:**	**SS4**	**Depth (m) :**	**2.3-2.9**
Sample Description :	**Gravel, Some Sand, Trace Silt**					**Figure :**	**13**

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

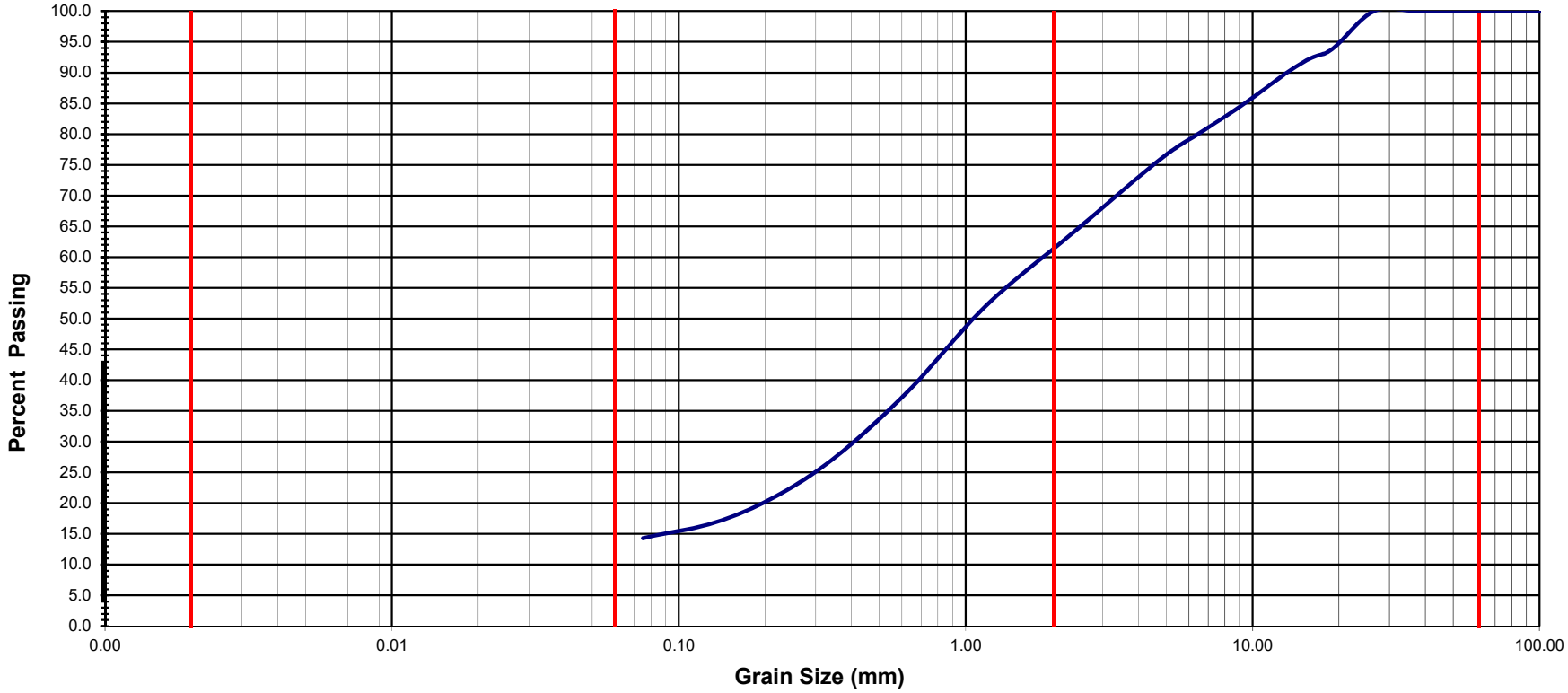
Grain-Size Distribution Curve

Method of Test for Sieve Analysis of Aggregate

ASTM C-136 (LS-602)

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL		
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse



Exp Project No.:	**OTT-00236288-A**	**Project Name :**	**Geotechnical Investigation, Proposed Residential Subdivision**				
Client :	**Mr Steve Smith**	**Project Location :**	**1009 Derry Road Beckwith, ON**				
Date Sampled :	**April 18, 2017**	**Borehole:**	**BH-2**	**Sample:**	**SS2**	**Depth (m) :**	**0.8-1.4**
Sample Description :		**Sand & Gravel, Some Silt**				**Figure :**	**14**

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

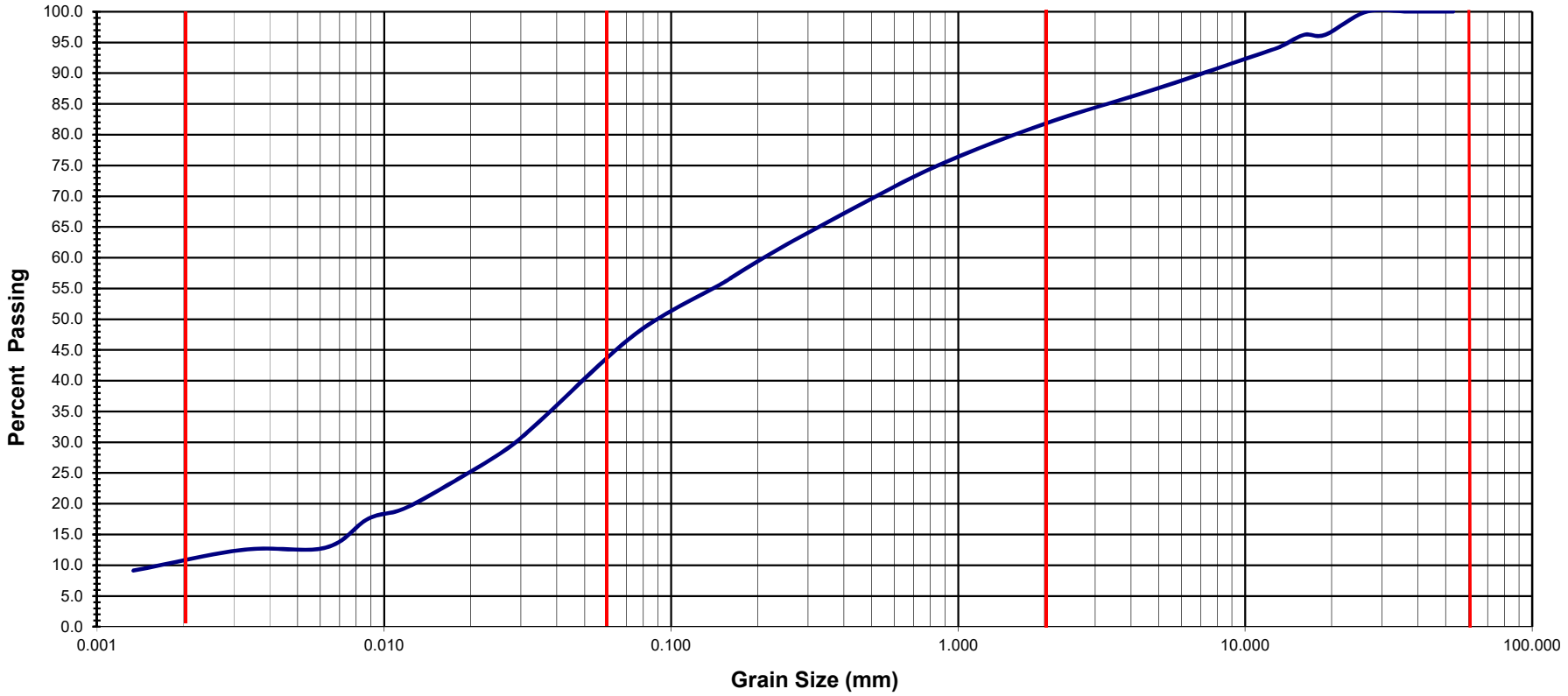
Grain-Size Distribution Curve

Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL			
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	



Exp Project No.:	**OTT-00236288-A0**	**Project Name :**	**Geotechnical Investigation, Proposed Residential Subdivision**		
Client :	**Mr Steve Smith**	**Project Location :**	**1009 Derry Road, Beckwith, On**		
Date Sampled :	**April 18, 2017**	**Bore Hole/Test Pit No.:**	**BH-2**	**Sample No.: SS3**	**Depth (m) : 1.5-2.3**
Sample Description :		**Silt and Sand, Some Gravel and Clay**			**Figure : 15**

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

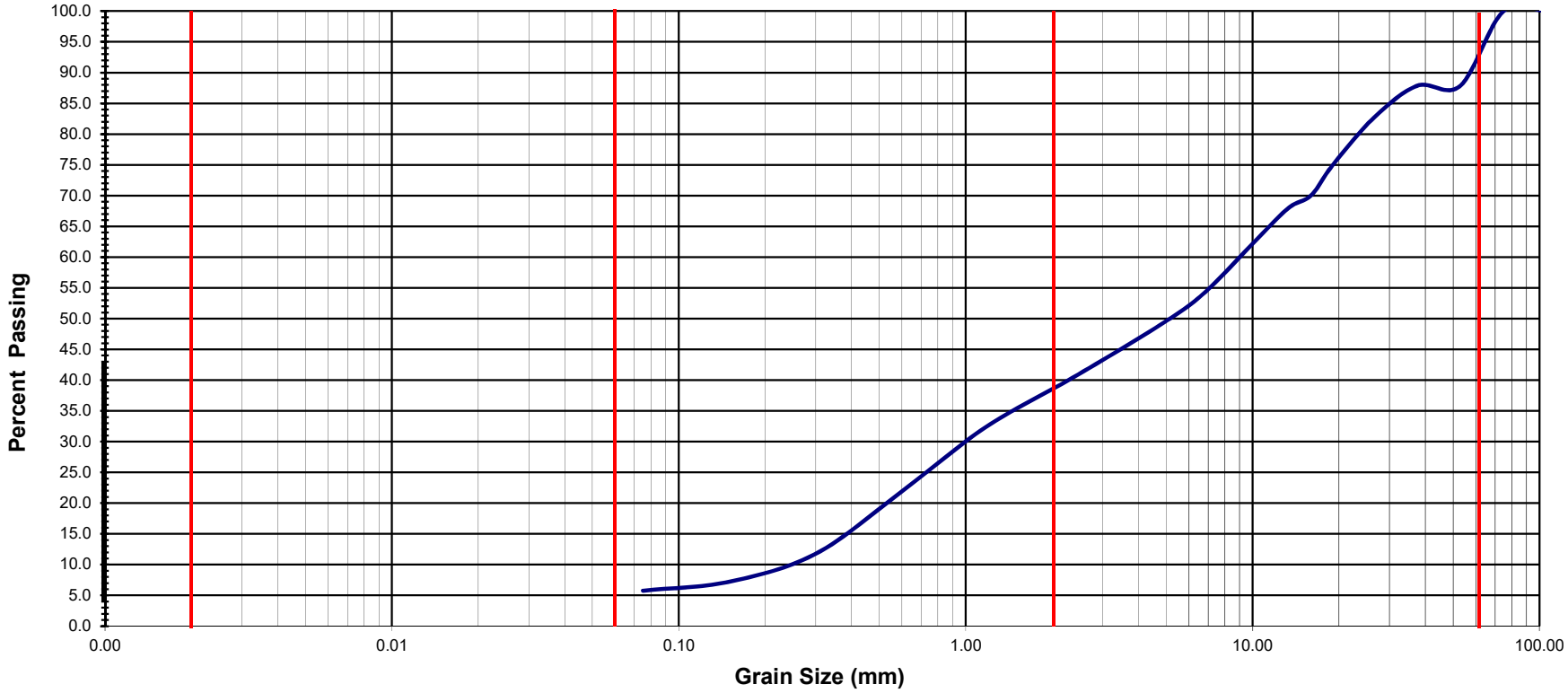
Grain-Size Distribution Curve

Method of Test for Sieve Analysis of Aggregate

ASTM C-136 (LS-602)

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL		
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse



Exp Project No.:	**OTT-00236288-A0**	**Project Name :**	**Geotechnical Investigation, Proposed Residential Subdivision**				
Client :	**Mr Steve Smith**	**Project Location :**	**1009 Derry Road, Beckwith, ON**				
Date Sampled :	**April 10, 2017**	**Test Pit:**	**TP4**	**Sample:**	**S2**	**Depth (m) :**	**0.18-0.9**
Sample Description :		**Sand & Gravel, Trace Silt**				**Figure :**	**16**

Test Pit Logs

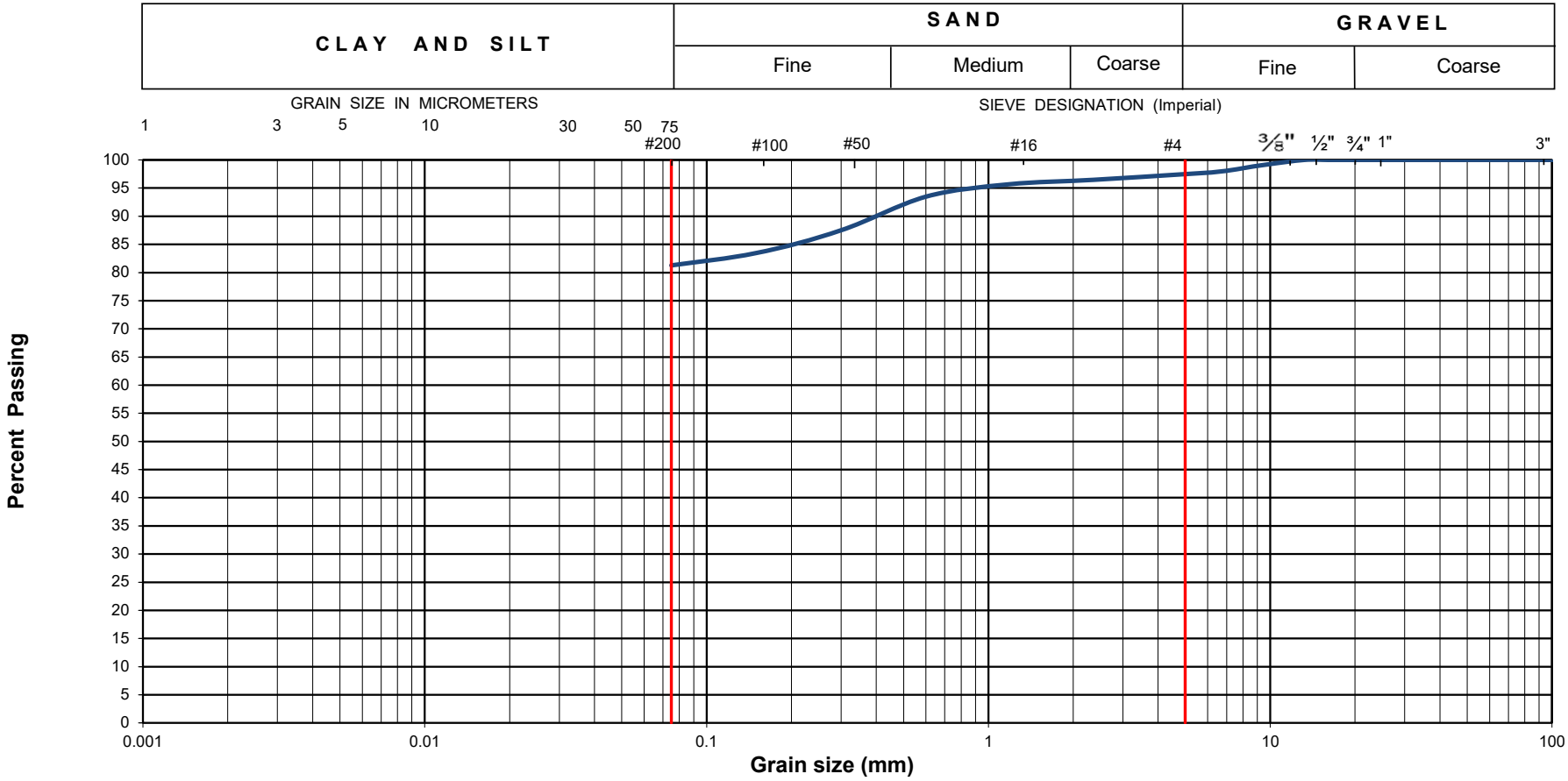
Derry Side Road – 2020 Test Pit Program

Test Pit	Depth (m)	Description
TP-1	0 – 0.3 0.3 – 0.6 0.6 – 0.9	Topsoil with organic matter, loose, moist. Fine sand with some clay, light brown, wet Coarse gravel and fine sand, grey, wet. Bedrock refusal
TP-2	0 - 0.3 0.3-0.9 0.9 – 1.2	Topsoil with organic matter, loose, moist. Medium grained sandy silt, moist Till - Fine grained sandy clay, some gravel, wet. Bedrock Refusal
TP-3	0 - 0.3 0.3 – 0.9 0.9 – 1.5	Sandy topsoil with organic matter, loose, moist. Fine sand and gravel with some clay, light brown, moist. Till – Fine sandy silt with some gravel, wet Bedrock at 1.5m.
TP-4	0 - 0.3 0.3-0.6 0.6-1.5	Topsoil with organic matter, loose, moist. Fine brown sandy silt, wet Fine brown sandy silt, some gravel, wet Bedrock at 1.5m
TP-5	0 – 0.15 0.15 – 0.5 0.5 – 1.5	Topsoil with organic matter, loose, moist. Fine grained sand and silt, light brown, wet. Medium grained sand and gravel mix, wet Bedrock not observed
TP-6	0 – 0.15 0.2 – 0.5 0.5 – 1.5	Topsoil with organic matter, loose, moist. Fine grained sand and silt, light brown wet. Fine grained sandy clay, some gravel, wet Bedrock at 1.5m

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Sieve Analysis of Aggregate
ASTM C-136

Unified Soil Classification System

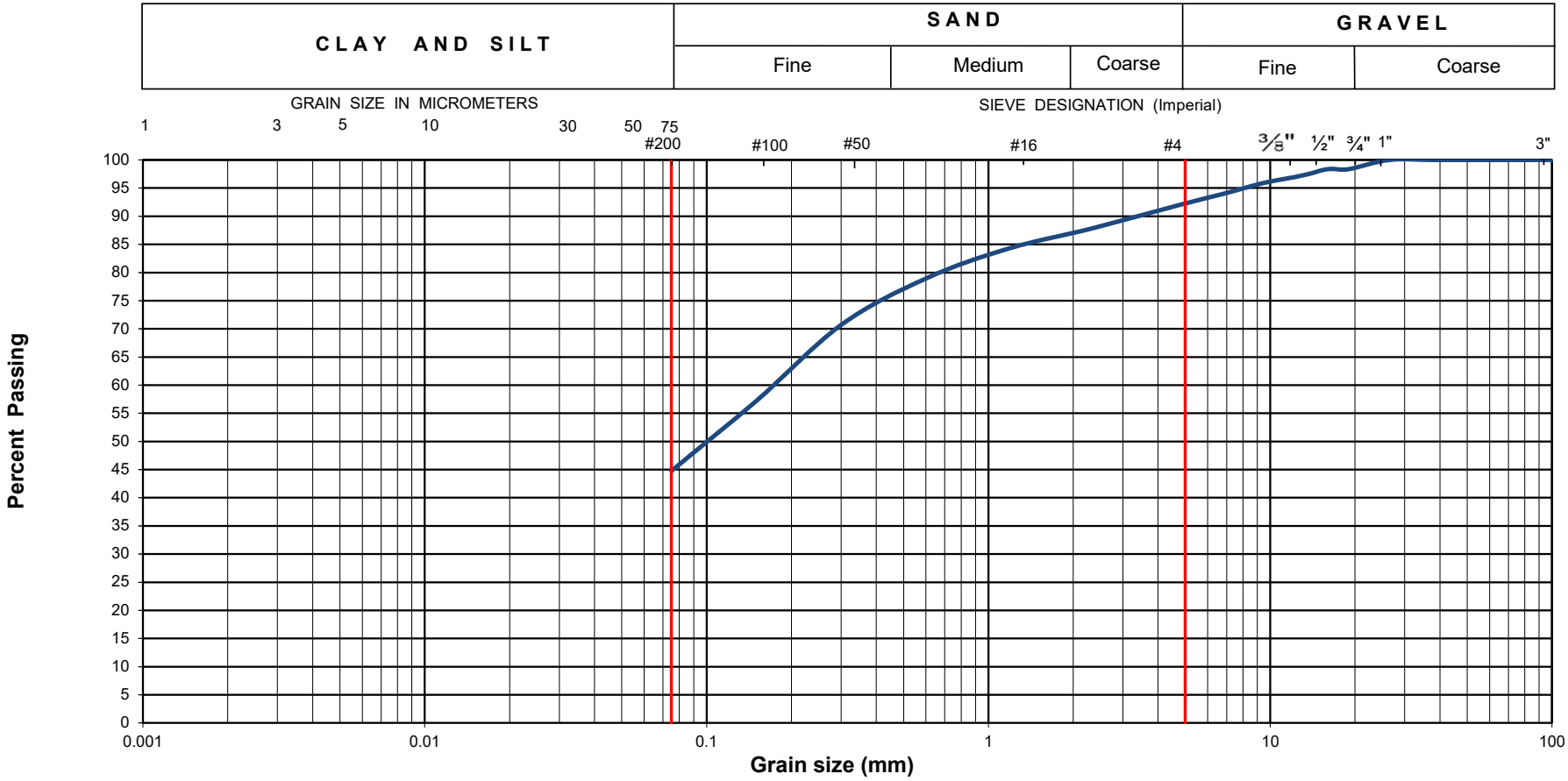


EXP Project No.:	**OTT-00236288-A0**	**Project Name :**	**Test Pit Investigation**						
Client :	**Steve Smith**	**Project Location :**	**1009 Derry Sideroad, Beckwith, ON**						
Date Sampled :	**March 20, 2020**	**Borehole No:**	**TP1**		**Sample:**	**SS2**		**Depth (m) :**	**0.3-0.6**
Sample Composition :		**Gravel (%)**	**3**	**Sand (%)**	**16**	**Silt & Clay (%)**	**81**	**Figure :**	**xxx**
Sample Description :		**Silt & Clay, some Sand, trace Gravel**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Sieve Analysis of Aggregate
ASTM C-136

Unified Soil Classification System



EXP Project No.:	**OTT-00236288-A0**	**Project Name :**	**Test Pit Investigation**					
Client :	**Steve Smith**	**Project Location :**	**1009 Derry Sideroad, Beckwith, ON**					
Date Sampled :	**March 20, 2020**	**Borehole No:**	**TP4**	**Sample:**	**SS3**		**Depth (m) :**	**0.6-1.5**
Sample Composition :		**Gravel (%)**	**8**	**Sand (%)**	**47**	**Silt & Clay (%)**	**45**	**Figure :** **xxx**
Sample Description :		**Sand & Silt, trace Gravel**						

Appendix F:
Rainfall Data Records

loamy Ottawa

WBNRMSD.150

Ottawa Int'l A, ON WATER BUDGET MEANS FOR THE PERIOD 1939-2008 DC20492

LAT.... 45.24 WATER HOLDING CAPACITY...150 MM HEAT INDEX... 36.40
LONG... 75.67 LOWER ZONE..... 90 MM A..... 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.8		63	11	14	0	0	0	21	87	141	297
28- 2	-9.1		56	10	15	0	0	0	22	119	144	354
31- 3	-2.9		67	30	80	5	5	0	99	76	149	421
30- 4	5.7		71	66	81	31	31	0	115	0	150	492
31- 5	12.9		76	76	0	80	80	0	15	0	132	568
30- 6	18.3		82	82	0	116	116	0	4	0	93	650
31- 7	20.8		86	86	0	135	126	-9	1	0	52	735
31- 8	19.5		82	82	0	117	96	-21	1	0	37	818
30- 9	14.7		82	82	0	75	67	-8	2	0	50	901
31-10	8.2		75	75	0	37	36	-1	6	0	83	75
30-11	1.2		79	62	8	10	10	0	20	10	122	155
31-12	-7.2		80	26	15	1	1	0	24	50	138	235
AVE	6.0	TTL	900	688	213	607	568	-39	330			

Ottawa Int'l A, ON STANDARD DEVIATIONS FOR THE PERIOD 1939-2008 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	2.9	27	15	18	1	1	0	29	46	20	61
28- 2	2.5	27	14	26	1	1	0	35	60	18	65
31- 3	2.5	29	22	52	5	5	0	56	91	6	72
30- 4	1.8	30	30	92	9	9	0	90	3	2	79
31- 5	1.9	33	33	3	12	12	0	24	0	21	91
30- 6	1.2	38	38	0	9	8	1	17	0	41	103
31- 7	1.1	36	36	0	8	19	20	6	0	40	104
31- 8	1.3	37	37	0	9	23	24	4	0	42	117
30- 9	1.4	39	39	0	8	14	13	13	0	47	126
31-10	1.5	37	37	1	7	7	2	18	0	47	37
30-11	1.7	26	27	8	4	4	0	29	13	35	45
31-12	2.9	31	22	14	1	1	0	29	35	23	57

Sand / Ottawa

WBNRMSD.100

Ottawa Int'l A, ON WATER BUDGET MEANS FOR THE PERIOD 1939-2008 DC20492

LAT.... 45.24 WATER HOLDING CAPACITY...100 MM HEAT INDEX... 36.40
LONG... 75.67 LOWER ZONE..... 60 MM A..... 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.8		63	11	14	0	0	0	23	87	97	297
28- 2	-9.1		56	10	15	0	0	0	24	119	98	354
31- 3	-2.9		67	30	80	5	5	0	102	76	100	421
30- 4	5.7		71	66	81	31	31	0	115	0	100	492
31- 5	12.9		76	76	0	80	80	0	15	0	82	568
30- 6	18.3		82	82	0	116	112	-4	4	0	47	650
31- 7	20.8		86	86	0	135	114	-21	1	0	18	735
31- 8	19.5		82	82	0	117	85	-32	1	0	14	818
30- 9	14.7		82	82	0	75	65	-10	3	0	29	901
31-10	8.2		75	75	0	37	36	-1	8	0	60	75
30-11	1.2		79	62	8	10	10	0	31	10	89	155
31-12	-7.2		80	26	15	1	1	0	32	50	96	235
AVE	6.0	TTL	900	688	213	607	539	-68	359			

Ottawa Int'l A, ON STANDARD DEVIATIONS FOR THE PERIOD 1939-2008 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	2.9	27	15	18	1	1	0	28	46	8	61
28- 2	2.5	27	14	26	1	1	0	36	60	8	65
31- 3	2.5	29	22	52	5	5	0	57	91	0	72
30- 4	1.8	30	30	92	9	9	0	91	3	2	79
31- 5	1.9	33	33	3	12	12	0	24	0	21	91
30- 6	1.2	38	38	0	9	12	11	17	0	35	103
31- 7	1.1	36	36	0	8	26	28	6	0	28	104
31- 8	1.3	37	37	0	9	28	31	4	0	28	117
30- 9	1.4	39	39	0	8	16	16	13	0	35	126
31-10	1.5	37	37	1	7	6	3	19	0	37	37
30-11	1.7	26	27	8	4	4	0	33	13	21	45
31-12	2.9	31	22	14	1	1	0	31	35	10	57

clay / ottawa

WBNRMSD.280

Ottawa Int'l A, ON WATER BUDGET MEANS FOR THE PERIOD 1939-2008 DC20492

LAT.... 45.24 WATER HOLDING CAPACITY...280 MM HEAT INDEX... 36.40
LONG... 75.67 LOWER ZONE.....168 MM A..... 1.075

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.8	63	11	14	0	0	0	17	87	255	297
28- 2	-9.1	56	10	15	0	0	0	19	119	261	354
31- 3	-2.9	67	30	80	5	5	0	90	76	275	421
30- 4	5.7	71	66	81	31	31	0	111	0	280	492
31- 5	12.9	76	76	0	80	80	0	15	0	262	568
30- 6	18.3	82	82	0	116	116	0	4	0	223	650
31- 7	20.8	86	86	0	135	135	-1	1	0	173	735
31- 8	19.5	82	82	0	117	112	-5	1	0	143	818
30- 9	14.7	82	82	0	75	72	-3	2	0	151	901
31-10	8.2	75	75	0	37	36	0	6	0	183	75
30-11	1.2	79	62	8	10	10	0	15	10	228	155
31-12	-7.2	80	26	15	1	1	0	18	50	249	235
AVE	6.0 TTL	900	688	213	607	598	-9	299			

Ottawa Int'l A, ON STANDARD DEVIATIONS FOR THE PERIOD 1939-2008 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	2.9	27	15	18	1	1	0	27	46	41	61
28- 2	2.5	27	14	26	1	1	0	34	60	39	65
31- 3	2.5	29	22	52	5	5	0	57	91	16	72
30- 4	1.8	30	30	92	9	9	0	88	3	2	79
31- 5	1.9	33	33	3	12	12	0	24	0	21	91
30- 6	1.2	38	38	0	9	9	0	17	0	42	103
31- 7	1.1	36	36	0	8	8	3	6	0	51	104
31- 8	1.3	37	37	0	9	12	12	4	0	62	117
30- 9	1.4	39	39	0	8	9	6	13	0	69	126
31-10	1.5	37	37	1	7	7	1	18	0	65	37
30-11	1.7	26	27	8	4	4	0	27	13	55	45
31-12	2.9	31	22	14	1	1	0	28	35	44	57