GORRELL RESOURCE
INVESTIGATIONS

Hydrogeological Assessment – Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Gorrell Resource Investigations
Project No. 08360
December, 2011

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Overview

Proposed Braeside Quarry
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Municipality of McNab-Braeside

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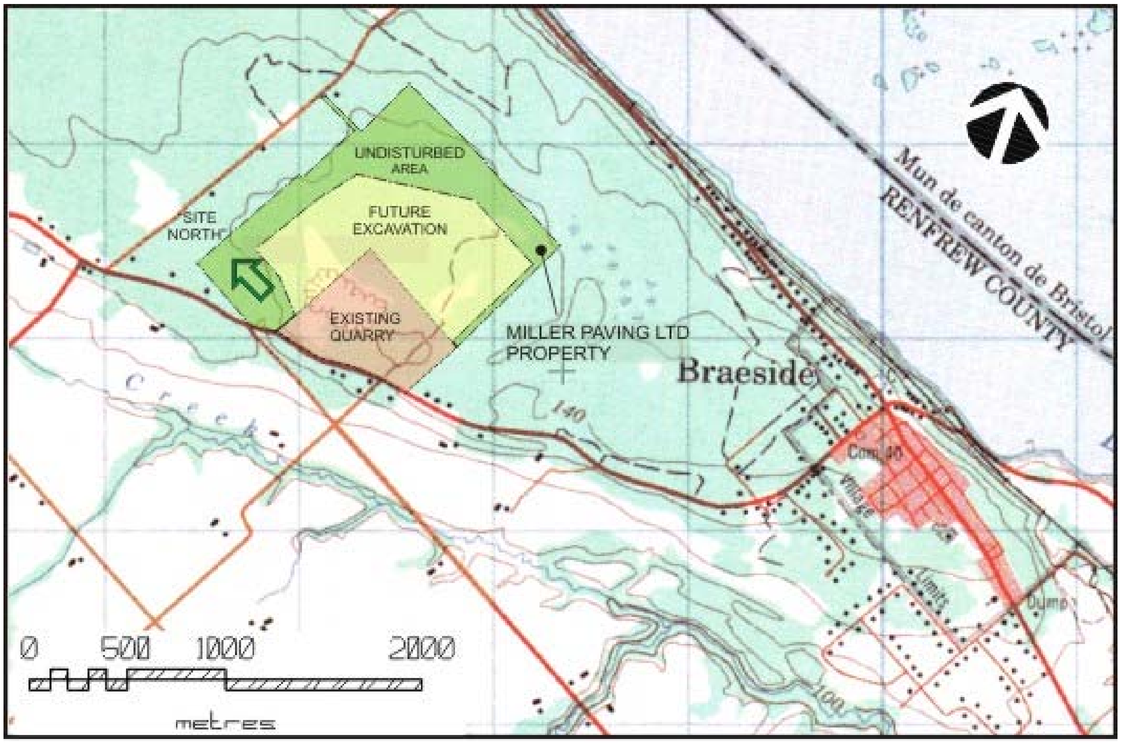
1 Hydrogeological Assessment-Overview

Miller Paving Limited (Miller) owns property located on Part of Lots 16 and 17, Concession A, Municipality of McNab-Braeside, Renfrew County. Miller's land holdings, referred to in this document as the Site, or the Braeside Quarry, is shown on Figure 1. As indicated on Figure 1, part of the property is licensed under the Aggregate Resources Act (ARA), ARA License # 16173, to operate a quarry which is currently permitted to extract and process the bedrock reserves, and to operate portable asphalt production and concrete production plants. The existing quarry removes accumulations of water from the quarry under approvals under the Ontario Water Resources Act; Permit to Take Water # 5617-8DXMU3[1] allows water to be pumped from the excavation at rates greater than 50,000 L/day and Certificate of Approval for Industrial Waste Water Treatment # 6988-6VZJFB allows for the treatment and discharge of the pumped water into the off-site surface water receiver.

Figure 1: Miller Paving Limited Braeside Quarry and Proposed Expansion



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Gorrell Resource Investigations (GRI) were retained by Miller initially through their subsidiary company Smith Construction Ltd. and subsequently directly, to conduct hydrogeological investigations at the site.

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[1] Draft final PTTW dated August 11, 2011

Investigations at the existing quarry were conducted in 2002. Subsequently, GRI was retained to investigate the hydrogeological setting of the proposed quarry expansion area and to provide recommendations for development of the expansion area, identify potential impacts of the proposed expanded quarry and to provide recommendations for mitigation if necessary. The reports prepared by GRI are listed in the report Reference section.

1.1 Study Method

The Miller property were investigated through the construction of 21 test wells drilled using rotary percussion and diamond drill methods. Eleven wells were constructed as sentry wells around the perimeter of the site. The wells were pump tested and are used for potentiometric monitoring. Packer tests were conducted on the cored holes, piezometers were installed and rising head hydraulic conductivity tests were completed.

The geology and surface water patterns and features were mapped in detail. Groundwater and surface water samples were taken for groundwater characterization.

A door-to-door survey was conducted to collect available information on neighbouring groundwater use. Interested residents interviewed, where possible the wells were examined and a water level measured, and a water sample was taken for general groundwater characteristics. Of 53 contacted, 38 residents participated in the survey.

1.2 Site Setting

The existing excavation has been in operation since the 1950s and is currently 17.1 ha with an average depth of 12 to 15 meters or 135 to 138 m above sea level (ASL) with a licensed quarry base of 125 m ASL. The proposed expansion area bounds an existing active quarry on two sides. The proposed expansion area is 103.0 ha with a proposed extraction area of 68.4 ha. The remainder of the licensed property will remain in setbacks that include planning setbacks, operational setbacks, a significant wildlife protection area and a wildlife corridor. The proposed licensed base of the quarry is also 125 m ASL.

The Miller properties are set on the Braeside Plateau that ranges in elevation from 154 m ASL down to 81 m ASL. Area land uses include rural residential, agricultural and recreational activities.

1.3 Geology

The crown and upper margins of the upland are veneered with unconsolidated sediment found as variously sized hummocky hills and long linear ridges. Most of the largest ridges on the Miller property were excavated between 1950 and 1970, and only remnants are found. The bedrock of the upland consists of the lower Bobcaygeon and Gull River Formations. A K-bentonite layer that has been correlated to a widespread volcanic eruption in the middle Ordovician period was found in the vicinity of the formational contact. The Gull River Formation below the contact is on the order of 10 m and extends to the base of the upland on the inland side of the property. The lower bedrock along the Ottawa River side has been identified as the Rockcliffe Formation in regional mapping.

The upper surface is weathered primarily on the west side of the Miller property. The weathered zone developed on the flanks of the plateau. The existing quarry is completely within a part of the properties where weathered bedrock occurs. In the quarry, fractures extend from the surface to the contact between the Bobcaygeon Formation down to, but no lower than the contact with the Gull River Formation. The proposed extraction area will intercept the weathered bedrock zone primarily on the west side of the property, as illustrated on Figure 2.

1.4 Hydrogeology and Site Hydrology

The topography and competent and weathered geology combine to create an interconnected surface water – shallow groundwater flow system on the plateau and surrounding area that includes runoff, surface water accumulations on upper competent bedrock areas and two levels of springs on the both the east and west side of the upland escarpment faces. Surface water drains into the dissolution fractures and flows below surface to emerge at the base of the dissolution as springs at two distinct levels. Two identified wetlands have developed on upper competent bedrock on or near the Miller property.

A regional analysis of water well records indicates that regional groundwater flows from the plateau to the east and west. Analysis of water wells records shows that recorded water-bearing zones are generally well below the proposed base of the quarry. There are three potential aquifers; an overburden aquifer and aquitard have been grouped for the purpose of the study, a weathered bedrock aquifer and a competent bedrock aquifer. There is also an upper competent bedrock zone which forms an aquiclude/aquitard.

The overburden aquifer is discontinuous and on the Miller property are only found in the west central side. The weathered bedrock aquifer is unconfined, discontinuous and flow varies seasonally. On the Miller property, the aquifer is restricted to the flanks of the plateau and occurs in two distinct and separate layers. While there are small discontinuous water-bearing fractures in the competent bedrock, the first significant water bearing zone is generally encountered between 117 m and 120 m ASL both on the Miller property, and off as identified from MOE well records.

1.5 Impact Assessment

Impacts from the proposed operation were assessed for three stages in the quarry life, the active operation; post-operations when the quarry is filling with water, which will take approximately 27 years; and after full restoration. Impacts to the weathered bedrock and correspondingly to the upper springs that may result in minor impacts to the north-west and south-east wetlands are predicted.

The weathered bedrock zone is the only part of the hydrostratigraphy that will potentially be impacted by the proposed expansion. Approximately 12 ha of the proposed expansion excavation will extend into weathered bedrock as it progresses northward. Impacts that are predicted for the weathered bedrock have already been experienced in the most severe manner with the existing quarry yet observations and data show that there have been few significant impacts within the weathered bedrock.

There will be minimal impact in the competent bedrock aquifer. The minor discontinuous water-bearing zones above the quarry floor are low yielding and alone insufficient to sustain a typical residential water supply. The zones produce marginal flow and emerge out onto the escarpment faces. The first continuous and significant water bearing zone is 5 m below the proposed quarry floor. This is also the first significant water-bearing zone below the weathered bedrock that is used by area water wells. The protection has been designed through definition of the quarry floor and lowest sump elevation to prevent impacts.

A calculation completed by AECOM evaluating the potential zone of influence of the proposed expansion on the water-bearing zone *commonly* encountered between 117 and 120 m ASL. The calculation assumed conservatively that the aquifer is homogeneous and planar. The results found a potential drawdown of one metre in the aquifer at a distance of 500 m and 1.5 m at 300 to 400 m from the excavation, *if* the quarry intercepted the water bearing zone through the sump.

Although the local wells are about 300 to 400 m from the west and north boundaries of the proposed excavation, they are located about 600 to 800 m or more from a future lower lift pump chamber to be located in the northeast corner of the existing excavation. At this distance, a drawdown of 1 m is predicted for wells using the first significant WBZ exclusively assuming the lower lift pump-out intercepts the same zone. For most wells, this decline, should it occur, would not result in a significant decline in well water availability.

Details on a monitoring program for groundwater that expands on the existing PTTW program are provided. Monitoring of the springs and wetlands is not required because of the insignificant impact of the proposed quarry expansion on the features.

1.6 Peer Review Process and Report Structure

Gorrell Resource Investigations began investigating the hydrogeology of the Miller property in 2002. This document consolidates the data and summarizes the interpretation and conclusions from GRI Report 05460 dated September 2007 and the additional testing completed in 2009. The 2009 testing program was completed with input from Golder to ensure that it would provide the necessary level of effort to address the peer review questions and concerns.

Golder Associates Ltd. (Golder) was retained by the County of Renfrew and Township of McNab/Braeside to provide technical peer review services with respect to Miller's application for the Braeside Quarry Expansion as they related to an application for a Zoning By-Law Amendment under the Township of McNab/Braeside Official Plan (Section 9.3(3)) and an application to the Ministry of Natural Resources (MNR) for a quarry license permitting extraction below the water table. As part of the services, Golder provided a technical review of the hydrogeological work completed, beginning with a letter dated September 11, 2008. The correspondence prepared through the hydrogeological peer review is provided in Appendix L and discussed in Section 23.

This document incorporates the results agreed to from the hydrogeological peer review process. Pertinent data from the historic GRI studies is included within the information that follows.

2 Document Structure

The document is divided into three parts. Part 1 is a summary report, and Part 2 comprises the GRI Consolidated Hydrogeological Report . Part 3 contains the conclusions and recommendations of the hydrogeological investigations and presents the author's signatures and certification, as well as discusses the peer review process that was undertaken and that guided some of the components that were undertaken for the study.

The purpose of Part 1 was to summarize the site data collected in several field investigations and to present a consolidated analysis and interpretation. The key points of interest addressed specific items described in the Provincial Standards, the document which indicates the items that must be addressed in support of an application under the ARA. The summary report was prepared for, and reviewed and accepted by Golder with the agreed-upon changes.

Part 2 includes supplementary information that was compiled for the properties that was used as the base information for the hydrogeological interpretations, opinions, results and conclusions summarized in Part 1. Part 2 provides the details on the field investigations, field methods and includes the data base of site information related to geology and hydrogeology that was acquired in the study. The information was extracted from a previous GRI report dated November 2009 (see References). The information provided in Part 2 supersedes the November 2009 report, as it incorporates comments from the Golder peer review.

References, Figures, Photographs and Appendices follow Part 3.

3 Limitations

Gorrell Resource Investigations prepared this report (the "Report") for the account of Miller Paving Limited (the Client). The material in the Report reflects the judgment of GRI staff based upon the information made available to GRI at the time of preparation of the Report, including that information provided to it by the Client. Any use which a third party makes of this Report or any reliance on decisions to be based on it is the responsibility of such third parties. GRI accepts no responsibility whatsoever for damages, loss, expenses, loss of profit or revenues, if any, suffered by any third party as a result of decisions made or actions based on this Report.

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Part 1 – Summary Report

Proposed Braeside Quarry
Part Lots 16 and 17, Conc. A, Municipality of McNab-Braeside

Gorrell Resource Investigations
Project No. 08360
December, 2011

The purpose of Part 1 of this report is to summarize the site data collected in several field investigations and to present a consolidated analysis and interpretation. The data, which originates from field investigations conducted between 2002 and 2009, along with descriptions and analyses, is contained in GRI Report 08360, dated November 2009 found in Part 2 of this document. The site setting is shown in plan on Figure 2.

Note: Directional references on the property and adjacent areas refer to a site north; the relationship between site north and geographical north is shown on Figure 2. Golf Club Road is considered the site north boundary for the purpose of this project.

Appendix A provides an introduction to fundamentals of hydrogeology to assist lay readers with understanding of terms, definitions and basic concepts. It was included at the request of the overall Braeside Study Team.

4 Data Collection and Results

The study began with a review of the existing data and published information for the site and area. This included mapping and studies by Gadd (1963), Richard *et al* (1984), Williams *et al* (1984), Trotter *et al* (1986), Derry *et al* (1989) and Gorrell (Aggregate study of Renfrew County; unpublished). The water wells for the area were examined and statistically analysed for area water use characteristics. Data on the two site monitoring wells installed in 2002 were reviewed.

Thirteen new test wells at eight locations TW1 to TW8 were constructed with a rotary percussion drill as sentry monitors around the perimeter of the property. The wells were constructed by Saunders Well Drilling under supervision of GRI staff. The wells were drilled to various levels to distinguish, classify and isolate the different hydrogeological parameters that had been identified for the area. The wells were tested in April and May 2007, and surface water and groundwater data were collected over the course of the study. A door-to-door survey was conducted in the summer of 2006 within 500 m of the licensed quarry to collect available information on neighbouring groundwater use.

Ten additional wells at five locations (TW9 to TW13) were drilled on the site between January 13, 2009 and February 28 2009. The new holes were constructed using a diamond drill with HQ core. The equipment was operated by All-Terrain Drilling Ltd. of Waterloo under GRI supervision. Two additional exploration holes (F and G) were drilled on the quarry floor to depths within the licensed base by All-Terrain for Miller Group between March 1 and March 4 to obtain core for quality testing. This core was sent to a commercial laboratory for analysis and testing. The bedrock core was subsequently photographed and logged at the Smith Construction Ltd. office. The bedrock core was also reviewed separately by AECOM staff. AECOM was retained by Miller Paving to provide an overview function.

Following the test hole construction, the deeper well in each pairing was tested to assess the potential hydraulic conductivity. Two packers were installed to isolate either a 1.5 or 3 m zone. Packers were inflated to 400 psi and flow was induced into isolated zones of either 1.5 m or 3 m at the rate required to sustain a constant pressure within the packer. Generally, four pressure steps were used for each test interval. The flow at a given pressure step was measured as pressure steps were both increased and decreased.

Following drilling and packer testing, the boreholes were instrumented with 31.75 mm diameter PVC screens (1.5 to 3.0 m, length based on site conditions) attached to solid 31.75 mm diameter PVC risers. The annulus around the screen was packed with #4 silica sand and the remaining annulus was backfilled with bentonite. The wells were fitted with locking caps.

From May 4 to 8, 2009, rising head hydraulic conductivity tests were completed on the piezometers and on the two open cored floor holes (F and G).

Borehole logs for the test wells at the site can be found in Appendix B.

5 Site Data

Table 1 summarizes the transmissivity estimated from the initial pumping test data collected at boreholes TW1 to TW8. Table 2 lists hydraulic conductivity measured from the monitoring wells at TW9 to TW13 during the well response tests. The monitors were subdivided into four categories to represent the different hydrogeological conditions on the site as shown in Table 3.

Appendix C contains the potentiometric data from the monitors. The potentiometric data has been plotted for the competent bedrock aquifer (significant water bearing zone) in Figure 3. The variation in water level from 2006 to 2009 on the graphs in Figure 4.

6 Conceptual Model

Figure 5 shows the elevations of the installations on the site. There are three potential aquifers on the site; the overburden aquifer, the weathered bedrock aquifer and the competent bedrock aquifer. The upper bedrock has been subdivided into the weathered bedrock zone and an upper competent bedrock zone which is considered to be an aquitard. The aquifers and aquitard are shown in plan on Figure 2 and in profile on Figure 6.

6.1 Groundwater

6.1.1 Overburden Aquifer

Although there is some overburden on the site, there is no overburden aquifer (i.e. sustainable water supply aquifer) in the proposed extraction area. There is some saturated overburden that ranges on the site in thickness up to 0.30 to 2.5 m, commonly less than 1 m.

In the north-west part of the Miller property the bedrock trough filled with clay rhythmites. A thickness of clay of 5.8 m was recorded in TW4-1, while no clay was recorded in TW 3-1. This sediment is saturated but has a very low transmissivity.

Figure 4: Variation in Potentiometric Elevation, 2006 - 2009

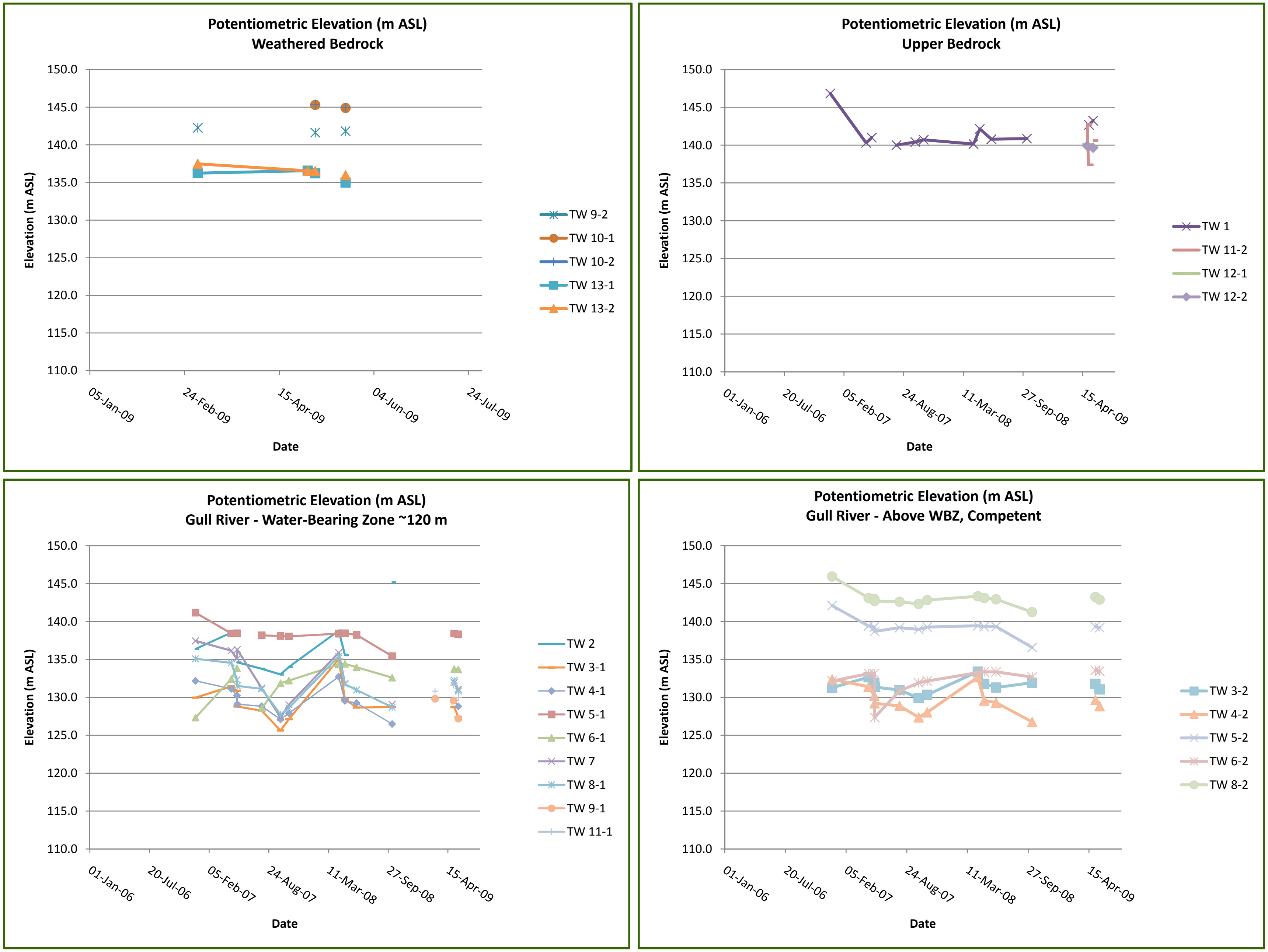
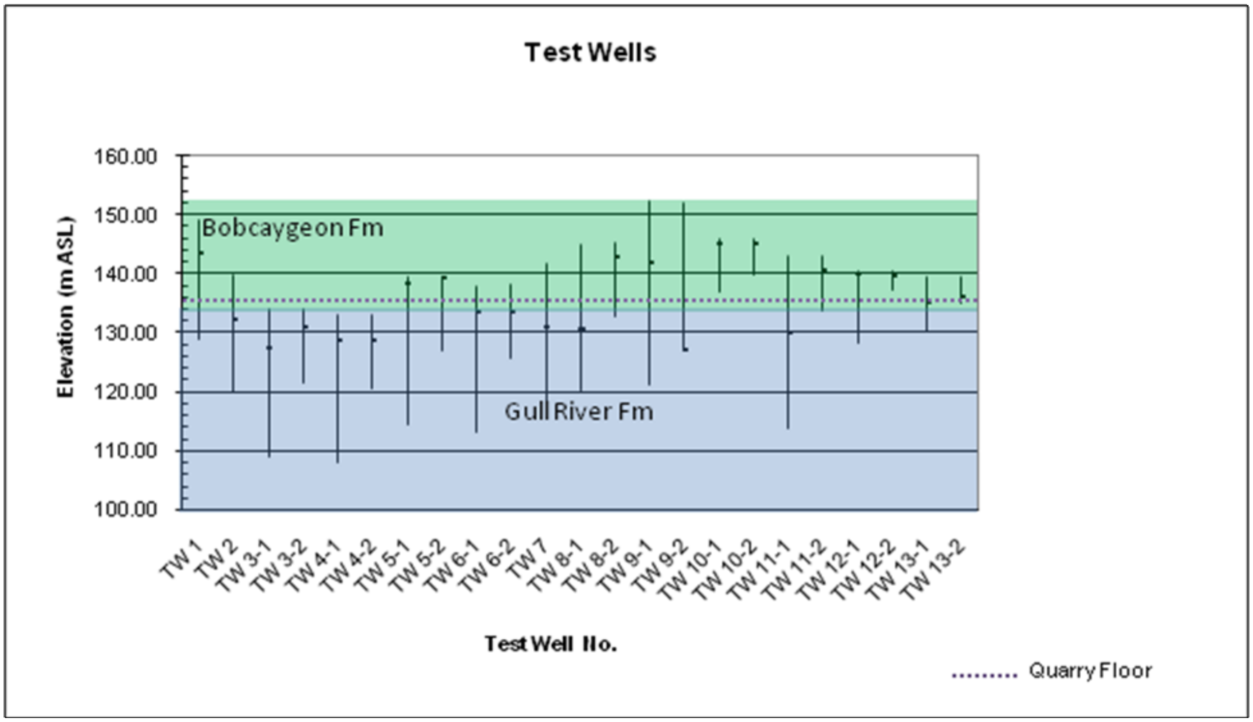


Figure 5: Elevation of Test Wells



6.1.2 Weathered Bedrock Zone Aquifer

The weathered bedrock aquifer is a zone of a variable thickness that has undergone weathering since the glacial period. Flow in the shallow weathered aquifer flow is localized in scope, and the available data indicated that the shape of the water table mimics the topography, controlling the surface water flow. This aquifer is predominantly unconfined. It is the dominant conduit for the drainage of precipitation and meltwater on the site and adjacent areas.

The weathered bedrock aquifer is discontinuous and flow volumes vary seasonally. The more permeable portion of this surface aquifer is restricted to the flanks of the plateau, The thickness of the weathered bedrock varies up to approximately 10 m with the saturated thickness up to about 5 m. The weathered bedrock is developed into the plateau, in widths ranging from approximately 100 to 400 m.

About 25.5 ha in total or 19% of the proposed licensed area, and approximately 12 ha of the proposed extraction area, consists of weathered bedrock at surface. The weathered zone is shown on Figures 1 and 6.

The hydraulic conductivity measured in the weathered bedrock zone ranges from 7.3 x 10^{-9} to 7.3 x 10^{-5} m/s.

Table 1: Summary of 2007 Borehole Pumping Test Results

Test Well	Test Interval (m ASL)	WBZ[1] Observed (m ASL)	$T_{Pumping}$[2] (m^2/d)	$T_{Recovery}$ (m^2/d)
1	128.9 – 147.8	--	0.06	ID[3]
2	119.8 – 138.1	--	0.17	0.079
3-1	109.5 – 128.4	110.4 and 119.9	1.03	0.29
3-2	121.7 - 128.4	126.9	0.09	0.11
4-1	108.5 – 127.4	112.1	0.26	0.40
4-2	120.9 – 127.6	--	0.08	0.12
5-1	114.9 – 133.8	--	0.11	ID[3]
5-2	127.1 – 133.8	--	0.08	0.16
6-1	113.0 – 133.3	117.3	0.18	ID
6-2	125.7 – 132.5	--	0.02	ID
7	116.8 – 136.3	129.0	0.21	0.37
8-1	120.0 – 139.6	121.8 and 134.0	0.59	0.83
8-2	132.6 – 139.6	--	0.02	0.04

Notes:

1. WBZ – water bearing zone;
2. Jacob and Theis equations are used for calculation of transmissivity (T)
3. ID – insufficient data;
4. Data excerpted from Part 2, Table 8.

Table 2: Summary of 2009 Well Response Test and Packer Test Results

Test Well	**Test Interval (mASL)**	**K (m/s)[1] Rising Head Test**	**Potential K (m/s) Packer Test (Pump in)**
9-1	122.0 - 123.5	2.09 x 10^{-6} (T1) 2.59 x 10^{-6} (T2)	4.41 x 10^{-7}
9-2	141.8 - 143.3	1.41 x 10^{-7}	2.58 x 10^{-5}
10-1	131.4 - 134.4	1.15 x 10^{-7}	4.72 x 10^{-8}
10-2	140.7 - 143.7	2.51 x 10-^{6}	2.4 x 10^{-6}
11-1	113.7 – 117.0	3.64 x 10^{-8}	1.71 x 10^{-8}
11-2	134.8 - 136.3	6.01 x 10^{-9} [2]	3 x 10^{-8}
12-1	129.2 - 132.2	ID[3]	7.6 x 10^{-8}
12-2	138.3 - 140.4	2.45 x 10^{-7}	2.7 x 10^{-5}
13-1	131.0 – 132.5	1.46 x 10^{-8}	0
13-2	135.9 - 137.4	7.28 x 10^{-9}	7.3 x 10^{-5}

Notes:

1. Hvorslev solution used for analysis of well response test data to estimate hydraulic conductivity (K);
2. Field data from TW11-2 analysed with Aqtesolv, see Appendix D
3. ID – insufficient data;
4. Data excerpted from Part 2, Table 10.

The packer testing at TW 13 in particular showed that in the upper weathered bedrock zone, while there may be voids within the bedrock (vugs, coral) they are not necessarily hydraulically interconnected. For example, the packer tests between 130.3 to 131.8 m ASL, and 133.3 to 134.8 m ASL showed how the voids around the test hole filled with water, but that once they were filled, the medium became impervious.

The existing quarry is situated both entirely within the weathered bedrock zone and within the most highly weathered part of the property. The expansion will extend into weathered bedrock as it progresses northward, but will not be in the weathered bedrock zone as it expands eastward.

6.1.3 Upper Competent Bedrock

The upper competent bedrock zone is shown on Figures 1 and 6. The zone is an aquiclude to aquitard, mainly consisting of low permeability rock of Bobcaygeon Formation. The 2009 borehole log showed that from approximately 0.45 m and below, the bedrock is massive with no open fractures or bedding planes. The upper 6 m has a slightly higher hydraulic conductivity than that below. The area on the central to east part of the Miller property, where the zone occurs, corresponds with the surface water accumulations in the depressions or swales on the bedrock surface identified after rainfall events.

The potential hydraulic conductivity for this part of the site, where a value could be measured, is on the order of 10^{-6} m/s but for over half the test sections where results were representative of in-situ conditions, the results were not calculable. The hydraulic conductivity measured from the well response tests ranged from 6.0×10^{-9} to 1.2×10^{-7} m/s.

The potentiometric data for the upper competent bedrock is summarized in Table 3.

Table 3: Hydrostratigraphic Setting of Site Groundwater Monitors

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	POT ELEV. 22-Jul-09
Weathered Bedrock Aquifer – flanks and Central Part of plateau				
TW 9-2	152.19	142.9[1]	140.76[1]	141.60
TW 10-2	145.72	143.3[1]	139.64[1]	145.19
TW 12-2	140.28	139.7[1]	137.23[1]	139.73
TW 13-2	139.52	138.5[1]	134.95[1]	136.33
Upper Competent Bedrock, Central Part of Plateau				
TW 1	148.98	147.78	128.87	141.05
TW 5-1	139.26	133.77	114.26	138.14
TW 11-2	142.91	137.4[1]	133.8[1]	142.34
TW 12-1	140.33	131.7[1]	128.14[1]	139.89
Competent Bedrock - Significant Water Bearing Zone Likely Intercepted				
TW 2	139.60	138.10	119.80	133.14
TW 3-1	133.90	128.41	108.90	126.39
TW 4-1	132.92	127.43	107.92	128.38
TW 4-2	133.09	127.60	120.59	128.47

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	POT ELEV. 22-Jul-09
TW 6-1	137.95	133.28	112.95	133.41
TW 7	141.79	136.30	116.79	130.56
TW 8-1	144.97	139.48	119.97	130.41
TW 9-1	152.04	123.1[1]	120.95[1]	125.93
TW 11-1	142.81	116.0[1]	113.85[1]	129.74
Competent Bedrock above Significant Water Bearing Zone				
TW 3-2	133.88	128.39	121.38	130.91
TW 5-2	139.27	133.78	126.77	139.17
TW 6-2	138.23	132.46	125.73	133.38
TW 8-2	145.05	139.56	132.55	143.16
TW 10-1	145.72	134.0[1]	130.36[1]	145.12
TW 13-1	139.41	131.0[1]	128.9[1]	136.06

Notes:

1. Elevations refer to the top of sand pack and base of well screen.

6.1.4 Competent Bedrock Aquifer

This aquifer was observed below the Upper Competent Bedrock and consists of the thick Gull River Formation underlain by the Rockcliffe Formation as shown on Figure 6. The aquifer with discrete water bearing zones is generally a poor aquifer as a whole and confined below the Miller property. The aquifer may become unconfined where exposed at surface at lower elevations along the flanks of the plateau. Between the zones, the bedrock is impervious.

The 2006 door to door interviews of the area found that two significant water bearing zones are generally used. The upper one was usually reported from 119 m to 109.5 m ASL. A deeper one, encountered at an elevation of approximately 80 m ASL or 61 m below the surface. None of the test wells intercepted this lower zone as the hydrostratigraphy was not investigated to this depth. Elevations of off-site water-bearing zones are approximate. It is normal for the elevation of the water-bearing zone to vary spatially. The upper two significant water bearing zones are situated within the Gull River Formation. Analysis of the geology for the area indicates that the lower aquifer is within the Rockcliffe Formation.

6.1.4.1 Discontinuous Water Bearing Zones

Open test holes 7 and 8-1 report water bearing zones in the competent bedrock of 129.0 and 134.0 m respectively. These zones at the higher elevations were not noted or logged in any of the other test wells. These zones may intersect the side of the plateau within a distance of approximately 300 to 350 m. An examination of the potentiometric data for these two wells illustrates that the zones provide a very small seasonal contribution to the aquifer. The potentiometric elevation may rise above the water bearing zone in the spring recharge period, but drops down to and below the zone through the season.

These discrete water bearing zones, which occur at or just below the contact between the Bobcaygeon and Gull River Formations, are of low yield and are very localized and discontinuous across the site. Therefore, they are insignificant from a water supply point of view.

6.1.4.2 First Significant Water-Bearing Zone

The first significant or highest consistent water bearing zone found on the Miller property is situated typically between 117 and 120 mASL on the properties, but the top of the zone was measured as high as 121.8 m ASL (BH 8-1) at the south end. The additional drilling, testing and coring intercepted the zone in TW 9-1 and TW 11-1.

Like the contact between the Bobcaygeon and Gull River Formations (Part 2, Section 14.2), the significant water bearing zone rises at the south end of the properties, where the upper limit of the zone was mapped at 121.0 m (BH 9-1) and 121.8 m ASL (BH 8-1). In the southern-most +/-100 m of the proposed excavation, the water-bearing zone rises slightly to its maximum recorded in the south-east corner of the properties. The zone is most *commonly* found between 117 and 120 m ASL on the Miller property and as reported in area water well records.

There are 9 monitors on the Miller property that appear to intercept the significant water bearing zone. The monitors are listed in Table 3 and the potentiometric data is found in Appendix C. The potentiometric elevation across the plateau was reported at between 125 m ASL at the flanks of the plateau increasing to approximately 135 m ASL in the centre. The data show that the potentiometric rises as high as 138.3 m ASL in the central part of the Miller property (TW 5-1), decreasing to the east and west. The interpreted direction of groundwater flow in the significant water bearing zone is shown on Figure 3. The variation of potentiometric elevation with time is shown in Figure 4.

The aquifer is confined below the Miller property and may become unconfined where exposed at surface at lower elevations. Here, springs along the lower flanks of the plateau emerge. The potentiometric contours illustrate that the topography of the escarpment is a strong controlling factor on even the confined hydrogeology.

Information from area wells in the door to door survey identified additional water bearing zones within the Gull River and Rockcliffe Formations. Below the first significant water bearing zone described above, the next recorded significant water bearing zones in the area are between 105 m ASL and 110 m ASL, and around 79 m ASL. The potentiometric surface of the deeper confined bedrock aquifer is deep, at around 80 m ASL.

6.2 Surface Water and Drainage

The surface water and drainage mapped over the period of March through June 2010 is shown on Figure 7. The surface drainage on the site and in the surrounding area consists of overland flow integrated with localized sub-surface migration.

6.2.1 Surface Water Accumulations on Competent Bedrock

Surface water accumulates in the saturated overburden and lower lying surfaces and depressions of the competent bedrock portions of the site. These areas are predominantly on the top of the plateau, and on the steps on the slopes, including the sediment-filled trough in the north-west corner of the site. The areas shown on Figure 7 are typical; there may be others that are intermittent or were not found in the multiple site traverses. The boundaries of the wetland features shown on Figure 7 are approximate and reflect the conditions observed during GRI's mapping. The hydrology and natural environment reports (Skelton Brumwell Associates (SBA), 2011) should be referred to for boundaries of key features.

6.2.2 Springs

The accumulated surface water flows overland following the surface topography until the weathered bedrock zone is encountered. At this point, the surface water drains into the dissolution fractures and flows below surface to emerge at the base of the dissolution as springs. The upper spring elevation is found approximately between 133 m ASL and 137 m ASL, initially developed because of the position on the flank of the plateau during the late glacial period.

The surface water that emerges in the form of the upper springs flows again along the base of the upland of Bobcaygeon Formation and then subsequently overland following the local surface topography until it nears the edge of another topographic drop where it meets the lower dissolution/ weathered bedrock zone. The surface water drains into this dissolution zone and emerges below in the form of the lower springs, at around elevation 125 m ASL. This is just above the base of the escarpment and the contact between clay (referred to as Renfrew clay loam in the hydrology report) and upland till/ bedrock (referred to as Farmington loam in the hydrology report). This flow pattern can be observed along the entire plateau, on both east and west sides.

6.2.3 North-West Wetland

On the north-west corner of the study, the natural environment report shows a wetland feature that is partially on the Miller property. The topographic mapping shows that this feature is originally present because of a natural bedrock trough filled with clay that had natural drainage constrained by the construction of Usborne St (Figure 2). The feature originally received drainage from up-gradient to the north which was augmented, due to its topographical positioning at to just below the upper spring elevation, with seasonal spring water. Currently, this surface water feature is now also augmented with the quarry discharge and a beaver dam.

The path that the quarry discharge takes through the wooded area was mapped and is shown on Figure 7. The flow follows a channel partially constructed (for approximately 4 to 5 m) and then through a natural channel, until it emerges into the wetland on the Miller property. The wetland has an outlet that is beyond the Miller property, which exits at Usborne Street at Campbell Drive and then meanders back through the Miller site before discharging again into the east roadside ditch on Usborne Street at the culvert.

The water level in the wetland was observed to increase noticeably by 5 to 10 centimetres initially for a short time when the quarry is discharging. These specific observations were made on July 3 following an extended rainfall period so the increase could not be attributed exclusively to quarry discharge since as noted above, there are other sources of recharge to this wetland. It was observed at this same visit that the water level did not increase at the wetland outlet at Usborne Street. A new beaver dam was found in the approximate location shown on Figure 7.

6.2.4 South-East Wetland

A small wetland area located on private property and found south-east of the Miller property originated because of a combination of factors; a topographically suitable bedrock depression on the competent bedrock step directly at to slightly below the elevation that the upper springs emerge. The natural heritage evaluation indicates that the wetland appears to be a typical example of the small, shallow, beaver-maintained ponds found commonly across southern Renfrew County. Although the pond has not been evaluated, it is the opinion of the team ecologists that there are no indications of significant natural features or functions here nor strong indications of the potential for such values to occur .

This wetland has an outlet, shown on Figure 7. The water level will vary seasonally, depending on the spring flow and beaver activity. The flow from the outlet had significantly decreased in the May 22-26 2009 visit in comparison to the peak flows observed in mid-April. The water level in the pond is also controlled by extensive beaver activity in the area.

7 Impact Assessment

The following sections provide assessment of potential impacts on groundwater and surface water due to long term quarry dewatering. As discussed in Section 6.1 above, only two aquifers, the weathered bedrock aquifer and the first significant WBZ within the competent bedrock aquifer below the future quarry floor, are identified to be more permeable and relatively consistent across the site. The groundwater impact assessment in this section, therefore, focuses on these two aquifers. The impact assessment for surface water focuses on the springs, the onsite north-west wetland and offsite south-east wetland as well as the adjacent Ryan Creek.

7.1 Weathered Bedrock

In the pre-quarry hydrogeological setting area, local groundwater recharge occurred by the infiltration of precipitation and snowmelt into the upper weathered bedrock and would subsequently migrate down into the competent bedrock zones. Springs through the base of the escarpment on the clay plain and Ottawa River side would provide recharge to the surface water systems and overburden aquifer, where present.

Mapping shows that approximately 25.5 ha in total or 19% of the proposed licensed area and approximately 12 ha of the proposed extraction area, has weathered bedrock upon it. The existing excavation, as noted previously is entirely within the weathered bedrock zone and the zone has been fully penetrated.

The weathered bedrock zone has an in-situ hydraulic conductivity of 7.3 x 10^{-9} to 2.9 x 10^{-8} m/s and a potential k of 7.3 x 10^{-5} m/s. The dissolution develops from none, at the competent bedrock, and increases to the outer edge, where the degree of development is highest. The location of TW 10 represents characteristics of a lower degree of development, while the locations of TW 9 and TW 13 represent an area of the site with the highest degree of weathering. The highest potential k was measured in TW 13-2, which is situated hydrostratigraphically in the range of the upper spring elevation in an area with the most highly-developed dissolution on the Miller property. This higher value represents this particular discrete interval and there is no coincidence that the higher k corresponds with the part of the stratigraphy where the upper springs are located. The lower values would represent a more average value over a broader profile – the voids filling and then having no outlet or a more restricted outlet - and discrete competent bedrock in the intervening beds.

To evaluate the impact of the quarry operation on the weathered bedrock zone, a saturated thickness of approximately 2.5 m on average and the highest potential hydraulic conductivity (7.3 x 10^{-5} m/s, or 6.3 m/d) measured during packer testing at monitor 13-2 were used. A theoretical drawdown cone was calculated using modified Theim Equations for steady state conditions assuming ideal aquifer conditions (homogeneity, uniform saturation, uniform thickness, isotropic hydraulic conductivity) and the highest potential hydraulic conductivity to calculate a worst case assessment. The discharge of 308 m^3/day, is the average of the 112,491 m^3 water surplus calculated for the existing quarry. An example of the theoretical calculation is presented in Appendix E. If an average saturated thickness of 2.5 m is used in the calculations, the effect of the excavation on the weathered zone could extend to approximately 780 m from the centre of the quarry and 306 m from the edge of the excavation. The approximate zone of influence is shown on Figure 8.

The radius of influence in the weathered bedrock was also calculated using the drainage equation (Hooghoudt, 1936) taking into account the recharge from precipitation. The conceptual model and equation, hydraulic parameters, data source and calculation are presented in Appendix D. The data show that the radius of influence could range from about 91 m to 186 m for the averaged potential hydraulic conductivity (K_a = $1x10_{-5}$ m/s to $5x10_{-5}$ m/s). If the highest hydraulic conductivity (7.3 x 10^{-5} m/s) found at monitor 13-2 is used, the radius of influence would reach about 269 m, generally comparable to the result using the Theim Equation, as discussed above.

The down-gradient impact of the expanded excavation on the weathered bedrock zone will be restored as long as the quarry sump discharge continues in the same pattern as it now does while the quarry is operated and during the period when the final excavation is filling. The existing discharge pattern restores the weathered bedrock zone hydrogeology by distributing the accumulated water back into the pathway it would have followed in pre-development. There is one small zone where the upper spring will be disrupted by the excavation, but again, the system will be restored to the lower elevations by the discharge.

Any impacts to the weathered zone and the springs are mitigated by the discharge pattern from the sump. The water that accumulates in the sump originates from overland runoff and drainage through the weathered bedrock zone. This accumulated water is discharged back to surface contributing to the north-west wetland shown on Figure 7, restoring the flow to its original flow pattern.

Therefore, in the north-west area of the Miller property where the weathered bedrock may potentially be impacted by the proposed expansion, the effects are now and will continue to be, mitigated by the operation through the operations as long as the present operational practices re the sump discharge are continued.

The offsite south-east wetland is not considered to be a significant feature as discussed in Part 1, Section 6.2.4. The wetland is mainly fed by surface runoff from a drainage area exclusive of the quarry lands, although minor inputs from the upper spring zone may occur in wet seasons. As contribution from the springs is negligible compared to surface runoff, no significant effect on the wetland will be expected as a result of loss of the contribution from the springs due to impacted weathered bedrock immediately south-east of the quarry excavation, Potential impacts on the wetland due to loss of the drainage area is further discussed in Part 1, Section 7.3.3.

7.2 Competent Bedrock Aquifer

The competent bedrock aquifer, mainly consisting of the Gull River Formation, is generally a poor aquifer as a whole. The First Significant Water Bearing Zone (WBZ) found in the Gull River Formation is a more permeable zone within the formation. The WBZ is more continuous and consistent across the site and potentially extends offsite representing a source of local water supply.

Appendix D contains a calculation completed by AECOM evaluating the potential zone of influence of the proposed expansion on the water-bearing zone *commonly* encountered between 117 and 120 m ASL. The calculation assumed, conservatively, that the aquifer is homogeneous, planar and of indefinite extent. The results found a potential drawdown of about one metre in the aquifer at a distance of 700 to 800 m and about 1.5 m at 300 to 400 m from the lower lift pump chamber, if the quarry intercepted the water bearing zone through it. The lower lift pump chamber is proposed in the northeast area of the existing quarry. The lower lift pump chamber has also been referred to in previous hydrogeological reports and in other technical reports as the lower lift sump. The decision to refer to the feature as the lower lift pump chamber in this and the final hydrology report was made to prevent confusion with the use of the word sump, which is used to refer to the sump used for discharging accumulated water from the excavation, and which is part of a Works described on the Certificate of Approval for Industrial Wastewater Treatment (the Discharge Permit, now known legally, effectively October 31, 2011, as an Environmental Compliance Approval (ECA).

The radius of influence is shown on Figure 9 along with potentially-affected groundwater and surface water features. The theoretical line is shown, however the actual potentially- impacted area is shaded. Areas within the theoretical line outside the shaded area will not be impacted because the ground elevation is below the proposed base of the quarry at approximately 125 mASL.

Wells shown on Figure 9 in the shaded area are within the radius of influence of the future lower lift pump chamber and would potentially experience 1 m drawdown based on theoretical calculations. However, there has been no reported decrease in well water availability resulting from the existing quarry operation. Similarly, monitoring wells within this zone of influence have not exhibited drawdown effects attributable to the existing quarry operation.

The closest off-site well is approximately 200 m from the southwest corner of the existing excavation. At this distance from the future lower lift pump chamber, a potential drawdown of 1 m is predicted. Even if the chamber was located at the southwest corner of the excavation, 200 m from the nearest well, the drawdown effect would be approximately 1.7 m. This is not the case, however, as the floor for both the Upper and Lower lifts in the excavation slopes to the northeast based on the quarry design and the lowest point of the lower floor will be in the northeast corner of the existing quarry and as a result, the closest well is actually located about 600 m from the future lower lift pump chamber.

The proposed extraction boundary was specifically drawn to maintain a minimum of 300 m from neighbouring residences to conform to the McNab-Braeside zoning requirements. This means that some of the wells within 500 m of the proposed expansion area are at or further than 300 m from the excavation. Although most of these wells are about 300 to 400 m of the west and north boundaries of the future excavation, they are located about 600 to 800 m or more from the future proposed lower lift pump chamber in the northeast corner of the existing excavation. At this distance, a drawdown of 1 m for wells using the first significant water bearing zone exclusively is predicted assuming the lower lift pump chamber intercepts the same zone. For wells for which available data was examined in this study, this decline, should it occur, would not result in a decline in well water availability.

To avoid the first significant water bearing zone, the pump chamber will not extend below 123 mASL. Also, to minimize opening of fracture, the final 2 m of rock will be loosened by jack hammer rather than blasting when drains or pump chambers are installed.

7.2.1 Analysis of Available Drawdown in Surrounding Water Wells

Wells in the area surrounding that rely on deeper water-bearing zones in addition to the first significant zone which will not be affected by the operation, and will not therefore experience impacts.

The available private water supply well information collected during the door-to-door survey has been compiled to assess available drawdown within wells that may theoretically be affected by the proposed quarry.

The following information (Tables 4 and 5) was compiled from data found in Sections 15 and 18 found in Part 2, the Supplementary Information. A statistical evaluation was completed first on all the previously analyzed water well records for the study area, and next locally on the identified water well records within the theoretical radius of influence that was presented in the June 2010 report. The water well records were used to calculate the available drawdown in the wells from the well depth and the reported static level data (Table 4).

Table 4: Analysis of Available Drawdown in Water Wells from MOE Water Well Records

Available Drawdown	**Previously Analysed Well**		**Identified Well Records**	
	# of records	**% of records**	**# of records**	**% of records**
< 10	0	0	0	0
10 - 15	3	4.2	2	13.2
15 - 20	8	11.3	3	20.0
20 – 25	11	15.5	3	20.0
25 – 30	8	11.3	0	0
30 - 35	5	7.0	2	13.3
>35	36	50.7	5	33.3
Total records analysed	**71**		**15**	

*Gorrell Resource Investigations, November 2007

The analysis also found that the maximum available drawdown was 78.3 m for all previously analyzed well records, and 63.1 m for identified well records within the radius of influence. The minimum available drawdown was 11.3 m, according to the analyzed well record data for all records analysed.

Next, the door-to-door survey information completed in 2006 and 2009 was also examined. The survey provided the following information on the water supply wells within 800 m of the proposed lower lift pump chamber. For the table below, a water well record was matched with a specific site, or a measurement was made in the field. BGC has a moderate to high level of confidence in the accuracy of this information.

The calculation by AECOM provided as Appendix D indicated a predicted drawdown of 1.0 m at 800 m from the proposed lower lift pump chamber. Comparing the predicted drawdown to the available well data indicates that this predicted drawdown (1.0 m) would comprise at most 10% of the available drawdown. The percentage of available drawdown depends on distance from the sump; with 1 m drawdown predicted at a distance of 800 m from the lower lift pump chamber. The nearest measured well from the lower lift pump chamber shown on Figure 9, based on available data is approximately 520 m away. The calculation would conservatively predict a theoretical drawdown of between 1.5 and 1.0 m at this location. The well was not accessible for measurement during the door-to-door survey, nor was a water well record available.

Table 5: Well Depth and Available Drawdown in Surrounding Private Wells in the Vicinity of the Proposed Lower Lift Pump Chamber (2006/ 2009 Door to Door Survey Data).

Site Reference[A]	Well Depth (m)[B]	Date Water Level Measured	Water Level (m)	Approximate Distance	Available Drawdown[C]
5818	24.4	June 2009	16.4	655	8.0
5729	25.9	June 2009	13.1	735	12.8
5900	35.1	June 2009	10.0	700	25.0
6621	27.1		n/a	1,000	n/a
7318	unk	August 2006	13.0	520	n/a
7543	unk	August 2006	13.8		n/a
6129	unk	June 2009	7.0	770	n/a
7335	54.3	June 2009	20.4	940	33.9
6938	unk	June 2009	13.1	870	n/a
6874	45.7		n/a	810	n/a
6723	38.1	June 2009	10.6	800	27.5
6632	73.2		n/a	780	n/a
6599	32.0	June 2009	4.2	730	27.8
6540	30.5	June 2009	9.5	850	21.0
Ground Surface at Well Head Lower than Quarry Base (By Elevation)					
5764	72.5	June 2009	16.5	670	56.1

Notes:

A. Specific location data cannot be published in a public document for privacy reasons, but is available to authorized personnel.

7.2.2 Quarry Sump

The sump at the quarry, which is located on the floor of the upper lift in the quarry, has been in the present location since at least 2002. The accumulations in the sump originate from overland runoff and shallow weathered bedrock zone; indications are that contributions from groundwater in the competent bedrock are negligible. The hydrology analysis (SBA 2011) showed that on average over the 5 years of data examined, the quantity of water discharged from the sump matched the water surplus within 18%.

In the mid to late summer when precipitation declines, the water level in the sump gradually lowers as the sump water is used for dust control and other approved purposes. The lowering of the sump level indicates that without runoff, there is no recharge to the sump.

7.2.3 Lower Lift

The initial cut for the second lift was made in August 2009. The lower lift was created with a slope towards the north-east corner, similar to the floor of the upper lift. The lower floor elevation is approximately 125.8 m ASL at the lowest and is generally 126.41 m ASL according to the total station survey completed in late September 2009.

Observations of the lower lift taken since it was created, illustrate that immeasurable seepage on the lift wall in the K-bentonite zone shows clearly at 5 m down from the upper lift marking the contact between the Bobcaygeon and the Gull River Formations. The floor has also been observed to be dry through the fall except after precipitation events. This observational data combines to show that there is no seepage occurring through the lower lift.

7.2.4 Vertical Seepage

As the hydraulic head of the first significant water bearing zone (WBZ) would likely be above the final quarry floor (125 mASL) over much of the year, upward gradients would exist and as a result, upward seepage from the WBZ would potentially take place through the quarry floor, albeit, very small.

A supplemental assessment of effects from the upward seepage is provided in Appendix D (Section 4.3 and attached Calculation Sheet 2). These calculations consider seasonal variation of upward gradients based on water level data from monitors below the existing quarry floor. The calculations also assume the vertical hydraulic conductivity of bedrock is one order of magnitude lower than the horizontal hydraulic conductivity. The calculations and discussions in Appendix D support the results of the previous assessment presented in Section 19.1 in Part 2, and conclude that no significant effect will be expected due to vertical seepage on the water bearing zone.

7.3 Surface Water

The springs and to a much smaller degree, the identified surface water features (the north-west and south-east wetlands) are dependent on the groundwater in the weathered bedrock zone. The recharge is seasonal and variable, depending on annual climate and activities of both humans and beavers in the surrounding area.

The quarry discharge is currently directed to the north-west part of the properties. The discharge contributes to maintenance of the wetland in this area which in turn drains offsite into the local drainage network. Any potential impacts to the weathered bedrock zone in this area are already mitigated by this system. Continuation of this practice will provide the mitigation of potential impacts to the north-west wetland from the proposed quarry expansion.

7.3.1 Springs

The springs in the north-west portion of the Miller property could potentially impacted by the proposed operation. In this area, the excavation approaches and may intercept part of the upper spring zone.

The hydrogeological aspect of the springs is already affected by the existing quarry. The existing quarry is situated entirely within the weathered zone. The radius of influence, calculated to be up to 300 m, now encompasses the entire upper weathered zone around the existing excavation. The existing impact area was examined in the natural heritage evaluation (SBA, 2011b), and the evidence collected showed that the vegetation within the theoretical impacted area (hydrogeology) has not been affected by the quarry.

The upper spring zone occurs where the weathered bedrock zone contacts underlying competent bedrock between approximately elevations 133 to 137 m ASL. The discharge from the springs flows across the competent bedrock step in the slope before draining abruptly into dissolution and emerging again at the base of the second weathered zone at the lower spring zone. In the north-west portion of the Miller property, the spring zone emerges into the wetland.

A small portion of this spring may be diverted into the excavation under the proposal. If this occurs, the infiltration will accumulate in the sump and will be pumped back out to the wetland. Therefore, there may be a temporary diversion of a small quantity of water that in the pre-development setting emerged as springs but in the post development will be re-circulated through the quarry.

During the operations, the impact to the local hydrogeological system will be completely mitigated by the quarry de-watering operation. A small portion of the upper springs will be diverted into the excavation between cessation of operations and full rehabilitation. At full rehabilitation, the flow will be re-established to the pre-development condition with the quarry lake as the recharge source.

The groundwater impacts on the weathered bedrock zone will be monitored as described in Part 1, Section 8. No additional monitoring will be required.

7.3.2 Wetlands in North-West part of Miller Property

This surface water feature developed upon the clay-filled trough scoured into competent bedrock. There is no hydraulic connection between competent bedrock and the identified surface water features in this area.

The current quarry discharge will continue and contribute to the wetland. The weathered bedrock contributes to these wetlands in a minor way through recharge from the upper springs at approximately 135 to 137 m ASL. The upper springs are not the exclusive or primary recharge source to the wetland. The wetland exists primarily because of the Usborne St construction which impeded the natural overland runoff. The runoff will continue post-operation, and it is the significant contributor to the feature.

The natural heritage assessment (SBA, 2011b) determined that the north-west wetland has local significance supporting common, representative vegetation and has the potential to support special features. The adjacent coniferous swamp forest is of similar status but has some Special Feature representation. The overall natural heritage value of this small wetland is minor according to the natural heritage assessment, and monitoring of the hydrogeological effects is not required. In the worst case, when the quarry is filling in the post-operations stage, a theoretical 17% reduction in drainage area could be diverted into the quarry (J. Clark, SBA, pers. comm.). However, this area is already within the radius of influence of the existing quarry with no natural heritage impacts evident. Monitoring and mitigation will not be required for this stage.

7.3.3 Off-Site Wetland South-East of Miller Property

The wetland is situated within a low-lying area of the competent bedrock. The hydrology report (SBA, 2011) indicates that approximately 1% +/- of the drainage area (approx. 0.8 ha of the total 77 ha area) of the feature is within the proposed excavation of the expansion. The opinion in the hydrology report is that the reduction in runoff and base flow to the feature from the loss of this capture area is "negligible".

The springs that contribute to the wetland are indirect surface water flow within the same drainage area. The recharge source for the springs in this area coincide with the area of competent bedrock within the wetland drainage area, which is equivalent to the area of impact identified in the hydrology report. Since the wetland is not groundwater dependent, the proposed expansion of the quarry will have an insignificant impact. No monitoring of the springs that contribute to the feature is therefore required.

7.3.4 Impact of Quarry on Base Flow to Ryan Creek

The potential for contribution of the groundwater at the quarry to base flow at Ryan Creek was evaluated. The opinion is formulated from evaluating the Miller property setting and hydrogeology, the surrounding geology and from observing the hydrology between the site and Ryan Creek since monitoring began in 2007 for the Discharge Permit.

The geology of the plateau consists of thin till and sand and gravel over bedrock. As described, there are portions of the escarpment face that consist of weathered bedrock, and this development initially during the post-glacial period, but continuing through the last 10,000 years has resulted in an interconnected surface water – shallow groundwater flow system consisting of runoff, abundant surface water accumulations and two levels of springs on the escarpment face on both the east and west sides. The patterns of flow were noted previously but were mapped in detail in the spring and summer of 2009.

The mapping showed a consistent pattern where the springs emerge at the base of the escarpment. Just down-slope on the plain below, the escarpment developed at depth below the surface of the Champlain Sea, and a thickness of clay, determined to be on the order of 7 m from local water well records, was deposited. This clay has a very low primary and secondary hydraulic conductivity, which results in a very low transmissivity. Any groundwater originating from the escarpment emerges as springs to the surface at the base of the escarpment or continues downward through the bedrock flow system.

Due to the low hydraulic conductivity/ transmissivity of the clay, any well or other discharge point such as a creek would be capturing groundwater from no further than 200 to 300 m. Therefore, no groundwater from the escarpment, either from the quarry site or the plateau itself is providing base flow to Ryan Creek.

To verify this conclusion, flows from the discharge point on the quarry site through to Ryan Creek have been observed on a regular basis for 2009.

Groundwater that emerges as springs at the base of the escarpment drains overland through the roadside drainage network. During periods of peak flow, such as spring runoff or significant precipitation events (such as the 1:100-year or more- severe storm that occurred on July 24, 2009), runoff from the base of the escarpment combined with runoff through the drainage network from Usborne Street, down Campbell Road and then along Carmichael Road does reach Ryan Creek, but this period is brief. In periods other than these peak or anomalous events, the flow in the drainage system was observed to end consistently along Campbell Road.

From this point on, the drainage system is dry to Ryan Creek. The location was marked each time a monitoring event is completed since monitoring for the discharge permit began in the spring of 2009 through that monitoring year. The quarry began dewatering on March 23 2009 and weekly observations were made through to April 28, followed by monitoring events geared to various stream and quarry stages during the season. SW 5, one of the monitoring stations for the discharge permit, is situated approximately half-way between Campbell Road and Ryan Creek. The records indicate the following from 2007 to 2009:

Quarry Pumping Commences for Season	Observation Date	Status of Flow at SW 5
2007: April 10, 2007	April 19 2007	Spring runoff, flow
	July 20 2007	Significant precipitation event, flow
2008: April 8 2008	April 9 2008	Spring runoff, flow; 15 cm water depth @ 15.5 m/s
	April 28 2008	0.10 cm water@ 7.4 m/s
	May 5 2008	6 cm @ 0.67 m/s

	May 20 2008	Dry
	June 3 2008	Dry
	Oct 10 2008	Dry
	Oct 15 2008	Dry
2009: March 23 2009	April 6 2009	12 cm @ 11.7 m/s
	April 20 2009	7 cm @ 3.13 m/s
	April 30 2009	4 cm @ 1.98 m/s
2009: March 23 2009	June 9 2009	Dry
	July 22 2009	Dry
	July 25 2009	Storm 1:100 or more severe on July 24. Significant flow but damage to observed area watercourses widespread. Less than a week later, SW 5 was dry again.

During the above-referenced period, there was no flow to Ryan Creek observed from the plateau under normal weather conditions from mid-May through to the end of the year. The actually impact of the quarry discharge is minimal if there is any. In 2009, there was a significant precipitation event on July 24. At that time, roads in the township and cottages along the Ottawa River were severely impacted by flooding and wash-outs. Post-event photographs of the area where the quarry discharges reaches Ryan Creek showed that the significant impact came from the opposite side of the creek as evidenced from the matted vegetation and the gravel bars that developed in the creek.

In a memorandum dated November 28, 2008, Muncaster Environmental Inc. outlined the work completed on the aquatic habitat of Ryan Creek. The memorandum noted some vegetation that might be indicative of groundwater upwelling that contributed to the watercourse base flow. The areas were examined and the geological and hydrogeological conditions were noted on several occasions through 2009. No seepage was observed on any of the occasions.

Ryan Creek is located about 800 m west of the quarry excavation with the creek bed in overburden at an elevation of about 105 mASL well below the final quarry floor (125 mASL). Even if seepage were observed in the vicinity of the creek, it would be from localized sources and the groundwater would originate from within 200 to 300 m of the top of the banks; there would be no contribution by the quarry or discharge. The reasons include separation distances, the geological composition of the soils and the fact that the quarry will not impact the confined bedrock aquifer.

In the pre-development condition, the discharge from the quarry would have flowed into the system through the springs and then overland towards the creek. There is no groundwater currently entering the quarry from below the weathered zone, so the quarry operation is currently adding no additional flow to the system. The current quarry discharge management removes water diverted from the pre-development setting but restores it to the normal flow pattern below the upper springs in the small wetland on the Miller property. Therefore, the existing flow pattern from the quarry is consistent in direction and quantity from the flow pattern before any quarry was established.

8 Groundwater Monitoring Plan

To provide ongoing assessment of the conceptual model, and to refine impact predictions, the bedrock zone will be monitored groundwater monitoring program. Monitoring of groundwater will be used to confirm the assessment on both groundwater and surface water conditions. Under current legislation, the monitoring program will be administered through the PTTW.

Groundwater monitoring is currently undertaken under the direction of the PTTW. That program entails measurement of water levels in the Miller property wells every other month.

The recommended groundwater monitoring program is summarized in Table 6.

Table 6: Monitoring Wells Representing Hydrostratigraphic Setting

Hydrostratigraphic Setting	Representative Monitoring Wells	Frequency
Weathered Bedrock Zone	TW 9-2, TW 10-1, TW 10-2, TW 13-1, TW 13-2	Bi-monthly (alternate months) beginning in March and continuing through the operating season to November
Upper Competent Plateau	TW 1, TW 5-1, TW 11-2, TW 12-1, TW 12-2	
Competent Bedrock Aquifer	TW 2, TW 3-1, TW 4-1, TW 4-2, TW 6-1, TW 7, TW 8-1, TW 9-1, TW 11-1	

The hydrogeological conditions at the site will be reviewed annually by a qualified professional retained by the company, and a report will be provided to the operator by March 31 of each year which will present and interpret the monitoring data for the 12 month period ending December 31 of the previous year.

The annual review will include a review of the annual and historic data, will assess the existing setting, document any groundwater-related problems such as well interference complaints that have occurred since the past review and provide any resultant recommendations to changes in operation or upgrade in monitoring program or other mitigation or remediation. The report and data will be kept available for review by the Ministry of Environment at their request.

Every 10 years, an update of the hydrogeology report will be prepared. The objective of the report will be to provide the data and analysis that will project impacts in a 10-year advance time frame. The analysis will be based on the projection of the next 10-years' operations and will include an updated well inventory for at least 500 m, or for the predicted area of influence if it is greater, around the projected 10-year excavation.

The rationale for updating and staging the inventory is that it will ensure that data collected and analysed is current to the operating period and projected operations over a real timeframe, and will contain current information with respect to area water supply requirements and uses, the geographical development of the surrounding area, current (to the application time) legislation any other factors that may influence the hydrogeological regime and impact assessment. The procedure that would be followed would be, in summary;

1. Evaluate past data and identify any changes, improvements, etc. that might be required.
2. Define the projected operations in the next 10-years, and model the predicted impact of the projected operations using current monitoring and pumping information.
3. Update area information, environmental, well uses, etc., in the 500 m or projected radius of influence of the 10-year period, using door to door survey or other measures.
4. Identify any wells or environmental features that may potentially be impacted by the next stage of operations.
5. Implement specific measures to monitor and/or remediate to mitigate the predicted negative impacts before they occur.

It is recommended that the target date for the first update report is July 2014, in preparation for the current PTTW expiry date of July 31, 2015, following on a 10-year cycle thereafter.

9 Trigger Mechanism

The trigger mechanism will have two components. The emphasis is on preventing impacts through monitoring and predictive modeling. The monitoring data will be reviewed annually by a qualified professional. This analysis will permit an evaluation of ongoing impacts and will provide a prediction of upcoming problems and will provide advance warning of any off-site impacts. If off-site impacts are forecast as a result of the annual review, the potentially impacted wells will be investigated and an appropriate remedial action taken and/or the operations will be reviewed and modified as necessary to prevent the problem from occurring.

Even with substantial data and an accurate model, occasionally unexpected problems occur. To address this possibility, an emergency response program will be implemented with response triggered by the distance from the properties boundary. If an unexpected problem occurs, an investigation and remediation program will be triggered as described in the Contingency Plan.

One specific trigger mechanism is recommended related to the groundwater monitoring network. Monitors TW 9-1, TW 9-2, TW 10-1, TW 10-2, TW 12-1, TW 12-2, TW 13-1, TW 13-2 will be replaced with new monitors more distant from the extraction boundary if a groundwater level drawdown in excess of 1 metre (maximum yearly drawdown) is indicated to have occurred as a result of extraction.

10 Mitigation/ Contingency Plan

10.1 Impacts to Weathered Bedrock and Surface Water

The hydrological study (SBA, 2011) and natural environment study (SBA, 2011b) found that the surface water features were not identified in the municipal documents or during the studies as areas requiring environmental protection, as Provincially Significant Wetlands or as sensitive areas of concern. The predicted impacts on the south-east wetland due to the proposed quarry excavation is small (SBA, 2011 and this report, Section 7.3).

The existing quarry discharge management is currently directed from the sump towards the north-west part of the properties. The discharge contributes to the maintenance of wetland in this area which in turn discharges off site into the off-site drainage network. Any potential impacts to the weathered bedrock zone in this area are already being mitigated by this system. Continuation of this practice through the quarry operation will provide the necessary mitigation of potential impacts to the weathered bedrock zone from the proposed excavation.

10.2 Off-Site Groundwater Users

The implementation of the contingency plan for surrounding groundwater users will depend on how a problem is encountered.

10.2.1 Receipt of Unexpected Well Problem

If a well problem is identified to the operator, the operator will undertake the following staged remedial plan:

1. To locations within 500 m of the property boundary, provide an interim potable water supply (within 24 hours, as indicated in PTTW 0035-6T8HMJ);
2. Within 1 kilometer of the site, notify the appropriate regulatory agency or agencies of the complaint;
3. Retain a qualified professional at the operator’s expense to conduct a site investigation, determine the cause, and within 15 days provide a report with recommendations on the best way to remediate the problem.

4. If it is found that the quarry operation is responsible, restore the water supply to its original condition or better.

10.2.2 Predicted Negative Impact on Neighbouring Wells

If a negative impact on a neighbouring well or wells is predicted through a hydrogeological review of the data collected under the prescribed monitoring program agreed to with the appropriate regulatory agency or agencies (i.e. through the Permit to Take Water or Site Plan Conditions) and conducted by Miller Paving Limited. or their representative, the well(s) will with owners' permission, be deepened in advance of the impact, to access the available and proven deeper water bearing zones that will not be affected by the quarry operation.

10.3 Protection of Groundwater Quality

Protection to the groundwater and surface water from contaminants from an asphalt plant or other contaminant will be accomplished through management and operation of the materials and equipment to the industry standards and legislative requirements. Equipment such as the asphalt plant or a refuelling area and materials storage will be installed in an appropriate container on an impervious platform with secondary containment. Regulatory requirements of the TSSA will be adhered to as part of the operational practice.

A minimum of 30 m will be maintained between the asphalt plant and any surface water source, including the sump, the settling pond, and the culvert / ditch system used for quarry discharge, or from any other surface water source.

10.4 Emergency Spills Procedure

An emergency spills procedure is already in place at the existing quarry following corporate procedures, and it will continue to be implemented at the expanded operation. The site manager will be trained in the emergency spills procedure and pertinent telephone numbers.

It is recommended that the emergency plan include the following components: Any unexplained losses of fuel or other contaminants will immediately be reported to appropriate levels and/or agencies. A quantity of appropriate clean-up material such as absorbent mats and granular absorbent material will be kept on site when the quarry is operating. If a spill occurs, action will immediately be taken to contain and absorb the spilled material. The reporting requirements of the Ministry of Environment will be followed under the responsibilities of the designated staff at the main office, and who will be responsible for assuring that proper clean-up has occurred.

Part 2 – Supplementary Information from 2002 to 2009 Field Investigations

Proposed Braeside Quarry
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Gorrell Resource Investigations
Project No. 08360
December, 2011

11 Introduction to Part 2- Supplementary Information

Gorrell Resource Investigations (GRI) first began investigating the hydrogeology of the Miller properties in 2002 and has expanded on the knowledge in a series of drilling and field testing programs through 2009. This document consolidates the data and updates the interpretation and conclusions from GRI Report 05460 and the additional testing completed in 2009.

Work by GRI first began in 2000 when the quarry underwent a site plan amendment to permit deepening by a second lift. GRI was retained to recommend a final quarry floor elevation. Data collected from groundwater monitors were then used to secure a Permit to Take Water (PTTW) for the site in 2005, followed by a Section 53 Certificate of Approval for Industrial Wastewater Treatment (“Discharge Permit) in 2007. In 2005, GRI was retained to examine an area for a proposed quarry and to provide documentation on the hydrogeological setting and an impact analysis of the proposed operation. This information was provided in GRI Report 05460, dated October 2007.

In 2009, additional work was undertaken to corroborate interpretations made in the 2007 report and to address questions and comments provided by peer reviewers and agencies. The peer reviewer, Golder Associates Ltd., was retained by the County of Renfrew and the Township of McNab-Braeside. Preliminary comments were also received from the Ministry of Environment and the Ministry of Natural Resources. The 2009 work plan was discussed with the peer reviewers before implementation to ensure that it would provide the additional requested information, but it also intended to address issues of the other agencies.

The investigated property is adjacent to the existing Braeside Quarry, ARA License # 16173 on Part of Lots 16 and 17, Concession A, Municipality of McNab-Braeside, Renfrew County. The site location is shown on Figure 1.

12 Additional Study Components

The primary study components were described in Part 1, Section 2.0. In addition to the components previously described the following tasks were completed.

Groundwater levels in the monitoring network were recorded as part of the study and the regular groundwater monitoring program undertaken for the PTTW. Water level monitoring data is available from December, 2006 to present.

In July, 2009, groundwater samples were collected from several springs, select new monitors and surface water features for analysis for general groundwater characteristics. The purpose of the data collection was to provide data for analysis of the relationships between the various components of the hydrogeological cycle to provide additional insight into their interconnections.

Between March and July 2009, the Miller property was traversed on a number of occasions to observe variations in the geological, hydrogeological and hydrological site conditions, the geological variations in weathering, the locations of springs and surface water features and the pathway that the sump discharge followed through the property. The purpose was to provide a comprehensive understanding of the hydrological/ hydrogeological relationship on the site and in the surrounding area. On April 17, May 22, May 26, June 3 to 8, June 10 and July 3, key or representative areas were documented photographically and by GPS tracking. The time span permitted documentation of changes that occurred through the snowmelt and spring runoff and continued through the summer so that seasonal changes to the system could be observed.

Beginning in June 15 2009, residents at 38 properties within 500 m of the existing quarry and proposed expansion license were interviewed a water sample was taken for general groundwater characteristics taken to collect information about area water supply wells, general groundwater use and quality to add to the baseline information that was collected in 2006.

13 Site Characteristics

The quarry is located approximately three kilometres northwest of the Village of Braeside. The Miller properties are designated for mineral extraction in the County of Renfrew Official Plan. The existing quarry property and a large portion of the surrounding area were originally used as a sand and gravel source in the 1930s where the upper 1 to 3 m consisted of wave-wash and wave alternated flaggy limestone. Smiths Construction bought the property in the 1950s and once the sand and gravel was removed the site has operated as a quarry since approximately 1973 (Derry *et al*).

The site is located upon a bedrock plateau or mesa that runs parallel to the Ottawa River and extends for approximately 15 km from south of the Village of Braeside to north of Rhoddy's Bay on the Ottawa River. The majority of this plateau is undeveloped and covered with trees. The mesa has a relief on the order of 30 to 40 m with sharply dropping faces westward onto a clay plain and eastward into the Ottawa River.

The clay plain is located within the valley that is located just west of the site. As shown on Figure 2, the land surface abruptly drops westward towards Ryan Creek. This is the physiographic region that Chapman and Putnam (1984) describe as Upper Reach of the Ottawa Valley Clay Plain. The feature consists of small to medium size valleys that are separated by uplands consisting of either Palaeozoic bedrock, such as is found on this site, or Precambrian bedrock. The closest Precambrian bedrock upland is located approximately 3 km south of the side.

14 Geological Setting

The Braeside quarry is situated on one of the many Palaeozoic uplands located within the upper Ottawa Valley. The upland is an elongated and streamlined ridge that extends approximately six kilometres from Rhoddy's Bay in the northeast[2] to the Village of Braeside to the south. It reaches a maximum elevation of 154 m ASL and decreases on the east side to 81 m ASL (the Ottawa River) and to 106 m ASL on the western side.

14.1 Site Topography

On the site, the highest point of bedrock is in the south-east corner. From this location, the surface slopes gently to the north and north-west, and more steeply to the west. Regionally, the crest of the bedrock ridge has an elevation of 153 m ASL, and the base of the ridge is approximately 125 m ASL. On the site, the maximum elevation is approximately 150 m, sloping down to approximately 130 m in the north-west corner of the existing quarry. At the base of the ridge the gradient drops to less than 10%, and the ground surface slopes gently towards the Ryan Creek, which lies at an approximate elevation of 113 m ASL.

14.2 Bedrock Geology

The upland consists of the middle Ordovician-age bedrock formations, the Bobcaygeon and Gull River Formations, which are part of the Ottawa Group (Williams *et al*, 1984; Williams and Telford; 1986). The youngest bedrock unit on the site is the Bobcaygeon Formation (450 million years). The drilling and bedrock mapping that have been completed for this investigation indicate that this formation extends from an approximate elevation of 136 to 152 m ASL and forms an upper plateau or cap to the upland. The geological boundary of this formation with the underlying Gull River Formation is gradational.

The lower Bobcaygeon consists of light grey to brown microcrystalline to fine crystalline, thick to massively bedded limestone with interbeds of fine to medium grained calcarenite (Photo 1). Shale partings are generally thin, are often wispy and are not present between every limestone bed. This formation was probably deposited in an intra-continental shelf environment which was a broad sea between continents that is commonly less than 10 m deep.

The gradational and conformable contact between the Bobcaygeon and the underlying Gull River Formation is defined as the base of the massive limestone unit of high purity. The detailed logging of Drill Holes 9 to 13 indicated that the contact ranged from 133.4 to 140.8 m ASL. The elevation of the contact is higher at the south end of the site, due to some structural changes to the bedrock.

The upper portion of the Gull River Formation below the contact is on the order of 10 m thick, which is consistent with the record from across the province. This upper portion of the formation consists of light grey microcrystalline to fine crystalline thin bedded limestone with shaly partings. The colonial coral tetradium is abundant in this member. A good example of this coral was intercepted in TW 13 (Photo 2).

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[2] Directions refer to site north, which is towards Golf Club Road.

In Drill Holes 9 to 11 and 13, a clay shale bed was observed in the Upper Gull River Formation between elevations of 127.8 and 140.8 m ASL (Photo 3). This is a K-bentonite layer (Liberty, 1969) that has been correlated to a widespread volcanic eruption in the middle Ordovician period. These beds have also been recorded in the Kingston and Simcoe areas of Ontario.

The Gull River Formation stratigraphic column extends to the base of the upland on the west side. The lower bedrock along the Ottawa River has been identified as the Rockcliffe Formation (Williams *et al*.; 1984). That bedrock unit was not encountered during the field investigation for this study, but analysis from water well records from wells east of the site and from the door-to-door survey indicate that the Rockcliffe Formation has been encountered.

The St. Martin Member of the Rockcliffe Formation consists of interbedded fine-grained light greenish-grey quartz sandstone, shaley limestone and shale. The formation is generally reported as “red and green limestone” or comparably in water well records. From area well records it is inferred that the contact between the Gull River and Rockcliffe Formations slope downward to the east, and occurs between 64 m ASL and 70 m ASL.

14.3 Regional Bedrock Structure

GRI report 05460 commented that “throughout the area large open fractures are readily apparent”. The fractures were observed [in the quarry] to extend from the surface to appreciable depth. Rust staining and weathering of the bedrock from the surface to the base of the quarry (Photos 4 and 5) is observed on the quarry walls. This staining illustrates how surface water, in places where there are these openings, can migrate down to at least the base of the quarry.

This characteristic was initially attributed to the entire Miller site. However, additional data collected in 2009 revealed that this fracturing is not found across the property, although the existing quarry is completely within that identified zone.

The dominant bedrock joint directions throughout North America are 85^{o}, 105^{o} and 175^{o} with spacing on the order of 5 m (Williams and Telford; 1986). Province-wide where the bedrock is within 4 m of the ground surface, these joints are commonly widened by solution. In the study area, the joints are typically closed in the centre of the upland and more open towards the flanks. Photo 6, taken in the lower lift shows that the enhanced fractures extend down to, but not through, the contact between the Bobcaygeon and Gull River Formations in the weathered zone[3].

In the centre of the upland in the area of upper competent bedrock, surface water will accumulate and then flow along the bedrock surface or overburden/bedrock contact to troughs or furrows that are eroded into the bedrock surface. From these furrows the water flows overland or through the overburden/bedrock contact to the margins of the upland, where the water disappears into the

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[3] Photos 23 to 27 show additional photos of the lower lift

widened fractures and grikes. The dissolution[4] enhanced zones are present on both the east and western sides of the upland.

The joints were initially widened by one or more of several mechanisms: i) ancient tectonic and structural movement, ii) expansion of an unconfined face into an open area, with additional enhancement by iii) meltwater drainage through the upper bedrock fractures near the end of the last ice age, and iv) by post-glacial meteoric surface water flow. The manner of dissolution development and enhancement continues today in a self-perpetuating pattern because of the upland setting with tight joints in the central portion and widened joints on the flanks.

The mechanisms are not restricted to the Braeside upland. The same patterns have been observed by these authors in the Paleozoic upland south of Clay Banks on the Renfrew and Lanark County boundary, on the two uplands near Panmure, and on the uplands near Constance Bay in West Carleton Township in the City of Ottawa.

14.4 Geomorphology and Surficial Geology

Figure 10 is an excerpt from the published geological mapping showing the regional surficial geology (Richard, 1984).

Glaciers covered the study area up until approximately 12,000 years ago. When they initially advanced across the region they eroded the existing sediment and scoured and plucked the exposed bedrock. There would have been influxes of meltwater at the base of the ice from up-ice lakes and water bodies. Meltwater from the ice surface would have drained through moulins and crevasses to the base. The glacier would alternate between being in direct contact with the bed (no water), or being partially supported by meltwater.

Under these circumstances, any bedrock blocks present during this period, such as those created by dissolution or erosion, would have been ripped away as the glacier refroze to the bed and advanced. The Dummer Moraine that extends from the Niagara escarpment to the Tweed area developed in this manner. The very large limestone blocks that are commonly found within the moraine originated when the glacier froze to the bed (ground surface) and plucked them from the surface.

In contrast, the Fort Covington till of this area does not contain these large bedrock blocks and boulders. If dissolution and weathering had occurred before or during the glacier advance, the weathered bedrock blocks would have been ripped away as they were during the formation of the Dummer Moraine that formed in the same period. Similarly to the Dummer Moraine terrain, the blocks and boulders would be found in the area till. This shows that the widened joints that are found along the margins of the upland had to have developed *after* the glacier advanced and actively eroded the area, or within the past 10,000 to 12,000 years.

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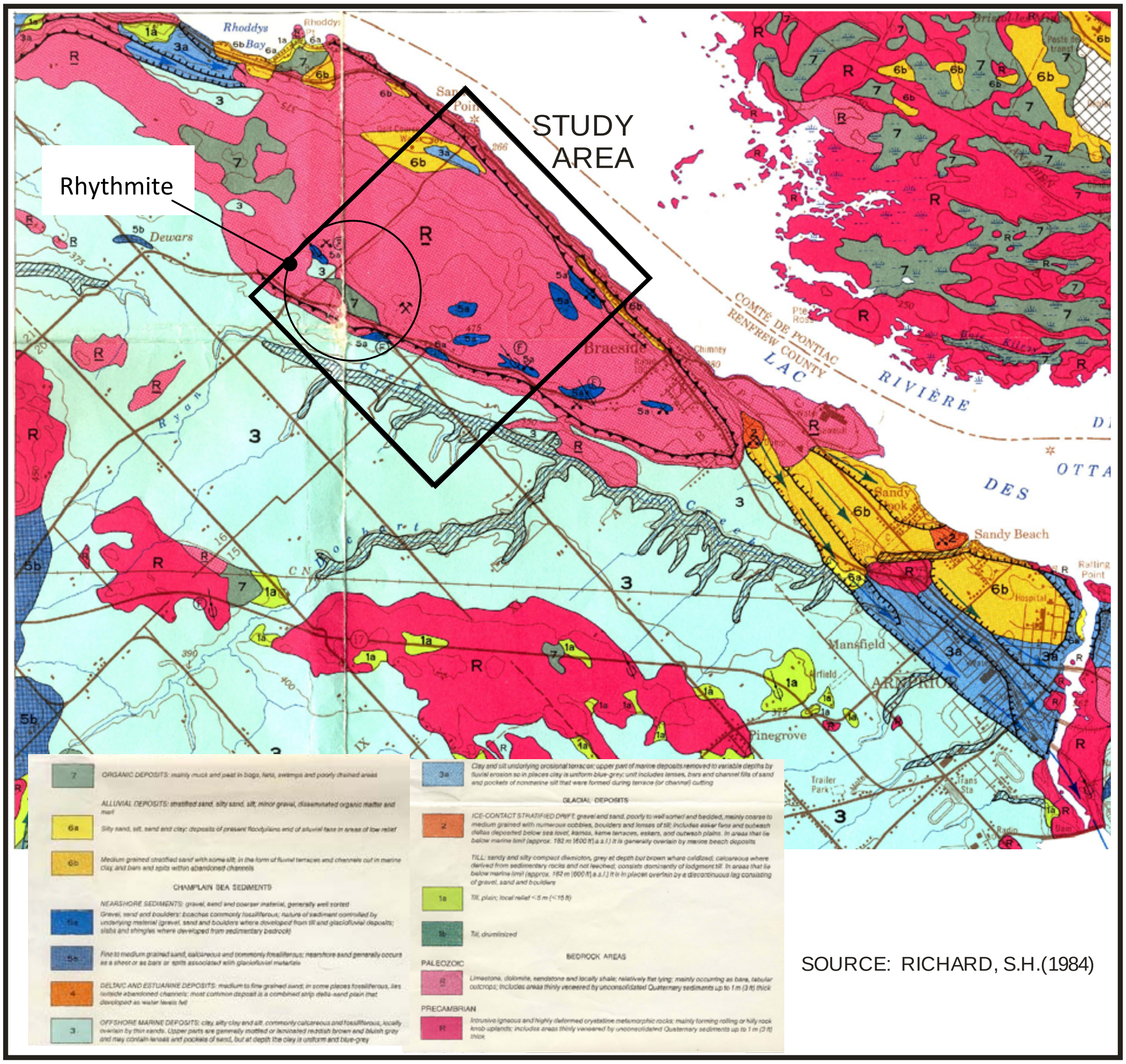
[4] weathering of the limestone along the joints by water

Figure 10: Regional Surficial Geology Mapping (Richard, 1984)



SOURCE: RICHARD, S.H.(1984)

Near the end of the last ice age, volumes and flows of meltwater at the base of the glacier increased exponentially as the glacier melted. The large glaciofluvial deposits that are present in the County of Renfrew such as those that are in the vicinity of Westmeath, Cobden, Round Lake, Sandy Beach, Arnprior and Galetta were deposited by these sub-glacial (under or through-ice) meltwater flows. Current work by the Geological Survey of Canada (work in 2008, 2009 and in prep) with continuous core drilling and kilometre -long seismic studies suggests that the glaciofluvial gravel is present beneath many of the valleys that are filled with clay in the upper Ottawa Valley basin. Well records for the area west of the upland do report occurrences of gravel, indicating that the condition is probably true for this area, that there are thick glaciofluvial sand and gravel beds below the clay. The clay plain west of the Miller properties may be the northern extension of the glaciofluvial assemblage that extends from the Village of Galetta, through the Town of Stittsville to Richmond (Gorrell, 1991).

As the glacier retreated (melted) the massive volume of runoff generated by the melting glacier did not flow as a sheet covering the whole Ottawa basin, it was channelled around the large bedrock uplands and escarpments that are found in the area (Figure 10). On the top of the uplands, the glacier would have been grounded (frozen to and/or stuck to the ground surface), causing zones of high pressure where there would be no meltwater was present. Near the margins of the uplands where the glacier was not grounded, meltwater, if present, was also under high pressure due to the proximity to the grounded glacier. The high pressures increase the ability of the meltwater to dissolve calcium carbonate (Smart, 1984, Wadham, 2006), accelerating dissolution of existing weaknesses in the bedrock. The joint enhancement could have begun at this time. With meltwater flowing at the base of the glacier, the ice would have thinned. As the glacier further down-wasted and retreated from the area, the bedrock blocks formed by the enhanced fractures could not have been plucked, because at this late stage, the ice never re-grounded in the affected area due to the presence of water.

In the north-west part of the Miller property, just east of the junction of Golf Club Road and Usbourne Street there is a trough in the bedrock surface that extends south-westward to cross Usbourne St at the junction of Campbell Drive. This trough was probably cut by a combination of meltwater and glacier ice near the end of the last ice age. The sides of the trough are bedrock, but the base, at 130 m ASL is filled with clay rhythmites up to 7 m thick (Figure 10).

When the glacier completely retreated, the area was covered by the Champlain Sea. This sea was an extension of the Atlantic Ocean that covered the area due to the isostatic depression of the land[5] from the weight of the glacier. The sea extended from the Atlantic Ocean and covered most of the Ottawa Valley. Its western limit extended approximately from the Town of Renfrew in the northwest to the Village of Lanark in the west and down to the City of Brockville in the southwest (coinciding approximately with the east side of the Frontenac Axis).

The crown and upper margins of the upland are covered with a veneer of unconsolidated sediment. The majority of the sediment has limnological (shoreline) origin because the upper portion of the Braeside streamlined hill crest was at the wave base (at to slightly below the water surface) of the sea. Such limnological influences as wave/wash and storm surges washed and winnowed the till that was deposited on the top of the upland when the glacier was grounded, and re-deposited the sediment as strand lines or upper shoreface and foreshore bars and ridges on the sides and top of the upland. These features are seen as variably-sized hummocky hills and long linear ridges. Most of the largest of these ridges on both the site and adjacent properties were excavated between 1950 and 1970. Remnants of the deposits can be seen on the site (Figure 2). The quarry was developed after the 1- to 3-m thick sand and gravel deposits were removed.

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[5] The ground surface was pushed down by the mass of the glacier; isostatic rebound is still occurring today.

At the base of the hill, in what would have been deep water because it was well below the wave base of the Champlain Sea, an offshore zone existed. In this area, there would have been little water movement from waves or currents. Consequently, silt- and clay- sediment fractions that originated from spillways north-west of the area and from washing the local till was deposited as the present-day clay plain on the west side of the upland. Clay was also deposited on the eastern side of the ridge, but the ancient Ottawa River in one of several earlier channels eroded the clay on the eastern side.

14.4.1 Modern and Present-Day Processes

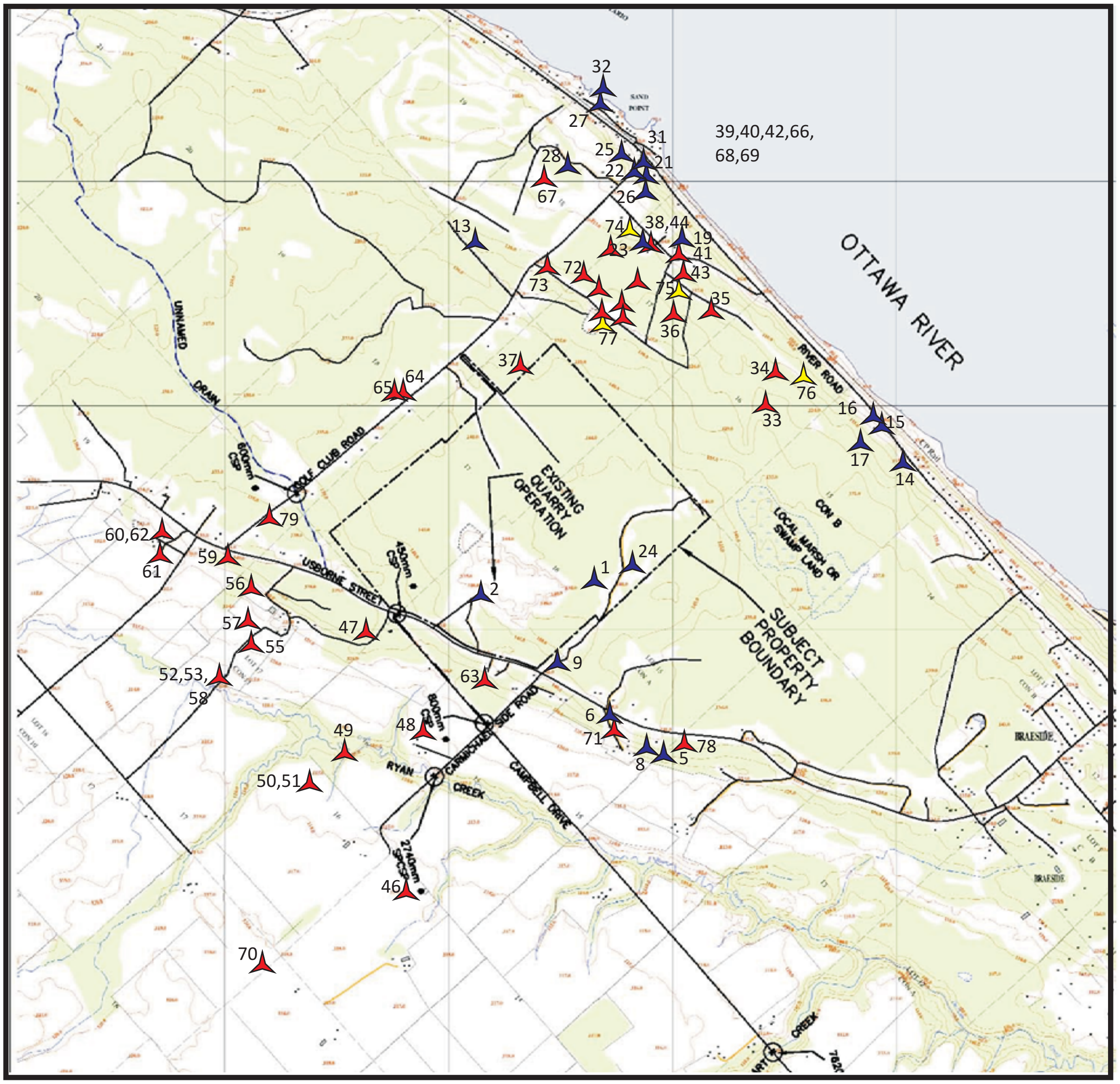
The dissolution that started with the flow of meltwater continued once the Champlain Sea drained from the area, and continues today. In the centre of the upland where the joint systems are tight, meteoric water accumulates on the surface and within saturated overburden, and flows along the bedrock surface or bedrock/till/gravel interface to troughs or low areas on the bedrock surface. This water drains as overland sheet and localized channelized flow (depending on available pathways) down-slope towards the flanks of the upland on both the east and west sides, where it abruptly drains into the enhanced fractures and flows downward through the weathered fracture system.

The lower member of the Bobcaygeon formation is susceptible to dissolution, unlike the underlying Gull River Formation, and consequently the surface water exits the shallow flow system at the formational contact between 133 to 137 m ASL over most of the site. Springs are found on the flanks of the plateau at this level on both the western and eastern margins.

There is another break in the flank surface, subtle on the west side, more prominent on the east flank as the elevation decreases. Near the edge of this lower bedrock step, another zone of increased weathering is found. The spring water that exits the bedrock in the upper springs at the Gull River contact (133 to 137 m ASL) again drains overland or ponds and pools on the competent bedrock until the lower weathered zone is intercepted. Again the flow drains abruptly into this lower dissolution zone and migrates downward through the weathered fracture system. This water exits as a lower level of springs just above the clay plain.

15 Regional Groundwater Analysis

Well records obtained from the Ministry of Environment (MOE) included data from wells drilled May 1959 to present. A summary of the well records is included in Appendix F. In GRI Report 05460, only 22 of the available well records could be spatially analysed because location information. Since that analysis was completed, the MOE has updated the database, and as a result, an additional 48 well records for surrounding users were available for use in a spatial analysis. Figure 11 shows the location of these wells. The elevations at which water was recorded in the well records is illustrated on Figure 12. In the analysis, it was assumed that the well position was correct and the surface elevation at that location was interpreted from the 1:10,000 Ontario Base Map. The error in elevation water found is estimated to be +/- 5 m, assuming that the data in the water well record, including the assigned location, is accurate.



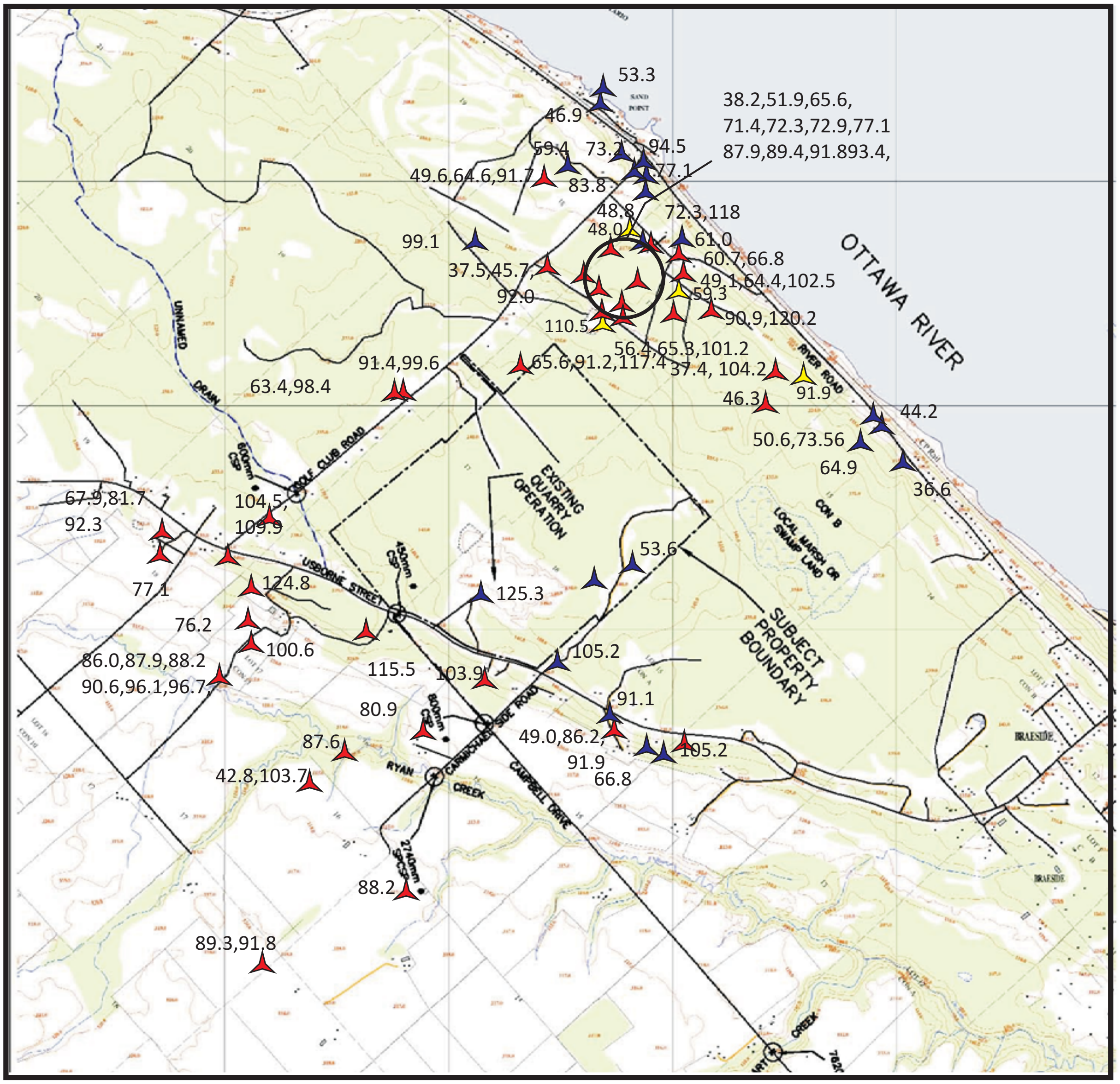
UPDATED FROM gri REPORT 02180, MARCH 2004

FIGURE 11

REGIONAL WATER WELL LOCATIONS

PROPOSED BRAESIDE QUARRY EXPANSION
PART LOTS 16 & 17, CONCESSION A
TOWNSHIP OF MCNAB-BRAESIDE

GORRELL RESOURCE INVESTIGATIONS gri



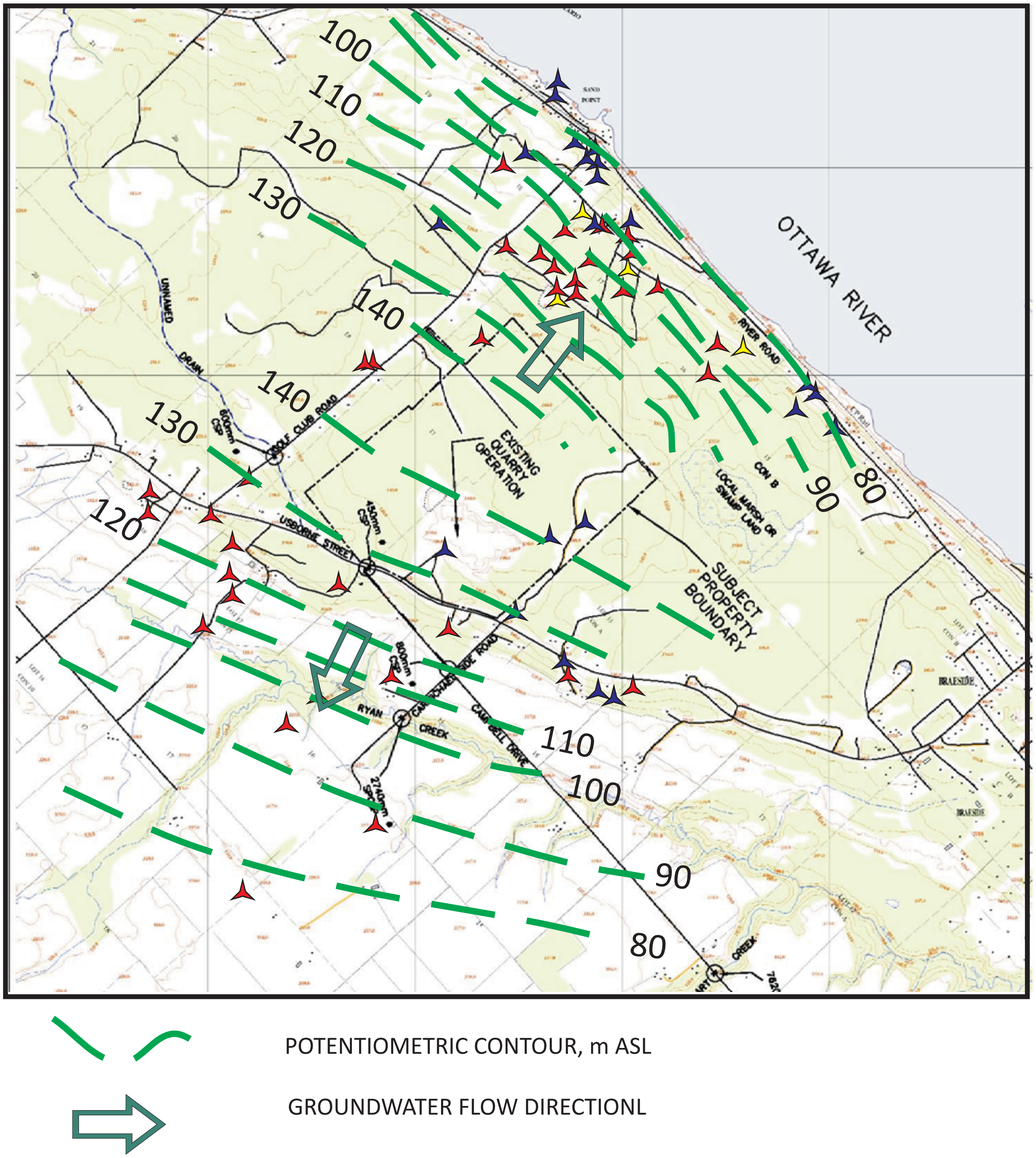
UPDATED FROM gri REPORT 02180, MARCH 2004

FIGURE 12

REGIONAL WELLS: REPORTED ELEVATION WATER FOUND

PROPOSED BRAESIDE QUARRY EXPANSION
PART LOTS 16 & 17, CONCESSION A
TOWNSHIP OF MCNAB-BRAESIDE

GORRELL RESOURCE INVESTIGATIONS gri



UPDATED FROM gri REPORT 02180, MARCH 2004

FIGURE 13

REGIONAL WELLS: GROUNDWATER FLOW

PROPOSED BRAESIDE QUARRY EXPANSION
PART LOTS 16 & 17, CONCESSION A
TOWNSHIP OF MCNAB-BRAESIDE

GORRELL RESOURCE INVESTIGATIONS gri

The elevation water found analysis shows that area wells obtain their water supply from one or more reported water-bearing zones that for the majority of wells are below the proposed quarry floor of 125 m ASL. The reported water bearing zones are generally deeper on the east side of the property. This is because the surface elevation for most residences in this area is at or below the proposed quarry base.

The data can be used to broadly interpret the regional groundwater flow. The potentiometric elevation[6], shown on Figure 13, was derived from static level[7] on the well records and surface elevation information. The interpretation shows that the plateau is a zone of local recharge[8] to the bedrock aquifer. The Ottawa River is a regional discharge zone[9], and the clay plain area is a local discharge zone. The Miller properties are on the edge of the plateau in a zone of transition.

15.1 Local Climate Data

The quantity of precipitation that occurs during a test may influence the results, particularly in the upper weathered bedrock aquifer. As noted, during most of the testing period, plenty of surface water was present on the site and in the study area. The precipitation received over the 2007 testing period was taken from Environment Canada's Shawville weather station.

The hydrology report (Skelton Brumwell & Associates Inc.,(SBA) 2011) considered data from five nearby Canadian Climate Stations – Arnprior Grandon, Claybank, Renfrew, Shawville and Luskville, and indicates the Shawville or Luskville data are representative of the conditions that would be encountered at the site. The daily precipitation and temperatures from the Shawville station are shown on Figure 14.

Although the Shawville Climate Station is the closest active and representative station (topographically and geographically), it has had intermittent data in the past several years and could not provide a good precipitation record. The hydrology analysis (SBA, 2011) used precipitation data from Luskville to represent the site precipitation. However, the hydrology report notes that to assist in annual analysis of pumping volumes and water level interpretations, a station with similar precipitation patterns to the site is useful.

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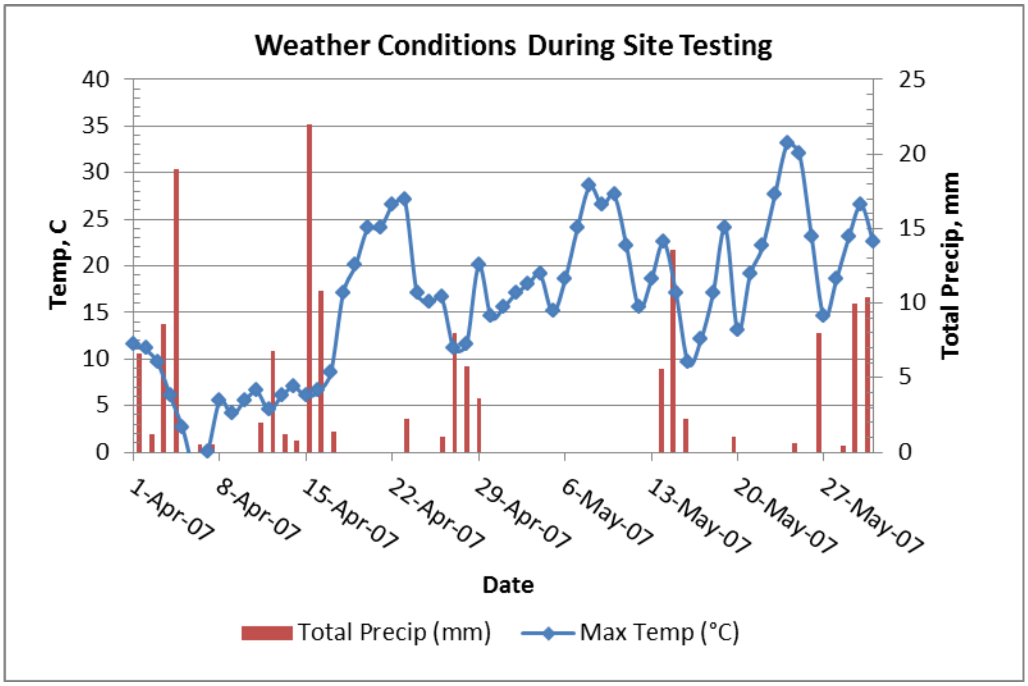
[6] Potentiometric elevation - stable or "at rest" level to which the water level will rise in a well within a confined aquifer expressed as a geodetic ("above sea level") elevation (see Appendix A)
[7] Static level – stable or "at rest" level to which the water level will rise in a well, expressed on Ontario water well records as a depth from ground surface (see Appendix A)
[8] Recharge Zone – groundwater enters the aquifer system (see Appendix A)
[9] Discharge Zone – groundwater exits the aquifer system (see Appendix A)

Figure 14: Weather Conditions during 2007 Testing Period



The analysis (Table 7) indicates that the Luskville Climate Station can provide a suitable record for comparing daily precipitation events, as the precipitation records were in agreement with respect to occurrence 85% of the time. If in addition, anecdotal records are kept at the site on precipitation occurrence and intensity, the information will provide a satisfactory information base for interpretation of pumping data.

The hydrology report (SBA, 2011) recommended a site weather station be installed.

Table 7: Analysis for Selection of Representative Climate Station for use at Braeside Quarry

	Total events, Jan 1 1993 to Sept 30 1994	%
Total Days Analysed	637	
Luskville vs. Claybank Stations		
PP at Luskville but not at Claybank	50	7.8
PP at Claybank but not at Luskville	46	7.2
PP at both Claybank and Luskville	233	36.6
no PP at either station	308	48.4
McDonald-Cartier Airport vs. Claybank Stations		
PP at M-C but not at Claybank	68	10.7
PP at Claybank but not at M-C	78	12.2
PP at both Claybank and M-C	201	31.6
no PP at either station	290	45.5

16 Site Testing

Altogether, current to December 2011, there are 13 test well locations on the property and at most sites there are two wells for a total of 23 test wells. The well locations, which were surveyed by 43 Degrees North Surveying in September 2009, are shown on Figure 2. The drill logs and water well records are found in Appendix B. The well test data and analysis are found in Appendix G.

16.1 2002 Drill Holes

The original two monitoring wells were drilled on the site on July 10, 2002 by George Law and have previously been reported on in GRI Report 02180 dated March 2004. That report provided supporting documentation to permit the deepening of the existing quarry to a base elevation of 125 m ASL and to support the application for a Permit to Take Water.

16.1.1 Test Well 1

Test Well 1 was drilled a depth of 20.11 m or 128.9 m ASL. No overburden was encountered and only limestone of the Bobcaygeon Formation was intercepted. Soft zones were observed in the upper 7.5 m of the hole, but none of the zones yielded groundwater. The well had soft zones at 1.82 m or 147.2 m ASL, 3.05 to 3.65 m or 145.3 to 145.9 m ASL, and 7.32 to 7.62 m or 141.4 to 141.7 m ASL. Below 7.5 m, the bedrock was thin to medium bedded and was generally fine to slightly medium crystalline. The well record reports no water bearing zone, and the well had an estimated yield of less than 1.5 L/min (0.2 IGPM) upon completion. The upper part of the well was cased and grouted to 147.8 m ASL.

Test Well 1 was pumped at a constant rate of 3.8 L/min (0.8 IGPM) for a period of 48 minutes. The well drained to 80% of its available drawdown. The recovery was monitored for 4 hours, at which time the well had recovered to 19% of its original level. The Jacob method was used to calculate a low transmissivity of 0.06 m^2/day. The Theis recovery method could not be used for the water level in the well did not recover sufficiently; it was essentially dry.

16.1.2 Test Well 2

Test Well 2 was drilled to a depth of 19.8 m to an approximate elevation of 119.8 m ASL. The upper 0.60m of the stratigraphy consisted of fill. Below that through to the base of the hole, limestone of the Bobcaygeon Formation was encountered. Soft zones were common in the upper 13 m of the hole. One significant soft zone was encountered between 12.19 and 13.72 m depth, or from 125.9 to 127.4 m ASL. Groundwater was encountered in this zone at an estimated yield of less than 1.5 L/min. Other soft zones occurred at 5.02 m or 134.6 m ASL, and 8.23 m or 131.4 m ASL. Below that the bedrock was thin to medium bedded and was generally fine to slightly medium crystalline. Upon completion, the well had an estimated yield of less than 1.5 L/min (0.2 IGPM). The upper part of the well was cased and grouted to 138.1 m ASL.

Test Well 2 was pumped at a constant rate of 2.85 L/min (0.6 IGPM) for a period of 362 minutes. The well drained to 79.7% of its available drawdown. The recovery was monitored for 4 hours at which point the well had recovered to 79% of its original level. An analysis of the test data found that the well could sustain a pumping rate of less than 0.5 IGPM. Jacob and Theis recovery methods were used to calculate the transmissivity of the well. The calculated value was very low at between 0.079 and 0.10 m^2/day.

16.2 2006 Drill Holes

The well groups at locations 3 to 8 were drilled in August 2006. The wells were drilled by Saunders Well Drilling Ltd. of Braeside using rotary air percussion with water circulation under supervision from GRI staff. Wells were cased with 6 m of casing and the annulus was grouted with bentonite slurry. With the exception of TW 7, each site had two wells drilled. The deep levels were drilled to at least 5 m below the proposed quarry floor. The shallow level targeted the shallow bedrock aquifer.

During well drilling, qualitative observations are made on the cuttings (rock particles washed up in circulation during drilling) and the mechanics of the drill. Changes in torque or movement of the bit can signify change in the formation, the presence of soft or weathered, and potentially water-bearing zones. The change in the return rate of the circulation water can also indicate the presence of voids or water-producing zones. While the factors are qualitative, with sufficient experience and knowledge of the geological setting by the logger, they can be used to evaluate the hydrostratigraphy with an adequate accuracy to provide the necessary impact evaluation, as the subsequent 2009 drilling program showed.

TW 3 was positioned and constructed to address a condition in the PTTW to construct a third well monitor.

The 2006 wells were drilled with a rotary well rig in the same manner as the majority of the local wells were completed. When this project began, a primary concern of review agencies and surrounding residents was potential impact on water supply. The rationale for the construction method used in the test holes then was to provide representative monitors/ sentry wells between the site operations and off-site groundwater users by constructing the wells in the same way neighbouring water supplies would be if well drilling regulations were followed. The depths that were selected were to and below the proposed quarry floor to locate water bearing zones within the profile that would be potentially affected by the quarry so that impacts within this zone could be monitored.

None of the wells were dry although significant water bearing zones of comparable development to those reported in area water well records were not encountered. Specifically any of the wells drilled in the competent bedrock above the proposed quarry floor had little water. This showed that there would be no groundwater (within the zone that would be affected by the quarry) if wells are constructed to regulatory standards. A few of the wells that were drilled below the quarry floor had yields that are characteristic of the wells that are being used by the surrounding homes that are completed to a similar depth.

Although the wells in the 2006 drilling program were constructed during the summer to permit access to the locations around the site perimeter, the testing was conducted in the spring during high flow/ recharge. At the time of the testing, the area had abundant surface water sufficient to make access to most of the wells impassable by a normal vehicle. Equipment was carried to each well location by the site loader. Towards the end of the testing period, which extended from April 27 to May 10, the area was drying up and most locations could be accessed.

16.2.1 Test Wells 3-1 and 3-2

The test wells are located on the west side of the site north of the main site entrance with a surface elevation of 133.9 m ASL. Test Well 3-1 was drilled to 24.4 m, or approximate elevation 109.5 m ASL. Water bearing zones were noted at 14.0 m (119.9 m ASL) and 23.5 m (110.4 m ASL) depths. The well was cased and grouted to 128.4 m ASL. Test Well 3-2 is 12.2 m deep and is completed to an approximate elevation of 121.7 m ASL. A water-bearing zone was noted on the well record at 7.0 m (126.9 m ASL). The well was cased and grouted to 128.4 m ASL.

TW 3-1 was pumped at a rate of 49.5 L/min for 250 mins at which time the water level was drained to the pump intake. The recovery of the water level was measured for 50 minutes following pump shut off. During the test, the water level was lowered to 98.8% of the available drawdown and the water level recovered to within 97.3% of the original static level during the recovery.

During the pumping, no change was noted around 14 m, but cascading was noted at approximately 24 m depth. Cascading is observed when groundwater can be detected flowing into the well after the water level has lowered to below a water-bearing zone. It can be audible or determined from a response observed in the water level equipment. The level noted corresponds to the noted 23.5 m water level reported on the well record. Once the water level in the well was drained below the water-bearing zone, the well drained in 10 minutes.

The transmissivity of the well was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.29 to 1.03 m^2/day. The lower value, calculated from the recovery data, is representative of the aquifer characteristics, the higher the well itself.

Observations were made in TW 3-2, located adjacent to TW 3-1 approximately 6 m away. During the pumping of TW 3-1, the water level in TW 3-2 also lowered to a maximum of 0.84 m, and recovered slightly to 0.63 m.

Test Well 3-2 was pumped at a rate of 3.6 L/min for 100 minutes, at which time the well was drained to the pump intake. The water level in the well was monitored for 2 hours following the pump shut off, and the water level recovered to 41.5% of the original static level. During pumping, the water level in TW 3-1 was also monitored. The water level in the well lowered a maximum of 0.04 m, but was recovering as TW 3-2 was drained.

The transmissivity of the well was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.09 to 0.11 m^2/day.

16.2.1.1 General Observations

TW 3-1 is a groundwater-producing well. The yield was estimated by back-calculating from the recovery data to determine that the water-bearing zone at around 109.5 m ASL was producing a small flow approximately 6.8 L/min. The remainder of the 12,375 litres removed during pumping came from storage in the well bore and in the bedrock surrounding.

TW 3-2, representing the upper part of the bedrock, was dry. The well did recharge after it was drained by pumping; approximately 73 L infiltrated in the 2 hour recovery measurement period, in contrast to the 360 litres that were pumped out during the test. The source of the recharge is most probably the storage in TW 3-1, flowing between the boreholes along bedding plane that was noted as being common between the two adjacent wells. At the close distance, and with the high flux induced by the drained well, infiltration from TW 3-1 is the most likely recharge source. When TW 3-1 was pumped a few days after TW 3-2, the water levels in both wells had recharged to levels about 20 cm lower than the static levels measured in the earlier test. In summary, the groundwater that recharged TW 3-2 originated from TW 3-1 and entered the well from along a bedding plane. If TW 3-1 was not in as close proximity the recovery in TW 3-2 would have been less.

The results of the hydraulic conductivity analysis indicate a low permeability for the intercepted bedrock.

16.2.2 Test Wells 4-1 and 4-2

The test wells are located in the north-west corner of the site. It was drilled in the area where the bedrock escarpment or plateau gradient changes. Test Well 4-1 was drilled to 24.4 m, or approximate elevation 108.5 m ASL. At this location, 5.8 m of clay were recorded over the bedrock. A water bearing zone was noted at a depth of 21.0 m (112.1 m ASL). The well was cased and grouted to 127.4 m ASL

Test Well 4-2 is 12.2 m deep and is completed at approximately elevation 120.9 m ASL. No water-bearing zone is recorded on the well record. The well was cased and grouted to 127.6 m ASL.

TW 4-1 was pumped at a rate of 16.65 L/min for 6 hours at which time the water level was drained to 77.6% of the available level. The recovery of the water level was measured for 251 minutes following pump shut off. The water level recovered to within 98.5% of the original static level during the recovery. A volume of 5,994 L were pumped from the well during testing, and a volume of 298 L entered during the recovery.

Between 110 and 200 mins, the water level in the well rose briefly before continuing to draw down at slightly decreased rate. The discharge rate was checked and no adjustment was required. This signifies that a small local recharge source – such as a groundwater-filled void in the bedrock – was intercepted. In the recovery period an opposite “blip” occurred at a comparable water level.

The transmissivity of the well was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.26 to 0.40 m^2/day.

Observations were made in TW 4-2, located adjacent to TW 4-1 approximately 6 m away. During the pumping of TW 4-1, the water level in TW 4-2 also lowered to a maximum of 1.07 m. The drawdown on the observation well accelerated after approximately 118 minutes of pumping and the drawdown continued through the recovery period.

Test Well 4-2 was pumped at a rate of 2.03 L/min for 35 minutes, at which time the well was drained to the pump intake. The water level in the well was monitored for 160 minutes following the pump shut off, and the water level recovered to 23.2% of the original static level. During pumping, the water level in TW 4-1 was also monitored. The water level in the well lowered a maximum of 0.19m, which continued to decline during the recovery period. A volume of 71 L were pumped from the well during testing, and a volume of 37 L entered during the recovery.

The transmissivity of the well was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.08 to 0.12 m^2/day.

16.2.2.1 General Observations

When the recharge source was encountered during pumping of TW 4-1, the drawdown in the monitoring well, TW 4-2 accelerated. During the recovery, an opposite change in slope occurred when the water levels in the two wells were the same. The recharge source that was intercepted was TW 4-2, and the analysis indicates that this source contributed to the groundwater in the TW 4-1 test. In pumping, the slope changed when the water level was at approximately 17.5 m deep. In recovery, the change occurred when the water levels in the two wells coincided, at approximately 4.5 m deep.

The fact that recovery did occur during each test indicates that there is a small amount of recharge occurring, 0.3 L/min at TW 4-1 and 0.06 L/min at TW 4-2. Groundwater was also being transmitted between the wells during the testing. The zone through which the transmission occurred was between 11 and 17.5 m deep, or 117.5 to 124 m ASL. If TW 4-1 was not present TW 4-2 would have recovered much less.

16.2.3 Test Wells 5-1 and 5-2

The test wells are located along the north boundary, approximately half-way along the northern perimeter at a surface elevation of 139.3 m ASL. Test Well 5-1 was drilled to 24.4 m, or approximate elevation 114.9 m ASL. Test Well 5-2 is 12.2 m deep and is completed at approximately elevation 127.1 m ASL. No water bearing zones were noted in either well. The wells were cased and grouted to 133.8 m ASL.

TW 5-1 was pumped at a rate of 12.4 L/min for 43 minutes, at which time the water level was drained to 98.5% of the available level. The recovery of the water level was measured for 197 minutes following pump shut off. The water level recovered only 5.7% of the original static level. A volume of 533 L were pumped from the well during testing, and a volume of 24 L entered during the recovery. The well drained steadily during the test and did not recover.

The transmissivity of the well was calculated using the Jacob method. The calculated transmissivity for this well is 0.11 m^2/day. Observations were made in TW 5-2, located adjacent to TW 5-1 approximately 6 m away. During the pumping of TW 5-1, the water level in TW 5-2 declined 0.01 m. The rise is most probably due to changes in atmospheric pressure, not to a connection between wells.

Test Well 5-2 was pumped at a rate of 4.5 L/min for 55 minutes, at which time the water level had declined to 99.3% of the available drawdown. The well drained steadily during the test. The water level in the well was monitored for 2 hours following the pump shut off, and the water level recovered to

22.3% of the original static level. A volume of 247.5 L were pumped from the well during testing, and a volume of 46 L entered during the recovery for an inflow rate of 0.4 L/min.

The transmissivity of the well was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.08 to 0.16 m^2/day.

16.2.3.1 General Observations

The static level at TW 5-2 was consistently at the ground surface during the spring. This suggests a direct connection between the surface drainage and the shallow weathered bedrock aquifer in this area of the site. The area where the wells were drilled was an island completely surrounded by standing water to a depth greater than 0.45 m during the testing period.

The data collected on this well – the static level is the same as the ground surface elevation, the lack of interconnection during testing and the low hydraulic conductivity of the upper weathered bedrock zone combine to illustrate that in this area of the site, the bedrock has a very low to impermeable hydraulic conductivity in the absence of an immediately open dissolution enhanced fracture.

16.2.4 Test Wells 6-1 and 6-2

The test wells are located in the north-east corner of the site. Test Well 6-1 was drilled to 24.4 m, or approximate elevation 113.0 m ASL. The well was cased and grouted to 133.3 m ASL. A water bearing zone was noted at 20.72 m deep (117.3 m ASL). Test Well 6-2 is 12.2 m deep and is completed at approximately elevation 125.7m ASL. No water-bearing zone is recorded on the well record. The well was cased and grouted to 132.5 m ASL.

TW 6-1 was pumped at a rate of 10.35 L/min for 40 minutes, at which time the water level was drained to 98% of the available level. The recovery of the water level was measured for 120 minutes following pump shut off during which the water level recovered 5.3% of the original static level. A volume of 414 L were pumped from the well during testing, and a volume of 19 L entered during the recovery. After four minutes of pumping (water level 7.3 m), the well drained steadily during the test, accelerating further after 30 minutes (water level 19.8 m) and did not recover.

The transmissivity of the well was calculated using the Jacob method. The calculated transmissivity for this well is 0.18 m^2/day.

Test Well 6-2 was pumped at a rate of 0.75 L/min for 40 minutes, at which time the water level had drained the available drawdown. The well drained steadily during the test. The water level in the well was monitored for 90 minutes following the pump shut off, and the water level recovered to 13.9% of the original static level. A volume of 30 L were pumped from the well during testing, and a volume of 17 L entered during the recovery for an inflow rate of 0.2 L/min.

The transmissivity of the well was calculated using the Jacob method. The calculated transmissivity for this well is 0.02 m^2/day.

Observations were made in TW 6-1, located adjacent to TW 6-1 approximately 6 m away. During the pumping of TW 6-2, the water level in TW 6-1 rose 0.02 m. The rise is most probably due to changes in atmospheric pressure, not to a connection between wells.

16.2.4.1 General Observations

The acceleration of drawdown after 30 minutes of pumping corresponds to the water level declining below the noted water-bearing zone. Once the water-bearing zone was bypassed, the effect of the contribution of the zone diminishes due to pressures in the aquifer, resulting in an increased rate of drawdown in the well. The change in rate of drawdown helps pinpoint the water-bearing zone elevation.

16.2.5 Test Well 7

Test Well 7 was constructed along the east side, approximately mid-way along the north-south property boundary. Test Well 7 was drilled to 24.4 m, or approximate elevation 116.8 m ASL. A water bearing zone was noted at 12.8 m deep (129.0 m ASL). The well was cased and grouted to 136.3 m ASL.

TW 7 was pumped at a rate of 7.2 L/min for 58 minutes, at which time the water level was drained to 95.3% of the available level. The recovery of the water level was measured for 120 minutes following pump shut off during which the water level recovered 25.3% of the original static level. A volume of 418 L were pumped from the well during testing, and a volume of 77 L entered during the recovery (0.6 L/min). The well drained steadily during the test, accelerating after approximately 22 minutes (water level +/- 15 m).

The transmissivity of the well was calculated using methods by Theis and Jacob. The calculated transmissivity for this well ranges from 0.21 to 0.37 m^2/day.

16.2.5.1 General Observations

The acceleration of drawdown after 22 minutes of pumping corresponds to the water level declining below the noted water-bearing zone. Once the water-bearing zone was bypassed, the effect of the contribution of the zone diminishes due to pressures in the aquifer, resulting in an increased rate of drawdown in the well. The change in rate of drawdown helps pinpoint the water-bearing zone elevation.

16.2.6 Test Wells 8-1 and 8-2

The test wells are located in the south-east corner of the site. Test Well 8-1 was drilled to 24.4 m, or approximate elevation 120.0 m ASL. Water bearing zones were noted at 10.97 m (134 m ASL) and 23.16 m (121.8 m ASL). The well was cased and grouted to 139.5 m ASL. Test Well 8-2 is 12.2 m deep and is completed at approximately elevation 132.9m ASL. No water-bearing zone is recorded on the well record. The well was cased and grouted to 139.6 m ASL.

TW 8-1 was pumped at a rate of 15.75 L/min for 6 hours, at which time the water level was drained to 76.5% of the available level. The recovery of the water level was measured for 120 minutes following pump shut off during which the water level recovered 54.3% of the original static level. A volume of 5,670 L were pumped from the well during testing, and a volume of 87 L entered during the recovery. A slight decrease in the rate of acceleration of the drawdown occurred around t=140 minutes.

The transmissivity of the well was calculated using methods by Theis and Jacob. The calculated transmissivity for this well ranges from 0.59 to 0.83 m^2/day.

Observations were made in TW 8-2, located adjacent to TW 8-1 approximately 6 m away. During the pumping of TW 8-1, the water level in TW 8-2 rose over the test to a maximum of 0.22 m. The discharge hose was sufficiently close to TW 8-2 that it is most probable that the discharge recharged the well.

Test Well 8-2 was pumped at a rate of 1 L/min for 49 minutes, at which time the water level had drained the available drawdown. The well drained steadily during the test. The water level in the well was monitored for 120 minutes following the pump shut off, and the water level recovered to 15.9% of the original static level. A volume of 49 L were pumped from the well during testing, and a volume of 29 L entered during the recovery for an inflow rate of 0.2 L/min. The transmissivity of the well was calculated using methods by Theis and Jacob. The calculated transmissivity for this well ranges from 0.02 to 0.04 m^2/day.

Table 8: Summary of 2007 Well Testing

Pumping Well, Test #	**Observed Water-Bearing Zones (WBZ) m ASL***	**Pump Rate Duration; L/min (Hr:Min)**	**Total Drawdown (%)**	**Range of Calculated T (m^2/day)**	**Obser. Well**	**Maximum Drawdown (m)**
TW 1 (2002)	Soft zones, dry @ 141.4 to 141.7, 145.3 to 145.9, 147.2	3.8 (0:48)	80.6	0.06		
TW 2 (2002)	Soft zones, dry @ 125.9 to 127.4	2.85 (6:02)	79.7	0.08 – 0.10		
TW 3-1	WBZ @ 110.4, 119.9	49.5 (4:10)	98.8	0.29 – 1.03	TW 3-2	0.84
TW 3-2	WBZ @ 126.9	3.6 1:40	99.2	0.09 – 0.11	TW 3-1	0.04
TW 4-1	WBZ @ 112.1	16.65 (3)	77.6	0.23 – 0.40	TW 4-2	1.07
TW 4-2	None	2.03 (0:35)	96.5	0.08 – 0.12	TW 4-1	0.19
TW 5-1	none	12.38 (0:43)	98.5	0.11	TW 5-2	0.01

Pumping Well, Test #	Observed Water-Bearing Zones (WBZ) m ASL*	Pump Rate Duration; L/min (Hr:Min)	Total Drawdown (%)	Range of Calculated T (m^2/day)	Obser. Well	Maximum Drawdown (m)
TW 5-2	none	4.5 (0:55)	47.5	0.08 – 0.16		
TW 6-1	WBZ @ 117.3	10.35 (0:40)	98	0.18		
TW 6-2	none	0.75 (0:40)	97.5	0.02	TW 6-1	-0.02
TW 7	WBZ @ 129.0	7.2 (0:58)	95.3	0.21 – 0.37		
TW 8-1	WBZ @ 121.8, 134.0	15.75 (6:00)	76.5	0.59 - 0.83	TW 8-2	-0.22
TW 8-2	none	1 (0:48)	80.6	0.02 – 0.04		
* Elevations in Table 8 have been adjusted to reflect the total station survey of wells completed in 2009. Values differ from those reported in GRI Report 05460 dated September 2007.						

16.2.6.1 General Observations

The rise in water level in TW 8-2 during the pumping of TW 8-1 suggests that the discharge was providing recharge to the observation well. The response illustrates the high degree of interconnection of the surface to the shallow weathered bedrock on parts of the site. A similar rapid response of water level in wells to spring melt, a comparable recharge source, has been observed by GRI at several locations in similar geological setting in the Brockville area.

16.3 Groundwater Temperature

During some tests, the groundwater temperature was measured. The purpose of the temperature measurements is to assist in the evaluation of potential impacts of discharge water on Ryan Creek which is identified by MNR as a cold water creek. The measured temperatures from the tests are reported in Table 9.

Table 9: Discharge Temperature in Well Tests

Well	Date Measured	Dissolved Oxygen (mg/L)	Discharge Temp (^{O} Celcius)
TW 3-1	May 1	5.37	8.8
TW 8-2	May 2	9.09	14.2

The measurements indicate a noticeable difference in the groundwater temperatures between the discharges originating from the shallow aquifer and the deeper aquifer. The 8.8°C reading is within the range typical of groundwater. The 14.2°C is significantly warmer than what would be expected. This reinforces the conclusion that the water in the shallow well originates directly from surface water infiltration.

16.4 2009 Testing

GRI Report 05460 and the other supporting environmental reports (hydrology and natural environment, SBA, 2011 and 2011b) describe a variable and dynamic system of surface water and shallow groundwater interaction on the study site and surrounding area. The peer reviewers requested additional hydrogeological investigation of the upper bedrock zones to provide support for the conclusion that the proposed quarry would not have an impact on hydrological or natural features as a result of this connection.

Between January 13, 2009 and March 4, 2009, twelve new holes were drilled on the site. To provide additional site information to address questions by the peer reviewers, the holes were constructed to: i) gather textural, lithololigical and other characteristic (colour, grain size, bed thickness) information to augment the geological information in GRI Report 05460, ii) provide additional detail on fractures and bedding planes, iii) permit potential hydraulic conductivity testing using the packer method to augment data obtained in 2006, and iv) install piezometers at additional levels within the hydrostratigraphy. In addition, some drilling was conducted to provide core for formation quality testing for use by Miller in their operation. The hole locations and drill depths were determined from the review of the data that has been gathered since 2006 and the holes were designed to add to and enhance the data and knowledge that was available from the earlier work.

The new holes were constructed using a diamond drill with HQ core. The equipment was operated by All-Terrain Drilling Ltd. of Waterloo under GRI staff supervision. The water well records and borehole logs are found in Appendix B.

The packer tests were conducted using the Lugeon injection method. For each deep hole in the well pair, flow was induced into isolated zones of 1.5 m or 3 m at rates to sustain a constant pressure within the packer. Generally, 4 pressure steps were used. The flow at a given pressure step was measured both as pressure steps were increased and decreased.

Using both increasing and decreasing pressure steps assists in the interpretation of potential hydraulic conductivity, as the plot indicates whether the induced pressure is clearing or clogging undeveloped fracture zones or hydrofracturing the test zone. The packer test data and analyses are found in Appendix H. Type curves for the different responses to testing, excerpted from Royle are found at the front of the appendix.

The packer test measures potential hydraulic conductivity. Additionally, the results of the specific tests have to be interpreted to differentiate between in-situ conditions and induced conditions due to hydrofracturing or development of fractures. Although a given zone may have the capability to transmit groundwater, a water source is still required. To illustrate, consider the following: If water is injected into a dry sponge, the quantity of water that the sponge could absorb would be high. However, if the attempt was made to withdraw water from the originally dry sponge, the results would be significantly different. This illustrates the importance of establishing the in-situ condition to evaluate potential impacts. One way to accomplish this is to conduct other comparable forms of testing, such as rising head hydraulic conductivity tests, on the same setting. This method will consider whether there actually is water present or not, representing the real site conditions. An assessment of whether groundwater not present during the testing might be present under other seasonal conditions or situations is still made, but the values used in analysis consider the representative setting overall.

Brief details of each packer interval are provided in Appendix H so that the validity of each result can be assessed. In the tests at the base of the borehole, only an upper packer was used. In every borehole, this appeared to affect the test results, and as a consequence, the final tests for each hole were not used in any analysis. A review of the data other hydrogeological professional peers solicited by GRI suggested that during the single packer tests, some leakage may have been experienced. For this reason, the analyses from the single-packer tests, which comprised one test per well at the lowest level in the borehole, were not used in the assessment. Note that “effects” such as hydrofracturing or washing of, or clogging by sediment or gouge that appear significant on the packer test graphs are actually microscopic in scale, as the hydraulic conductivities determined for the bedrock, with the exception of the weathered zone, are generally on the order of magnitude of 10^{-5} m/s or less.

AECOM reviewed the packer test data found in Appendix H. Representative packer test results were screened by AECOM, as discussed in Section 2.2 of the Supplemental Assessment of this report, and presented in Table 1 of the report’s Appendix D. K values estimated from all packer tests were not used in AECOM’s assessment for radius of influence except shallow weathered bedrock aquifer as explained in Section 2.2 of the supplemental assessment, (July 2010). As referenced in Calculation Sheet 1 (AECOM, 2010, Appendix D), K values from packer tests for shallow test intervals are used to calculate radius of influence in the weathered bedrock zone. For the competent bedrock aquifer and significant water bearing zone, we use K values from well response tests and pumping tests as we believe hydraulic testing data from these two test methods are more accurate and consistent although the packer test data generally support the results from the two test methods. AECOM did not comment on whether or not packer leaking in the bottom-most packer tests had occurred, they concurred that the results were anomalous.

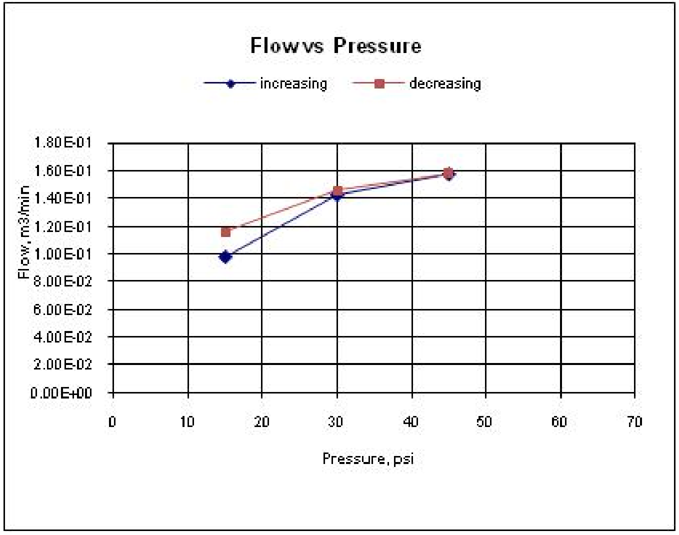
16.4.1 Drill Holes 9-1 and 9-2

These holes were drilled in the south-western corner of the existing licensed quarry (Figure 2). They are located between the quarry and residences that are located west and southwest of the site. The holes were drilled on the portion of the site where dissolution features can be observed on the surface. The highest degree of dissolution is found in this area.

The location is the topographically highest part of the Braeside upland in the study area. Drill Hole 9-1 was constructed to a depth of 31.09 m or to an elevation of 120.95 m ASL. Two formations were encountered in this hole; the Lower Bobcaygeon Formation and the Gull River Formation.

Several interesting observations were made at this location, which helped highlight the differences in geology between the flanks and the central part of the plateau. The first is that the upper 7 to 10 m is very highly weathered and tree roots or mat were encountered to depths of 7 m within the Bobcaygeon Formation (Photo 7). When packer tests were completed on this zone (Figure 15), tanker truck-loads of water could be pumped through the isolated interval, limited only by the rate that the pump could operate. This zone accepted the available water with little resistance.

Figure 15: Flows through Weathered Zone at 144.6 to 147.6 m ASL, TW 9-1. Induced flows at higher test pressures could not be stabilized due to



Below this level, at a depth of 11.3 to 11.7 m below surface (140.8 to 140.9 m ASL) a clayey shale bed was intercepted. The zone could be penetrated easily. Because of its position within the highly weathered zone, when it was first encountered it was thought that sediment had reached this depth by filtering through the open fractures. The water flow rate was increased when this zone was encountered in an attempt to clean out the hole and to permit drilling to advance. However, when the outer barrel passed by this level, the material collapsed around it, and the barrel became stuck. Water could not be circulated through the hole and the outer barrel had to be vigorously agitated before it was brought to the surface. This indicated that the zone is laterally extensive, not just an isolated zone. The first hole was terminated at 11.4 m, and a piezometer was installed with a screen interval from 141.8 to 143.3 m ASL as TW 9-2.

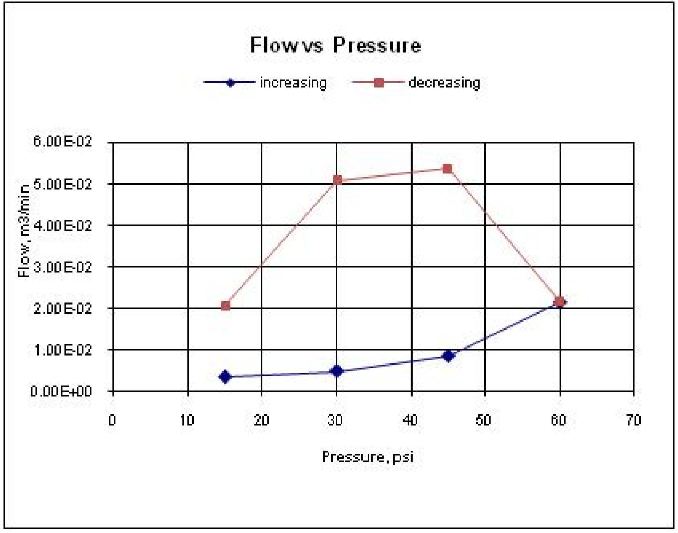
The clay unit was intercepted in every 2009 drill site except at TW 12, at approximately the same elevation. It is a distinct unit that has been identified as K-bentonite. The unit is attributed by geologists to widespread volcanic eruptions in the Middle Ordovician around 473 to 462 million years ago. The events deposited ash over much what would become eastern North America and has been observed at the Bobcaygeon/ Gull River contact in other parts of Ontario as well as in their equivalent formations in the northern United States (Charles E. Mitchell, 2004). Within and below this zone the volume of water that could be pumped into the test sections decreased significantly.

TW 9-1 was drilled 10 m away and when the K-bentonite zone was intercepted the outer barrel was slightly raised and the hole was then flushed for an extended period to ensure that the unconsolidated sediment was removed from the hole. The amount of time it took to clean the hole and advance the barrel corroborates that the zone is laterally extensive and a distinct unit. The test hole was completed at a depth of 31.1 m (121.0 m ASL), and following packer testing, the hole was instrumented with a piezometer that targets 122.0 to 123.5 m ASL. The description of the individual packer test results are found in Appendix H.

16.4.2 Drill Holes 10-1 and 10-2

These holes were drilled in the southeast corner of the site. They were drilled approximately 65 m northwest of TW 8. The purpose of this hole was to augment the data on the shallow bedrock. It was drilled in the area where there is little surface water, and where some dissolution is evident.

Figure 16: Flows at 142.7 to 139.6 m ASL, TW 10-1. Induced flows at higher test pressures result in hydrofracturing of test section which were not sustained in decreasing pressure



16.4.2.1 General Observations

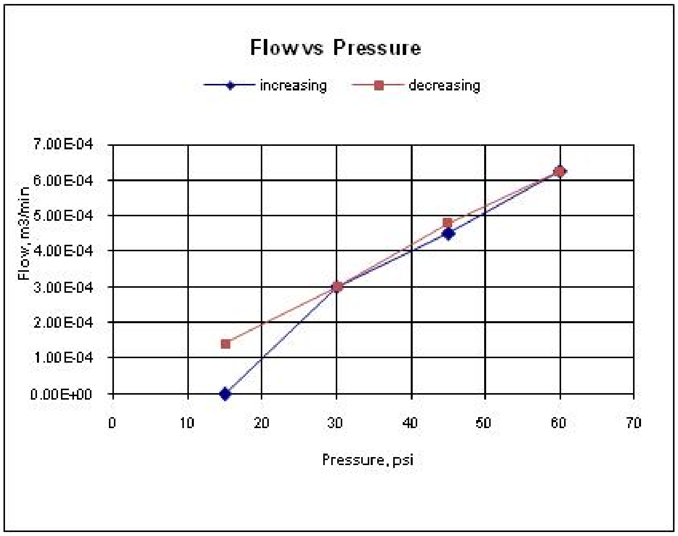
TW 10-1 was drilled to a depth of 15.36 m (130.36 m ASL) and encountered the Lower Bobcaygeon and Gull River Formations. A clayey-shale zone encountered between 12.50 to 13.11 m below ground surface (133.23 to 132.62 m ASL) was interpreted as K-bentonite.

Packer tests were completed on TW 10-1. Between 139.6 m ASL to surface (upper 6.13 m), the test zones did not accept water at low pressure. However, when the pressure was increased to levels higher than 45 psi, the isolated zone started to absorb significant volumes of water (Figure 16). During the decreasing pressure stage of the test, the zones continued to absorb significant volumes indicating that the increasing the water pressure resulted in hydrofracturing of the zone. Below 139 m ASL the higher pressure in the test zones did not result in a hydrofractured pressure profile (Figure 17). Upon completion of the packer tests, a piezometer was installed between 131.4 and 134.4 m ASL. Drill Hole 10-2 was completed to 6.1 m and instrumented with a piezometer that targets 140.7 to 143.7 m ASL.

16.4.3 Drill Holes 11-1 and 11-2

These holes were drilled in the east to north eastern portion of the site. They were drilled approximately 430 m northwest of TW 7 and approximately 440 m southwest of TW 6. The purpose of these holes was to augment data on both the deep and the shallow bedrock units. Surface water accumulates on the surface in the area surrounding the area.

Figure 17: Flows at 130.5 to 133.6, DH 10-1. Induced flows result in little to no hydrofracturing of test section, but may have been slight development of fractures.



16.4.3.1 General Observations

TW 11-1 was drilled to a depth of 28.96 m (113.85 m ASL) and encountered the Lower Bobcaygeon and Upper Gull River Formations. The K-bentonite zone was encountered between 14.81 to 15.04 m below ground surface (127.99 to 127.76 m ASL). Following packer testing, a piezometer was installed between 114.9 and 117.9 m ASL.

The packer tests that were completed on the zones 139.6 m ASL to surface (upper 6.13 m) did not accept water at lower pressures.

TW 11-2 was drilled to 9.14 m and instrumented with a piezometer that targets 134.8 to 136.3 m ASL.

16.4.4 Drill Holes 12-1 and 12-2

These holes were drilled in the north central part of the site, approximately 70 m southwest of TW 5, to augment data on the shallow bedrock characteristics. Surface water is present in the area surrounding the site.

16.4.4.1 General Observations

TW 12-1 was constructed to a depth of 12.19 m (128.13 m ASL) and encountered the Lower Bobcaygeon and Upper Gull River Formations. This was the only borehole in which the K-bentonite was not intercepted. Very large vugs and the coral tetradium were encountered near the base of the hole. Following packer testing, a piezometer was installed between 129.2 and 132.2 m ASL.

The packer tests that were completed on the zones 139.6 m ASL to surface (upper 6.13 m) in TW 12-1 did not accept water at lower pressures. However, when the pressure was increased to levels greater than 45 psi the isolated zone started to take significant volumes of water. When the pressure was decreased the zones continued to take significant volumes indicating that by increasing the water pressure, hydrofracturing had been induced. Below 139.6 m ASL, the increased pressure did not result in a hydrofractured pressure profile.

TW 12-2 was drilled to 3.1 m and instrumented with a piezometer that targets 138.3 to 140.4 m ASL.

16.4.5 Drill Holes 13-1 and 13-2

These holes were drilled in the north western part of the site approximately 220 m southwest of TW 4 and approximately 285 m northeast of TW 3. The purpose of these holes was to augment the data on the shallow bedrock unit in the area where wetland had been identified in the natural environment study (SBA, 2011b). There is little surface water accumulation in the area surrounding the site and some dissolution can be seen in the immediate vicinity.

16.4.5.1 General Observations

TW 13-1 was drilled to a depth of 9.37 m (130.04 m ASL) and encountered the Lower Bobcaygeon and Upper Gull River Formations. The clayey-shale zone was encountered between 6.34 to 6.71 m below ground surface (133.11 to 132.74 m ASL) and was interpreted to the K-bentonite. A large gap was encountered between 136.8 and 137.5 m ASL. For drilling logistics, this zone was penetrated and following packer testing, the lower piezometer was installed below it targeting elevation 131.0 – 132.5 m ASL.

TW 13-2 was drilled to 4.6 m and a piezometer was installed to target the gap zone, between 135.9 m ASL and 137.4 m ASL.

16.5 Rising Head Hydraulic Conductivity Tests

The results of the rising head hydraulic conductivity tests are summarized in Table 10. The test data and analysis are found in Appendix I.

Table 10 illustrates how the packer test measures *potential* hydraulic conductivity and not necessarily the in-situ condition. Rising head tests are required to determine whether the results are truly in-situ. As an example, tree roots were cored in TW 9 to a depth of 7 m. Observations of the surface in this area indicate that this area is on the edge of the upland and that dissolution in the area is common. The addition of water in this zone induces flow along existing open pathways. However, the tree roots extend to that depth because there *is* no water normally – to sustain the vegetation, the roots have to extend for significant depths. The packer tests result indicates a potential hydraulic conductivity value on the order of 10^{-5} m/s, but this is not the in-situ condition, which can be up to 2 orders of magnitudes lower.

Table 10: Summary of Rising Head Hydraulic Conductivity and comparison to Potential Hydraulic Conductivity for Same Interval

Drill Hole	**Surf Elev (m ASL)**	**Screen (m ASL)**		**k from rising head, (m/s)**	**potential k from packer test (m/s)**	**Comment**
		Base	**Top of Sand Pack**			
BH 9-1	152.04	121.0	123.1	2.09×10^{-6}	4.41×10^{-7}	Water bearing zone
BH 9-1 (T2)	152.04	121.0	123.1	2.59×10^{-6}		
BH 9-2	152.19	140.8	142.9	1.41×10^{-7}	2.58×10^{-5}	Dissolution

Drill Hole	Surf Elev (m ASL)	Screen (m ASL)		k from rising head, (m/s)	potential k from packer test (m/s)	Comment
		Base	Top of Sand Pack			
BH 10-1	145.74	130.4	134.0	1.15 x 10^{-7}	4.72 x 10^{-8}	In-situ
BH 10-2	145.72	139.6	143.3	2.51 x 10-^{6}	2.4 x 10^{-6}	Dissolution zone
BH 10-2 (T2)	145.72	139.6	143.3	2.98 x 10^{-6}		
BH 11-1	142.81	113.9	116.0	3.64 x 10^{-8}	3.45 x 10^{-10}	In-situ
BH 11-2	142.91	133.8	137.4	3.74 x 10-^{10}	3 x 10^{-8}	Dissolution
BH 12-1	140.33	128.1	131.7	2.45 x 10^{-7}	7.6 x 10^{-8}	In-situ
BH 12-2	140.28	137.3	139.7	1.46 x 10^{-8}	2.7 x 10^{-5}	Dissolution
BH 13-1	139.52	128.9	131.0	7.28 x 10^{-9}	0	In-situ
BH 13-2	139.41	134.8	138.5	2.91 x 10^{-8}	7.3 x 10^{-5}	Dissolution
Add'l Floor Holes						
F	136.33	127.186		1.31 x 10^{-7}	8.3 x 10^{-7}[11]	
G	138.27	129.126		1.18 x 10^{-9}	9.2 x 10^{-7}	

17 Surface Water and Drainage

The surface water and drainage mapped over the period of March through June is shown on Figure 7. The surface drainage on the site and in the surrounding area consists of overland flow integrated with localized sub-surface migration.

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[10] i.e. impervious

[11] Averaged over borehole. Upper approximately 1.5 m of bedrock below quarry floor has slightly higher potential k which has been attributed to blasting effects.

17.1 Surface Water Accumulations on Competent Bedrock

Surface water accumulates in the saturated overburden and lower lying surfaces and depressions of the competent bedrock portions of the site (Figure 7). These areas are predominantly on the top of the plateau, and on the steps on the slopes, including the sediment-filled trough in the north-west corner of the site. The areas shown on Figure 7 are typical; there may be others that are intermittent or were not found in the multiple site traverses. The boundaries of the wetland features shown on Figure 7 are approximate and reflect the conditions observed during GRI's mapping. The hydrology and natural environment reports (SBA, 2011 and 2011b) should be referred to for boundaries of key features.

17.2 Springs

The accumulated surface water flows overland following the surface topography until the weathered bedrock zone is encountered. At this point, the surface water drains into the dissolution fractures and flows below surface to emerge at the base of the dissolution as springs. The upper spring elevation is found approximately between 133 m ASL and 137 m ASL, and as indicated in Section 14, initially developed because of the position on the flank of the plateau during the late glacial period.

The surface water that emerges in the form of the upper springs flows again along the base of the upland of Bobcaygeon Formation and then subsequently overland following the local surface topography until it nears the edge of another topographic drop where it meets the lower dissolution/ weathered bedrock zone. The surface water drains into this dissolution zone and emerges below in the form of the lower springs, at around elevation 125 m ASL. This is just above the base of the escarpment and the contact between clay (referred to as Renfrew clay loam in the hydrology report) and upland till/ bedrock (referred to as Farmington loam in the hydrology report). This flow pattern can be observed along the entire plateau, on both east and west sides.

17.3 North-West Wetland

On the north-west corner of the study, the natural environment report shows a wetland feature that is partially on the Miller property. The topographic mapping shows that this feature is originally present, as described in Section 14.4, because of a natural bedrock trough filled with clay that had natural drainage constrained by the construction of Usborne St (Figure 2). The feature originally received drainage from up-gradient to the north which was augmented, due to its topographical positioning at to just below the upper spring elevation, with seasonal spring water. Currently, this surface water feature is now also augmented with the quarry discharge.

17.3.1 Quarry Discharge Contribution to Surface Water Features

The path that the quarry discharge takes through the wooded area was mapped and is shown on Figure 7. The flow follows a channel partially constructed (for a length of approximately 4 to 5 m) and from that point naturally developed, until it emerges into the wetland on the Miller property. The quarry discharge entering the wetland is clear (Photo 8). The wetland has an outlet that is beyond the Miller property, which exits at Usborne Street at Campbell Drive and then meanders back through the Miller site before discharging again into the east roadside ditch on Usborne Street at the culvert.

The water level in the wetland was observed to increase noticeably by 5 to 10 centimetres initially for a short time when the quarry is discharging. These specific observations were made on July 3 following an extended rainfall period so the increase could not be attributed exclusively to quarry discharge since as noted above, there are other sources of recharge to this wetland. It was observed at this same visit that the water level did not increase at the wetland outlet at Usborne Street. A new beaver dam was found in the approximate location shown on Figure 7. The increases/changes in flow from to the beaver activity resulted in noticeable turbidity in the adjacent water (Photo 9). Despite the turbidity of the water entering the wetland from the north, the water was clear though slightly coloured where it emerged into the Usborne St roadside ditch.

17.4 South-East Wetland

A small wetland area found south-east of the Miller property originated because of a combination of factors; a topographically suitable bedrock depression on the competent bedrock step directly at to slightly below the elevation that the upper springs emerge. The natural heritage evaluation indicates that the wetland appears to be a typical example of the small, shallow, beaver-maintained ponds found commonly across southern Renfrew County. Although the pond has not been evaluated, it is the opinion of the evaluator that there are no indications of significant natural features or functions here nor strong indications of the potential for such values to occur (these indications would include the existence of exceptional adjacent habitats, a strategically important location for wildlife passage, representation of particularly good potential habitat for potential Species At Risk; etc.).

This wetland has an outlet, shown on Figure 7. The water level will vary seasonally, depending on the spring flow and beaver activity. The flow from the outlet had significantly decreased in the May 22-26 2009 visit in comparison to the peak flows observed in mid-April. The water level in the pond is also controlled by extensive beaver activity in the area.

17.5 Geochemical Analysis

The general geochemistry of various hydrogeological components was used in the analysis of the surface water/ groundwater interaction. Samples from the surface water (SP*-T in the spring sample series) and associated upper (SP*-M) and lower (SP*-B) springs were taken at three locations. The connection between the three levels was inferred from site observations and the topography. Water quality from the off-site surface water monitoring stations, the sump and different levels of groundwater were also analysed. The laboratory reports are found in Appendix J, and the data used in the analysis is found in Table 11 and shown on Figure 18.

On a Piper plot, samples of like origin or composition cluster together. The graph permits a view of how various components may contribute to one another. The water quality from springs on the east side (SP-1 series and SP-2 series, points 5 to 10) differs from the water quality on the west side (SP-3 series, points 11 to 13). For each spring series on the east side, the results plot in a close distinct group indicating their similar origin.

Table 11: General Characteristics of Groundwater and Surface Water Components (Concentration in mg/L)

Date	Sample	Graph Ref.	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	F
30-Apr-09	Sump	1	97.00	12.00	48.00	1.00	207	0.0	83.00	55.00	0.13
30-Apr-09	SW 4	2	51.00	15.00	43.00	3.00	177	0.0	68.00	9.00	0.12
30-Apr-09	SW 5	3	135.00	16.00	51.00	1.00	292	0.0	98.00	84.00	<0.10
30-Apr-09	SW 6	4	51.00	15.00	43.00	3.00	174	3.0	72.00	10.00	0.12
17-Apr-09	SP1-B	5	59.00	3.00	<2.00	1.00	168	0.0	2.00	5.00	<0.10
17-Apr-09	SP1-M	6	63.00	3.00	<2.00	1.00	168	0.0	3.00	5.00	<0.10
17-Apr-09	SP1-T	7	61.00	1.00	<2.00	1.00	164	0.0	2.00	2.00	<0.10
17-Apr-09	SP2-B	8	71.00	4.00	<2.00	1.00	203	0.0	3.00	6.00	<0.10
17-Apr-09	SP2-M	9	65.00	2.00	<2.00	1.00	179	0.0	2.00	4.00	<0.10
17-Apr-09	SP2-T	10	66.00	2.00	<2.00	1.00	175	0.0	2.00	4.00	<0.10
17-Apr-09	SP3-B	11	109.00	13.00	38.00	1.00	261	0.0	104.00	17.00	<0.10
17-Apr-09	SP3-M	12	63.00	5.00	<2.00	1.00	175	0.0	1.00	14.00	<0.10
17-Apr-09	SP3-T	13	67.00	2.00	2.00	<1.00	181	0.0	1.00	14.00	<0.10
Date	Sample	Graph	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	F
03-Jul-09	TW 9-2	14	189.00	21.00	11.00	4.00	228	0.0	13.00	322.00	0.16
03-Jul-09	TW 10-	15	64.00	25.00	15.00	7.00	262	0.0	7.00	24.00	0.58
03-Jul-09	TW 13-	16	70.00	12.00	16.00	3.00	221	0.0	2.00	28.00	0.26
03-Jul-09	TW 9-1	17	93.00	20.00	4.00	2.00	250	0.0	2.00	78.00	0.46
03-Jul-09	TW 10-	18	56.00	23.00	3.00	5.00	250	0.0	2.00	14.00	0.46

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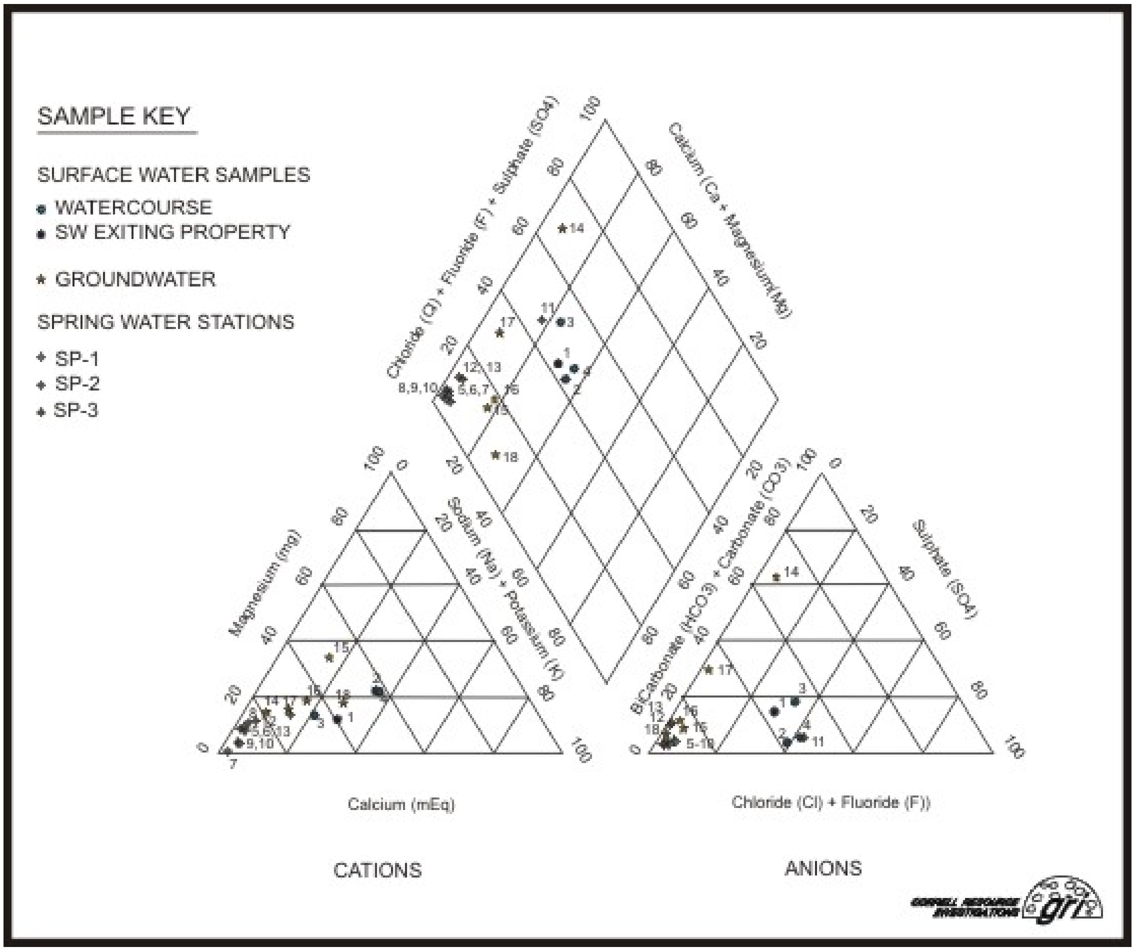
[12] where result was below the detection limit, the MDL was used in the graphing

Figure 18: General Characteristics of Groundwater and Surface Water Components



On the west side, the source water sample (SP3-T) and upper spring sample (SP3-M) has a different quality than the lower spring sample (SP3-B). This suggests either that the location assumed to be the source of the lower spring was incorrect, or that the lower springs on the west side have other influences than the upper springs. The base spring, SP3-B has a similar quality to surface water from SW5 suggesting that it is also receiving recharge flow from along Campbell Drive.

Samples 14 (south-west), 16 (north-west) and 18 (south-east) represent the shallow bedrock quality. Sample 14, from TW 9-2, has a high sulphate concentration unlike any samples from the rest of the site. The location of the piezometer is just above the quarry floor and 24 m from the quarry face. Sample 16 is similar to the water quality of the springs on the west side, indicating that they come from a similar source. This makes sense, as the elevation of TW 13-1 from which the sample was taken is approximately 130 m, within the same stratigraphic zone and the vicinity of the springs. Sample 18, from TW 10-2 is one of the highest monitoring points on the site and would be considered recharge water.

Sample 15 is from within the weathered bedrock zone, deeper in the profile, and Sample 17 is from the significant water bearing zone. The chemistry from the east and west sides is different, with the sample from TW 9-1 being farthest from the sample cluster, again because the sulphates are elevated although not as high as in TW 9-2.

18 Door to Door Survey

A door to door survey was first conducted between May and August 2006 as part of the PTTW monitoring program. An initial door-to-door survey of wells within 500 m of the existing quarry license boundary was completed. Owners or residents of 17 sites were contacted out of the possible 18. The survey consisted of an interview, collection of a baseline water sample and where possible or permitted, a direct water level measurement. The locations of the sites are shown on Figure 9. Participants were informed privately of the water quality results.

18.1 2006 Survey

The survey found that area users rely on two aquifers, the unconfined weathered bedrock, and the deeper confined bedrock aquifer. Within the deep aquifer, water is obtained from two distinct levels. Wells that use the unconfined weathered bedrock aquifer exclusively have a less reliable yield, and wells that include this zone are susceptible to bacteriological contamination. Of the wells examined in the upper aquifer, 7 were found to be unpotable in 2006 due to the presence of bacteria at unacceptable concentrations. This was not surprising due to the direct connection between surface water and the weathered bedrock zone down to an appreciable depth. If the wells are not constructed to cased off and seal the weathered zone, water from the surface can directly enter the well bore through the hydrostratigraphy and the well annulus.

Anecdotal information from several sources also describes potability problems with area wells. One local driller indicated that some newer and in some cases older wells in the area that do not have casing grouted to 15 m or deeper are being retro-fitted with sleeves. These sleeves are being installed in the wells to ensure that the upper bedrock zones, the zones that are directly connected to the surface, are shut off so groundwater of shallow origin cannot contribute to the well.

18.2 2009 Survey

The door to door survey was expanded in 2009 to include the properties within 500 m of the proposed expansion properties. The initial intent was to conduct the survey in late 2007, but the survey was deferred until after initial peer review comments were received and other site activities were completed.

In the initial contact, in October 2007, information packages were either hand delivered by GRI staff or left in a mailbox or door. The package consisted of a letter from Miller Group introducing GRI and the purpose of the survey, and a response page with an addressed postage paid envelope and response date for indication of interest. Of the 31 packages delivered, one refusal was received by telephone and 8 requests for inclusion in the survey were received.

As awareness of the project increased, additional requests were received by Miller for well water testing. Between November 2007 and December 2009, 15 additional requests for sampling were made, including residents in the area that had been surveyed previously. Of the requests, 5[13] were determined to be outside the 500 m survey radius, and the owners were informed accordingly. The remaining 10 were advised of the proposed sampling and interview program details and were added to the survey list.

To ensure that contact had been made, an additional repeat package of information was mailed to the property contacts that had not been surveyed in the 2006 survey and to those within the original survey area who had requested updated water samples. The contact information for the properties was provided by the County of Renfrew. The packages were mailed by ExpressPost with delivery confirmation or hand delivered to the civic address where contact information could not be correlated (12 locations). One addressed and returned package was subsequently hand delivered to the new owner. At the end of the 2009 survey, an attempt had been made to contact or re-contact the owners within 500 m of the existing quarry and proposed expansion quarry properties with an offer to conduct a new interview or collect a replicate water sample. A total of 53 owners were included in the survey, including two owners beyond the 500 m area who were included before the terms of reference for the survey were finalized. At completion of the survey, 38 owners had participated.

Following the interview, the water samples were delivered within 24 hours to the Bodycote Test Group laboratory in Ottawa for bacteriological and chemical analysis. Upon receipt of bacteriological results, if they showed an unpotable water supply, the owners were immediately contacted and informed. In addition, as a courtesy, disinfecting pellets and instructions for disinfection were provided to most affected sites by GRI. Upon receipt of the laboratory results, a courtesy letter providing the results and short interpretation was mailed to every participant. A few interviewees had specific questions about well quality that had arisen during the interview and that were answered. Three re-samples of 2006 sites are yet to be completed.

The survey locations are shown on Figure 9. The results of the survey are summarized In Table 12. The results do not show any identifying information, but they show the following general trends. Some specific local groundwater quality issues are highlighted below.

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[13] Two properties were included in the survey before the radius to be surveyed was communicated to team members, and these wells are included in analysis

Table 12: Summary of General Household Quality, 2009 Surveyed Residences

Study ID	Bact Contam	NO_3	Cl	Na	hardness	Fl	Fe
6621		<0.10	288	356	12	0.25	<0.03
5461	x	<0.10	71	43	309	0.13	<0.03
5504	x	<0.10	2	3	234	<0.10	0.13
6129		<0.10	126	258	<1	0.17	<0.03
6361		<0.10	179	39	603	0.31	<0.03
5478	x	0.25	78	44	332	0.11	<0.03
5900	x	0.88	63	38	425	0.15	<0.03
7631		0.69	14	16	324	0.14	<0.03
7495		<0.10	24	32	455	0.14	0.24
7500		<0.10	9	55	197	0.45	<0.03
6480		<0.10	143	29	510	0.28	0.57
7570		<0.10	<1	<1	260	0.12	<0.03
6632		0.16	17	45	461	0.45	0.07
5525	x	0.5	51	27	334	<0.10	<0.03
6452		<0.10	678	261	783	0.25	0.1
7335	x	<0.10	1	<2	234	<0.10	<0.03
6540		<0.10	36	10	357	0.2	<0.03
6938	x	<0.10	179	319	<1	0.71	<0.03
7321		<0.10	9	22	355	0.2	<0.03
6277		0.32	340	169	524	0.22	<0.03
6874		<0.10	9	57	1440	0.67	<0.03
5764		<0.10	64	29	360	0.31	0.03
6599		<0.10	10	163	<1	0.68	<0.03
5729		<0.10	3	3	287	<0.10	<0.03
6723	x	<0.10	8	60	1590	0.84	0.3

Study	Bact	NO_3	Cl	Na	hardness	Fl	Fe
5818	x	0.12	26	16	354	0.13	<0.03
6335	x	0.77	42	23	350	<0.10	<0.03
7318	x	2.57	75	31	501	0.19	<0.03
6284		0.16	9	178	<1	0.35	<0.03

18.3 Bacteriological Potability Impacts

Of the 25 samples taken, 9, or 36% of the wells showed bacteriological contamination that resulted in an unpotable water supply, compared to 7 of 17, or 41% in 2006. There is overlap in the contaminated sites between 2006 and 2009. Two-thirds of the identified wells are clustered on the south-west part of the survey area within the geological setting that has a high degree of weathering in the upper zones. In this part of the study area, documentation shows that localized surface water regularly migrates down to approximate elevation 134 m ASL.

The purpose of the minimum standards for well casing and grouting is to prevent direct drainage of surface water through the annulus due to the well construction, but the minimum requirement does not necessarily prevent surface water from entering a well water supply depending on site specific conditions. Wells may be constructed to the regulatory standards of the well drilling regulations (O.R. 903) with the minimum 20 ft (6.1 m) of casing and grout and still permit surface water to circumvent the casing and enter the well because of the surrounding hydrostratigraphy. In some hydrostratigraphic settings (the more obvious one addressed in the regulations, an overburden thickness of greater than 6 m) more casing is added. Similarly in subdivisions, the subdivision conditions allow for a greater than regulatory casing length[14]. The subdivision conditions also specify that the well construction should be supervised by the developer's hydrogeological consultant to ensure that their recommendations are followed.

However, in most planning situations, there is no method of enforcing a greater casing length. In the particular hydrostratigraphic setting of the study area, which occurs on both sides of the escarpment, a casing length of 60 ft (20 m) should provide the necessary protection from surface water contaminants. A local well driller informed us that he had successfully retrofitted several contaminated wells in the Sullivan subdivision using this method. One well amendment record was found recording this remediation.

18.4 Natural Gas

Natural gases, notably hydrogen sulphide were detected by the interviewer and/or reported by the interviewee in 8 of the sites, for 32%. These sites are predominantly located on the east side of the

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[14] For the Sullivan subdivision, the consultant's report specifies a minimum of 12 m of casing and grouting.

escarpment. Impacts of the gas range from variable concentrations of odour that may or may not be being treated, to sputtering when the taps were run, to corrosion impacts in fixtures. At one particularly severe site, when the outside tap sputtered, puffs of gas could actually be observed wafting from the faucet.

To determine whether other harmful gas such as methane was present, a photo-ionization meter with and without methane elimination was used at a follow-up visit to that site, with the owner's permission, and no gas concentrations were detected in the well head.

Wells with natural gas can be hazardous both during drilling, if the driller is unaware of the area presence, and during use if the gas is not vented sufficiently. Methane gas is colorless and odorless. At high enough levels, the gas can be seen or heard bubbling in the well. At the particularly severe site, when the water was taken the effervescence in the sample resulted in cloudiness.

Often the gas is dissolved in the water due to high pressure and low temperature in the well. When the well is pumped, the water level lowers and pressure in the well is reduced, bringing the gas out of solution. It may be released to the atmosphere if the well is vented, or may build up in the well if the well is sealed. If the gas is trapped, such as in a well pit or pump house, it can build up to an explosive level. The spark from a pump motor or pressure switch will then set off an explosion. This is more likely to occur in older wells which may be buried in well pits or situated in a pump house or basement.

To prevent a dangerous situation from occurring, the well casing has to be vented to the outside. Most new wells are located away from buildings and use a pitless adapter and vented cap but the risk remains for the older-type wells described above.

Gas can also accumulate in pressure tanks and hot water heaters. When this happens, the gas builds up until it spurts out of the household taps. The burst of gas can knock a drinking glass out of someone's hand. Gas release vents can be installed on some pressure tanks and on hot water heaters. These won't solve the gas problems, but can make them manageable.

The origin of the natural gas is most probably the Rockcliffe Formation which underlies the Gull River Formation. The formation was not encountered on the Miller properties because of its depth, but on the east flank of the escarpment it is reported in many well records. It is distinguished by the description "red and green layers", characteristic of the formation in the area west of Ottawa.

Within the Rockcliffe Formation consists it is the shale layers that are gas producing. The St. Martin Member has more frequent shale beds in the study area. The approximate elevation of the contact between the Rockclliffe Formation and the overlying Gull River Formation was reported in well records at between 64 m ASL and 90 m ASL, so only wells on properties with lower surface elevations, such as those found in the subdivision, or very deep wells are likely to encounter it.

18.5 Nuisance Bacteria

Iron and Sulphur bacteria are frequently found in water supplies, and the study area was no exception. The bacteria are considered a nuisance and are not render a water supply unpotable. The strains originate in overburden and can migrate down into the lower aquifers through natural or anthropogenic means. The well drilling regulations require disinfection of drilling equipment between wells to prevent cross contamination of bacteria, but they can be introduced from plumbing activities such as pump installation. The strains frequently thrive in a deeper well environment, particularly if it is slightly reducing.

Iron bacteria can be identified as red slime in the toilet tank or hot water heater; sulphur bacteria cause a black residue in fixtures and sometimes appear as feather-like particles. Iron bacteria especially can cause clogging in water treatment equipment, hot water heaters or other similar fixtures. They can be removed by oxidizing the water, and in cases where they are prolific, down-the-well treatment systems using hydrogen peroxide or chlorine can be used to adjust the environment within the well itself and discourage or prevent growth.

The samples were not analysed for iron or sulphur bacteria, but anecdotal information was collected during the interviews that indicate that both strains are common to a degree in the study area.

18.6 General Groundwater Quality

In general, the groundwater quality from the local aquifers is very hard, similar to the rest of Eastern Ontario where sedimentary bedrock is prevalent. The high hardness results in scale build-up in appliances and fixtures. A water softener is generally used to reduce the concentration. In the softener, the dissolved calcium and magnesium ions are replaced with sodium ions from induced salt brine. The resulting treated water usually has a sodium concentration that is close to, or exceeds, the Ontario Drinking Water Standard. Thirteen of the homes reported the use of a water softener. At two of the homes, only a softened supply was available for sampling.

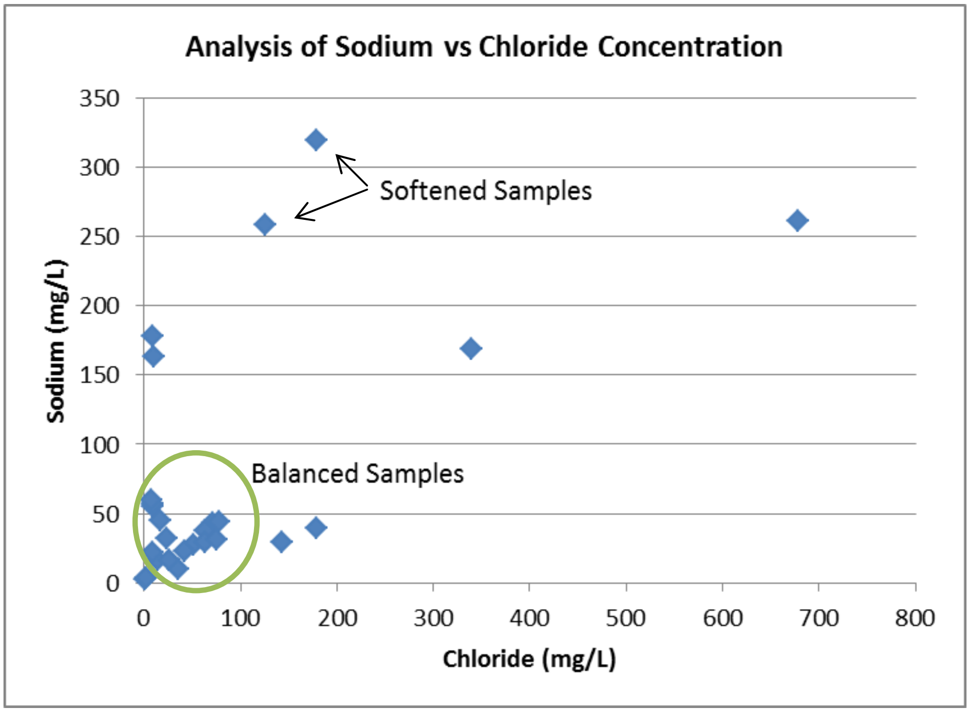
A naturally high iron concentration is also usually common in Eastern Ontario groundwater, but for most homes that a raw sample was obtained (16 sites or 64%) the iron concentration was below the analytical detection limit. The remainder have variable iron concentration ranging from 0.03 to 0.57 mg/L. The iron results in staining of fixtures and appliances. A moderate iron concentration can be removed with a water softener. More severe concentrations can be removed with iron removal units. Five homes reported the use of oxidizing units; none report the use of greensand filters.

At five of the sites (20%), residents indicated that they have detected sediment in their wells on occasion. The possible relationship of blasting events to the sediment encounters is being examined in conjunction with the blasting engineers.

Nitrate was not found to be prevalent in the analysed samples. The highest nitrate concentration recorded from the samples was 0.88 mg/L. The results for 13 of the sites (52%) was less than the method detection limit of 0.1 mg/L

Sodium and chloride and their relationship were also examined. At the homes with softened samples, the sodium concentration exceeded the Ontario Drinking Water Standard (ODWS). In normal balance, the sodium and chloride ions are approximately equal. The balanced samples are circled on Figure 19 The softened samples can be identified by the high sodium and chloride concentration combined with the minimal calcium and magnesium ion concentration, and there are two such samples labelled on Figure 19.

Figure 19: Analysis of Sodium vs Chloride Concentration in Sampled Wells

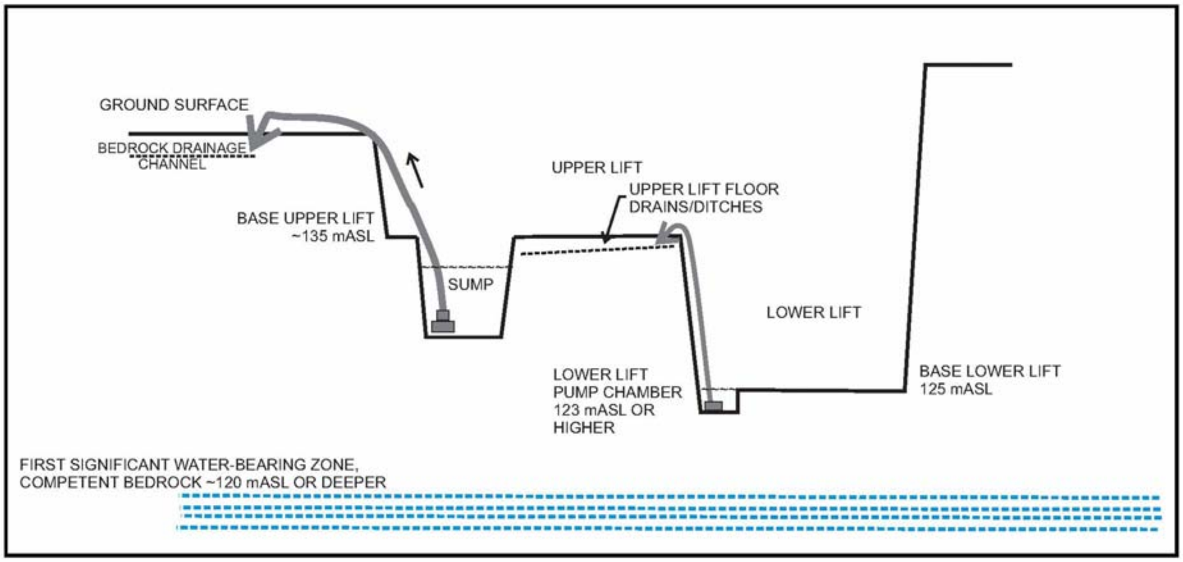


There are five remaining samples unaccounted for. There are natural variations of sodium and chloride associated with some bedrock formations. The Rockcliffe Formation is one that can produce “salty” water, particularly along the Ottawa River in West Carleton Township. Another explanation is the influence of road salt applied in winter. This is usually identified by the well location in relation to the road network where road salt is applied, with particular attention to locations such as corners, stop signs or curves. Both are possible explanations for the anomalous concentrations.

19 Groundwater Calculations

A schematic cross-section showing the various levels in the existing quarry profile and defining the terminology used in the following sections is provided in Figure 20.

Figure 20: Schematic Cross-Section Illustrating Quarry Lifts and Internal Water Management System



19.1 Vertical Seepage

The quarry may influence the deeper bedrock aquifer water bearing zones through seepage through the quarry floor. The calculation of vertical seepage initially calculated in GRI Report 05460 was approximately 3 m^3/day at full quarry development.

The 2007 report, the analysis assumed a hydraulic conductivity of 3.0 x 10^{-11} m/s.

The calculations were refined using the updated data on hydraulic conductivity from the bedrock zone between 121 and 125 m ASL across the Miller properties (Table 2 and Appendix H and I). A sensitivity analysis indicates that the key influence on the calculation is hydraulic conductivity. Additional information gained from the testing is available for the refined calculation.

In the 2009 evaluation using the additional discrete data collected, the potential hydraulic conductivity for the low permeability portion of the bedrock, 1.18 x 10^{-7} m/s was used to represent bedrock beneath the quarry floor. The potentiometric elevation ("Pot Elev") of 127.2 m was measured in May 2009. This potential hydraulic conductivity value was measured in Hole G on the floor of the quarry, so theoretically it will include potential effects from blasting on the quarry floor. Even so, it was still approximately an order of magnitude higher than the assumed value used in the 2007 calculation. The updated calculation of potential vertical seepage found in Table 13 is similarly higher by an order of magnitude. However, even with the refined rate, the vertical seepage would be considered low.

Table 13: Refined Estimation of Vertical Seepage from Confined Aquifer at Full Quarry Development using Darcy's Formula

Calculation Assumptions:			
Quarry Floor			
quarry area, full development =	68.4	ha	
Formula:	Q = k*i*A	Where,	Q = discharge in m^3/s
			k = hydraulic conductivity in m/s
			i = hydraulic gradient, and
			A = x-sectional area in m^2
Aquifer Characteristics:			
WBZ =	121	m ASL	
Static level ~	127.2	m ASL	
Bedrock Characteristics:			
$k_{(vert)}$ * =	1.18×10^{-9}	m/s	* assume $k_{(vert)}$ is 1/100 of k-horizontal
n =	n/a		
Vertical Seepage Calculation:			
For base elev =>		125	
i =		0.55	
		cu. m/day	Litres/day
Q (floor, full quarry)		38.35	38,354
Q (floor, per ha)		0.56	561

The zone of influence created by this seepage from the water bearing zone can be calculated. The two-dimensional analysis for steady state well discharge uses the formula of Theim (1906 described in Driscoll, 1986). An analysis of the impact of this withdrawal on the water bearing zone indicates that the seepage will not result in a negative impact to the water bearing zone (Appendix E), with a calculated radius of influence of only 1.5 m. Visualizing, this makes sense. The seepage through the entire quarry floor is very low. The bottom of the quarry is essentially impervious; the daily seepage corresponds to an upward flux of only 5.6 x 10^{-5} m or 0.056 mm. In comparison, the estimated daily water surplus to the area is 374 mm/year (SBA, 2011), or 1.02 mm per day. Therefore, negligible impact to the competent bedrock aquifer is predicted from potential upward seepage.

A sensitivity analysis was completed (Table 14) to evaluate which parameter most affected the results. As with the seepage calculation, hydraulic conductivity provides the highest variation, although even with a magnitude change the change is still very small at 3%.

Table 14: Sensitivity Analysis – Cone of Influence Calculation

A = 68.4 ha

Equivalent r = 466.61 m

				Transmissivity*				
Case	**Change**	**H (m)**	**h (m)**	**K (m/s)**	**b**	**Q**	**R**	**% Diff**
Base Case		127	125	0.01	1.000	38.35	468.17	
Assume higher Pot Elev	Pot elevation increased by 1 m	128					468.95	100.17
Assume higher Q	Vertical Seepage increased by 1					39.35	468.13	99.99
Assume higher K	k increased by one order of magnitude (10 x)			0.10			482.47	103.05
Assume smaller b	aquifer thickness reduced by one order of magnitude (1/10)				0.1		466.76	99.70

[*] The parameters k and b are combined in the calculation as transmissivity, meaning either a transmissivity value with a default thickness of 1, or true k and b can be used.

19.1.1 Lower lift pump-out

As the quarry advances into the lower lift, operational accommodations will have to be made to remove the water accumulations in it. At some time in the operation it will be necessary to construct a sump in the lower lift. An analysis was completed to assess a suitable maximum depth for the lower lift pump chamber to extend below the floor. The pump chamber on the lower level will act as a "lift station" to the existing sump which will continue to perform as it does now to provide settlement of sediment before discharge.

Therefore, while it will provide some settlement depending on the frequency of pumping, the lower lift pump-out/pump chamber will not be required to provide the necessary settlement times for off-site discharge. The discharge from the quarry will therefore continue in the same pattern as currently occurs with the exception of any mitigation measures that might be required. The proposed location of the initial lower lift pump-out/pump chamber is shown on Figure 9; however, the position of the pump chamber on the lower floor may vary as the operation develops.

The analysis for lower lift pump-out/pump chamber depth was completed for several configurations (Table 15). A preferred capacity of 3,150 m^3 was provided by Millers operations staff to accommodate the equipment.

The results indicate that even with a 3 m depth, the pump chamber will have negligible groundwater seepage from the underlying significant water bearing zone. The critical parameter is the assumption of the hydraulic conductivity. A variation in hydraulic conductivity by an order of magnitude will correspondingly increase or decrease the calculated seepage by a factor of 10. The examination of the core from the quarry floor and borehole cores shows that there are few vertical fractures present in the competent bedrock, which provides assurance regarding the assumption of vertical hydraulic conductivity. The field observations and data indicate that the intervening bedrock (between significant fractures or water-bearing zones) is essentially impervious.

The critical factor in setting the sump depth is the zone that is affected by blasting, which was inferred to be on the order of 1.5 m from the packer testing. Therefore, to provide for a factor of safety, the sump depth should be no greater than 2.0 m to protect against vertical seepage from the underlying water-bearing zone. Using a hoe-ram or comparable equipment to construct the pump chamber may result in lower disturbance of the bedrock beneath floor than blasting. Maintaining the base of the pump chamber at or above 123 m ASL will provide more than enough assurance that the operation will not interfere with the significant water bearing zone.

Table 15: Calculation of Seepage through Lower lift pump-out for Various Configurations

Pump Chamber Configurations Analysed:					
capacity (m$^{3)}$	3150				
Depth (m)	5	2	3		
Area (m^2)	630	1575	1050		
Aquifer Characteristics					
k (vert)* =	1.18E-11	m/s	Static level ~	127.2	m ASL
	1.02E-06	m/day	WBZ =	121	m ASL
n =	n/a	* assume K (vert) is 1/100 of k-horizontal			
Analysis:		**no chamber**	**2-m deep chamber**	**2.5-m deep chamber**	**3-m deep chamber**
For base elev =>		125	123	122.5	122
For capacity of 3,150 m^3, area =			1575	1260	1050
i =		0.55	2.1	3.2	5.2
Q through chamber *(m^3/day)*		0.00	0.00	0.005	0.006

19.2 Time to Fill Quarry Following End of Operations

The water level in the excavation will fill from precipitation over the excavation, runoff, and inflow of groundwater from the underlying bedrock aquifer. The final lake elevation is predicted to be approximately 132 m ASL, based on the understanding of the hydrogeology and the available field testing and monitoring data. An estimate of the time to fill the quarry upon completion of operations can be made as follows:

19.2.1 Quarry Configuration at Completion:

Final excavation area:	680,000	m^2
Final water depth (to +/- 132 m ASL):	7	m
Final drainage area:	912,000	m^2
volume to fill =	Excavation area x depth	
=	4,760,000	m^3

19.2.2 Available Inflow from Surface Water Sources:

Excavation will receive precipitation minus evapotranspiration at rate of:	0.374	m/yr[15]
For excavation, inflow =	680,000 x 0.374	
	254,320	
Excavation will receive runoff from surrounding drainage area at rate of:	0.145	m/yr
From surrounding drainage area, inflow =	(912,000-680,000) x 0.145	m^3/year

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[15] SBA, 2011

= 33,640 m^3/year

Total available inflow = 254,320 + 33,640

= 287,960 m^3/year

19.2.3 Groundwater Influx From Water-bearing Zone:

The analysis (Section 19.1) indicates that up to 38.35 m^3/day of groundwater may seep through the quarry floor, or about 14,000 m^3/year. Influx will contribute until the depth in the quarry reaches approximately 2 m or for approximately 4 years. For the remainder of the quarry, the rate of filling will decline as the rate of recharge through the floor increases with water depth to the maximum of 33.5 m^3/day, calculated using the same method as Section 19.1. The remaining quarry will take approximately 16.2 years to fill, for a total time to fill of approximately 20 years.

Part 3 –Conclusions and Recommendations

Proposed Braeside Quarry
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Gorrell Resource Investigations
Project No. 08360
December, 2011

20 Summary and Conclusions

Predicted effects from the proposed Braeside Quarry expansion by Miller Paving Limited will have limited impacts on the surrounding groundwater and surface water environment or can be mitigated.

The testing and data collection on the site identified three potential aquifers in the area, the overburden aquifer, the weathered bedrock aquifer and the deeper bedrock confined aquifer. Area groundwater users rely on the shallow weathered bedrock aquifer and the deeper bedrock aquifer for water supply.

The first potential aquifer, the overburden aquifer, is discontinuous and minimal on the site but may be present in other locations. Where present, it may form a restricted local aquifer. Most commonly in this setting, the overburden provides storage of groundwater, while the underlying weathered bedrock provides the transmission into a well.

Where there is no overburden present, the second potential aquifer, the shallow weathered bedrock aquifer has a high degree of connectivity to the surface and is influenced by precipitation events and runoff.

Underlying the shallow weathered bedrock is the third potential aquifer, the semi-confined to confined bedrock aquifer. The water-bearing zones are not directly connected to the local surface, but are recharged through more distant recharge sources. In the area, this aquifer discharges on either side of the escarpment through springs at approximate elevation 125 m ASL. These springs provide some recharge to the surface water systems and overburden aquifer.

The analysis of the site conditions shows that the proposed excavation will not impact the local groundwater setting due to the natural topography and geology. The escarpment on which the property is situated is a major influence on the hydrogeological regime of the area, controlling the potentiometric surface at 125 m ASL. The expansion of the quarry, which will remain at least 5 m above the significant water bearing zones in the area, will not have additional impact. The continued management of discharge from the quarry in the manner currently used at the site will maintain the natural surface water and shallow groundwater flow regime.

A groundwater monitoring program is proposed that will provide protection to surrounding groundwater users against perceived or actual impact from the proposed quarry operation, even though no additional impacts are predicted. Water level measurements taken every other month in site wells will be evaluated annually and compared to historical results. An annual report will provide any recommendations on changes required, mitigation or remediation.

The comprehensive hydrogeological assessment will be re-evaluated on a 10-year cycle. The groundwater model and impact prediction will be updated based on the prediction of the next 10-year operation, and any predicted impacts will be mitigated before they occur.

Upon completion of the excavation of the quarry, the pumps will be turned off and the quarry will be allowed to fill with the water surplus associated with the quarry and infiltration/ runoff through the shallow weathered bedrock aquifer that drains to the quarry. The final lake level in the excavation is predicted to be approximately 132 m ASL, and the groundwater flow regime will be reinstated to the pre-development setting.

21 Recommendations

The following is a summary of the recommendations that were indicated through the main report.

a. The quarry floor should extend no lower than 125 m ASL.

b. A regular groundwater monitoring program will be continued. The details of the program will be amended as necessary based on an annual review and interpretation of the data with input from a qualified professional representing the operator, and the regulatory agency or agencies.

c. An annual review will be completed by a qualified professional. Any predicted problems identified will be remediated before they occur.

d. If an unexpected complaint regarding water supply is received, an investigation will be conducted by a qualified professional, and if the problem is attributed to the quarry operation, remediation or compensation will be offered by the operator as soon as possible.

e. Every 10 years, an update of the hydrogeology report will be prepared. The analysis will be based on the projection of the next 10-years' operations and will include an updated well inventory for at least 500 m around the excavation, or for the predicted area of influence if it is greater. The first review should be conducted a year before the Permit to Take Water expiry date.

f. The depth of the pump chamber installed in the lower lift should not extend below 123 m ASL. The chamber should be constructed with a hoe-ram or comparable equipment to minimize disturbance to the underlying bedrock.

g. The lower lift pump chamber should not be installed within 200 m of the south quarry boundary.

h. The quarry discharge should continue to be managed in the current pattern to maintain existing flows on west, north-west part of the Miller properties.

i. An emergency spills plan should be developed for and posted at the site with pertinent company and MOE telephone numbers. A supply of appropriate materials for containment and absorption maintained in a convenient location.

j. The operation should include best management practices with regard to water discharge management and water conservation at the quarry.

22 Qualifications

As required in the Report Standards for Category 2 Applications, Section 2.2.10, we make the following statement. All site investigation and testing has been completed by or under the direct supervision of George A. Gorrell M.Sc. F.G.A.C. The analysis and report have been completed by Mr. Gorrell and Jennifer B. Gorrell M.Sc. P.Eng. P.Geo. Through our firm Gorrell Resource Investigations, we worked in the field of hydrogeology, as related to the aggregate industry, from 1988 - 2010. Curriculum vitae are attached as Appendix K.

23 Peer Review Process

Golder Associates Ltd. (Golder) were retained by the County of Renfrew to conduct a technical review of various reports related to the proposed quarry application. Golder reviewed and provided comment on GRI Reports:

> Hydrogeological Investigation, Braeside Quarry Expansion Part Lots 16 and 17, Conc. A, Township of McNab-Braeside; Report No. 05460, September 2007.
>
> Consolidated 2006-2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion, Part Lots 16 and 17, Conc. A, Township of McNab-Braeside; Report No. 08360, November 2009.
>
> Summary Report, Hydrogeological Investigations; Proposed Braeside Quarry Expansion, Part Lots 16 and 17, Conc. A, Township of McNab-Braeside; Report No. 08360, June 2010.

The comments were provided to GRI and replies were prepared as follows:

September 11, 2008	Golder Comments on Assessment Report
November 29, 2009	GRI Reply to Golder Comments
March 9, 2010	Golder Comments on both November 2009 GRI Reply and Consolidated Report
July 31, 2010	GRI Reply to Golder's March 9, 2010 Comments
November 5, 2010	Golder Comments on GRI Summary Report
March 17, 2011	Response to Golder Comments on Summary Report (BGC, 0910-006)
May 10, 2011	Golder Letter to County on Natural Environment, Hydrology and Hydrogeology
June 9, 2011	BGC Letter Addressing Comments in Golder Letter to County

The points raised by the above-referenced Golder reviews and the location they are addressed in the report are tabulated in Appendix L.

24 Closure

If you have any questions about this report, please feel free to contact one of the undersigned.

Respectfully submitted:

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Gorrell Resource Investigations; Consolidated 2006-2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 08360 dated November 2009 [incorporated into and superseded by current report).

Gorrell Resource Investigations; Summary Report, Hydrogeological Investigation Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 08360 dated June 2010 (incorporated into and superseded by current report).

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Photographs

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
Division of Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

List of Photographs

Lower Lift:

Photo 23:	After initial blast, August 12 2009. Face shows dampness below K-bentonite layer probably due to disturbance during blast
Photo 24:	Annotated Photo taken September 3, 2009 as last of blasted rock removed from lower lift cut (Miller photo)
Photo 25:	Sept 18, 2009; showing dry lower floor (approx date of previous precipitation Sept 14 from Macdonald-Cartier Climate Sta.
Photo 26:	Taken Oct 8 09; No seepage on walls. Water on floor is accumulation of rainfall that occurred intermittently on daily basis that week. Note contact between Bobcaygeon and Gull River Formations

Photo 1: Lower Member, Bobcaygeon Formation, massively bedded limestone

Photo 2: Teradium Coral in Gull River Formation

Photo 3: K-bentonite Layer

Photo 4: Iron staining on face shows how surface water migrates down to significant levels – note minor seepage from lower 3 m.

Photo 5: Iron staining in lower quarry face

Photo 6: Joints, enhanced in weathered bedrock zone, extend down to the contact between Bobcaygeon and Gull River Formations (November 23 2009 photo)

Photo 7: Root Mass and K-Bentonite at 145 m ASL, TW 9-1

Photo 8: Clear Water from Quarry Discharge entering North-West Wetland

Photo 9: Discharge from up-gradient recharge to wetland from north showing sediment load

Photo 10: Infiltration Drains around home in Ridge View Estates, typical

Photo 11: Portion of Ditch constructed to Divert Seasonal Springwater Flow in the Subdivision (July 24 2009 photo)

Photos 12 to 26
Existing Sump and Lower Lift

Existing Sump -2007

Photo 12: Sump, July 30. 2007

Photo 13: August 16 2007

Existing ("Main") Sump -2008

Photo 14: Second Day of Pumping, April 9, 2008

Photo 15: May 20, 2008

Photo 16: October 15, 2008

Existing ("Main") Sump -2009

Photo 17: April 16 2009; still winter accumulations in north-east corner, shows drainage ditch in floor and sump

Photo 18: July 22, 2009; Sump level is significantly lowered and floor ditch has no flow

Photo 19: This photo was taken following the July 24 2009 significant storm event that occurred along Ottawa River hitting Kanata and areas north-west

Photo 20: September 18, 2009 – very dry period. Water level in sump can be seen in Photo 19

Photo 21: Close up of Sump level, September 18, 2009

Photo 22: October 14, 2009 – note the sump level is below the base of the floor ditch

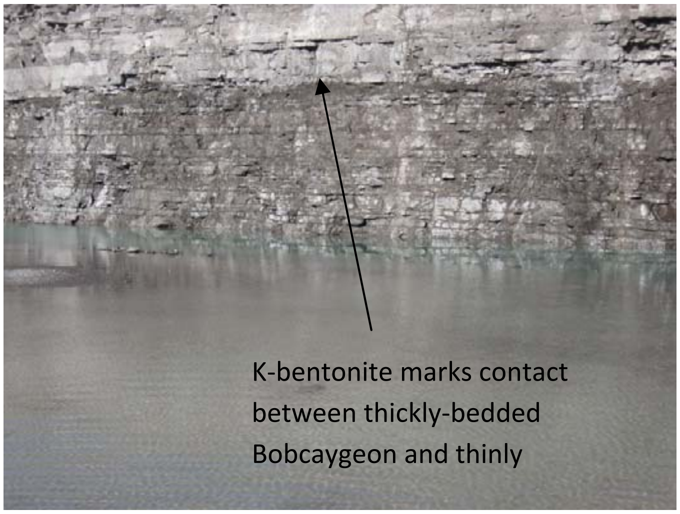
Lower Lift – August to October, 2009

Photo 23: After initial blast, August 12 2009. Face shows dampness below K-bentonite layer probably due to disturbance during blast

Photo 24: Annotated Photo taken September 3, 2009 as last of blasted rock removed from lower lift cut (Miller photo)

Photo 25: Sept 18, 2009; showing dry lower floor (approx date of previous precipitation Sept 14 from Macdonald-Cartier Climate Sta.; Luskville data is 3 months delayed

Photo 26: Taken Oct 8 09; No seepage on walls. Water on floor is accumulation of rainfall that occurred intermittently on daily basis that week. Note contact between Bobcaygeon and Gull River Formations



Figures

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
Division of Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360

December 2011

BASE MAP PROVIDED BY SKELTON BRUMWELL & ASSOCIATES INC.

NO.	REVISION	DATE	BY

R.R. #1
Oxford Mills,
Ontario, K0G 1S0

GORRELL RESOURCE INVESTIGATIONS
gri

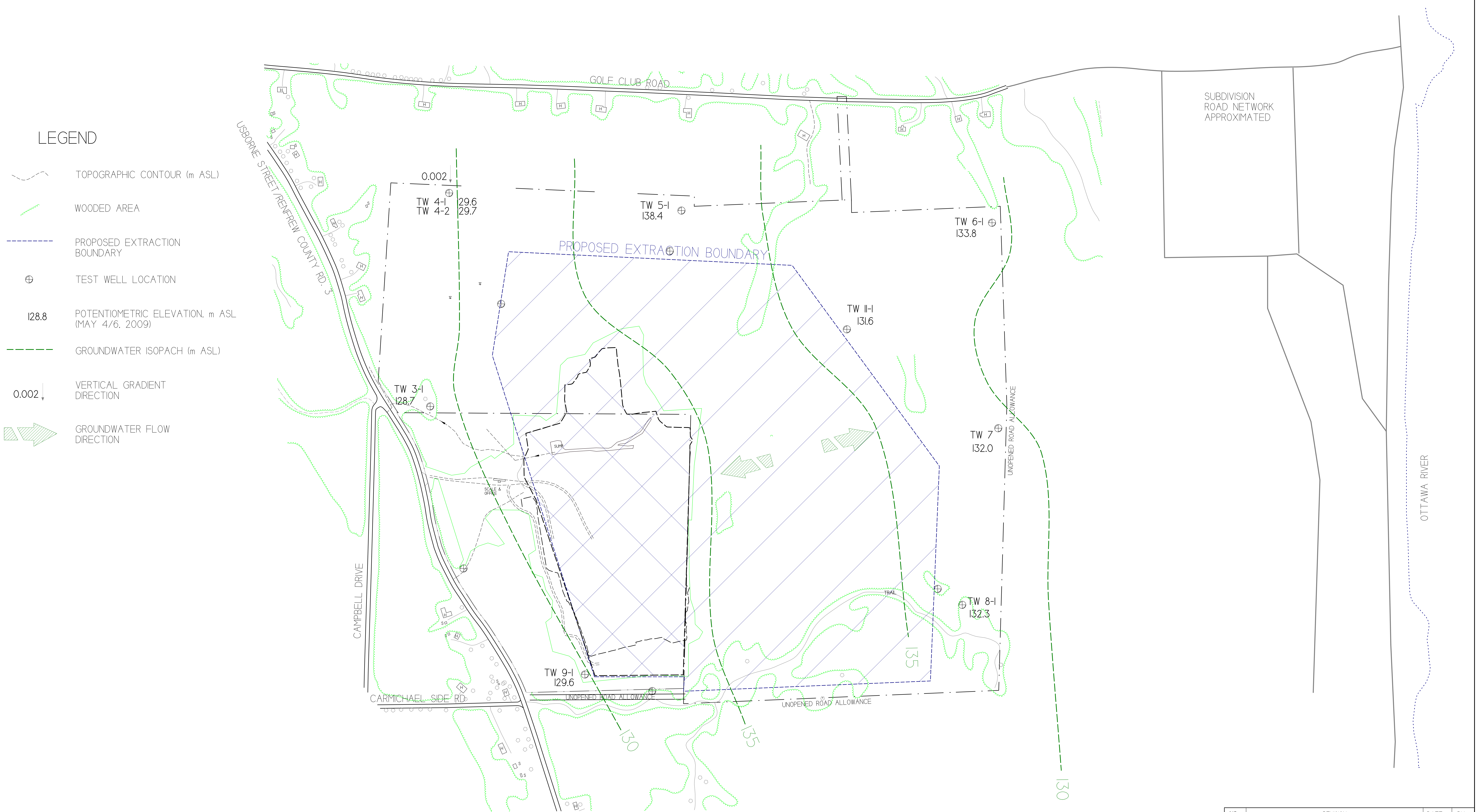
FIGURE 2:

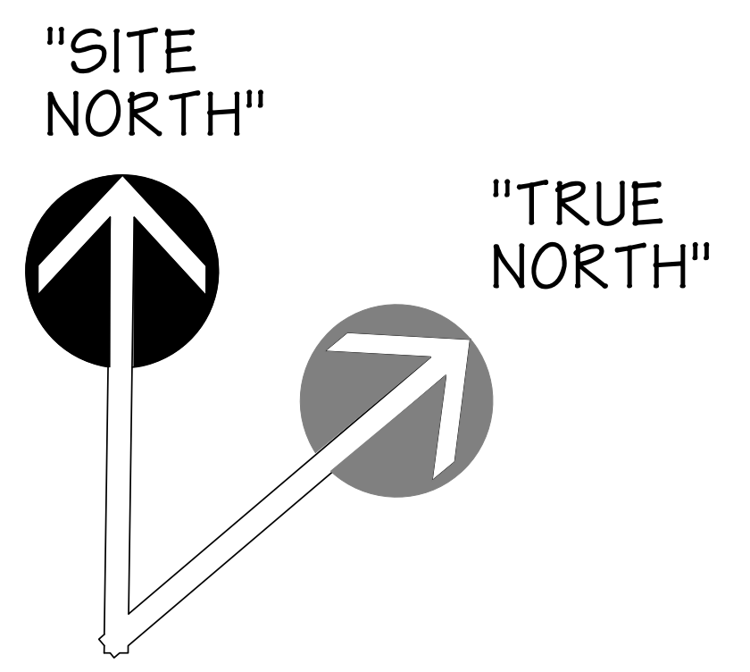
SITE CHARACTERISTICS

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

PROJECT NO. : 08360
DRAWN BY: JG
DESIGNED BY: JG
DATE: DEC 2011
CHECKED BY: J.G.
CAD. FILE NO. :

CAD. FILE NO. : FIGURE 2 SITE CHARACTERISTICS.VCD





NO.	REVISION	DATE	BY
I.	READINGS REVISED TO REFLECT UPDATE IN SITE ELEVATION SURVEY	07/II	JBG

R.R. #1
Oxford Mills,
Ontario, K0G 1S0

GORRELL RESOURCE INVESTIGATIONS
gri

FIGURE 3:

POTENTIOMETERIC ELEVATIONS, SIGNIFICANT WATER BEARING ZONE

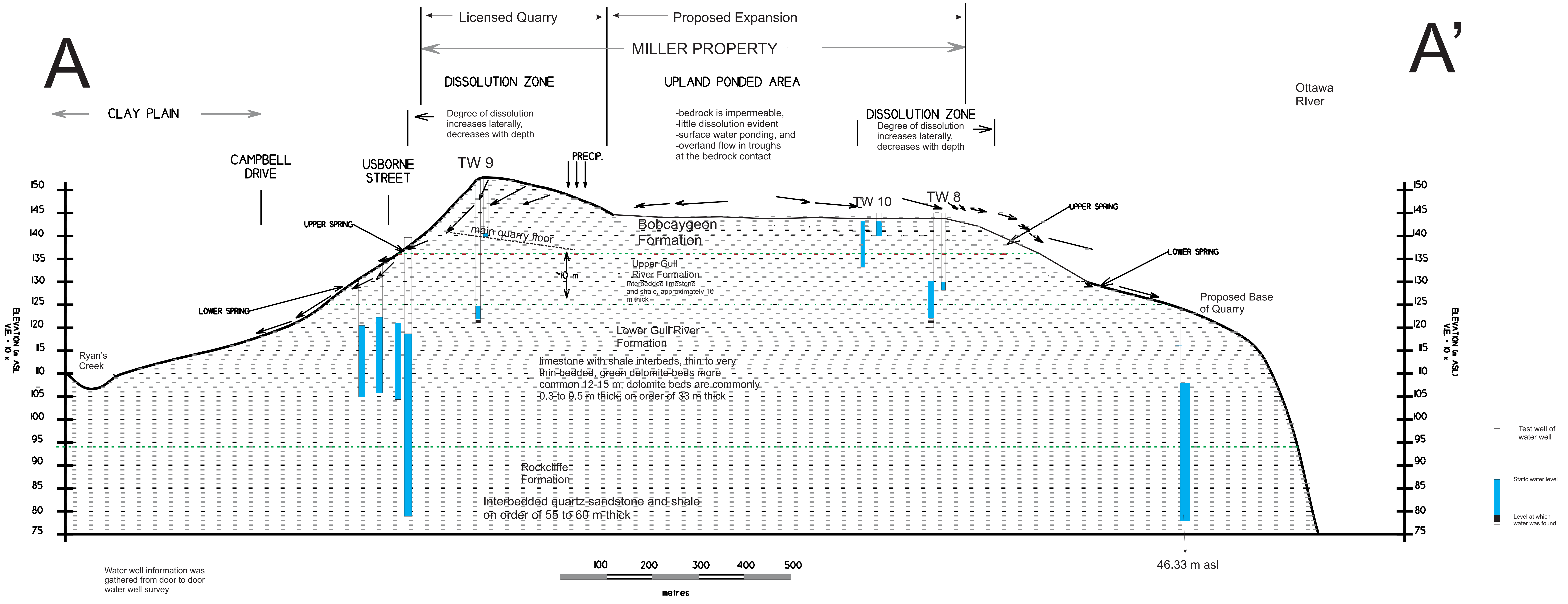
EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS I6, I7 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

PROJECT NO. : 08360	DRAWN BY: JG DESIGNED BY: JG
DATE: DEC 20II	CHECKED BY: J.G.
	CAD. FILE NO. :

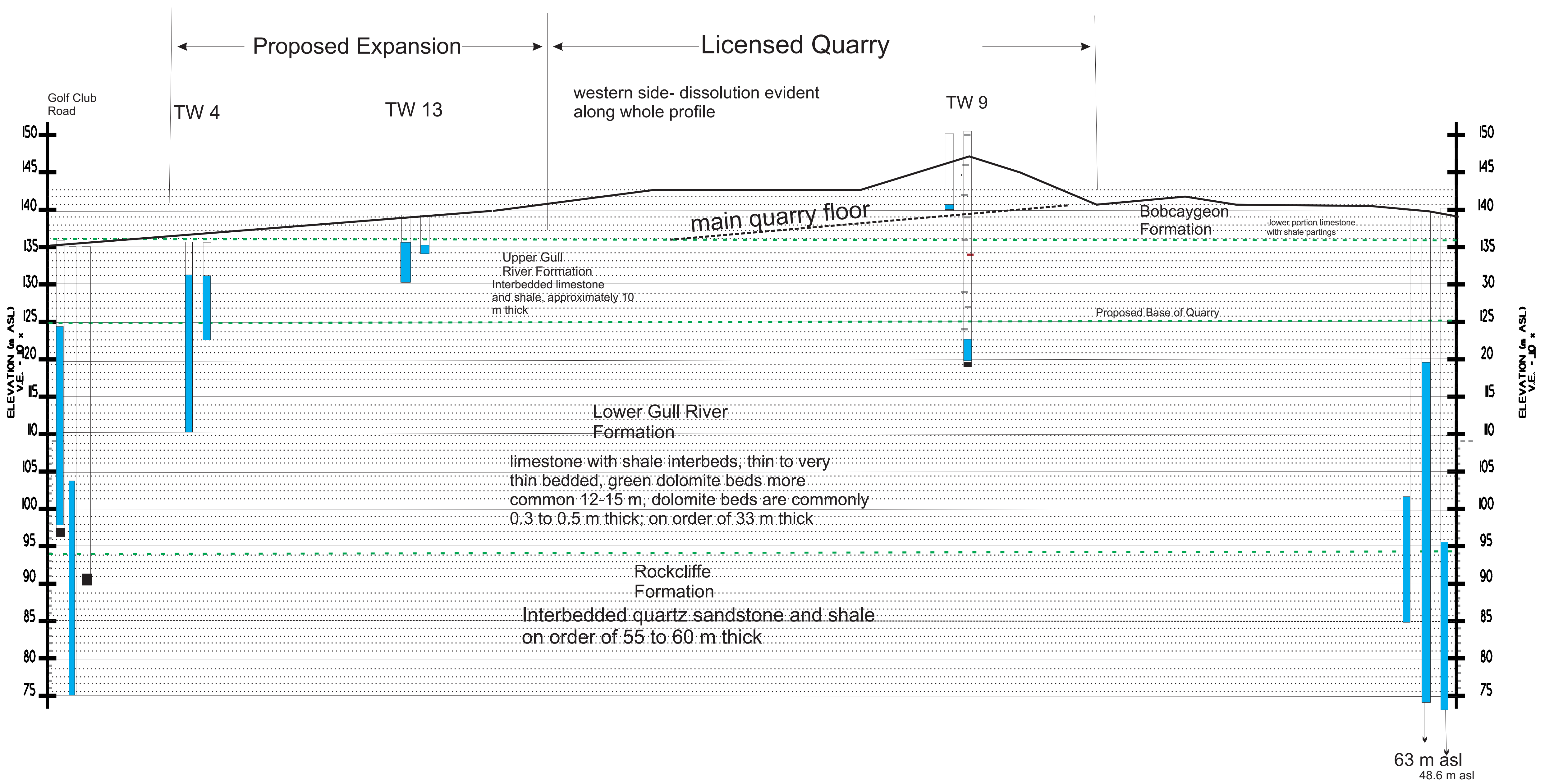
CAD. FILE NO. : FIGURE 3 - POTENTIOMETRIC ELEVATIONS, SIGNIFICANT WATER BEARING ZONE.VCD

POTENTIOMETRIC ELEVATIONS MEASURED MAY 4 AND 6, 2009. POTENTIOMETRIC ISOPACHS ARE INTERPRETED FROM COLLECTED DATA AND ARE GENERALIZED, BASED ON READINGS AND SITE SETTING.

PROFILE A -A’
MILLER PAVING LTD



PROFILE B-B’
MILLER PAVING LTD.



NO.	REVISION	DATE	BY

RR #1
Oxford Mills
Ontario, K0G 1S0

GORRELL RESOURCE INVESTIGATIONS gri

FIGURE 6:

GEOLOGICAL CROSS-SECTIONS A-A’ AND B-B’

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17, CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

PROJECT NO.: 08360	DRAWN BY: JG	DESIGNED BY: JG
DATE: DECEMBER, 2011	CHECKED BY: JG	
	CAD FILE NO.: FIGURE 6.CDR	

NO.	REVISION	DATE	BY
I.	READINGS REVISED TO REFLECT UPDATE IN SITE ELEVATION SURVEY	07/II	JBG

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Ontario, K0G 1S0

GORRELL RESOURCE INVESTIGATIONS

FIGURE 6:

SURFACE WATER FEATURES

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

PROJECT NO. : 08360	DRAWN BY: JG	DESIGNED BY: JG
DATE: DEC 2011	CHECKED BY: J.G.	
	CAD. FILE NO. : FIGURE 2.VCD	

BASE MAP PROVIDED BY SKELTON BRUMWELL & ASSOCIATES INC.

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Ontario, K0G 1S0

GORRELL RESOURCE INVESTIGATIONS

FIGURE 8:

RADIUS OF INFLUENCE
WEATHERED BEDROCK ZONE

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

PROJECT NO. : 08360	DRAWN BY: JG	DESIGNED BY: JG
DATE: DEC 2011	CHECKED BY: J.G.	
	CAD. FILE NO. :	

CAD. FILE NO. : FIGURE 8-R01 WEATHERED BEDROCK 08282011.VCD

BASE MAP PROVIDED BY SKELTON BRUMWELL & ASSOCIATES INC.

NO.	REVISION	DATE	BY

R.R. #1
Oxford Mills,
Ontario, K0G 1S0

GORRELL RESOURCE INVESTIGATIONS

FIGURE 9:

RADIUS OF INFLUENCE
COMPETENT BEDROCK
SIGNIFICANT WATER-BEARING ZONE

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

PROJECT NO. : 08360
DRAWN BY: JG
DESIGNED BY: JG
DATE: DEC 2011
CHECKED BY: J.G.
CAD. FILE NO. :

CAD. FILE NO. : FIGURE 9-R01 COMPETENT BEDROCK 08282011.VCD

Appendix A
Background Hydrogeology Explanation

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Interpretation of Groundwater Setting

The definition of aquifer is precise – *"a saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients"*[1]. The application of the definition is relative, depending on the local setting. For example, in some areas, till would not be considered an aquifer if there are higher producing alternatives, but in areas where the till is the best possible source of groundwater, it will be used for water supply in the absence of other alternatives. The combination of the availability of the groundwater and the ability of it to flow through the medium in a given locale is what characterizes an aquifer. In summary, to be an aquifer, there has to be groundwater present, and the medium has to have some ability to transmit it.

The ability of the medium to transmit the water determines how quickly the groundwater flows and also determines from what distance the groundwater can be captured from. Transmissivity can be visualized as a resistance. The less able to transmit (low transmissivity), the "harder" it is for the groundwater to move.

An aquifer may be unconfined or confined or somewhere in between. The degree of confinement depends how closely the groundwater system is connected to the surface or atmosphere. An unconfined aquifer is directly connected to the surface; a completely confined aquifer has no direct connection. The connection to the surface affects a number of factors including the reliability of a water supply and its susceptibility to contamination.

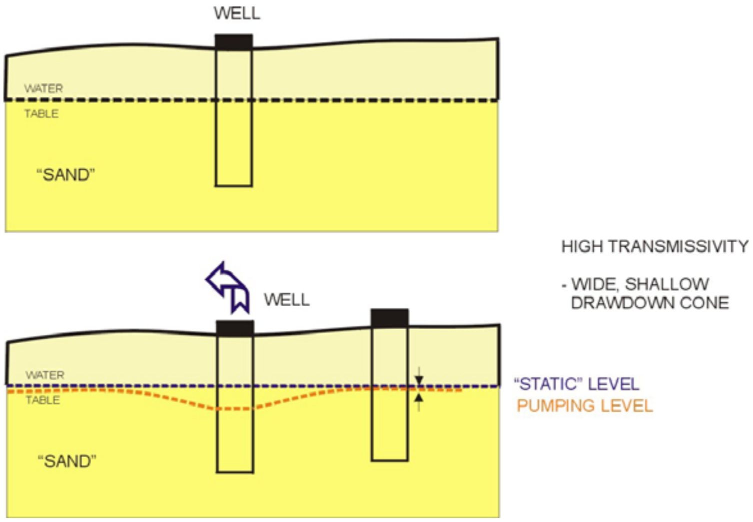
In an unconfined aquifer (such as in soil), the water table approximately coincides with the level that the groundwater is intercepted and is the point in the stratigraphic profile that the medium becomes saturated. This water table is visible in a hole dug in the medium. In sand, the water table stabilizes rapidly because the medium, sand, has a high transmissivity – it is "easy" for the groundwater to move through it. In contrast, in clay or till, the medium has a low transmissivity. The groundwater is present – evident by the dampness or saturation of the soil – but it moves slowly into the hole or well. It can take many orders of magnitude (100 to 10,000 times) longer a time to fill a hole in a fine grained (clay or till), low transmissivity aquifer than a high transmissivity one. If the time taken is too slow, the medium is not considered to be an aquifer but an aquitard or aquiclude. A simple illustration of the behaviour of a pumped well in a permeable medium such as sand (Figure G-1) compared to a low permeability medium such as till is shown in Figure G-2. No distances have been shown in the example; actual distances depend on the aquifer characteristics.

The diagram shows that in a highly permeable medium, groundwater may be captured from a large area, the distance depending on the withdrawal rate. When pumped, the drawdown in the well itself is relatively shallow, and the shape of the water table returns rapidly to near the original static level (undisturbed level), but may remain slightly depressed for a large distance. Drawdown cones (used to describe the shape of the water table in profile) in a highly transmissive aquifer are typically shallow and wide, although at a short distance the water table will have returned almost to the static level.

---

[1] R. A. Freeze and Cherry, J.A.; *Groundwater*, Prentice-Hall Inc, 1979

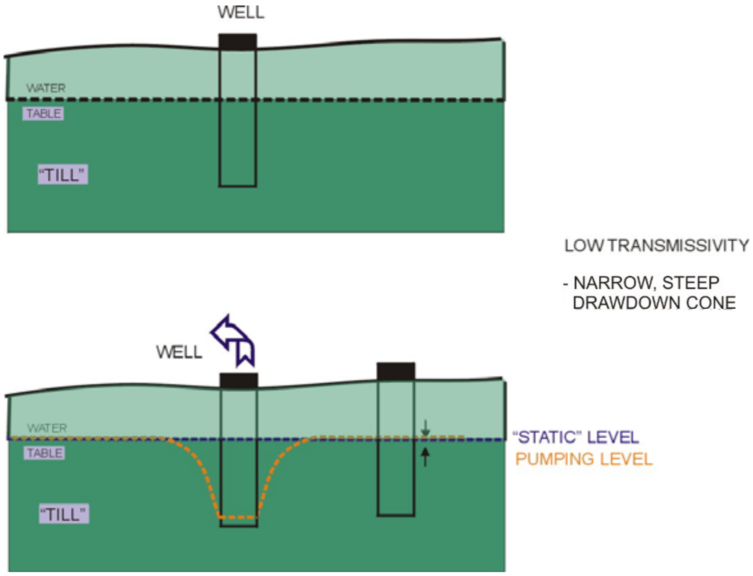
Figure A-1: Theoretical Water Table in High Transmissivity Medium



In contrast, a well in a low transmissivity aquifer, such as till, will see a greater drawdown in the well, but only has the ability to draw from a much smaller capture area, so the water table is restored to it's static level at a much shorter distance. Drawdown cones in a low transmissivity aquifer are deep (the water stored in the well is removed but not instantly recharged as in a high transmissivity well) and typically narrow. The water table is restored to the original static level within a comparatively short distance because the aquifer will not transmit groundwater from a long distance. A neighbouring well in the high transmissivity aquifer would not be impacted by the taking, as the result would be a very small depression in the water table. The same neighbouring well in the low transmissivity aquifer would not be impacted because it is beyond the distance from which the pumping well is drawing.

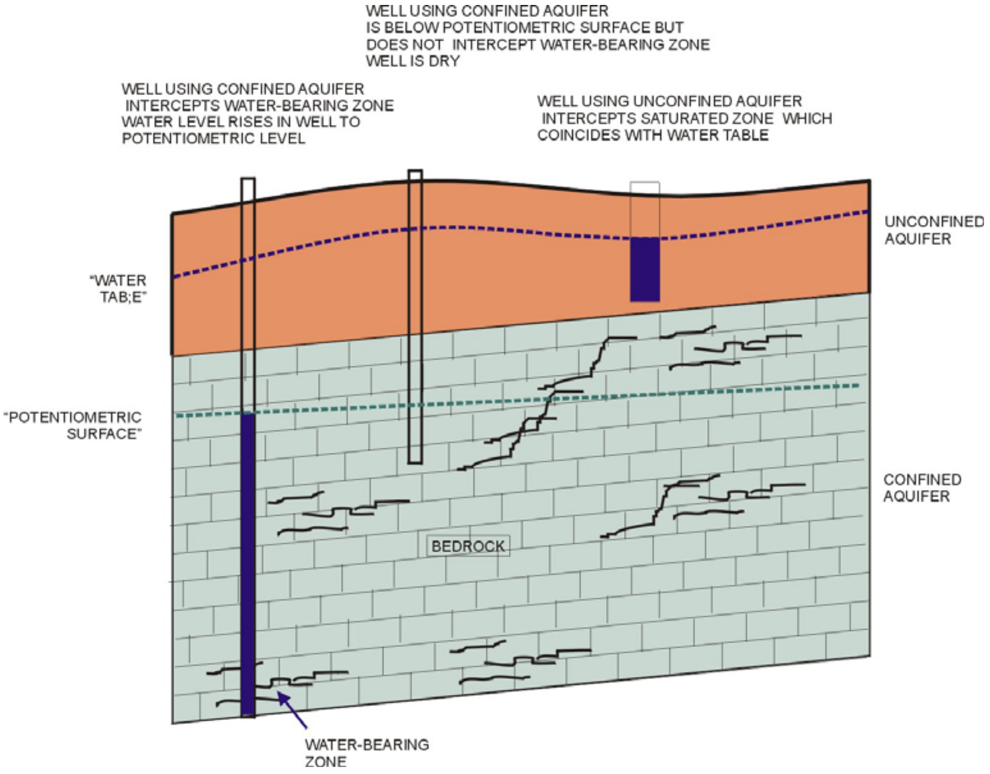
The situation in a confined aquifer is different than an unconfined. The groundwater in a confined aquifer is under pressure due to the mass of the overlying formation. The water table in a confined aquifer is called the "potentiometric surface", and the position of the potentiometric surface will be somewhere above the top of the aquifer. An aquifer in bedrock is an example of a confined aquifer. In the bedrock aquifer, unlike the granular aquifers described above, the groundwater is found only in discrete layers or fractures known as water-bearing zones. A well in bedrock may only encounter one or two distinct water bearing zones. The amount of interconnection between fractures influences the transmissivity of the bedrock aquifer.

Figure A-2 Theoretical Water Table in Low Transmissivity Medium



Unlike the water table of the unconfined aquifer, the potentiometric surface is not a real, visible feature in the aquifer. To "see" the potentiometric surface, i.e. the static level in a well, the water-bearing zone has to be intercepted. Simple excavating to the potentiometric level without penetrating the source (i.e. water bearing zone) would reveal nothing. If the source of the groundwater is not intercepted, there will be no water table (Figure G-3).

Figure A-3: Water Table vs. Potentiometric Surface in a Theoretical Cross-Section



Potentiometric pressures do provide equalization in such a way that if water was to be introduced into the setting in some other way (i.e. from runoff), the system will attempt to stabilize according to the potentiometric pressures. This means that in the situation of an excavation into bedrock, such as a quarry, even if a water-bearing zone in the formation was not intercepted by the excavation, accumulation of runoff in the excavation would endeavour to match the same potentiometric elevation, i.e the excavation would eventually fill to that stable level. A related factor that has to be addressed even if the water bearing zone is not directly intercepted is whether there is a sufficient connection and hydraulic connectivity that will induce vertical seepage from a water bearing zone through the floor of the excavation.

Appendix B
Drill Holes;
MOE Well Records and GRI Borehole Logs

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Ontario Ministry of the Environment

The Ontario Water Resources Act
WATER WELL RECORD

Print only in spaces provided.
Mark correct box with a checkmark, where applicable.

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot
Renfrew	McNab	Con 4	16

Owner's surname / First Name	Address	Date completed (day month year)
Smith's Construction Company	Po Box 218 276 Madawaska Blvd. Arnprior, Ont	10 07 2002

Zone ☐☐ Easting ☐☐☐☐☐☐ Northing ☐☐☐☐☐☐☐

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
brown	loose fill			0	1'
gray	Shaile limestone			1'	65'
	GRI TW 1				

WATER RECORD

Water found at - feet	Kind of water
NO water	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD

Inside diam Inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6¼	☑ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	0	4'
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			

SCREEN

Sizes of opening (Slot No.)
Diameter inches
Length feet
Material and type
Depth at top of screen feet

PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at - feet From	To	Material and type (Cement grout, bentonite, etc.)
4'	0	Cement Grout

PUMPING TEST

Pumping test method ☐ Pump ☐ Bailer
Pumping rate GPM
Duration of pumping .... Hours .... Mins
Static level feet
Water level end of pumping feet
Water levels during ☐ Pumping ☐ Recovery
15 minutes feet 30 minutes feet 45 minutes feet 60 minutes feet
If flowing give rate GPM
Pump intake set at feet
Water at end of test ☐ Clear ☐ Cloudy
Recommended pump type ☐ Shallow ☐ Deep
Recommended pump setting feet
Recommended pump rate GPM

FINAL STATUS OF WELL

☐ Water supply
☐ Observation well
☑ Test hole
☐ Recharge well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Abandoned (Other)
☐ Dewatering
☐ Unfinished
☐ Replacement well

WATER USE

☐ Domestic
☐ Stock
☐ Irrigation
☐ Industrial
☐ Commercial
☐ Municipal
☐ Public supply
☐ Cooling & air conditioning
☐ Not use
☐ Other Reading

METHOD OF CONSTRUCTION

☐ Cable tool
☐ Rotary (conventional)
☐ Rotary (reverse)
☐ Rotary (air)
☑ Air percussion
☐ Boring
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Other

LOCATION OF WELL

In diagram below show distances of well from road and lot line. Indicate north by arrow.

248451

Name of Well Contractor: George H. Law + Son Ltd
Well Contractor's Licence No.: 3323
Address: Box 155 Calabogie, Ont K0J-1H0
Name of Well Technician: Allan Fougere
Well Technician's Licence No.: T-0432
Signature of Technician/Contractor: A. Fougere
Submission date: 10 07 2002 (day mo yr)

MINISTRY USE ONLY

1 - CONTRACTOR'S COPY

0506 (07/00) Front Form 9

Ontario

Ministry
of the
Environment

The Ontario Water Resources Act

WATER WELL RECORD

Print only in spaces provided.
Mark correct box with a checkmark, where applicable.

County or District: Renfrew
Township/Borough/City/Town/Village: McNab
Con block tract survey, etc.: Con 4
Lot: 16

Owner's surname / First Name: Smiths Construction Company
Address: Po Box 218, 276 Madawaska Blvd. Arnprior, Ont K7S-3H4
Date completed: 10 07 2002 (day month year)

Zone ☐ Easting ☐ Northing ☐

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
brown	loose fill			0	2'
gray	Shaile limestone			2'	65'
	GRI TW 2				

WATER RECORD

Water found at - feet	Kind of water
unknown	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6 1/4	☑ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	0	5
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			

SCREEN

Sizes of opening (Slot No.):
Diameter: Inches
Length: feet
Material and type:
Depth at top of screen: feet

PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

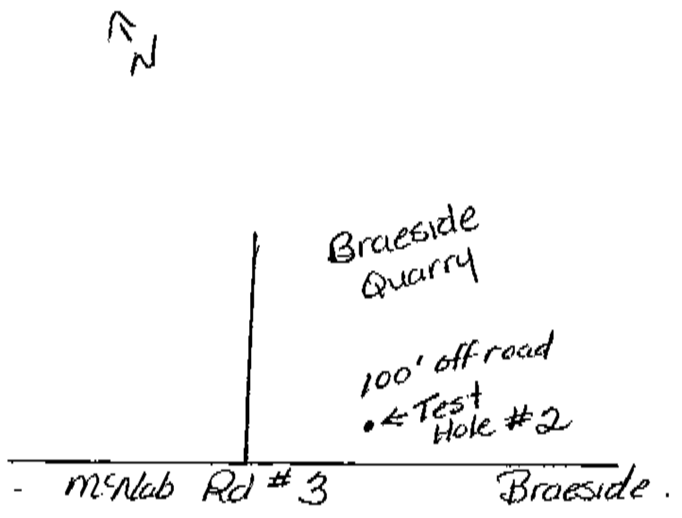
Depth set at - feet From	To	Material and type (Cement grout, bentonite, etc.)
5'	0	Cement Grout

PUMPING TEST

Pumping test method: ☐ Pump ☐ Bailer
Pumping rate: GPM
Duration of pumping: Hours Mins
Static level: feet
Water level end of pumping: feet
Water levels during ☐ Pumping ☐ Recovery
15 minutes: feet
30 minutes: feet
45 minutes: feet
60 minutes: feet
If flowing give rate: GPM
Pump intake set at: feet
Water at end of test: ☐ Clear ☐ Cloudy
Recommended pump type: ☐ Shallow ☐ Deep
Recommended pump setting: feet
Recommended pump rate: GPM

LOCATION OF WELL

In diagram below show distances of well from road and lot line.
Indicate north by arrow.



234770

FINAL STATUS OF WELL

☐ Water supply
☐ Observation well
☑ Test hole
☐ Recharge well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Abandoned (Other)
☐ Dewatering
☐ Unfinished
☐ Replacement well

WATER USE

☐ Domestic
☐ Stock
☐ Irrigation
☐ Industrial
☐ Commercial
☐ Municipal
☐ Public supply
☐ Cooling & air conditioning
☐ Not use
☐ Other

METHOD OF CONSTRUCTION

☐ Cable tool
☐ Rotary (conventional)
☐ Rotary (reverse)
☐ Rotary (air)
☑ Air percussion
☐ Boring
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Other

Name of Well Contractor: George H. Law + Son Ltd
Well Contractor's Licence No.: 3323
Address: Box 155 Calabogie, Ont K0J-1H0
Name of Well Technician: Allan Fougere
Well Technician's Licence No.: T-0432
Signature of Technician/Contractor: Alfred Law
Submission date: 10 07 2002 (day mo yr)

MINISTRY USE ONLY

1 - CONTRACTOR'S COPY

0506 (07/00) Front Form 9

Ontario Ministry of the Environment

W... int number below)
A 054429
A054429

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Help Desk (Toll Free) at 1-888-396-9355.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only
MUN CON LOT

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: M^cNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 386848 Northing 5036125
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see Instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	24.38

GRI # 3-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water		
4.02 m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	
☐ Other: UNTESTED			
23 m46	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	
☐ Other: UNTESTED			
☐ m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	
☐ Other:			

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify CLEARING

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+ .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at (metres): 24.0
Pumping rate - (litres/min): 22.5
Duration of pumping: 6 hrs + 0 min
Final water level end of pumping: 7.24 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ______ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	5.08		
1	6.2	1	6.99
2	6.4	2	6.48
3	6.45	3	6.08
4	6.5	4	6.45
5	6.5	5	5.82
10	6.8	10	5.53
15	6.8	15	5.59
20	6.85	20	5.69
25	6.97	25	5.69
30	7.0	30	5.44
40	7.0	40	5.52
50	7.05	50	5.37
60	7.07	60	5.34

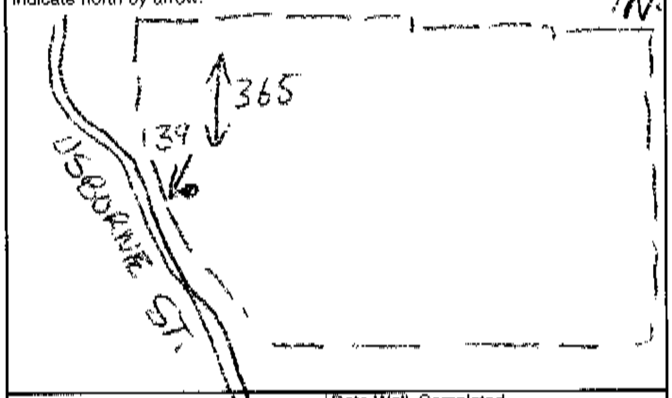
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. Z 55056
Date Well Completed YYYY 2007 MM 05 DD 25
Was the well owner's information package delivered? ☐ Yes ☐ No
Date Delivered YYYY 2007 MM 05 DD 25

Method of Construction

☐ Cable Tool
☐ Rotary (conventional)
☐ Rotary (reverse)
☐ Rotary (air)
☒ Air percussion
☐ Boring
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Other

Water Use

☐ Domestic
☐ Stock
☐ Irrigation
☐ Industrial
☐ Commercial
☐ Municipal
☐ Public Supply
☒ Not used
☐ Cooling & air conditioning
☐ Other

Final Status of Well

☐ Water Supply
☒ Observation well
☐ Test Hole
☐ Recharge well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Unfinished
☐ Dewatering
☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted YYYY 2007 MM 06 DD 25

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well T… mber below)
A 054430
A 054430

Well Record

Regulation 903 Ontario Water Resources Act

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Instructions for Completing Form

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- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only
MUN CON LOT

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 8 3 Zone 18 Easting 386845 Northing 5036122
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19
	GRI # 3-2				

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water
7.01 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify CLEARING

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 +.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 12.19
Pumping rate - (litres/min) 3.6
Duration of pumping 1 hrs + 40 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

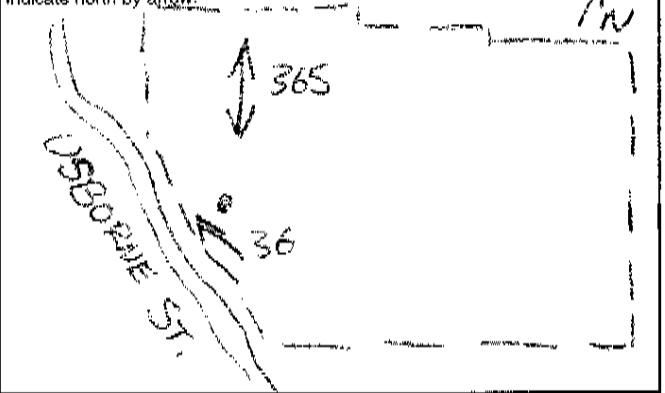
Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	2.67		
1	3.68	1	11.72
2	4.10	2	11.71
3	5.71	3	11.69
4	6.72	4	11.67
5	7.74	5	11.65
10	5.27	10	11.42
15	5.67	15	11.18
20	6.17	20	10.97
25	6.55	25	10.87
30	6.97	30	10.61
40	7.97	40	10.27
50	8.77	50	9.94
60	8.25	60	9.82

Plugging and Sealing Record ☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. Z 55057
Date Well Completed YYYY MM DD: 2007 05 25
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD: 2007 05 25

Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse) ☐ Rotary (air) ☒ Air percussion ☐ Boring ☐ Diamond ☐ Jetting ☐ Driving ☐ Digging ☐ Other

Water Use

☐ Domestic ☐ Stock ☐ Irrigation ☐ Industrial ☐ Commercial ☐ Municipal ☐ Public Supply ☒ Not used ☐ Cooling & air conditioning ☐ Other

Final Status of Well

☐ Water Supply ☒ Observation well ☐ Test Hole ☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Unfinished ☐ Dewatering ☐ Replacement well ☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x
Date Submitted YYYY MM DD: 2007 06 25

Ministry Use Only
Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006) **Well Owner's Copy** *Cette formule est disponible en français*

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below)
A 054436
A 054436

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

Instructions for Completing Form

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- Please print clearly in blue or black ink only.

Ministry Use Only
MUN CON LOT

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: MCNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 386564 Northing 5036502 Unit Make/Model MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	CLAY		DENSE	0	4.87
GREY	CLAY			4.87	5.79
BROWN	LIMESTONE	GREY LIMESTONE		5.79	24.38

GRI # 4-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres / Kind of Water
21.03 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify CLEARING

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 +.50	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 5.63
Duration of pumping: 4 hrs + 57 min
Final water level end of pumping: 14.78 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	3.21		
1	3.85	1	14.78
2	3.98	2	14.78
3	4.00	3	
4	4.16	4	
5	4.20	5	
10	4.34	10	
15	4.56	15	
20	5.10	20	
25	5.22	25	
30	5.42	30	
40	5.95	40	
50	6.03	50	
60	6.26	60	

WELL DID RECOVER

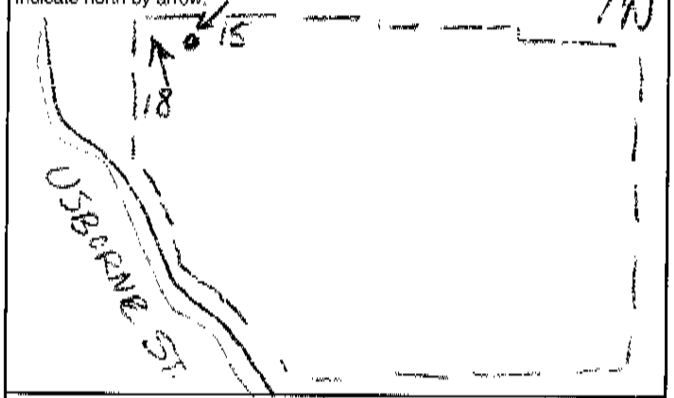
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse) ☐ Rotary (air) ☒ Air percussion ☐ Boring ☐ Diamond ☐ Jetting ☐ Driving ☐ Digging ☐ Other

Water Use

☐ Domestic ☐ Stock ☐ Irrigation ☐ Industrial ☐ Commercial ☐ Municipal ☐ Public Supply ☒ Not used ☐ Cooling & air conditioning ☐ Other

Final Status of Well

☐ Water Supply ☒ Observation well ☐ Test Hole ☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Unfinished ☐ Dewatering ☐ Replacement well ☐ Abandoned, (Other)

Audit No. **Z 55054**
Date Well Completed (YYYY MM DD): 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered (YYYY MM DD): 2007 05 28

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x Troy Saunders
Date Submitted (YYYY MM DD): 2007 06 28

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006) **Well Owner's Copy** *Cette formule est disponible en français*

Ontario Ministry of the Environment

Well Tag (number below) **A 054437**

A054437

Well Record

Regulation 903 Ontario Water Resources Act

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Instructions for Completing Form

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- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN ___ CON ___ LOT ___

Well Owner's Information and Location of Well Information

First Name:

Last Name: MILLER CONSTRUCTION

Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD

County/District/Municipality: RENFREW

Township/City/Town/Village: ARNPRIOR

Province: **Ontario**

Postal Code: K7S 3N2

Telephone Number (include area code): 613-623-3141

Address of Well Location (County/District/Municipality): RENFREW

Township: McNAB/BRAESIDE

Lot:

Concession:

RR#/Street Number/Name: 1498 USBORNE ST.

City/Town/Village: BRAESIDE

Site/Compartment/Block/Tract etc.:

GPS Reading: NAD 83 Zone 18 Easting 385571 Northing 5036496

Unit Make/Model: MAGELLAN

Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify ___

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	CLAY		DENSE	0	4.87
GREY	CLAY		SOFT	4.87	5.79
BROWN	LIMESTONE	GREY LIMESTONE		5.79	12.1

GRI # 4-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water

- ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
- ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: ___
- ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: ___

After test of well yield, water was

☐ Clear and sediment free

☐ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.060	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP

Pump intake set at - (metres): 12.19

Pumping rate - (litres/min): 2.03

Duration of pumping ___ hrs + 30 min

Final water level end of pumping 11.50 metres

Recommended pump type. ☐ Shallow ☐ Deep

Recommended pump depth. ___ metres

Recommended pump rate. ___ (litres/min)

If flowing give rate - ___ (litres/min)

If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	3.42		
1	5.5	1	11.29
2	6.10	2	11.28
3	6.65	3	11.27
4	6.90	4	11.25
5	7.15	5	11.25
10	8.51	10	11.20
15	9.49	15	11.19
20	10.20	20	11.13
25	10.90	25	11.08
30	11.50	30	11.03
40		40	10.98
50		50	10.87
60		60	10.80

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse) ☐ Rotary (air) ☒ Air percussion ☐ Boring ☐ Diamond ☐ Jetting ☐ Driving ☐ Digging ☐ Other ___

Water Use

☐ Domestic ☐ Stock ☐ Irrigation ☐ Industrial ☐ Commercial ☐ Municipal ☐ Public Supply ☒ Not used ☐ Cooling & air conditioning ☐ Other ___

Final Status of Well

☐ Water Supply ☐ Observation well ☒ Test Hole ☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Unfinished ☐ Dewatering ☐ Replacement well ☐ Abandoned, (Other) ___

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD

Well Contractor's Licence No.: 4879

Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT, K0A 1G0

Name of Well Technician (last name, first name): SAUNDERS, TROY

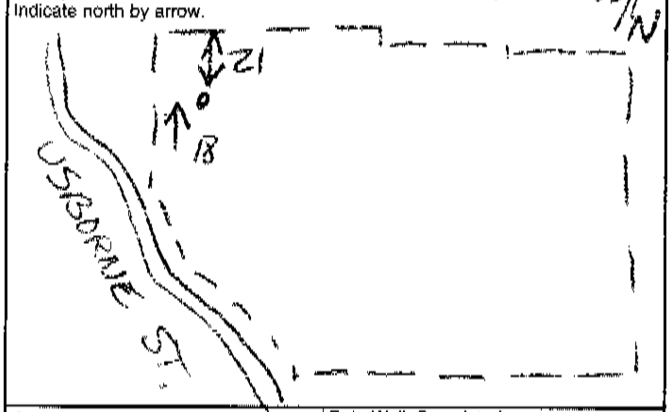
Well Technician's Licence No.: T-517

Signature of Technician/Contractor: x

Date Submitted: YYYY 2007 MM 06 DD 28

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. **Z 55055**

Date Well Completed: YYYY 2007 MM 05 DD 28

Was the well owner's information package delivered? ☒ Yes ☐ No

Date Delivered: YYYY 2007 MM 05 DD 28

Ministry Use Only

Data Source:

Contractor:

Date Received: YYYY MM DD

Date of Inspection: YYYY MM DD

Remarks:

Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well T… …mber below) **A 054438**

A054438

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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- Please print clearly in blue or black ink only.

Ministry Use Only
MUN ____ CON ____ LOT ____

Well Owner's Information and Location of Well Information

First Name	Last Name	Mailing Address (Street Number/Name, RR,Lot,Concession)		
	MILLER CONSTRUCTION	276 MADAWASKA BLVD		
County/District/Municipality	Township/City/Town/Village	Province	Postal Code	Telephone Number (include area code)
RENFREW	ARNPRIOR	Ontario	K7S 3N2	613-623-3144

Address of Well Location (County/District/Municipality)	Township	Lot	Concession
RENFREW	M'NAB/BRAESIDE		

RR#/Street Number/Name	City/Town/Village	Site/Compartment/Block/Tract etc.
1498 USBORNE ST.	BRAESIDE	

GPS Reading	NAD	Zone	Easting	Northing	Unit Make/Model	Mode of Operation:
	8 3	18	386988	5036840	MAGELLAN	☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify ____

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	24.38

GRI # 5-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water		
___ m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	☐ Other: UNKNOWN
___ m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	☐ Other:
___ m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify WELL PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at (metres) 21.58
Pumping rate (litres/min) 12.74
Duration of pumping ___ hrs + 45 min
Final water level end of pumping 23.64 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. (WELL PUMPED DRY

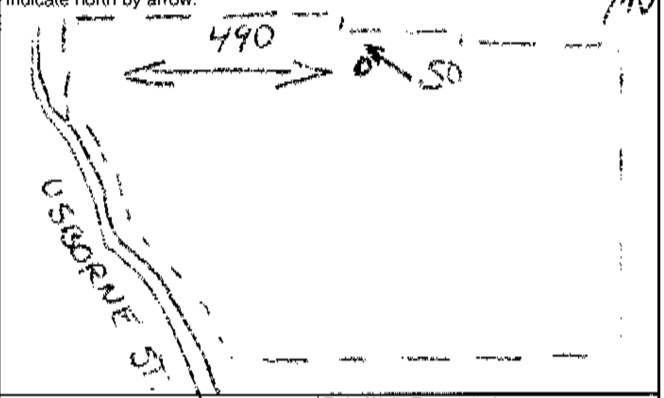
Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	1.43		
1	3.05	1	23.64
2	3.96	2	23.64
3	4.25	3	23.61
4	4.47	4	23.57
5	5.08	5	23.55
10	7.61	10	23.50
15	10.51	15	23.48
20	13.28	20	23.48
25	15.51	25	23.48
30	18.58	30	23.47
40	23.64	40	23.47
50		50	23.47
60		60	23.33

Plugging and Sealing Record ☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.04	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Method of Construction

☐ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☒ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☒ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☑ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor	Well Contractor's Licence No.
T SAUNDERS DRILLING LTD	4879
Business Address (street name, number, city etc.)	
RR#1 BRAESIDE K0A 1G0	
Name of Well Technician (last name, first name)	Well Technician's Licence No.
SAUNDERS TROY	T-517
Signature of Technician/Contractor	Date Submitted YYYY MM DD
X Troy Saul	2007 05 29

Audit No. Z 55050

Date Well Completed YYYY MM DD 2007 05 24

Was the well owner's information package delivered? ☒ Yes ☐ No

Date Delivered YYYY MM DD 2007 05 24

Ministry Use Only

Data Source	Contractor
Date Received YYYY MM DD	Date of Inspection YYYY MM DD
Remarks	Well Record Number

0506E (08/2006)

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Ontario Ministry of the Environment

Well Tag Number (place number below) **A 054439**

A 054439

Well Record

Regulation 903 Ontario Water Resources Act

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Instructions for Completing Form

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- Please print clearly in blue or black ink only.

Ministry Use Only
MUN ___ CON ___ LOT ___

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 876 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S3N2
Telephone Number (include area code): 613-623-5144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 386985 Northing 5036832
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19

GRI # 5-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water
☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify WELL PUMPED DRY
Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 12.19
Pumping rate - (litres/min) 4.5
Duration of pumping 1 hrs + 0 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	.62		
1	1.76	1	11.45
2	1.81	2	11.32
3	1.87	3	11.29
4	1.93	4	11.26
5	2.05	5	11.23
10	2.99	10	11.14
15	3.44	15	11.05
20	5.3	20	11.0
25	6.58	25	10.93
30	7.28	30	10.80
40	9.53	40	10.66
50	10.91	50	10.45
60	12.19	60	10.31

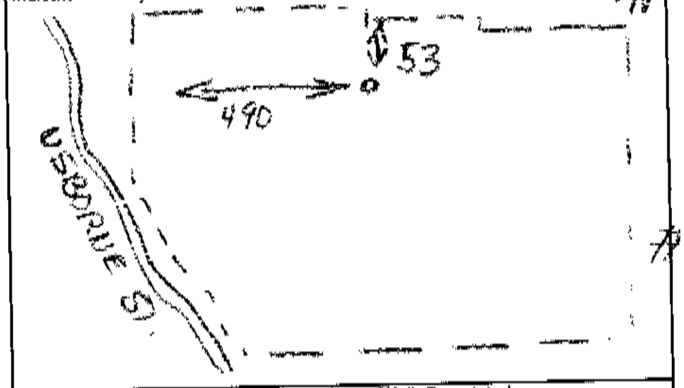
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse)
☐ Rotary (air) ☒ Air percussion ☐ Boring
☐ Diamond ☐ Jetting ☐ Driving
☐ Digging ☐ Other

Water Use

☐ Domestic ☐ Stock ☐ Irrigation
☐ Industrial ☐ Commercial ☐ Municipal
☐ Public Supply ☒ Not used ☐ Cooling & air conditioning
☐ Other

Final Status of Well

☐ Water Supply ☒ Observation well ☐ Test Hole
☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality
☐ Unfinished ☐ Dewatering ☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saunders
Date Submitted: 2007 06 29

Audit No. Z 55052
Date Well Completed: 2007 05 29
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: 2007 05 29

Ministry Use Only
Data Source:
Contractor:
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks:
Well Record Number:

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Well Owner's Copy

Ontario Ministry of the Environment

Well Tag (number below) **A 054432**
A 054432

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

Instructions for Completing Form

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- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only MUN ______ CON ______ LOT ______

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 876 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 380504 Northing 5037238
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify ______

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	SHALE			0	.45
BROWN	LIMESTONE	GREY LIMESTONE		.45	24.3
	GRI # 6-1				

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres	Kind of Water		
20.7 m	☒ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	
☐ Other: UNTESTED			
___ m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	
☐ Other:			
___ m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	
☐ Other:			

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB PUMP
Pump intake set at - (metres) 24.30
Pumping rate - (litres/min) 1.7
Duration of pumping ___ hrs + 50 min
Final water level end of pumping 24.81 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	4.62		
1	5.13	1	23.5
2	6.47	2	23.52
3	6.82	3	23.32
4	7.51	4	23.32
5	9.6	5	23.32
10	12.45	10	23.31
15	15.25	15	23.30
20	17.57	20	23.30
25	18.80	25	23.30
30	24.80	30	23.29
40	24.81	40	23.28
50		50	23.28
60		60	23.27

Plugging and Sealing Record ☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.04	BENTONITE SLURRY	.192

Method of Construction

☐ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☒ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☒ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT.
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T 517
Signature of Technician/Contractor: x
Date Submitted: YYYY 2007 MM 06 DD 28

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.

Audit No. Z 55051
Date Well Completed: YYYY 2007 MM 05 DD 22
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 28

Ministry Use Only

Data Source:
Contractor:
Date Received: YYYY MM DD
Date of Inspection: YYYY MM DD
Remarks:
Well Record Number:

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Ontario Ministry of the Environment

Well Tag Number (place sticker and/or print number below)
A 054431
A054431

Well Record

Regulation 903 Ontario Water Resources Act

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- Please print clearly in blue or black ink only.

Ministry Use Only
MUN ___ CON ___ LOT ___

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: MCNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 387490 Northing 5037241
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth From	Metres To
BROWN	SHALE			0	.45
BROWN	LIMESTONE	GREY LIMESTONE		.45	12.19

GRI # 6-2

Hole Diameter

Depth From	Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres	Kind of Water	
___ m	☐ Fresh	☐ Sulphur
☐ Gas	☐ Salty	☐ Minerals
☐ Other: UNKNOWN		
___ m	☐ Fresh	☐ Sulphur
☐ Gas	☐ Salty	☐ Minerals
☐ Other:		
___ m	☐ Fresh	☐ Sulphur
☐ Gas	☐ Salty	☐ Minerals
☐ Other:		

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth From	Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.19
Pumping rate - (litres/min): .75
Duration of pumping ___ hrs + 40 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Static Level	5.65		
1	6.20	1	12.05
2	7.05	2	12.03
3	7.76	3	12.03
4	8.12	4	12.03
5	8.50	5	11.71
10	9.50	10	11.70
15	10.10	15	11.70
20	10.60	20	11.69
25	11.10	25	11.69
30	11.60	30	11.68
40	12.19	40	11.67
50		50	11.67
60		60	11.65

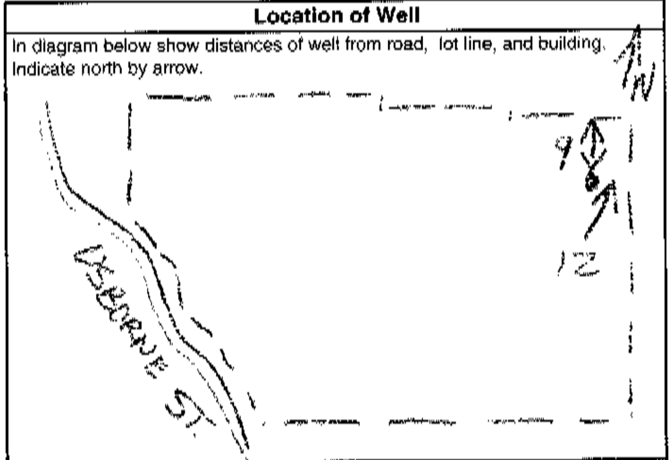
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Method of Construction

☐ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☒ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☒ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Audit No. Z 55053
Date Well Completed: YYYY 2007 MM 05 DD 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 28

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted: YYYY 2007 MM 06 DD 28

Ministry Use Only
Data Source:
Contractor:
Date Received: YYYY MM DD
Date of Inspection: YYYY MM DD
Remarks:
Well Record Number:

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Ontario Ministry of the Environment

W... int number below)
A 054433
A054433

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only
MUN CON LOT

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N8
Telephone Number (include area code): 613-623-5648
Address of Well Location (County/District/Municipality): RENFREW
Township: M^cNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 83 Zone 18 Easting 377757 Northing 5030979
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	SHALE			0	.60
BROWN	LIMESTONE	GREY LIMESTONE		.60	24.38

GRI # 7

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres	Kind of Water	
22.80 m ☐ Gas ☐ Other: UNTESTED	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals
m ☐ Gas ☐ Other:	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals
m ☐ Gas ☐ Other:	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals

After test of well yield, water was
☐ Clear and sediment free
☒ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Casing

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 +.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			

Screen

Outside diam	Material	Slot No.	Depth Metres From	Depth Metres To
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			

No Casing or Screen

	Depth Metres From	Depth Metres To
☒ Open hole	6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 7.2
Duration of pumping ___ hrs + 60 min
Final water level end of pumping: 23.13 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	7.20		
1	9.33	1	23.13
2	9.94	2	23.12
3	9.97	3	23.08
4	10.0	4	23.07
5	10.4	5	23.05
10	12.0	10	22.81
15	13.5	15	22.58
20	14.0	20	22.44
25	15.9	25	22.2
30	16.7	30	22.13
40	19.7	40	21.83
50	22.1	50	20.87
60	23.13	60	19.87

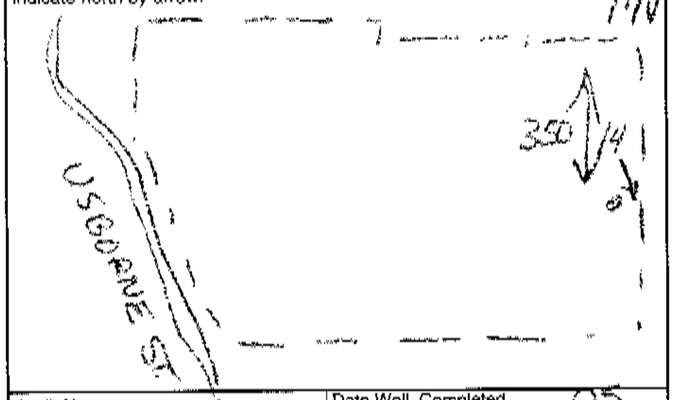
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. Z 55058
Date Well Completed YYYY MM DD 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD 2007 05 28

Method of Construction

☐ Cable Tool
☐ Rotary (conventional)
☐ Rotary (reverse)
☐ Rotary (air)
☒ Air percussion
☐ Boring
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Other

Water Use

☐ Domestic
☐ Stock
☐ Irrigation
☐ Industrial
☐ Commercial
☐ Municipal
☐ Public Supply
☒ Not used
☐ Cooling & air conditioning
☐ Other

Final Status of Well

☐ Water Supply
☒ Observation well
☒ Test Hole
☐ Recharge well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Unfinished
☐ Dewatering
☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor X Troy Saul
Date Submitted YYYY MM DD 2007 06 08

Ministry Use Only
Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (Place Sticker and/or Print number below)
A 054434
A054434

Well Record

Regulation 903 Ontario Water Resources Act

page 2 of 3

Instructions for Completing Form

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- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Help Desk (Toll Free) at 1-888-396-9355.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN | CON | LOT

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 338029 Northing 5036588
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	SHALE			0	.91
BROWN	LIMESTONE	GREY LIMESTONE		.91	24.38

GRI # 8-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water
10.97 m	☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
23.16 m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify CLEARING

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 +.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 15.75
Duration of pumping: 6 hrs + 0 min
Final water level end of pumping: 22.3 metres
Recommended pump type: ☐ Shallow ☐ Deep
Recommended pump depth: metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	13.32		
1	16.60	1	20.75
2	16.67	2	20.6
3	16.74	3	20.55
4	16.80	4	20.27
5	16.64	5	20.09
10	17.10	10	19.64
15	17.50	15	18.89
20	17.90	20	19.25
25	18.20	25	18.93
30	18.70	30	18.72
40	18.90	40	18.66
50	19.15	50	18.82
60	19.50	60	18.96

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse)
☐ Rotary (air) ☒ Air percussion ☐ Boring
☐ Diamond ☐ Jetting ☐ Driving
☐ Digging ☐ Other

Water Use

☐ Domestic ☐ Stock ☐ Irrigation
☐ Industrial ☐ Commercial ☐ Municipal
☐ Public Supply ☒ Not used ☐ Cooling & air conditioning
☐ Other

Final Status of Well

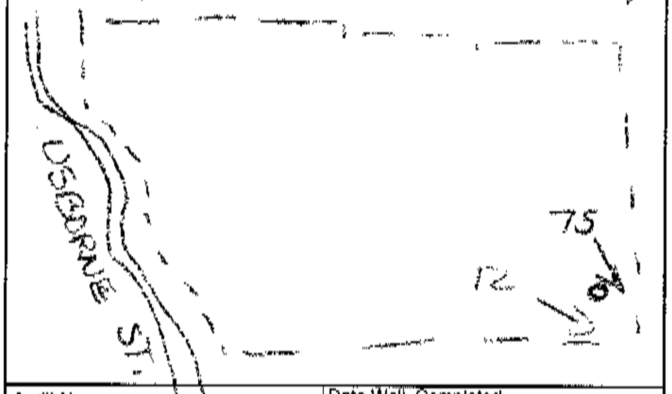
☐ Water Supply ☒ Observation well ☐ Test Hole
☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality
☐ Unfinished ☐ Dewatering ☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X
Date Submitted: YYYY 2007 MM 06 DD 30

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. Z 55049
Date Well Completed: YYYY 2007 MM 05 DD 30
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 30

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well (number below) **A 054435**

A054435

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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- Please print clearly in blue or black ink only.

Ministry Use Only

MUN | CON | LOT

Well Owner's Information and Location of Well Information

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N8
Telephone Number (include area code): 613 623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 388033 Northing 5036594
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19

GRI # 8-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water

☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN

☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.0
Pumping rate - (litres/min): 4.55
Duration of pumping: 0 hrs + 40 min
Final water level end of pumping: 11.50 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WATER DRAWDOWN TO WELL BOTTOM

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	5.61		
1	4.05	1	12.14
2	4.18	2	12.03
3	4.30	3	12.01
4	4.56	4	11.97
5	4.70	5	11.95
10	5.80	10	11.84
15	7.10	15	11.80
20	7.80	20	11.74
25	9.00	25	11.68
30	10.00	30	11.66
40	11.50	40	11.63
50	/	50	11.59
60	/	60	11.37

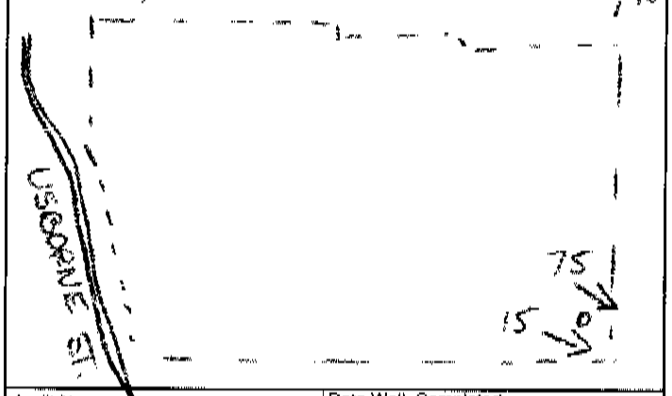
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. Z 55045

Date Well Completed YYYY 2007 MM 05 DD 30

Was the well owner's information package delivered? ☒ Yes ☐ No

Date Delivered YYYY 2007 MM 05 DD 30

Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse) ☐ Rotary (air) ☒ Air percussion ☐ Boring ☐ Diamond ☐ Jetting ☐ Driving ☐ Digging ☐ Other

Water Use

☐ Domestic ☐ Stock ☐ Irrigation ☐ Industrial ☐ Commercial ☐ Municipal ☐ Public Supply ☒ Not used ☐ Cooling & air conditioning ☐ Other

Final Status of Well

☐ Water Supply ☒ Observation well ☐ Test Hole ☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Unfinished ☐ Dewatering ☐ Replacement well ☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-577
Signature of Technician/Contractor X
Date Submitted YYYY 2007 MM 06 DD 30

Ministry Use Only

Data Source | Contractor
Date Received YYYY MM DD | Date of Inspection YYYY MM DD
Remarks | Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

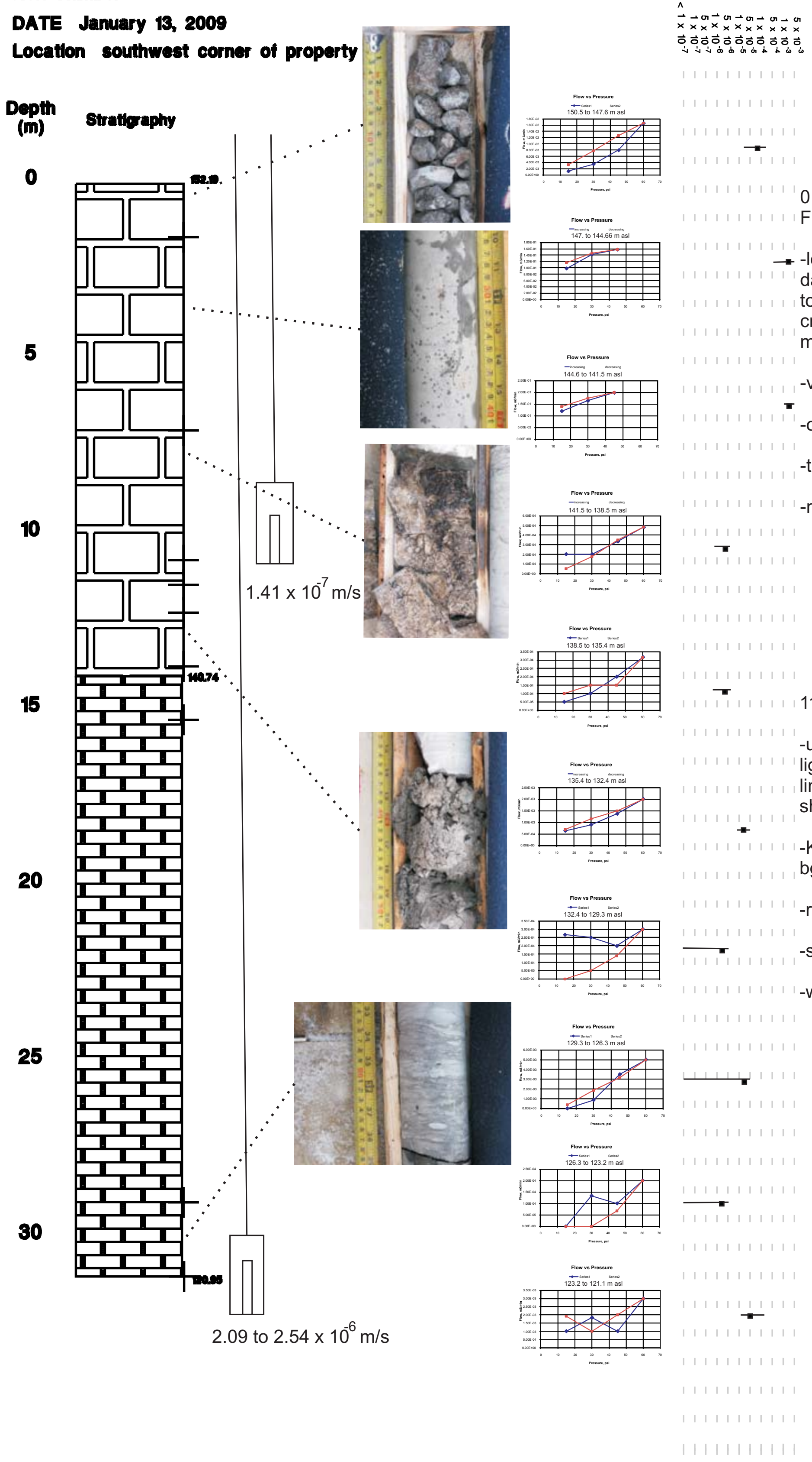
PROJECT 05490

Hole Number 9-1

DATE January 13, 2009

Location southwest corner of property

DRILL TYPE: diamond drill, CME 75



0 to 11.30 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded,medium to thickly bedded

-very weathered to 3 m bgs

-occasional vug present

-tree roots split core at 7.01 m bgs

-most breaks are mechanical breaks

11.30 to 30.65 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with
shale interbeds

-K-bentonite present from 11.28 to 11.73 m bgs

-rust staining at

-small vugs below 12.0 m bgs

-water bearing zone at 31.09 m

GORRELL RESOURCE INVESTIGATIONS

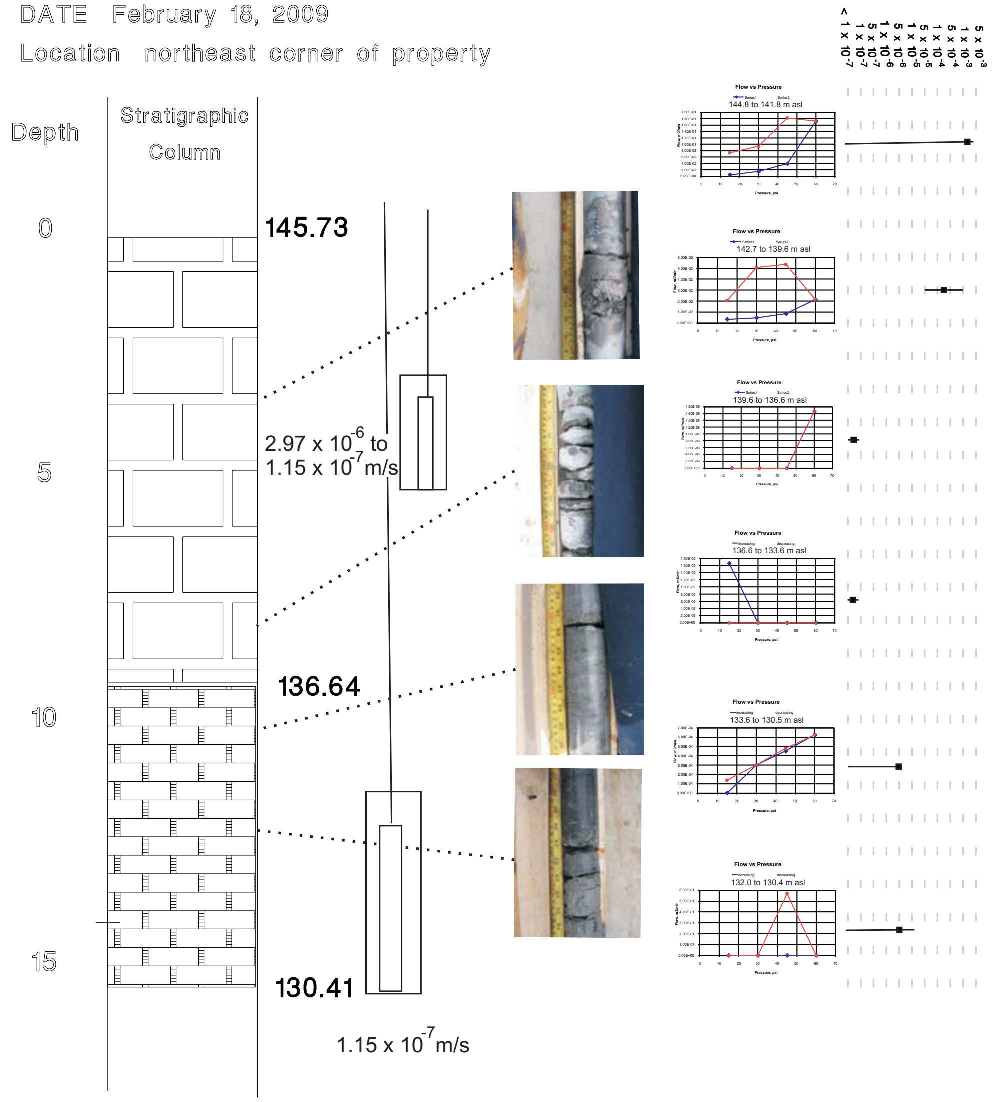
PROJECT 05490

Hole Number 10

DATE February 18, 2009

Location northeast corner of property

DRILL TYPE: diamond drill, CME



0 to 9.09 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly beddeD

-occasional vug present

-possible K-bentonite layer at 3.35 to 3.40 & 8.38 m

-rust staining at 2.16, 2.5,4.88 to 5.18 and 7.75 to 7.80 m bgs,

-most breaks are mechanical breaks

9.09 to 15.32 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite present from 12.50 to 13.11 m bgs

-rust staining at 12.12

·small vugs below 11.49 m bgs

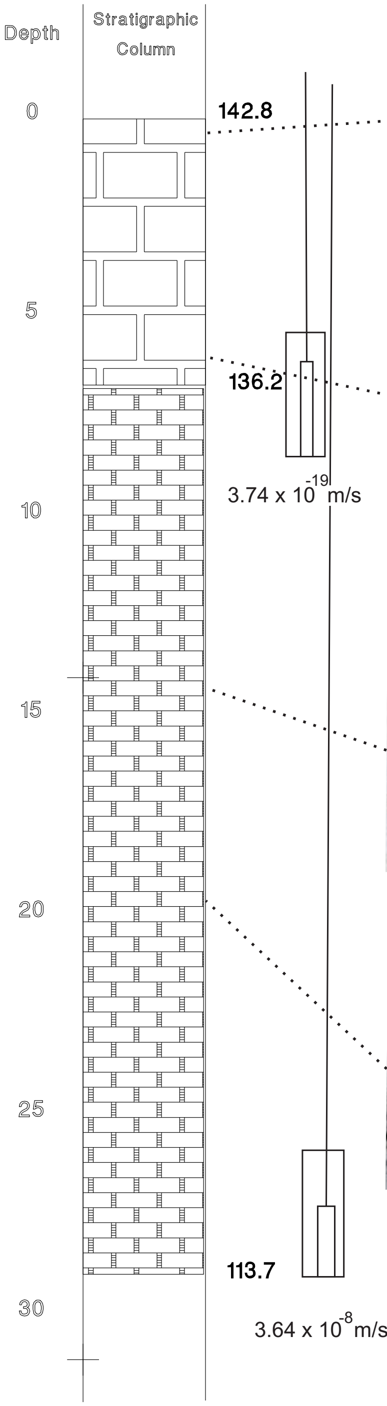
PROJECT 05490

Hole Number 11

DATE February 18, 2009

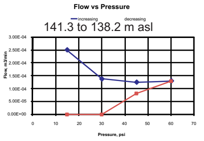
Location northeast side

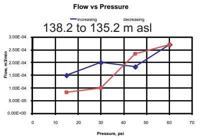
DRILL TYPE: diamond drill, CME

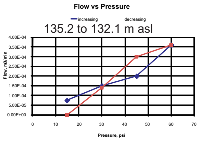


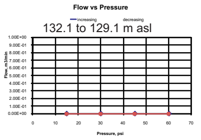
3.74×10^{-19} m/s

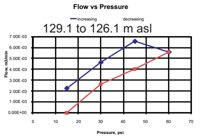
3.64×10^{-8} m/s

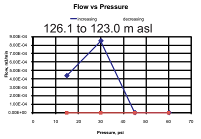


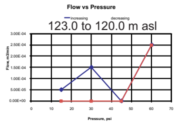


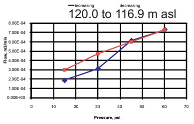


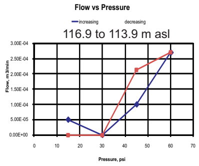


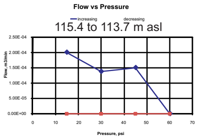


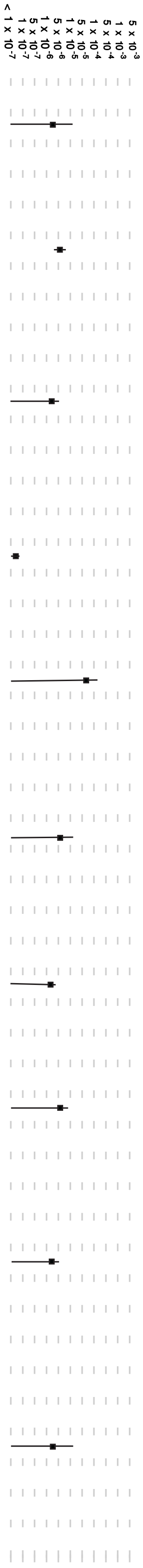












0 to 6.65 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

6.65 to 29.10 m GULL RIVER FORMATION

-6.65 to 15.27 upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-15.27 to 29.10 lower member of formation, consists of interbedded limestone and dolostone, sharp contacts, predominately limestone that is fine to very fine crystalline

-K-bentonite layer at 14.81 to 15.04

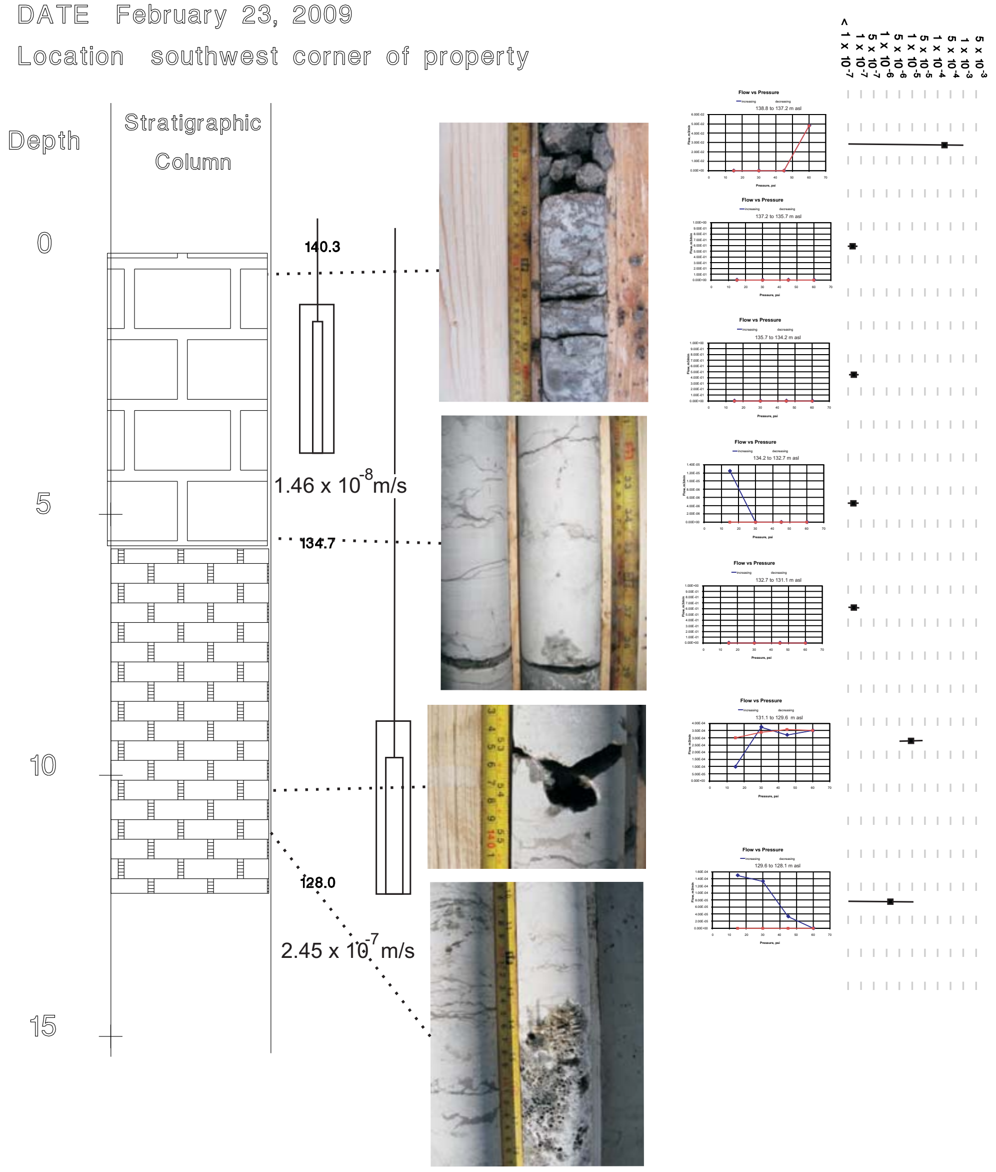
PROJECT 05490

DRILL TYPE: diamond drill, CME

Hole Number 12

DATE February 23, 2009

Location southwest corner of property



0 to 5.6 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded,

-occasional vug present

5.58 to 12.27 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-large vug present at 10.5 m, tetradium coral zone from 10.97 to 11.10 m

GORRELL RESOURCE INVESTIGATIONS gri

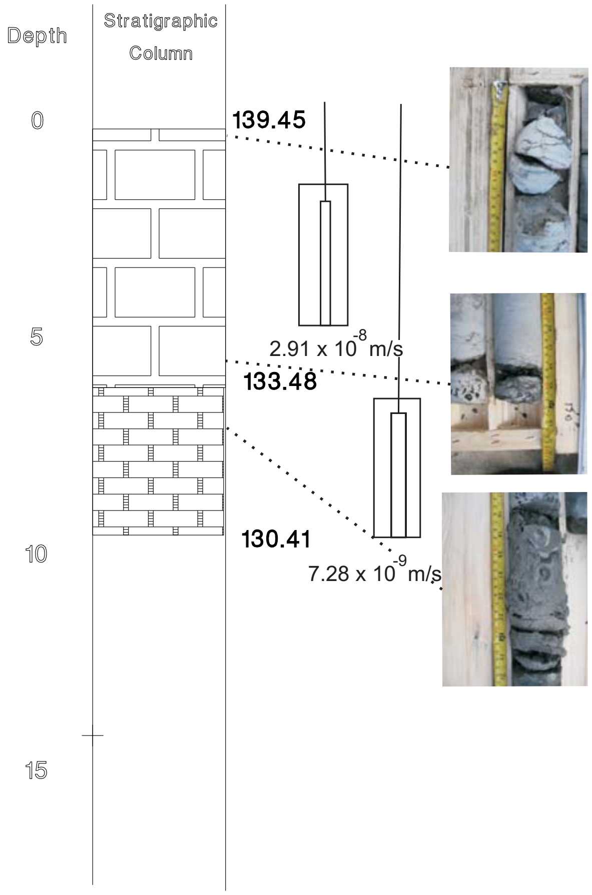
PROJECT 05490

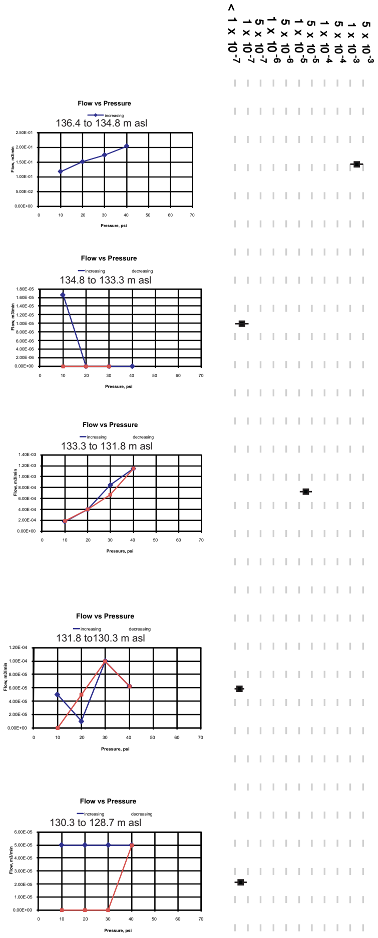
Hole Number 13

DATE February 25, 2009

Location northwest corner of property

DRILL TYPE: diamond drill, CME





0 to 5.97 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded, medium to thickly bedded

-highly weathered zone at 1.98 to 2.74

-occasional vug present

-fractures at 3.76, 3.84, 5.33

5.97 to 9.37 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-fracture at 6.02

-K-bentonite present from 6.34 to 6.71 m bgs

GORRELL RESOURCE INVESTIGATIONS

PROJECT 05490

DRILL TYPE: diamond drill, CME 75

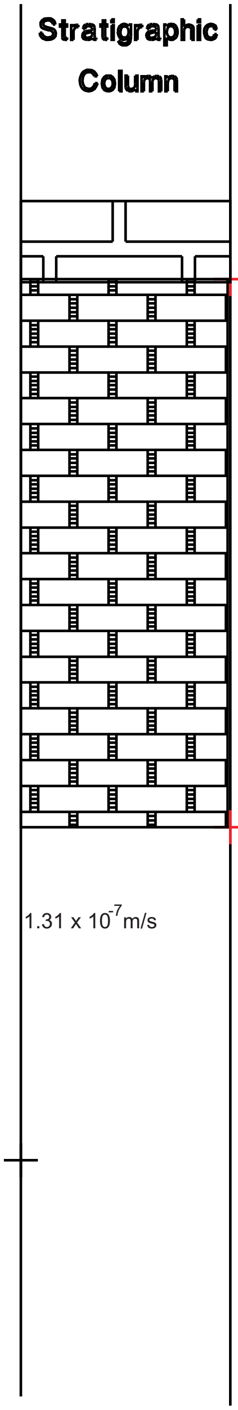
Hole Number F

DATE March 4, 2009

Location quarry floor, just south of sump; drilled for core to be tested

Depth

Stratigraphic Column



0

136.33

5

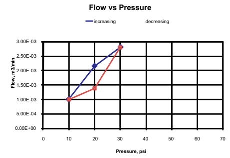
135.19

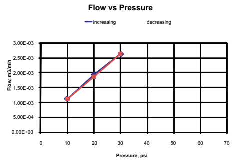
10

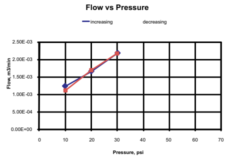
127.19

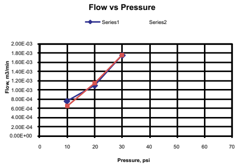
15

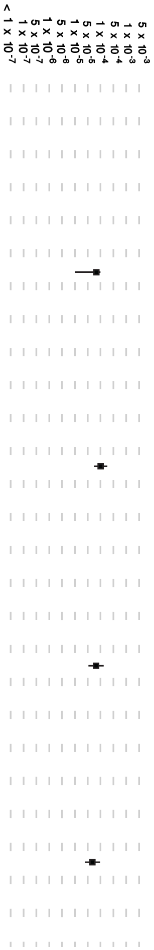
1.31 x 10^{-7} m/s











0 to 1.14 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

-occasional vug present

1.14 to 9.14 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite at 4.47 m (131.9 m asl)

GORRELL RESOURCE INVESTIGATIONS gri

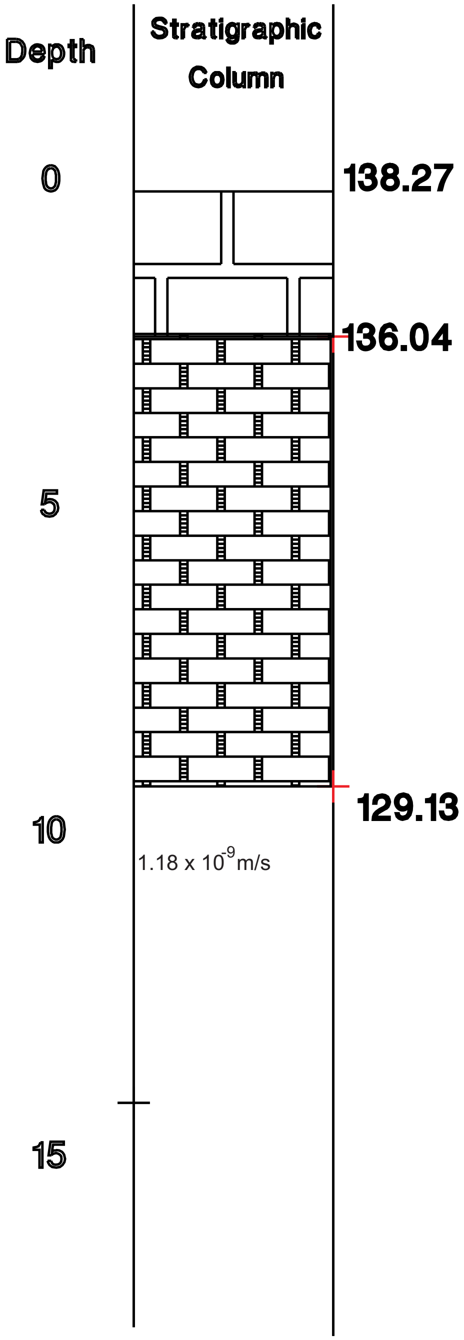
PROJECT 05490

DRILL TYPE: diamond drill, CME 75

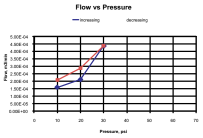
Hole Number G

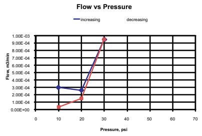
DATE March 5, 2009

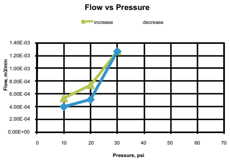
Location quarry floor, south portion of quarry; drilled for core to be tested

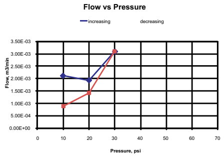


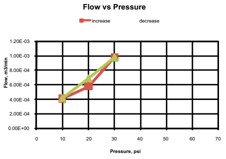
1.18×10^{-9} m/s

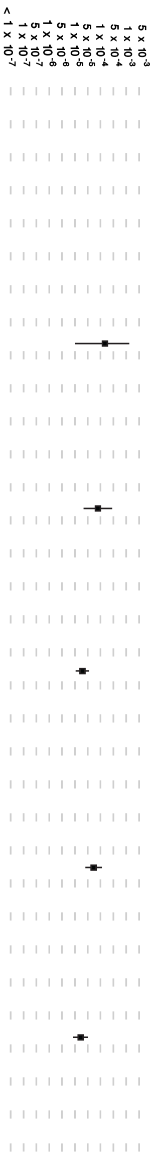












0 to 2.23 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

-occasional vug present

2.23 to 9.14 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite at 4.11 m (134.16 m asl)

GORRELL RESOURCE INVESTIGATIONS
gri

Appendix C
Potentiometric Data

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Potentiometric Elevations 2006 - 2009
Miller Group Inc. Braeside Quarry

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	21-Dec-06	20-Apr-07	09-May-07	10-May-07	31-Jul-07	02-Oct-07
Weathered Bedrock Aquifer									
TW 9-2	152.19		140.76						
TW 10-1	145.72		130.36						
TW 10-2	145.74		139.64						
TW 13-1	139.41		130.04						
TW 13-2	139.52		134.95						
Upper Bedrock, Central Part of Plateau									
TW 1	148.98	147.78	128.87	146.83	140.31	140.99		140.00	140.41
TW 11-2	142.91		133.51						
TW 12-1	140.33		128.14						
TW 12-2	140.28		137.23						
Competent Bedrock - Significant Water Bearing Zone Intercepted									
TW 2	139.60	138.10	119.80	136.39	138.54		134.62	133.77	133.02
TW 3-1	133.90	128.41	108.90	129.96	131.46	130.87	128.80	128.24	125.64
TW 4-1	132.92	127.43	107.92	132.18	131.13	130.25	129.11	128.83	127.10
TW 4-2	133.09	127.60	120.59	132.38	131.40	130.23	129.21	128.89	127.36
TW 5-1	139.26	133.77	114.26	141.17	138.43	138.45		138.19	138.09
TW 6-1	137.95	133.28	112.95	127.33	132.43	133.86		128.56	131.87
TW 7	141.79	136.30	116.79	137.45	136.16	135.08	136.30	131.22	127.36
TW 8-1	144.97	139.48	119.97	135.09	134.55	132.32	131.52	131.12	127.72
TW 9-1	152.04		120.95						
TW 11-1	142.81		113.85						
Competent Bedrock - No Significant Water Bearing Zone Intercepted									
TW 3-2	133.88	128.39	121.38	131.27	132.65	131.84	131.36	130.97	129.90
TW 5-2	139.27	133.78	126.77	142.11	139.42	139.27	138.70	139.19	138.96
TW 6-2	138.23	132.46	125.73	132.16	133.13	133.13	127.35	130.85	131.92
TW 8-2	145.05	139.56	132.55	145.94	143.11	142.99	142.72	142.62	142.33

Potentiometric Elevations 2006 - 2009
Miller Group Inc. Braeside Quarry

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	30-Oct-07	14-Apr-08	05-May-08	13-Jun-08	10-Oct-08	03-Mar-09
Weathered Bedrock Aquifer									
TW 9-2	152.19		140.76						142.26
TW 10-1	145.72		130.36						
TW 10-2	145.74		139.64						
TW 13-1	139.41		130.04						136.24
TW 13-2	139.52		134.95						137.48
Upper Bedrock, Central Part of Plateau									
TW 1	148.98	147.78	128.87	140.71	140.14	142.14	140.78	140.86	
TW 11-2	142.91		133.51						
TW 12-1	140.33		128.14						
TW 12-2	140.28		137.23						
Competent Bedrock - Significant Water Bearing Zo									
TW 2	139.60	138.10	119.80	134.00	138.80	135.58		145.18	
TW 3-1	133.90	128.41	108.90	127.11	135.04	129.74	128.65	128.73	
TW 4-1	132.92	127.43	107.92	127.91	132.72	129.53	129.25	126.49	
TW 4-2	133.09	127.60	120.59	128.03	132.65	129.58	129.30	126.75	
TW 5-1	139.26	133.77	114.26	138.04	138.40	138.45	138.23	135.43	
TW 6-1	137.95	133.28	112.95	132.22	134.33	134.43	133.97	132.60	
TW 7	141.79	136.30	116.79	129.03	135.90	131.82		129.06	
TW 8-1	144.97	139.48	119.97	128.61	135.41	131.74	130.97	128.70	
TW 9-1	152.04		120.95						129.82
TW 11-1	142.81		113.85						130.82
Competent Bedrock - No Significant Water Bearing									
TW 3-2	133.88	128.39	121.38	130.34	133.40	131.78	131.30	131.94	
TW 5-2	139.27	133.78	126.77	139.28	139.45	139.33	139.33	136.58	
TW 6-2	138.23	132.46	125.73	132.16	133.25	133.36	133.36	132.68	
TW 8-2	145.05	139.56	132.55	142.84	143.33	143.10	142.94	141.25	

Potentiometric Elevations 2006 - 2009
Miller Group Inc. Braeside Quarry

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	30-Apr-09	04-May-09	06-May-09	20-May-09	22-Jul-09	24-Sep-09	23-Nov-09
Weathered Bedrock Aquifer										
TW 9-2	152.19		140.76		141.63		141.81	141.60	141.13	141.64
TW 10-1	145.72		130.36		145.31		144.90	145.12	144.71	145.37
TW 10-2	145.74		139.64		145.38		144.98	145.19	144.78	145.45
TW 13-1	139.41		130.04	136.56	136.22		134.98	136.06	135.86	136.27
TW 13-2	139.52		134.95	136.55	136.53		135.98	136.33	136.11	136.63
Upper Bedrock, Central Part of Plateau										
TW 1	148.98	147.78	128.87			142.67	143.24	141.05	141.48	142.57
TW 11-2	142.91		133.51	142.77	137.40		140.60	142.34	142.44	142.64
TW 12-1	140.33		128.14	140.11	139.94		139.77	139.89	139.65	140.06
TW 12-2	140.28		137.23	139.91	139.77		139.65	139.73	139.48	139.88
Competent Bedrock - Significant Water Bearing Zc										
TW 2	139.60	138.10	119.80			134.66	132.36	133.14	132.54	134.57
TW 3-1	133.90	128.41	108.90			128.70	127.42	126.39	125.60	127.35
TW 4-1	132.92	127.43	107.92			129.58	128.81	128.38	127.77	128.56
TW 4-2	133.09	127.60	120.59			129.65	128.84	128.47	127.88	128.70
TW 5-1	139.26	133.77	114.26			138.42	138.31	138.14	138.00	138.20
TW 6-1	137.95	133.28	112.95			133.75	133.69	133.41	133.30	133.32
TW 7	141.79	136.30	116.79			131.96	131.07	130.56	127.70	131.00
TW 8-1	144.97	139.48	119.97			132.26	130.83	130.41	127.83	129.91
TW 9-1	152.04		120.95		129.56		127.19	125.93	125.05	127.20
TW 11-1	142.81		113.85		131.62		129.98	129.74	127.80	128.79
Competent Bedrock - No Significant Water Bearing										
TW 3-2	133.88	128.39	121.38			131.80	131.05	130.91	130.63	131.47
TW 5-2	139.27	133.78	126.77			139.33	139.18	139.17	138.93	139.34
TW 6-2	138.23	132.46	125.73			133.57	133.46	133.38	133.32	133.37
TW 8-2	145.05	139.56	132.55			143.24	142.90	143.16	142.80	143.37

Appendix D
Supplemental Assessment on Radius of Influence – AECOM June 2010

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Miller Paving Limited

Supplemental Assessment – Radius of Influence from Quarry Dewatering – Proposed Braeside Quarry Expansion

Prepared by:

AECOM
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Markham, ON, Canada L3R 5Z6 905 477 1456 fax
www.aecom.com

Project Number:

60117237

Date:

July, 2010

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- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
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Table of Contents

List of Attachments

1. Introduction

This supplemental assessment is intended to address Golder's specific comments dated September 11, 2008, and subsequently, March 9, 2010, on the GRI's hydrogeological assessment reports (November 2007 and November 2009, respectively) with regard to the potential radius of influence in groundwater due to quarry dewatering at the site.

Information on the bedrock setting and hydrogeologic characteristics of the site as well as specific water bearing zones/fractures identified during field testing programs have been presented in detail in the GRI reports. Representative testing results for bedrock hydraulic conductivity presented in the reports are used in this assessment. Some field testing data from the reports were further analyzed in this assessment using software (Aqtesolv) for aquifer testing to confirm representative hydraulic parameters. Finally, the representative aquifer parameters are used to estimate the potential radius of influence due to quarry dewatering using appropriate analytical solutions with the software.

2. Hydraulic Test Data Review

2.1 Well Response Test and Pumping Test

We have reviewed the pumping test data from wells TW1 to TW8 and well response test (slug test) data from the monitoring wells at boreholes TW9 to TW13 presented in Appendices C and E of the consolidated report (GRI, November 2009). In general, the field test methods and data analysis using the Jacob and Theis equations for the pumping test data and the Hvorslev solution for the slug test data are acceptable. The pumping test data analysis previously using the Hvorslev method for boreholes TW5-1, TW5-2, TW6-2, TW7 and TW8-2, found in Appendix C of the consolidated report, will be removed from the final version of the report and are not included in this summary report. The transmissivity from the pumping test data and the hydraulic conductivity from the slug test data, presented in Tables 1 and 2 of the summary report, are considered to be representative hydraulic parameters and have been used for general groundwater impact assessment as presented in Sections 3.2 and 3.3 of this submission.

2.2 Packer Test

We have reviewed the pump-in (injection) packer testing data presented in Appendix D of the consolidated report. The field test method is described in Section 2 of the summary report (GRI, July 2010). The references for the field test protocol and data analysis include Standard Operating Procedures for Borehole Packer Testing (Michael Royle, SRK North America). The references for these data review also include Earth Manual, Part 2 - A Water Resource Technical Publication by US Bureau of Reclamation, 1990, USBR 7310-89: Procedure for Constant Head Hydraulic Conductivity Tests in Single Drill Holes.

Due to injection of water into test intervals under increasing pressures, the interference from potential fracture washout or clogging, hydrofracturing or turbulent flow might occur and as a result, only representative packer test results are included in Table 1 showing the linear relationship due to laminar flow conditions between the system pressure and measured flow. The reasons for excluding some individual tests from each test interval due to the non-linear effects are briefed in the last column (Comment) of Table 1. Although the individual tests, showing non-linear effects due to either potential fracture washout, fracture clogging, hydrofracturing or turbulent flow conditions were not included, but the initial tests under lower water pressures before these effects took place are included. It is noted that test results from descending pressure steps are not included in Table 1 if non-linear effects had taken place during ascending pressure steps for the same depth interval. If the linear relationship existed due to consistent laminar flow conditions, the test results from the ascending pressure steps were considered representative of the test interval and therefore, the results from the descending pressure steps are also not included.

It should be noted that possible natural boundary conditions of fractures (such as fractures close or open up, or fractures in connection with localized unsaturated rock openings such as significant joints/voids) could have made the system tested more complex and the test data more difficult to interpret. Due to limitations of the pump-in test method and multiple factors potentially affecting the flow data, we generally agree with GRI to consider the hydraulic conductivity estimated from the pump-in tests as the potential hydraulic conductivity. Therefore, the hydraulic conductivity from the packer tests was not used and instead, we have used representative hydraulic conductivity or transmissivity derived from the more reliable well response tests or pumping tests for this groundwater impact assessment (such as radius of influence). It is noted however, that for more conservative assessment, the highest range of potential hydraulic conductivity in the order of 10^{-5} m/s from the packer tests on the shallow bedrock has been used to assess general radius of influence in the weathered bedrock aquifer as shown in Appendix I of the consolidated report and the attached Calculation Sheet 1 of the summary report.

Discussion

Pump-in packer tests are very efficient and effective in identifying discrete permeable fracture zones within competent bedrock so that dedicated monitoring wells can be installed and further tested to characterize the permeable zones using the well response tests (slug test) or pumping tests. In many cases, however, the potential hydraulic conductivity from pump-in packer tests may have to be used for general groundwater impact assessment if well response test data are not available, or insufficient, or less representative. Although properly performed pump-in packer tests with carefully selected water pressure steps may produce representative hydraulic conductivity, the preferred packer test method is to conduct well response tests (slug test) on isolated depth intervals with packers, to minimize the possible non-linear effects and boundary conditions due to water injection with the pump-in method as discussed above.

3. Summary of Bedrock Aquifers

We generally agree with the site hydrogeological model described in detail in the GRI report (GRI, November 2009), based on information from on-site boreholes and monitoring wells, as well as local water well records. As summarized in the Executive Summary of the report, there are two identified bedrock aquifers which are more permeable and extensive in the local area. These include the shallow weathered bedrock within the Bobcaygeon Formation and the first significant water bearing zone (WBZ) within the competent bedrock of the Lower Gull River Formation.

The surficial weathered bedrock zone is unconfined with hydraulic conductivity varying from about $2x10^{-7}$ to $5x10^{-5}$ m/s and saturated thickness varying from about 0.5 m to 5.5 m across the site. The first significant WBZ is identified to be moderately permeable with hydraulic conductivity varying from about $2x10^{-6}$ to $2x10^{-5}$ m/s and occur at elevations approximately between 120 and 117 mASL, based on both on-site borehole information and local MOE well records.

Between the weathered bedrock and underlying first significant WBZ, there are discrete water bearing fractures found within the competent bedrock of the Upper Gull River Formation. The borehole information and hydraulic testing data suggest that these water bearing fractures are localized, discontinuous and of low yields and therefore, considered to be insignificant from a water supply point of view.

4. Potential Effects from Quarry Dewatering

4.1 Radius of Influence Due to Drainage from Weathered Bedrock

It is apparent that dewatering of the weathered bedrock due to quarry operations takes the form of drainage under unconfined conditions from the surrounding weathered bedrock to rock faces of the quarry excavation throughout the entire quarry development phases. As the recharge from precipitation directly effects the drawdown cone in the shallow weathered bedrock around the quarry, recharge should be taken into account in the equation to estimate the radius of influence.

We feel that the drainage equation, Hooghoudt (1936), used for determining the trench spacing based on hydraulic conductivity and infiltration from precipitation is appropriate in estimating the radius of influence from quarry dewatering in the surrounding unconfined, weathered bedrock. The attached Calculation Sheet 1 presents the references and formula as well as the source of input parameters for the equation. Chart 1 attached illustrates the conceptual model of the Hooghoudt Equation.

The normal infiltration rate (190.5 mm/a) is estimated based on the water budget derived from the long term meteorological data at the local weather station (Claybank Station, Ottawa) and the MOE infiltration factors for land development applications. The average saturated thickness of the weathered bedrock is assumed to be about 2.5 m in total with the more permeable upper 2 m and less permeable lower 0.5 m. The radius of influence is then calculated to be in the range of about 90 m for hydraulic conductivity $K_a = 1x10^{-5}$ m/s to about 190 m for $K_a = 5x10^{-5}$ m/s, with $K_b = 5x10^{-6}$ m/s unchanged (K_a refers to the upper 2 m and K_b the lower 0.5 m). The sources of the parameters used for the calculation are described in the calculation sheet. It is noted that the highest potential hydraulic conductivity values ($1x10^{-5}$ to $5x10^{-5}$ m/s) estimated from pump-in packer tests are used in this assessment.

4.2 Radius of Influence Due to Lower Lift Sump Pumping

The purpose of this assignment is to assess potential impacts from long-term operations of the lower lift sump in case the sump intercepts the first significant water bearing zone (WBZ) below the final quarry floor. An analytical solution with Aqtesolv and the refined aquifer parameters based on results of our data review are used in the assessment.

4.2.1 Background

It is understood that this water bearing zone (WBZ) below the final quarry floor is situated within the Lower Gull River Formation at elevations found typically between 120 and 117 mASL, as stated in Sections 9.2.4.2 and 11.3.2 of the GRI report (November 2009). It is also noted that this WBZ has been encountered on-site at 119.9 mASL (TW3-1), 117.3 mASL (TW6-1), 121.8 mASL (TW8-1) and 121.0 mASL (TW9-1), as referenced in Tables 2 and 4 of the GRI report and summarized in the attached Table 2. It should be indicated that although the well screen of TW9-1 is installed between 121.0 and 123.1 mASL, the actual water bearing fracture was found at a depth of 31.09 m or 120.95 mASL as shown in the core photo found in the borehole log for TW9-1 (found in Appendix B of the GRI report).

The GRI report recommends in Sections 11.3.2.2 and 14.1 that the base of the lower lift sump be set at 123 mASL or 2 m below the final quarry floor (125 mASL) to maintain a minimum separation from the underlying WBZs noted above. As shown above, elevations of the identified significant WBZ below the quarry may vary from the typical range of 120 to 117 mASL, the sump base may potentially intercept the WBZ at the site. The purpose of this assessment is then to determine potential long-term effects on this WBZ due to the sump operations if the WBZ is intercepted by the sump, and to confirm the monitoring program and mitigation/contingency plan in place to deal with potential adverse impacts.

4.2.2 Hydraulic Parameters of the Underlying WBZ

TW3-1, TW6-1 and TW8-1 were tested by well pumping in 2007 and TW9-1 was tested in 2009 by a well response test (slug test). The detailed field test data and results of data analysis can be found in Appendices C and E of the GRI report (November 2009). The attached Table 2 shows the transmissivity of the WBZs estimated through our independent analysis of the drawdown data (residual drawdown included) from TW3-1, TW6-1 and TW8-1. The drawdown data were analyzed with Aqtesolv, Professional Version 4.5 using the analytical solution for confined aquifers (Papadopulos-Cooper, 1967) that deals with wellbore storage. The graphs showing the results of data analysis with Aqtesolv are also attached.

The attached Table 2 shows that the transmissivity of this WBZ varies from about 0.6 m^2/day at TW9-1 to 4.3 m^2/day at TW3-1. TW6-1 is not accounted for due to significant well loss during the test. The wide range of transmissivity suggests heterogeneity of the WBZ across the site, consistent with field observations during borehole drilling and logging. Therefore, the geometric mean of transmissivity (1.6 m^2/day) is assumed to be representative of the WBZ of the aquifer as a whole, for purposes of general assessment using analytical solutions.

4.2.3 Methodology and Assumptions

This section provides brief information of the analytical solution and model parameters used and the main assumptions made, as well as the assumed operational conditions of the sump, to assess the potential radius of influence due to partial penetration of the underlying WBZ.

Commercial Software .....Aqtesolv for Window, 2007, Professional Version 4.5.

Analytical Solution..........Dougherty-Babu, 1984, a transient solution for confined aquifers taking into account the storage of the sump and partial penetration of the sump into the aquifer.

Partial Penetration ....The sump base is assumed to be cut about 0.5 m into the underlying WBZ which is about 3 m thick.

Sump Size.......................The equivalent radius of the sump is about 22.4 m based on the area (1,575 m^2) required for a 2 m deep sump for the sump base set at 123 mASL (Table 11 of the GRI report, November 2009).

Aquifer Parameters.........The transmissivity (T) of the WBZ equals 1.6 m^2/day which is the geometric mean of T values estimated from TW3-1, TW8-1 and TW9-1 as presented in attached Table 2. The transmissivity (1.6 m^2/day) and calculated hydraulic conductivity ($6.2x10^{-6}$ m/s) represent the average hydraulic parameters of the WBZ.

Maximum Drawdown ......The maximum drawdown at the lower lift sump is about 3 m estimated from the difference between 127 mASL (the static level in the WBZ on average over the seasons, measured at TW9-1) and 124 mASL (1 m above the base of the sump).

Pumping Conditions.......The pumping rate starts initially at about 310 m^3/day (about 47 igpm) and decreases over time to about 7.1 m^3/day (about 1.1 igpm) after one year of operations. The decreasing pumping rates selected are required to maintain the sump level within the maximum drawdown of 3 m over the entire operational period. As shown in the attached drawdown vs. time graph (Appendix B), the sump operational cycles on an annual basis include eight months of continuous pumping to control sump levels followed by four months of winter shutdown for recovery (due to frozen conditions), as specified in the attached data sheet following the graph.

Groundwater Recharge ..Groundwater recharge on the WBZ is not taken into account by the analytical solution used with Aqtesolv.

4.2.4 Results and Discussions

The cumulated drawdown over time and distance from the sump are calculated using the Forward Solution for the given aquifer parameters and operational conditions of the sump as described above. The results of theoretical calculations, shown in the attached Table 3, suggest that in case the sump base intercepts the top 0.5 m of the WBZ, the radius of influence for 1 m drawdown may extend to about 500 m after one year of operation, about 800 m after five years of operation and about 1,000 m after 10 years of operation. Table 3 also shows that the drawdown would increase over time and distance but at extremely slow rates. The relatively small drawdown and very slow increase rates are largely attributed to the lower pumping rates required to maintain the sump level at 124 mASL (or a maximum drawdown of 3 m) and the annual recovery periods due to winter shutdown.

The results suggest that in case the sump intercepts the WBZ, the potential drawdown in the local supply wells about 300 m to 400 m to the west and north of the site would be up to 1.5 m if the sump is located at the site boundaries. This is obviously not the case as the floor for both upper and lower lifts in the excavation slopes to the northeast based on the quarry design and the lowest point of the lower floor should be in the northeast corner of the existing excavation and as a result, the closest well is actually located about 600 m from the future lower lift sump. The potential maximum drawdown, therefore, would be about 1 m at the wells located about 300 to 400 m of the west and north site boundaries; if the sump is located at the northeast corner of the excavation. The above discussions suggest that the northeast corner of the existing quarry excavation, where a lower lift cut has been constructed, is the preferred location for the future lower lift sump to maximize the distance to the local wells thus minimizing potential impacts on local water supply.

The predicted potential small drawdown at the local wells will unlikely cause adverse effects on water supply due to the large available drawdown in these deep supply wells. Furthermore, it should be noted that the analytical solution used in this assessment does not account for natural groundwater recharge to the pumped WBZ. In reality, recharge from infiltration onto the regional and local WBZ always takes place and will significantly reduce the predictive drawdown and radius of influence within the WBZ shown in the attached Table 3. Finally, the existing monitoring well network established along the perimeter of the property will be used to provide early warning and recommendation to investigate and/or implement the proposed mitigation/contingency measures, if required, to deal with any potential significant off-site well interference complaints. In this way, any adverse effects on the local supply wells due to quarry dewatering will be detected at an early stage and will be mitigated accordingly.

4.3 Effects Due to Upward Leakage Through Final Quarry Floor

This assignment is intended to confirm and update the assessment presented in Section 11.3.2.1 of the GRI report (November 2009), with regard to vertical seepage from the confined aquifer (the significant WBZ) below the final quarry floor. The existing data of vertical seepage calculation presented in the report were reviewed. The available hydraulic testing data from boreholes in the existing quarry floor and seasonal water level data of the WBZ were reviewed and used in this assessment to calculate seasonal upward gradients and flow from the WBZ. Potential long term effects on the WBZ, as a result of upward leakage from the WBZ through the quarry floor, are discussed.

4.3.1 Upward Leakage from the WBZ Through Final Quarry Floor

The licensed final quarry floor will be set at an elevation of 125 mASL about 5.1 to 7.7 m above the WBZ near TW3 and TW6 in the north part of the site and about 3.2 to 4.1 m above the WBZ near TW8 and TW9 in the south part of the site. The potentiometric surface of the WBZ was measured at TW9-1 from the highest 129.82 mASL on March 3, 2009, to the lowest 125.05 mASL on September 24, 2009, (Appendix H in the GRI Report). As the hydraulic head of the WBZ would likely be above the final quarry floor over much of the year, upward gradients would exist and upward leakage from the WBZ would potentially take place through the quarry floor.

The Darcy equation is used to estimate upward flow from the WBZ through the entire quarry floor. The hydraulic conductivity of bedrock below the existing quarry floor is estimated from slug tests on open testholes F and G drilled in the existing quarry floor to a depth of about 9 m. The results of slug tests can be found in Appendix E of the GRI report (November 2009). The information of the testholes, test intervals, water levels and slug test results are summarized in the attached Calculation Sheet 2.

The results of slug test analysis with Hvorslev Equation (1951) show that the horizontal hydraulic conductivity (K_h) ranges from $1.31x10^{-7}$ m/s at hole F to $1.18x10^{-9}$ m/s at hole G. It is noted that on the test day, the water levels were about 1.43 m and 2.38 m below the quarry floor at open testholes F and G, respectively. This suggests that test intervals were likely below the impact zone from blasting. As the horizontal hydraulic conductivity (K_h) may vary significantly across the site, the geometric mean of K_h ($1.24x10^{-8}$ m/s) is used to represent average conditions of the competent bedrock below the quarry floor.

We believe the vertical hydraulic conductivity (K_v) in the competent bedrock is generally about 10 to 100 times lower than the horizontal hydraulic conductivity (K_h) in the limestone setting with flow largely controlled by bedding plane fractures. To be conservative, the K_v is estimated to be $1.24x10^{-9}$ m/s about 10 times lower than the geometric mean of K_h, which is comparable to the K_v value used in Table 9 of the GRI November 2009 report.

As shown in the attached Calculation Sheet 2, the upward flow is calculated for both dry and wet seasons as upward gradients potentially vary significantly with the seasons. The results show that the upward flow through the entire final quarry floor would vary from about 0.91 m^3/day in dry seasons to 87.45 m^3/day in wet seasons. The flow (38.35 m^3/day) estimated by GRI (Table 9, November 2009 report) falls well within the above range.

4.3.2 Discussions of Potential Effects on the WBZ Due to Upward Leakage

The above estimated range of upward flow can be expressed as the following ranges: 0.013 to 1.278 m^3 per day per hectare or 0.0013 to 0.1278 Litres per day per square metre, of the final quarry floor. The actual long-term effect on the WBZ due to such small upward leakage, however, should take into account the following aspects:

- The upward flow would vary seasonally following the yearly cycle including 0.91 m^3/day in the summer, 87.45 m^3/day in the fall, no flow due to frozen conditions in the winter and 87.45 m^3/day again in the spring. These suggest that the actual upward flow would be significantly lower on a yearly basis and on long term as well.
- The calculation for the upward flow from the WBZ is largely affected by upward gradients. The upward gradients shown in Calculation Sheet 2 were estimated based on 2009 water level data. Year 2009 was an extremely wet year likely representing highest groundwater conditions and resulting in the highest upward gradients and flow. Much lower upward gradients and flow, therefore, are expected to occur under long-term average or normal groundwater conditions.
- The upward leakage through the final quarry floor could potentially depressurize the WBZ below and in the immediate areas of the quarry floor. The declining hydraulic head of the WBZ would result in decreasing upward gradients and flow through the quarry floor. Therefore, a declining upward flow is expected from the WBZ on a long-term basis.

- The upward flow into the quarry would take place only at times the hydraulic head of the WBZ is higher than the final quarry floor at 125 mASL. No upward flow into the quarry is expected at times the hydraulic head of the WBZ is temporarily lower than 125 mASL during dry seasons or has permanently declined to below 125 mASL due to depressurization. The water levels from the wet 2009 show that the hydraulic head of the WBZ varied from about 125.05 to 129.82 mASL. It is therefore reasonable to assume that 127 mASL represents a yearly average of the hydraulic head of the WBZ under the current conditions. These suggest that the WBZ below the site would be depressurized by a maximum 2 m on an average and long-term basis.
- Groundwater recharge from precipitation (downward leakage) through the quarry floor into the WBZ would take place only when the hydraulic head of the WBZ declines to below 125 mASL. During the post development phases, the recharge potential to the WBZ would greatly increase as the quarry lake level rises.

The above discussions suggest that potential effects from the depressured WBZ on local supply wells about 300 m to 400 m to the west and north of the site would be insignificant. This is largely attributed to the very small upward flow which would decline over time, only up to 2 m of drawdown to occur in the WBZ below the quarry floor, the recharge from precipitation through the quarry floor, the greater distances of the wells from the site, as well as the large available drawdown in these deep supply wells.

The existing monitoring well network established along the perimeter of the property will be used to provide early warning and recommendation to investigate or implement the mitigation/contingency plan, if required, to deal with any potential significant off-site effects.

5. Limitations

It should be indicated that in addition to the assumptions for calculations specified in the above sections, a number of other assumptions also apply to the simple theoretical equations (Hooghoudt, 1936 and Darcy, 1856) and the analytical solutions rendered with the software (Papadopulos-Cooper, 1967 and Dougherty-Babu, 1984). The actual radius of influence from quarry dewatering may vary from what is predicted with the theoretical calculations.

As the radius of influence derived in the above sections is based on theoretical calculations and assumptions given, the actual extent of influence in reality should be confirmed by field monitoring and further investigation/testing as required. Therefore, the results of radius of influence presented above should be used only for planning purposes, to determine monitoring requirements and develop mitigation and contingency plans.

Attachments

- Tables
- Calculations
- Chart
- Graphs

Table 1: Summary of Representative Borehole Packer Testing Results

Borehole No	Test Interval (masl)	Water Pressure (psi)	Potential Hydraulic Conductivity **K** (m/s)	Geometric Mean of Potential **K** (m/s)	Comment
9-1 (Ground at 152.19 mASL)	121.1 - 123.2	15	4.97E-07	3.79E-07	Turbulent flow conditions beyond 30 psi
		30	2.90E-07		
	123.2 - 126.3	30	4.03E-08	4.03E-08	Turbulent flow conditions beyond 30 psi
	126.3 - 129.3	30	1.21E-07	1.21E-07	Fracture partial washout beyond 30 psi
	129.3 - 132.4	15	5.43E-08	5.43E-08	Fracture partial clogging beyond 15 psi
	132.4 - 135.4	15	1.51E-07	1.44E-07	General Laminar flow conditions, slight fracture washout beyond 30 psi
		30	1.21E-07		
		45	1.45E-07		
		60	1.63E-07		
	135.4 - 138.5	15	9.06E-09	1.24E-08	Fracture partial washout beyond 30 psi
		30	1.71E-08		
	138.5 - 141.5	15	4.03E-08	4.03E-08	Fracture partial clogging beyond 15 psi and washed out beyond 30 psi
	141.5 - 144.6	15	2.62E-05	2.41E-05	General consistent laminar flow conditions
		30	2.42E-05		
		45	2.21E-05		
	144.6 - 147.6	15	5.03E-05	3.18E-05	Fracture partial clogging beyond 30 psi
		30	2.01E-05		
	147.6 - 150.5	15	2.62E-07	3.48E-07	Fracture partial washout beyond 30 psi and possible hydrofracturing beyond 45 psi
		30	4.63E-07		
10-1 (Ground at 145.74 mASL)	130.4 - 132.0	30	1.09E-07	1.17E-07	Fracture partial clogging beyond 45 psi
		45	1.25E-07		
	130.5 - 133.5	45	6.24E-08	6.14E-08	Laminar flow conditions beyond 30 psi
		60	6.04E-08		
	133.5 - 136.6	up to 60	0.00E+00	0.00E+00	Water pressure (up to 60 psi) likely not enough for low K bedrock at these depths
	136.6 -139.6	up to 60	0.00E+00		
	139.6 -142.7	15	1.23E-06	1.10E-06	Laminar flow condition from 15 to 45 psi with fracture partially washed out beyond 45 psi
		30	1.01E-06		
		45	1.09E-06		
	141.8 - 144.8	15	2.01E-06	2.46E-06	Fracture partially washed out beyond 30 psi and possible hydrofracturing beyond 45 psi
		30	3.02E-06		
11-1 (Ground at 142.81 mASL)	113.7 - 115.4	15	1.45E-07	1.45E-07	Fracture partial clogging beyond 15 psi and clogged up beyond 45 psi
	113.8 - 116.9	15	1.71E-08	1.71E-08	Fracture clogged up beyond 15 psi and washed out beyond 30 psi
	116.9 - 119.9	15	7.25E-08	6.72E-08	Fracture parially washed out beyond 30 psi
		30	6.24E-08		
	119.9 - 123.0	15	1.61E-08	2.21E-08	Fracture clogging up beyond 30 psi and patially washed out beyond 45 psi
		30	3.02E-08		
	123.0 - 126.0	15	1.61E-07	1.61E-07	Fracture clogged up beyond 30 psi
		30	1.61E-07		
	126.0 - 129.1	15	8.25E-07	8.86E-07	Lamilar flow from 15 to 45 psi and Fracture partial clogging beyond 45 psi
		30	1.05E-06		
		45	8.05E-07		
	129.1 - 132.1	up to 60	0.00E+00	0.00E+00	Water pressure (60 psi) likely not enough for low K bedrock at this depth
	132.1 - 135.2	15	3.02E-08	2.55E-08	General lamilar flow conditions from 15 to 45 psi and fracture partially washed out beyond 45 psi
		30	3.02E-08		
		45	1.81E-08		
	135.2 - 138.2	15	7.45E-08	5.87E-08	Turbulent flow conditions beyond 30 psi
		30	4.63E-08		
	138.2 - 141.3	15	1.01E-07	1.01E-07	Fracture partial clogging beyond 15 psi

Table 1: Summary of Representative Borehole Packer Testing Results

Borehole No	Test Interval (masl)	Water Pressure (psi)	Potential Hydraulic Conductivity **K** (m/s)	Geometric Mean of Potential **K** (m/s)	Comment
12-I (Ground at 140.28 mASL)	128.1 - 129.6	15	1.21E-07	1.21E-07	Fracture clogging up with time beyond 15 psi
	129.6 - 131.1	15 30	9.26E-08 1.65E-07	1.24E-07	Pressure partial clogging beyond 30 psi
	131.1 - 132.7	up to 60	0.00E+00	0.00E+00	Water pressure (up to 60 psi) likely not enough for low K bedrock at these depths
	132.7 - 134.2	up to 60	0.00E+00		
	134.2 - 135.7	up to 60	0.00E+00		
	135.7 - 137.2	up to 60	0.00E+00		
	137.2 - 138.8	15 30 45 60	5.23E-05 5.23E-05 4.83E-05 3.82E-05	4.74E-05	Consistent laminar flow conditions from 15 psi to 60 psi
13-I (Ground at 139.52 mASL)	128.7 - 130.3	up to 40	0.00E+00	0.00E+00	Water pressure (40 psi) too low for low K bedrock at these depths
	130.3 - 131.8	up to 40	0.00E+00		
	131.8 - 133.3	10 20	2.82E-07 1.85E-07	2.28E-07	Fracture partially washed out beyond 20 psi
	133.3 - 134.8	up to 40	0.00E+00	0.00E+00	Water pressure (40 psi) too low for low K bedrock at this depth
	134.8 - 136.4	10 20 30 40	1.05E-04 6.44E-05 6.04E-05 6.04E-05	7.04E-05	Consistent laminar flow conditions

Notes:

1) Complete test data and graphs for test intervals in each borehole found in Appendix D of the GRI Report (November 2009)
4) Packer tests were performed by All Terrain Drilling with packer pressure maintained at 400 psi throughout the tests
2) Data interpretation referenced to Standard Operating Procedures for Borehole Packer Testing, Michael Royle, SRK North America
6) The two highest depth intervals tested at borehole 9-1 was unsaturated during the test

Table 2: Hydraulic Parameters of the First Significant WBZ Below the Final Quarry Floor

Borehole/Well	WBZ Found mASL	**Transmissivity (T)** m2/day	Source of Testing Data	Analytical Solution	Comment
TW3-1	119.9	4.340	2007 Pumping test data	Papadopulos-Cooper (1967)	
TW6-1	117.3	0.071	2007 Pumping test data	Papadopulos-Cooper (1967)	Well loss significant
TW8-1	121.8	1.370	2007 Pumping test data	Papadopulos-Cooper (1967)	
TW9-1	120.95	0.597	2009 Slug test data	Hvorslev (1951)	Calculated from K assuming WBZ 3 m thick
Geometric Mean*		1.53			

Notes:
- the licensed final quarry floor is at 125 mASL and the base of the lower lift sump is to be set at 123 mASL
- The first significant water bearing zone (WBZ) below the final quarry floor is reportedly between 120 and 117 mASL
- WBZ Elevations at wells TW3-1, TW6-1 and TW8-1 refer to Table 2 of GRI Report (Nov-09)
- WBZ elevation at TW9-1 refers to Section 9.2.4.2 and core photos of borehole log in Appendix B of GRI Report (Nov-09)
- Slug test data analysis for TW9-1 can be found in Appendix E of GRI Report (Nov-09)
- Data analysis for other wells are independent and can be found in the attachment to this submision
- The analytical solution (Papadopulos-Cooper, 1967) deals with confined aquifers and well storage

* -Calculated geometric mean of T does not include TW6-1 due to significant well loss in the well during pumping test

Table 3: Potential Long Term Drawdown over Distance in the WBZ Due to Lower Lift Sump Operations

Distance to Sump	Duration of Lower Lift Sump Operation				
	1 Year	5 Years	10 Years	15 Years	20 Years
100 m	1.83	1.87	1.95	1.96	1.98
200 m	1.50	1.60	1.68	1.71	1.73
300 m	1.31	1.44	1.53	1.56	1.58
400 m	1.17	1.32	1.42	1.45	1.48
500 m	1.06	1.23	1.33	1.37	1.40
600 m	0.98	1.16	1.26	1.30	1.33
700 m	0.90	1.10	1.20	1.24	1.28
800 m	0.84	1.05	1.15	1.19	1.23
900 m	0.78	1.00	1.10	1.15	1.18
1000 m	0.73	0.95	1.06	1.11	1.14

Notes: Aqtesolv Pro Version 4.5 - Forward Solution (Dougherty-Babu, 1984) used for calculation

Main Assumptions:

The transmissivity of the first significant WBZ is 1.6 m^2/day (geometric mean)
The thickness of the WBZ is 3 m and the sump base cut 0.5 m into the WBZ
Drawdown in the sump will be maintained within 3 m from static over quarry operations
Sump annual operational cycles: 8 months of continuous pumping and 4 months of winter shutdown

Calculation Sheet 1

Radius of Influence Due to Quarry Dewatering In Shallow, Unconfined Weathered Bedrock

Reference Book:
Drainage Principles and Applications
by International Institute for Land Reclamation and Improvement (1973)
Theories of Field Drainage and Watershed Runoff
8. Subsurface Flow Into Drains

Hooghoudt Equation (1936)

$$R = q = \frac{8K_b dh + 4K_a h^2}{L^2}$$

see attached chart for concept model

Under steady state conditions, trench discharge rate equals infiltration rate

R	recharge/infiltration rate per unit surface area	m/day
q	trench discharge rate per unit surface area	m/day
K_a	hydraulic conductivity of the layer above drain level	m/day
K_b	hydraulic conductivity of the layer below drain level	m/day
d	trench level height above impervious base of trench	m
h	water table height above trench level at midway between two trenches	m
L	trench spacing	m
0.5 L	radius of influence where no drawdown occurs	m

Modified Equation

$$L^2 = \frac{8K_b dh + 4K_a h^2}{q}$$

Parameters					Source of Data
q	190.5	mm/a	190.5	mm/a	Infiltration rate derived from local meteorological data presented below
K_a	5.0E-05	m/s*	1.0E-05	m/s**	* -K values from Boreholes 9, 12 and 13; ** - K values from Boreholes 9 to 13
K_b	5.0E-06	m/s	5.0E-06	m/s	(packer test results for shallow weathered bedrock)
h	2	m	2	m	Avearge saturated thickness estimated from boreholes 9, 10, 12 and 13 with water
d	0.5	m	0.5	m	levels measured in shallow wells on May 4 and Sep 24, 2009
L^2 =	139093	m^2	33117	m^2	
L =	373.0	m	182.0	m	
0.5 L =	**186**	**m**	**91**	**m**	**Radius of Influence**

Water Budget

Long-term meteorological data at Claybank Station, Ottawa, Ontario

Average Anuual Precipitation	814	mm/a
Average Annual Evapotranspiration	521	mm/a
Average Annual Water Surplus	293	mm/a

Infiltration Factor

- based on MOE Hydrogeological Technical Information Requirements For Land Development Applications (April 1995)

		Factors
MOE Factors	Topography	0.2
	Soil Type	0.3
	Land Cover	0.15
	Total	0.65

Normal Infiltration = 190.5 mm

Reference: Hydrological Investigation (Skelton, Brumwell and Associates, October 2007)

Calculation Sheet 2

Upward Leakage from the WBZ Through Final Quarry Floor

Final Quarry Floor Area A = 68.4 ha

A = 684000 m2 Equivalent Quarry Radius = 466.6 m

Borehole Information from existing quarry floor

Open Test Hole F Ground Elevation = 136.33 mASL, Static Level = 1.43 m below ground on May 7, 2009

Open Test Hole G Ground Elevation = 138.27 mASL, Static Level = 2.38 m below ground on May 7, 2009

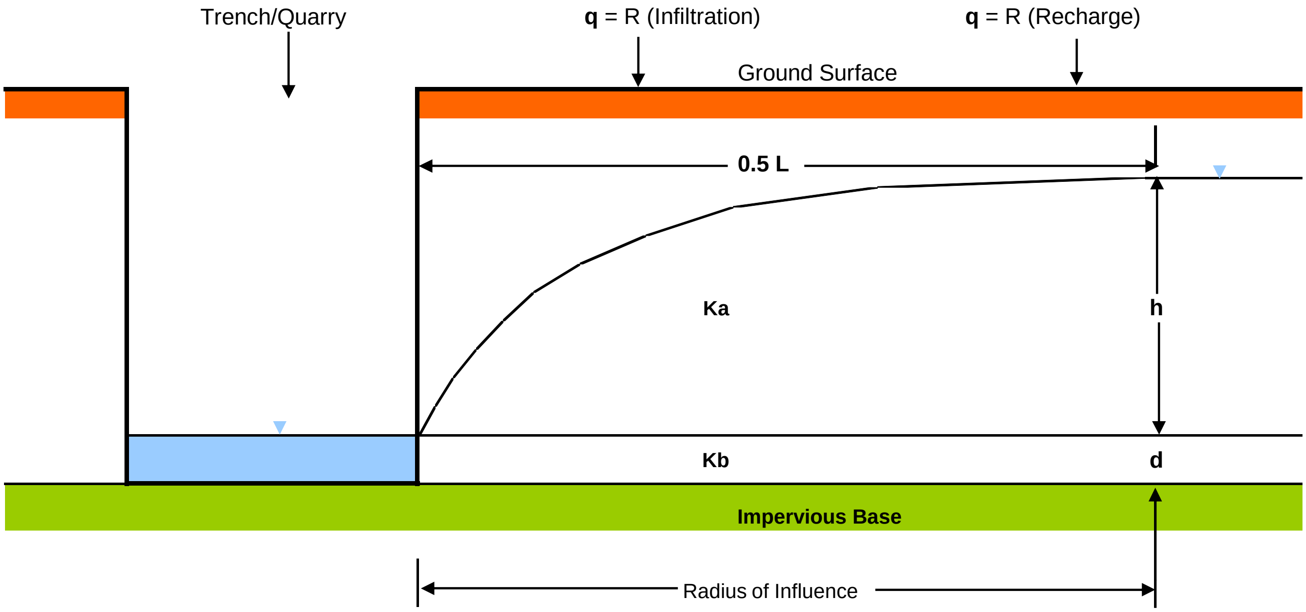
Relevant Hydraulic Testing Data

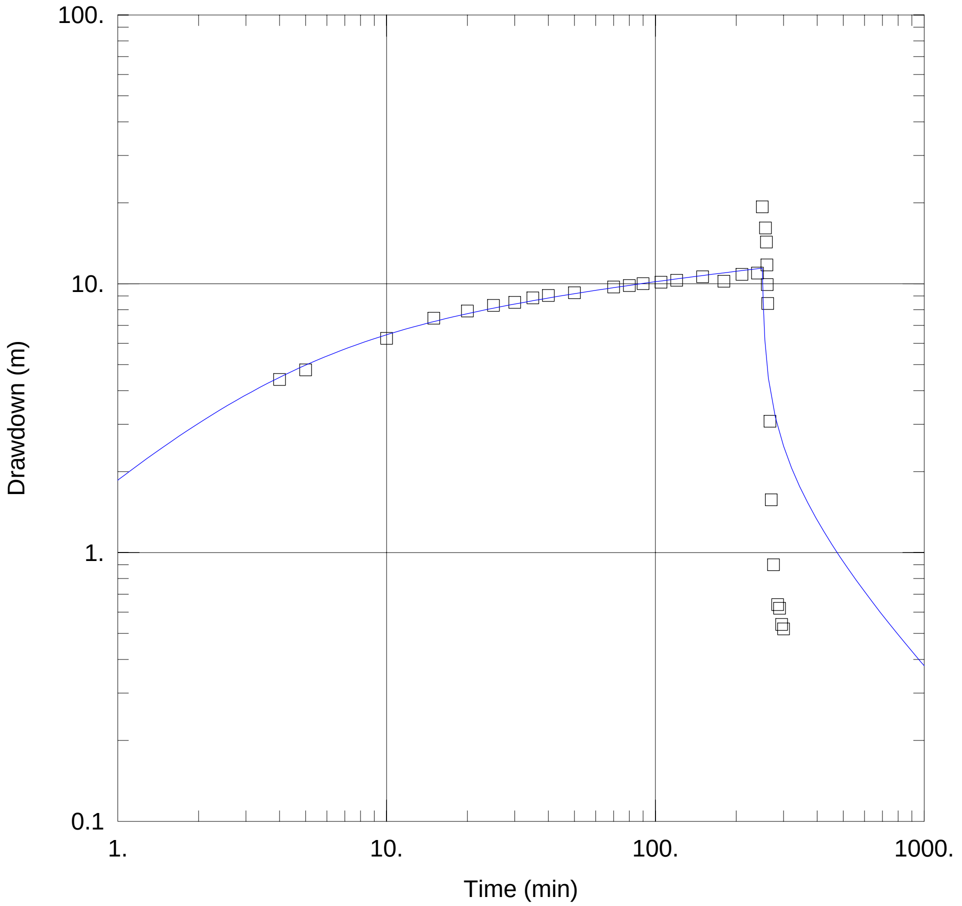
Measured Horizontal K =	1.31E-07	m/s	from Hole F	Test Interval 134.90 - 127.19 mASL, May 7, 2009	Slug Test (Rising Head)
	1.18E-09	m/s	from Hole G	Test Interval 135.89 - 129.13 mASL, May 7, 2009	Slug Test (Rising Head)
Geomean	1.24E-08	m/s			
K (vertical) =	1.24E-09	m/s	assuming vertical K is one order of magnitude lower than horizontal K below quarry floor		
=	1.07E-04	m/day			

	Dry Season	**Wet Season**		
	24-Sep-09	03-Mar-09		
Static Level at TW9-1=	125.05	129.82	mASL	
WBZ =	120.95	120.95	mASL	
Quarry Floor =	125	125	mASL	
Upward Gradient (dh/dL) =	0.012	1.190		
Darcy Upward Flow Q =	**0.907**	**87.45**	m3/day	Total flow through the entire quarry floor
Flow per ha =	0.013	1.278	m3/day/ha	Flow through one hectare of the quarry floor
Flow per m^2 =	0.0013	0.1278	L/day/m2	Flow through one m2 of the quarry floor

Note: Measured hydraulic conductivity (K) for BH-F and BH-G refers to Appendix E of GRI Report (Nov-09)

Chart 1: Conceptual Model for Hooghoudt Drainage Equation (1936)





BOREHOLE TW3-1 DRAWDOWN DATA ANALYSIS RESULTS

Data Set: D:\...\TW3-1 Drawdown data.aqt
Date: 05/26/10
Time: 13:02:01

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Well: TW3-1
Test Date: May 1, 2007

AQUIFER DATA

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

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW3-1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ TW3-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 4.343 m^2/day
S = 0.0452
r(w) = 0.076 m
r(c) = 0.076 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\TW3-1 Drawdown dat
Title: Borehole TW3-1 Drawdown Data Analysis Results
Date: 05/26/10
Time: 13:06:49

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Date: May 1, 2007
Test Well: TW3-1

AQUIFER DATA

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

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW3-1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.076 m
Well Radius: 0.076 m

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	49.5	250.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW3-1

X Location: 0. m
Y Location: 0. m

Radial distance from TW3-1: 0. m

Fully Penetrating Well

No. of Observations: 32

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
4.	4.4	180.	10.22
5.	4.78	210.	10.84
10.	6.26	240.	10.96
15.	7.44	250.	19.32
20.	7.92	257.	16.12
25.	8.3	259.	14.3
30.	8.52	260.	11.75
35.	8.86	261.	9.93
40.	9.04	262.	8.44
50.	9.26	267.	3.08

Time (min)	Displacement (m)	Time (min)	Displacement (m)
70.	9.72	270.	1.57
80.	9.85	275.	0.9
90.	10.01	285.	0.64
105.	10.13	290.	0.62
120.	10.3	295.	0.54
150.	10.62	300.	0.52

SOLUTION

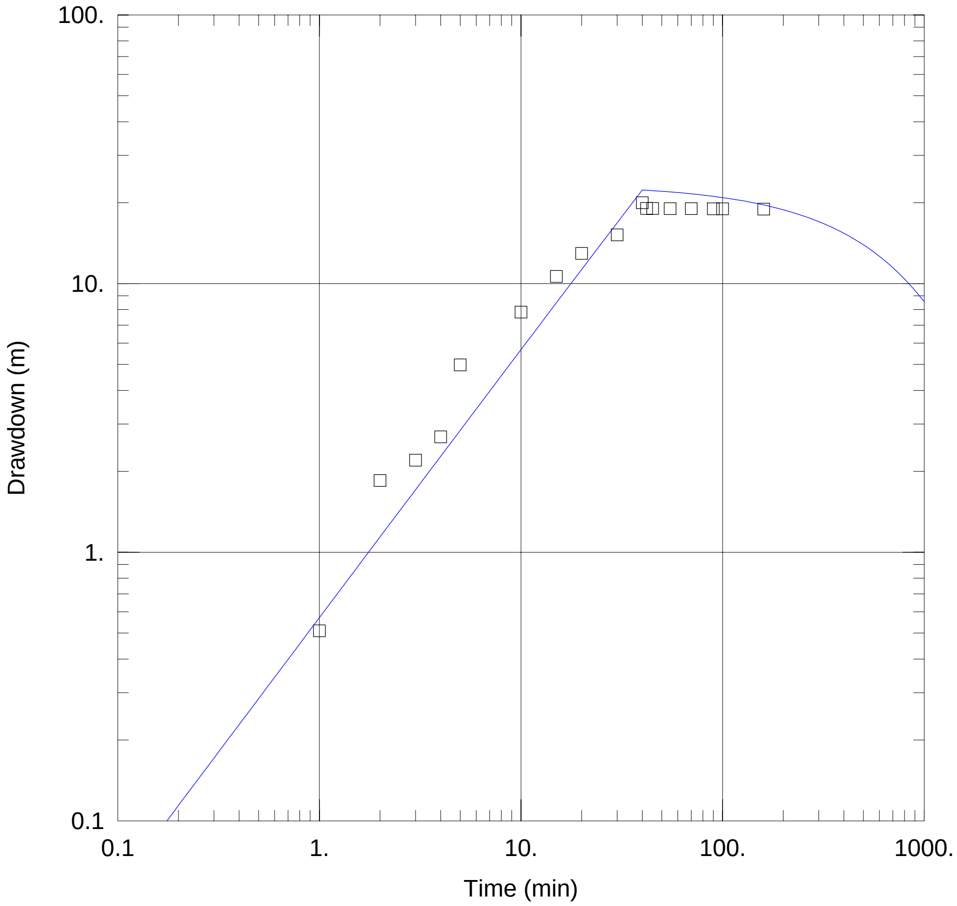
Pumping Test
Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	4.343	m^2/day
S	0.0452	
r(w)	0.076	m
r(c)	0.076	m

K = T/b = 1.448 m/day (0.001676 cm/sec)
Ss = S/b = 0.01507 1/m



BOREHOLE TW6-1 DRAWDOWN DATA ANALYSIS RESULTS

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Time: 13:00:25

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Well: TW6-1
Test Date: May 8, 2007

AQUIFER DATA

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

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW6-1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ TW6-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 0.07068 m^2/day
S = 2.16E-14
r(w) = 0.076 m
r(c) = 0.076 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\TW6-1 Drawdown dat
Title: Borehole TW6-1 Drawdown Data Analysis Results
Date: 05/26/10
Time: 13:05:57

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Date: May 8, 2007
Test Well: TW6-1

AQUIFER DATA

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

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW6-1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.076 m
Well Radius: 0.076 m

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	10.35	40.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW6-1

X Location: 0. m
Y Location: 0. m

Radial distance from TW6-1: 0. m

Fully Penetrating Well

No. of Observations: 17

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
1.	0.51	40.	19.98
2.	1.85	42.	19.03
3.	2.2	45.	19.03
4.	2.69	55.	19.01
5.	4.98	70.	19.
10.	7.83	90.	18.99
15.	10.63	100.	18.98
20.	12.95	160.	18.92
30.	15.18		

SOLUTION

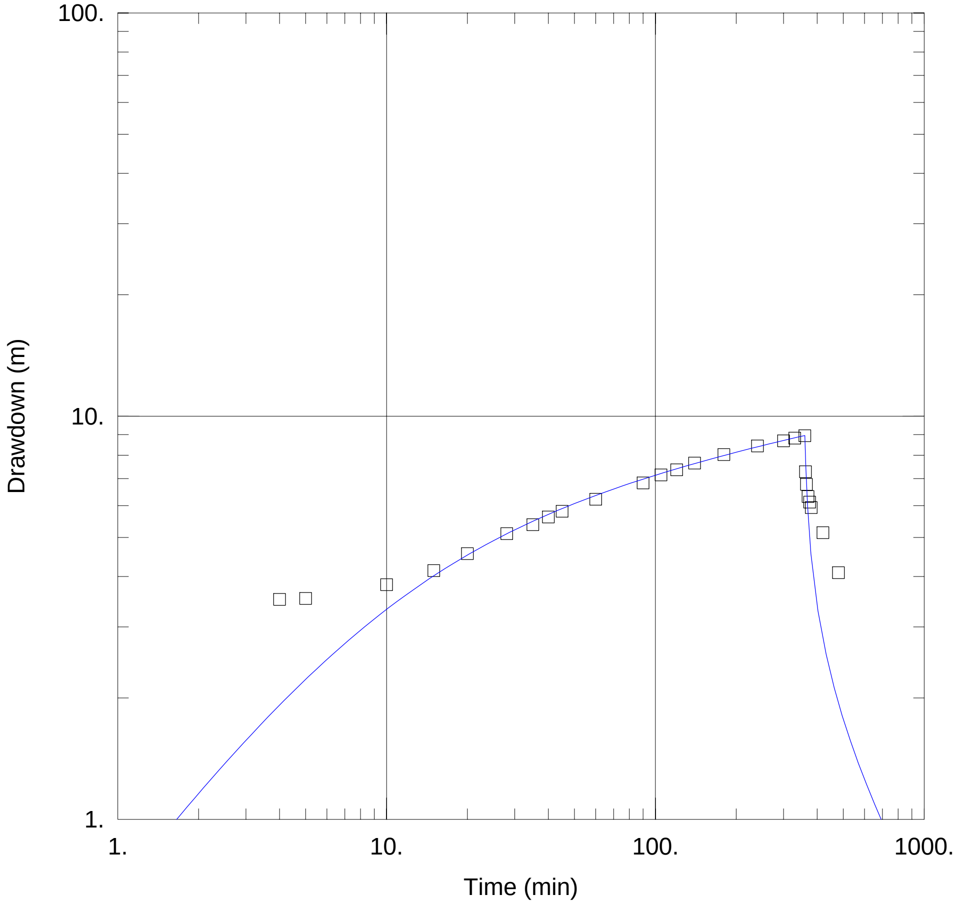
Pumping Test
Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	0.07068	m^2/day
S	2.16E-14	
r(w)	0.076	m
r(c)	0.076	m

K = T/b = 0.02356 m/day (2.727E-5 cm/sec)
Ss = S/b = 7.2E-15 1/m



BOREHOLE TW8-1 DRAWDOWN DATA ANALYSIS RESULTS

Data Set: D:\...\TW8-1 Drawdown data.aqt
Date: 05/26/10
Time: 13:04:32

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Well: TW8-1
Test Date: May 4, 2007

AQUIFER DATA

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

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW8-1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ TW8-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 1.37 m^2/day
S = 0.1416
r(w) = 0.076 m
r(c) = 0.076 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\TW8-1 Drawdown dat
Title: Borehole TW8-1 Drawdown Data Analysis Results
Date: 05/26/10
Time: 13:05:12

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Date: May 4, 2007
Test Well: TW8-1

AQUIFER DATA

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

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW8-1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.076 m
Well Radius: 0.076 m

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	15.75	360.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW8-1

X Location: 0. m
Y Location: 0. m

Radial distance from TW8-1: 0. m

Fully Penetrating Well

No. of Observations: 26

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
4.	3.51	140.	7.65
5.	3.53	180.	8.03
10.	3.82	240.	8.43
15.	4.14	300.	8.68
20.	4.56	330.	8.82
28.	5.11	360.	8.94
35.	5.38	362.	7.28
40.	5.62	365.	6.77
45.	5.81	370.	6.32
60.	6.22	375.	6.12

Time (min)	Displacement (m)	Time (min)	Displacement (m)
90.	6.83	380.	5.93
105.	7.15	420.	5.14
120.	7.36	480.	4.09

SOLUTION

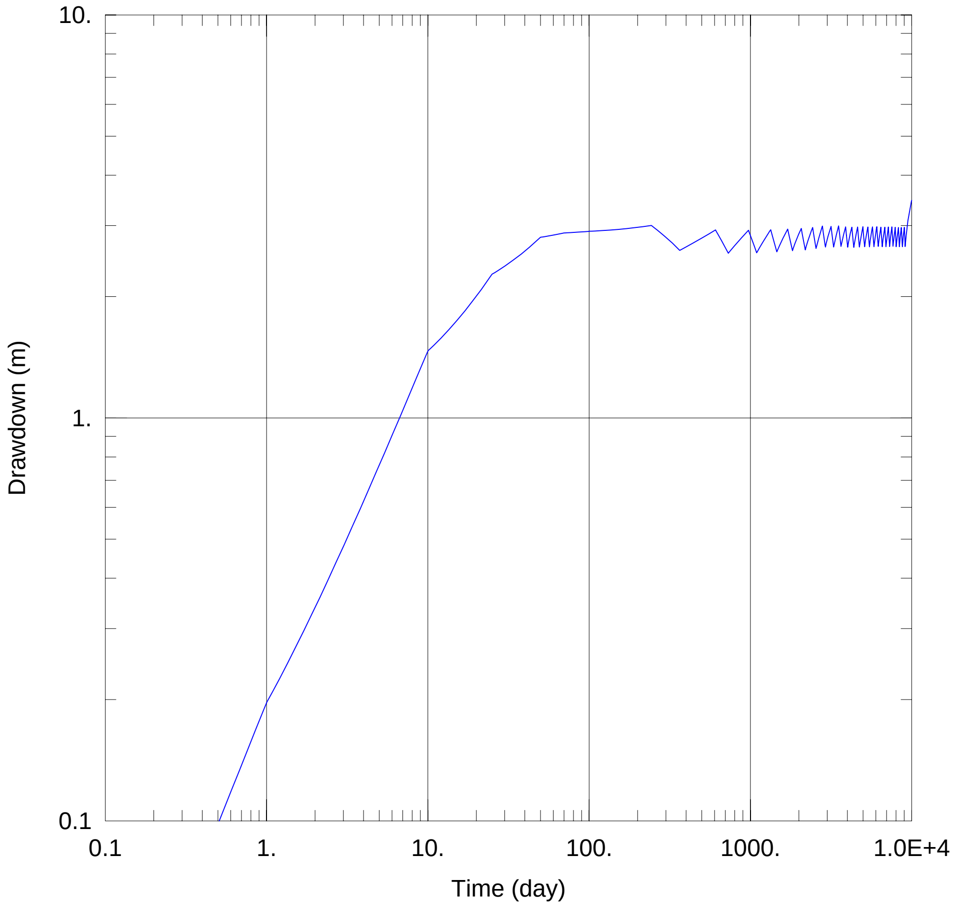
Pumping Test
Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.37	m^2/day
S	0.1416	
r(w)	0.076	m
r(c)	0.076	m

K = T/b = 0.4567 m/day (0.0005286 cm/sec)
Ss = S/b = 0.04721 1/m



PREDICTED LONG TERM DRAWDOWN CURVE IN LOWER LIFT SUMP DUE TO SUMP OPERATIONS

Data Set: D:\...\Lower Lift Sump5.aqt
Date: 05/27/10 Time: 09:57:35

PROJECT INFORMATION

Company: AECOM Canada Limited
Client: Miller Paving Limited
Location: Braeside, ON
Test Well: Lower Lift Sump

AQUIFER DATA

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

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Lower Lift Sump	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ Lower Lift Sump	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 1.63 m^2/day
Kz/Kr = 0.1
r(w) = 22.4 m

S = 0.0001
Sw = 0.
r(c) = 22.4 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\Lower Lift Sump5.aqt
Title: Predicted Long Term Drawdown Curve in Lower Lift Sump Due to Sump Operations
Date: 05/27/10
Time: 09:59:36

PROJECT INFORMATION

Company: AECOM Canada Limited
Client: Miller Paving Limited
Location: Braeside, ON
Test Well: Lower Lift Sump

AQUIFER DATA

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

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: Lower Lift Sump

X Location: 0. m
Y Location: 0. m

Casing Radius: 22.4 m
Well Radius: 22.4 m

Partially Penetrating Well
Depth to Top of Screen: 0. m
Depth to Bottom of Screen: 0.5 m

No. of pumping periods: 57

Pumping Period Data

Time (day)	Rate (cu. m/day)	Time (day)	Rate (cu. m/day)
0.	310.	4258.	0.
1.	225.	4380.	6.4
10.	90.	4623.	0.
25.	40.	4745.	6.4
50.	12.	4988.	0.
70.	7.8	5110.	6.3
100.	7.	5353.	0.
243.	0.	5475.	6.3
365.	7.1	5718.	0.
608.	0.	5840.	6.3
730.	7.1	6083.	0.
973.	0.	6205.	6.2
1095.	7.	6448.	0.
1338.	0.	6570.	6.2
1460.	6.9	6813.	0.
1703.	0.	6935.	6.2
1825.	6.8	7178.	0.
2068.	0.	7300.	6.2
2190.	6.8	7543.	0.
2433.	0.	7665.	6.1
2555.	6.8	7908.	0.
2798.	0.	8030.	6.1
2920.	6.6	8273.	0.
3163.	0.	8395.	6.1
3285.	6.6	8638.	0.
3528.	0.	8760.	6.1
3650.	6.4	9003.	0.
3893.	0.	9125.	6.1
4015.	6.4		

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: Lower Lift Sump

X Location: 0. m
Y Location: 0. m

Radial distance from Lower Lift Sump: 0. m

Partially Penetrating Well
Depth to Top of Screen: 0. m
Depth to Bottom of Screen: 0.5 m

No. of Observations: 0

SOLUTION

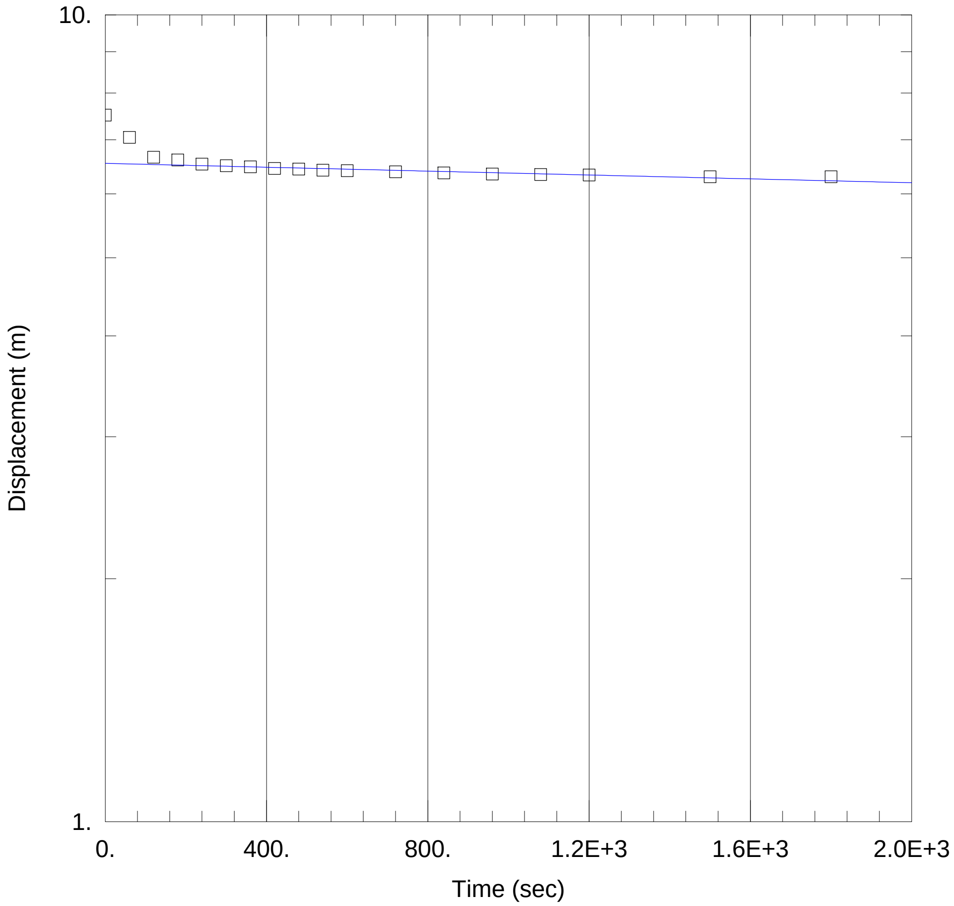
Pumping Test
Aquifer Model: Confined
Solution Method: Dougherty-Babu

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.63	m^2/day
S	0.0001	
Kz/Kr	0.1	
Sw	0.	
r(w)	22.4	m
r(c)	22.4	m

K = T/b = 0.5433 m/day (0.0006289 cm/sec)
Ss = S/b = 3.333E-5 1/m



MILLER BRAESIDE QUARRY MONITORING WELL 11-2 SLUG TEST DATA ANALYSIS RESULTS

Data Set: c:\...\11-2.aqt
Date: 06/17/10
Time: 15:35:29

PROJECT INFORMATION

Company: GRI and AECOM
Client: Miller Paving
Location: Braeside, Ontario
Test Well: BH11-2
Test Date: April 30, 2009

AQUIFER DATA

Saturated Thickness: 7.51 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11-2)

Initial Displacement: 7.51 m
Total Well Penetration Depth: 7.51 m
Casing Radius: 0.016 m
Static Water Column Height: 7.51 m
Screen Length: 3.6 m
Well Radius: 0.016 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 6.009E-9 m/sec
y0 = 6.545 m

Data Set: c:\D\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\11-2.aqt
Title: Miller Braeside Quarry Monitoring Well 11-2 Slug Test Data Analysis Results
Date: 06/17/10
Time: 15:33:42

PROJECT INFORMATION

Company: GRI and AECOM
Client: Miller Paving
Location: Braeside, Ontario
Test Date: April 30, 2009
Test Well: BH11-2

AQUIFER DATA

Saturated Thickness: 7.51 m
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: 11-2

X Location: 0. m
Y Location: 0. m

Initial Displacement: 7.51 m
Static Water Column Height: 7.51 m
Casing Radius: 0.016 m
Well Radius: 0.016 m
Well Skin Radius: 0.05 m
Screen Length: 3.6 m
Total Well Penetration Depth: 7.51 m
Corrected Casing Radius (Bouwer-Rice Method): 0.016 m
Gravel Pack Porosity: 0.3

No. of Observations: 17

Observation Data

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
60.	7.05	600.	6.41
120.	6.66	720.	6.39
180.	6.61	840.	6.37
240.	6.53	960.	6.35
300.	6.5	1080.	6.34
360.	6.48	1200.	6.33
420.	6.45	1500.	6.3
480.	6.44	1800.	6.3
540.	6.42		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Hvorslev
Log Factor: 0.1637

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	6.009E-9	m/sec
y0	6.545	m

K = 6.009E-7 cm/sec
T = K*b = 4.513E-8 m²/sec (0.0004513 sq. cm/sec)

Appendix E
Miscellaneous Supporting Calculations

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Shape of Drawdown Cone
Configuration 1 - spring zone only at highest k

Aquifer and Well Parameters

d=	**2**	**m**	{drawdown}			
Q=	**248**	**m3/d**	**H=**	**2**	**m**	{depth of water}
K=	**6.3**	**m/d**	**h=**	**0**	**m**	{depth of water remaining}
b=	**2**	**m**	**r=**	**473.37**	**m**	{radius of well}
			R(calc)=	**6.52E+02**	**m**	

Confined

$$Q = \frac{2.73 \times Kb(H-h)}{\log R/r}$$

Unconfined

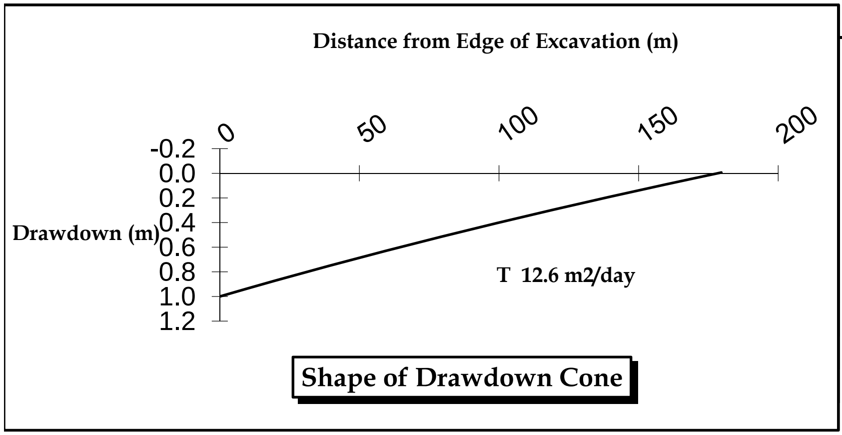
$$Q = \frac{1.366 \times K(H2-h2)}{\log R/r}$$

area= 703967.831 **m2**

Shape of Cone

$$s = \frac{0.366 \times Q\log R/r}{Kb}$$

Radius of Influence = 651.6 m (unconfined)



R	**s**	**Station**	**Observed Drawdown (m)**
0	1.0		
10	0.9		
20	0.9		
30	0.8		
40	0.7		
50	0.7		
60	0.6		
70	0.6		
80	0.5		
90	0.5		
100	0.4		
110	0.3		
120	0.3		
130	0.2		

Shape of Drawdown Cone of Potentiometric surface of First Significant Water Bearing Zone due to Vertical Seepage through Quarry Floor

Aquifer and Well Parameters

d=	**2**	**m**	{drawdown}				
Q=	**38.35**	**m3/d**		**H=**	**127**	**m**	{depth of water}
K=	**0.0101952**	**m/d**		**h=**	**125**	**m**	{depth of water remaining}
b=	**1**	**m**		**r=**	**466.61**	**m**	{radius of well}
				R(calc)=	**4.68E+02**	**m**	
				area=	684000	**m2**	

Confined

$$Q = \frac{2.73 \times Kb(H-h)}{\log R/r}$$

Radius of Influence = 468.2 m (confined)

Appendix F
Summary of MOE Well Record Data

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

WELL RECORD SUMMARY

MOE #	Well No.	Conc., Lot	Easting	Northing	Surface Elev. (ft)	Date Drilled	Water Found (ft)	Static Level (ft)	Pumped Level (ft)	Pump Rate (IGPM)	Owner, Log
TW 1	1		387620	5035980	492.126	Jul-02	DRY	25.4	56	0.85	loos fill 0001, grey shly lmsn 0065
TW 2	2		387120	5035930	456.037	Jul-02	45	25.8	39.2	0.65	loos fill 0002, grey shly lmsn 0065
55-08122	3	B,15				Feb-86	190	60	175	30	brwn shle 001, brwn lmsn 0200
	4	B, 17				Aug-89	199	30	150	7	sand loam 0060, grey lmsn 0205
55-04898	5	A, 15	387930	5035200	425	May-77	80	15	60	10	sand grvl 0010, grey lmsn 0085
55-02998	6	A, 15	387693	5035381	400	Feb-73	101	50	70	6	brwn loam 001, brwn lmsn 0105
55-10795	7	A, 15				Mar-92	239	98	244	5	fill 01, shle loam 03, grey lmsn 0195, grey lmsn snds lyrd 0245
55-01008	8	A, 15	387860	5035240	415	Aug-63	196	63	140	10	brwn shle 0010, grey lmsn 0200
55-03893	9	A, 16	387450	5035600	475	Nov-75	130	60	110	0	brwn shle 0013, unkn 0130
55-07769	10	A, 16				Apr-85	74	34	70	10	shle 03, red lmsn 0083
55-09461	11	A, 17				Apr-89	210	60	200	15	sand stns 004, grey lmsn shle 0165, grey shle snds 0218
55-09178	12	A, 17				Aug-88	208	52	215	12	sand stns 001, lmsn shle 0133, grey shle snds 0218
55-01009	13	A, 18	387080	5037480	415	Aug-60	90	10	70	6	msnd 005, grey lmsn 0100
55-05882	14	B, 15	389000	5036500	350	Jun-79	230	90	200	20	hpan 021, grey lmsn 0234
55-01068	15	B, 15	388905	5036660	300	Aug-64	155	80	140	2	lmsn 0160
55-01355	16	B, 15	388860	5036700	300	Jan-65	148	28	40	7	lmsn shle 0150

WELL RECORD SUMMARY

MOE #	Well No.	Conc., Lot	Easting	Northing	Surface Elev. (ft)	Date Drilled	Water Found (ft)	Static Level (ft)	Pumped Level (ft)	Pump Rate (IGPM)	Owner, Log
55-06996	17	B, 16	388799	5036599	375	Dec-62	162	68	174	10	fill 002, lmsn 0175,
55-10691	18	B, 17				Oct-91	252	6	261	10	sand stns 053, brwn lmsn 089, grey lmsn lyrd 0262
55-03621	19	B, 17	388000	5037500	350	May-74	150	15		0	fill 005, lmsn 0155
55-12419	20	B, 17				Sep-95	71	12	79	7	clay 56, S&G 061, grvl 70, grnt snds 080
55-03292	21	B, 18	387853	5037781	325	Oct-73	72	15	60	6	loam grvl 018, brwn lmsn 073
55-01069	22	B, 18	387840	5037780	335	Apr-59	60	10	10	10	msnd bldr 015, whit lmsn 0061
55-01070	23	B, 18	387825	5037480	365	Aug-60	112	32	50	15	loam 005, grey lmsn 0116
55-01071	24	B, 18	387790	5036050	260	Jul-67	84	6	40	15	fill 002, brwn shle 087
55-02159	25	B, 18	387730	5037880	350	Aug-68	110	30	90	3	grvl 015, shle 0120
55-03029	26	B, 18	387847	5037712	325	Mar-73	165	50	120	10	loam 006, brwn lmsn 0172
55-04969	27	B, 18	387650	5038100	250	Feb-76	96	20	70	5	sand grvl 012, brwn lmsn 0100
55-03046	28	B, 18	387505	5037820	360	May-73	165	70	140	10	loam 007, brwn lmsn 0172
55-09545	29	B, 18				Jul-89	285	50	299	15	grey clay 02, grey lmsn 0190, red lmsn 0202, grey lmsn 0234, whit snds 0244, grey lmsn 0300
55-12653	30	B, 18				May-96	65	4	65	50	fsnd 025, grvl 065
55-06374	31	B, 18	387799	5037799	350	Sep-81	40	60	90	9	sand 011, brwn lmsn 0120
55-03030	32	B, 18	387666	5038167	255	Apr-73	80	14	80	4	grvl sand 0014, brwn lmsn 0090

Notes:

1. UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
2. Date Work Completed
3. Well Contractor Licence Number
4. Casing diameter in inches
5. Unit of Depth in Feet
6. See Table 4 for Meaning of Code
7. STAT LVL: Static Water Level in Feet ; PUMP LVL: Water Level After Pumping in Feet
8. Pump Test Rate in GPM, Pump Test Duration in Hour : Minutes
9. See Table 3 for Meaning of Code
10. Screen Depth and Length in feet
11. See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	...	Code	Description	...	Code	Description	...	Code	Description	...	Code	Description
BLDR	BOULDERS		FCRD	FRACTURED		IRFM	IRON FORMATION		PORS	POROUS		SOFT	SOFT
BSLT	BASALT		FGRD	FINE-GRAINED		LIMY	LIMY		PRDG	PREVIOUSLY DUG		SPST	SOAPSTONE
CGRD	COARSE-GRAINED		FGVL	FINE GRAVEL		LMSN	LIMESTONE		PRDR	PREV. DRILLED		STKY	STICKY
CGVL	COARSE GRAVEL		FILL	FILL		LOAM	TOPSOIL		QRTZ	QUARTZITE		STNS	STONES
CHRT	CHERT		FLDS	FELDSPAR		LOOS	LOOSE		QSND	QUICKSAND		STNY	STONEY
CLAY	CLAY		FLNT	FLINT		LTCL	LIGHT-COLOURED		QTZ	QUARTZ		THIK	THICK
CLN	CLEAN		FOSS	FOSILIFEROUS		LYRD	LAYERED		ROCK	ROCK		THIN	THIN
CLYY	CLAYEY		FSND	FINE SAND		MARL	MARL		SAND	SAND		TILL	TILL
CMTD	CEMENTED		GNIS	GNEISS		MGRD	MEDIUM-GRAINED		SHLE	SHALE		UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE		GRNT	GRANITE		MGVL	MEDIUM GRAVEL		SHLY	SHALY		VERY	VERY
CRYS	CRYSTALLINE		GRSN	GREENSTONE		MRBL	MARBLE		SHRP	SHARP		WBRG	WATER-BEARING
CSND	COARSE SAND		GRVL	GRAVEL		MSND	MEDIUM SAND		SHST	SCHIST		WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED		GRWK	GREYWACKE		MUCK	MUCK		SILT	SILT		WTHD	WEATHERED
DLMT	DOLOMITE		GVLY	GRAVELLY		OBDN	OVERBURDEN		SLTE	SLATE			
DNSE	DENSE		GYPS	GYPSUM		PCKD	PACKED		SLTY	SILTY			
DRTY	DIRTY		HARD	HARD		PEAT	PEAT		SNDS	SANDSTONE			
DRY	DRY		HPAN	HARDPAN		PGVL	PEA GRAVEL		SNDY	SANDY			

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Water Use

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

4. Water Detail

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

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MCNAB TOWNSHIP CON A(016)	18 387430 5035822^{W}	1975/11 4767	06	FR 0130	060 / 110 / 2:0	DO		5503893 () BRWN SHLE 0013 UNKN 0130
MCNAB TOWNSHIP CON A(016)	18 387462 5036252^{L}	1985/04 4875	06 06	FR 0074	034 / 070 010 / 0:30	DO		5507769 () LOAM SHLE 0003 GREY LMSN 0058 BLUE LMSN 0072 GREY LMSN 0083
MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1989/04 4875	06 06	FR 0052 FR 0210	060 / 200 015 / 1:30	DO		5509461 (40980) BRWN SAND STNS 0004 GREY LMSN SHLE 0165 GREY SHLE 0185 GREY SHLE SNDS 0218
MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1988/08 4875	06 06	FR 0041 FR 0070 FR 0208	052 / 215 012 / 1:30	DO		5509178 (29545) BRWN SAND STNS 0001 GREY LMSN SHLE 0133 GREY SHLE SILT SNDS 0184 GREY SHLE SNDS 0218
MCNAB TOWNSHIP CON B(016)	18 388829 5036821^{W}	1982/12 4767	06 06	FR 0140 FR 0162	068 / 174 010 / 1:0	DO		5506996 () BRWN SHLE FILL LOOS 0002 BRWN LMSN SOFT LYRD 0175
MCNAB TOWNSHIP CON B(016)	18 388547 5037004^{W}	2004/02 4879	06	0244 UK 0169	102 / 157 010 / 1:0	DO		5515521 (Z04383) A004288 BRWN SHLE 0002 GREY LMSN LYRD 0244 GREY LMSN LYRD 0295
MCNAB TOWNSHIP CON B(016)	18 388600 5037150^{W}	2004/11 4879	06	0052 0271	121 / 193 015 / 1:0	DO		5515883 (Z20139) A019955 BRWN SAND FILL 0007 BRWN LOAM SHLE 0009 BRWN SHLE 0015 GREY LMSN 0148 GREY LMSN SHLE LYRD 0286
MCNAB TOWNSHIP CON B(017)	18 388303 5037429^{W}	2004/07 4879	06	0065 0161 0223	054 / 127 006 / 1:0	DO		5515704 (Z10623) A010594 BRWN SHLE LOAM FILL 0002 BRWN SHLE LOAM CLAY 0005 BRWN LMSN 0028 GREY LMSN 0167 GREY LMSN SHLE LYRD 0245
MCNAB TOWNSHIP CON B(017)	18 388132 5037403^{W}	2004/06 4879	06	0202 0055 0173	057 / 144 012 / 1:0	DO		5515653 (Z10639) A010588 BRWN SHLE LOAM STNS 0002 BRWN SHLE STNS SAND 0005 GREY LMSN LYRD 0191 GREY LMSN SHLE LYRD 0220
MCNAB TOWNSHIP CON B(017)	18 387441 5037172^{W}	2004/04 4879	06	0244 UK 0074 0160	058 / 158 010 / 1:0	DO		5515578 (Z10625) A004293 BRWN SHLE LOAM 0000 BRWN LMSN 0028 GREY LMSN 0160 GREY LMSN 0260
MCNAB TOWNSHIP CON B(017)	18 388153 5037669^{W}	2005/02 4879	06 05		/ / :0	DO	0056 05	5515953 (Z20169) A018270
MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1995/09 4879	06 06	UK 0071	012 / 079 007 / 1:0	DO		5512449 (165298) BRWN CLAY DNSE 0017 GREY CLAY SOFT 0058 GREY SAND GRVL 0061 GREY GRVL 0070 GREY SAND GRNT QRTZ 0073 GREY GRNT 0080
MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1991/10 4879	06 06	FR 0252	006 / 261 010 / 1:0	DO		5510691 (108251) BRWN SAND STNS 0004 GREY SAND STNS BLDR 0053 BRWN LMSN 0089 GREY LMSN LYRD 0262
MCNAB TOWNSHIP CON B(017)	18 388153 5037669^{W}	2004/09 4879	06	0175 0155	073 / 129 005 / 1:0	DO		5515835 (Z18433) A018270 BRWN SAND SHLE 0001 GREY LMSN 0155 GREY LMSN SHLE LYRD 0220

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MCNAB TOWNSHIP CON B(017)	18 387764 5037586^{W}	2006/03 4879	06	0133 0089 0125	032 / 088 010 / 1:0	DO		5516356 (Z40244) A040271 BRWN SAND STNS 0004 BRWN LMSN LMSN 0013 GREY LMSN 0038 GREY LMSN SHLE 0145
MCNAB TOWNSHIP CON B(017)	18 388177 5037588^{W}	2004/09 4879	06	0051 0176 0226	046 / 155 010 / 1:0	DO		5515788 (Z18430) A010619 BRWN SAND SHLE 0003 BRWN LMSN FCRD 0008 GREY LMSN LYRD LMSN 0165 GREY LMSN SHLE LYRD 0245
MCNAB TOWNSHIP CON B(017)	18 388030 5037722^{W}	1974/05 3323	06	FR 0150	015 / / 0:30	DO		5503621 () BRWN FILL 0005 GREY LMSN 0155
MCNAB TOWNSHIP B(017)		1989/08 2307	06 06	FR 0199	030 / 150 007 / 1:0	DO		5509660 (68901) BRWN SAND LOAM CMTD 0060 GREY LMSN HARD 0205

Well Computer Print Out Data as of October 15 2009

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MCNAB TOWNSHIP CON 11(015)	18 386917 5034820^{L}	1996/09 3323	06	FR 0088	008 / 092 020 / 1:0	DO		5512761 (153095) GREY CLAY 0045 GREY SHLE LMSN 0092
MCNAB TOWNSHIP CON 11(016)	18 386750 5035992^{W}	1965/04 4306	06 06	FR 0065	020 / 040 007 / 1:0	 DO		5501323 () SHLE 0065
MCNAB TOWNSHIP CON 11(016)	18 386990 5035522^{W}	1967/07 4806	06 06	FR 0112	003 / 010 010 / 1:0	ST DO		5501324 () BLUE CLAY 0094 GREY LMSN 0113
MCNAB TOWNSHIP CON 11(016)	18 386660 5035442^{W}	1950/09 1802	04 04	FR 0090	010 / 020 015 / 2:0	DO		5501322 () CLAY 0067 LMSN 0100
MCNAB TOWNSHIP CON 11(016)	18 386508 5035298^{L}	1996/11 4879	06 06	UK 0037	008 / 044 010 / 1:0	DO		5512794 (174948) BRWN CLAY DNSE 0012 GREY LMSN FCRD 0013 GREY LMSN LYRD LMSN 0037 GREY LMSN LYRD SHLE 0045
MCNAB TOWNSHIP CON 11(016)	18 386505 5035300^{L}	2003/10 4879	06 06	FR 0237	032 / 043 030 / 1:0	DO		5515486 (255355) BRWN SAND ROCK FILL 0004 BRWN LMSN FCRD 0008 BRWN LMSN 0043 GREY LMSN 0172 GREY LMSN SNDS 0238
MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1990/04 4879	06 06	FR 0080 FR 0095	014 / 099 005 / 1:0	DO		5509932 (69285) GREY LMSN 0100
MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1988/03 4875	06 06	FR 0062 FR 0089	035 / 090 007 / 1:0	DO		5508968 (21039) GREY LMSN SHLE 0098
MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1991/08 4879	06 06	FR 0080 FR 0060	039 / 069 014 / 1:0	DO AC		5510607 (108218) BRWN SHLE SNDY 0002 BRWN LMSN SHLE FCRD 0005 GREY LMSN 0089
MCNAB TOWNSHIP CON 11(017)	18 386229 5035921^{W}	1976/11 3323	06	FR 0080	010 / 010 010 / 1:0	DO		5504878 () BRWN SAND 0005 GREY LMSN 0085
MCNAB TOWNSHIP CON 11(017)	18 386220 5036172^{W}	1961/09 4306	05 05	FR 0050	012 / 100 001 / 1:0	DO ST		5501325 () MSND 0019 GREY LMSN 0100
MCNAB TOWNSHIP CON 11(017)	18 386230 5036022^{W}	1979/07 4006	06	FR 0160	085 / 160 005 / 2:0	DO		5505710 () GREY LMSN SHLY MGRD 0160 WHIT FLDS MGRD 0161 GREY LMSN SHLY MGRD 0165
MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1987/03 4875	06 06	FR 0088	027 / 045 012 / 1:30	DO		5508549 () GREY LMSN SHLE 0097
MCNAB TOWNSHIP CON 11(018)	18 386127 5036316^{W}	2002/07 4879	06 06	UK 0115 UK 0133	042 / 194 005 / 1:0	DO		5514810 (240550) BRWN SAND SHLE 0002 BRWN LMSN SHLE FCRD 0008 BRWN LMSN FCRD 0015 BRWN LMSN 0075 GREY LMSN 0195
MCNAB TOWNSHIP CON 11(018)	18 385829 5036421^{W}	1981/10 4767	06	FR 0140	020 / 120 010 / 1:0	DO		5506639 () BRWN LOAM 0006 BRWN LMSN 0148
MCNAB TOWNSHIP CON 11(018)	18 385830 5036322^{W}	1979/07 3323	06	FR 0190	040 / 150 015 / 1:0	 DO		5505811 () BRWN SAND 0001 WHIT LMSN 0197

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
MCNAB TOWNSHIP CON 11(018)	18 385830 5036422^{W}	1978/06 4767	06	FR 0175 FR 0220	030 / 200 005 / 1:0	DO		5505031 () BRWN LOAM 0001 BRWN LMSN 0225
MCNAB TOWNSHIP CON 12(016)	18 387280 5035772^{W}	1975/05 4767	06 06	FR 0102	010 / 065 008 / 2:0	DO		5503679 () BRWN LOAM SHLE 0003 BRWN LMSN 0110
MCNAB TOWNSHIP CON 12(018)	18 386913 5037054^{W}	2002/09 4879	06 06	SU 0116 SU 0143	042 / 149 025 / 1:0	DO		5514935 (240516) BRWN SHLE LOAM 0001 BRWN LMSN 0047 GREY LMSN 0150
MCNAB TOWNSHIP CON 12(018)	18 386875 5037055^{W}	2002/08 4879	06 06	UK 0120 UK 0235	038 / 244 015 / 1:0	DO		5514936 (240539) BRWN SAND SHLE 0002 BRWN LMSN 0072 GREY LMSN 0245
MCNAB TOWNSHIP CON 13()	18 387901 5037451^{W}	2005/05 4879	06	0162 FR 0084	012 / 045 008 / 1:0	DO		5516091 (Z20166) A019965 GREY LMSN LYRD 0170
MCNAB TOWNSHIP CON A(015)	18 387890 5035462^{W}	1963/08 4806	06 06	FR 0120 FR 0196	063 / 140 010 / 1:0	DO		5501008 () SHLE 0010 GREY LMSN 0200
MCNAB TOWNSHIP CON A(015)	18 387525 5035603^{W}	1973/02 4767	06 06	FR 0101	050 / 070 006 / 1:0	DO		5502998 () BRWN LOAM 0001 BRWN LMSN 0105
MCNAB TOWNSHIP CON A(015)	18 387884 5035804^{L}	1992/03 4879	06 06	FR 0195 FR 0239	098 / 244 005 / 1:0	DO		5510795 (108271) GREY CLAY FILL 0001 GREY SHLE LOAM 0003 GREY LMSN 0195 GREY LMSN SNDS LYRD 0245
MCNAB TOWNSHIP CON A(015)	18 387980 5035422^{W}	1977/05 3323	06	FR 0080	015 / 060 010 / 1:0	DO		5504898 () SAND GRVL LOOS 0010 GREY LMSN SOFT 0085
MCNAB TOWNSHIP CON A(016)	18 387462 5036252^{L}	1985/04 4875	06 06	FR 0074	034 / 070 010 / 0:30	DO		5507769 () LOAM SHLE 0003 GREY LMSN 0058 BLUE LMSN 0072 GREY LMSN 0083
MCNAB TOWNSHIP CON A(016)	18 387480 5035822^{W}	1975/11 4767	06	FR 0130	060 / 110 / 2:0	DO		5503893 () BRWN SHLE 0013 UNKN 0130
MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1989/04 4875	06 06	FR 0052 FR 0210	060 / 200 015 / 1:30	DO		5509461 (40980) BRWN SAND STNS 0004 GREY LMSN SHLE 0165 GREY SHLE 0185 GREY SHLE SNDS 0218
MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1988/08 4875	06 06	FR 0041 FR 0070 FR 0208	052 / 215 012 / 1:30	DO		5509178 (29545) BRWN SAND STNS 0001 GREY LMSN SHLE 0133 GREY SHLE SILT SNDS 0184 GREY SHLE SNDS 0218
MCNAB TOWNSHIP CON A(018)	18 387110 5037702^{W}	1960/08 4806	05 05	FR 0090	010 / 070 006 / 1:0	PS		5501009 () MSND 0005 GREY LMSN 0100
MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1995/09 4879	06 06	UK 0071	012 / 079 007 / 1:0	DO		5512449 (165298) BRWN CLAY DNSE 0017 GREY CLAY SOFT 0058 GREY SAND GRVL 0061 GREY GRVL 0070 GREY SAND GRNT QRTZ 0073 GREY GRNT 0080

TOWNSHIP CONCESSION (LOT)	UTM^{1}	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^{7} RATE^{8}/TIME HR:MIN	WATER USE^{9}	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
MCNAB TOWNSHIP CON B(017)	18 387764 5037586^{W}	2006/03 4879	06	0138 0089 0125	032 / 088 010 / 1:0	DO		5516356 (Z40244) A040271 BRWN SAND STNS 0004 BRWN LMSN LMSN 0013 GREY LMSN 0038 GREY LMSN SHLE 0145
MCNAB TOWNSHIP CON B(017)	18 387441 5037172^{W}	2004/04 4879	06	0244 UK 0074 0160	058 / 158 010 / 1:0	DO		5515578 (Z10625) A004293 BRWN SHLE LOAM 0000 BRWN LMSN 0028 GREY LMSN 0160 GREY LMSN 0260
MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1991/10 4879	06 06	FR 0252	006 / 261 010 / 1:0	DO		5510691 (108251) BRWN SAND STNS 0004 GREY SAND STNS BLDR 0053 BRWN LMSN 0089 GREY LMSN LYRD 0262
MCNAB TOWNSHIP CON B(018)	18 387511 5037900^{L}	2000/09 4879	06 06	FR 0074 FR 0205 FR 0262	070 / 269 006 / 1:0	DO		5514103 (218384) BRWN SAND 0011 BRWN LMSN 0055 GREY LMSN 0189 GREY LMSN LYRD SHLE 0270
MCNAB TOWNSHIP CON B(018)	18 387855 5037702^{W}	1960/08 4806	05 05	SU 0095 SU 0112 SU 0071	032 / 050 015 / 1:0	IR		5501070 () LOAM STNS 0005 GREY LMSN 0116
MCNAB TOWNSHIP CON B(018)	18 387877 5037934^{W}	1973/03 4767	06 06	FR 0120 FR 0165 FR 0080	050 / 120 010 / 1:0	DO		5503029 () BRWN LOAM 0006 BRWN LMSN 0172
MCNAB TOWNSHIP CON B(018)	18 387514 5037899^{L}	1989/07 4879	06 06	FR 0225 FR 0285	050 / 299 015 / 1:0	DO		5509545 (45157) GREY CLAY 0002 GREY LMSN 0190 RED LMSN 0202 GREY LMSN 0234 WHIT SNDS 0244 GREY LMSN 0300
MCNAB TOWNSHIP CON B(018)	18 387514 5037899^{L}	1996/05 3323	06	FR 0065	004 / 065 050 / 1:0	DO		5512653 (153063) BRWN FSND 0025 BRWN CGVL 0065
MCNAB TOWNSHIP CON B(025)	18 387966 5037545^{W}	2005/10 4879	06	0143 0207	096 / 120 010 / 1:0	DO		5516300 (Z29343) A027340 BRWN SAND GRVL 0004 BRWN LMSN 0028 GREY LMSN 0189 GREY LMSN SHLE 0220
MCNAB TOWNSHIP CON (027)	18 387840 5037401^{W}	2007/03 4879	06	0096 0140	017 / 104 012 / 1:0	DO		7046285 (Z44861) A054545 BRWN CLAY 0006 GREY LMSN LYRD SNDS 0170
MCNAB TOWNSHIP 10(015)	18 386270 5034459^{W}	2006/01 4879	05 06	0086 0094	010 / 021 010 / 1:0	DO		5516343 (Z40219) A027306 BRWN SAND 0003 BRWN CLAY 0018 GREY CLAY 0025 BRWN LMSN 0040 GREY LMSN 0052 GREY LMSN 0053 GREY LMSN 0058 GREY LMSN CLAY 0058 GREY LMSN LYRD 0104
MCNAB TOWNSHIP 12(015)	18 387854 5035530^{W}	2006/05 4879	06	0054 0282 0160	131 / 012 / 1:0	DO		5516384 (Z40227) A05036+ BRWN SAND STNS SHLE 0003 BRWN SHLE 0005 BRWN LMSN 0028 GREY LMSN 0160 GREY LMSN SHLE 0295
MCNAB TOWNSHIP (035)	18 387561 5037612^{W}	2008/11 4879	06 06	0060 0149 0198	019 / 067 010 / 1:0	DO		7117142 (Z87354) A073844 BRWN SAND STNS CLAY 0005 GREY LMSN 0187 GREY LMSN 0220

TOWNSHIP CONCESSION (LOT)	UTM¹	DATE ² CNTR ³	CASING DIA ⁴	WATER⁵,⁶ DETAIL	STAT LVL/PUMP LVL⁷ RATE⁸/TIME HR:MIN	WATER USE⁹	SCREEN INFO¹⁰	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND⁵,¹¹
MCNAB TOWNSHIP ()	18 387757 5036979ᵂ	2007/05 4879	06	0042	024 / 076 002 / :58	NU		7045848 (Z55058) A054433 BRWN SHLE 0002 BRWN LMSN 0080
MCNAB TOWNSHIP ()	18 386848 5036125ᵂ	2007/05 4879	06	0046 0077	017 / 024 005 / 6:0	NU		7045849 (Z55056) A054429 BRWN LMSN 0080
MCNAB TOWNSHIP ()	18 386845 5036122ᵂ	2007/05 4879	06	0023	009 / 040 001 / 1:40	NU		7045850 (Z55057) A054430 BRWN LMSN 0040
MCNAB TOWNSHIP ()	18 386569 5036502ᵂ	2007/05 4879	06	0069	008 / 048 001 / 4:57	NU		7045851 (Z55054) A054436 BRWN CLAY DNSE 0016 GREY CLAY 0019 BRWN LMSN 0080
MCNAB TOWNSHIP ()	18 386982 5036840ᵂ	2007/05 4879	06		005 / 078 003 / :43	NU		7045871 (Z55050) A054438 BRWN LMSN 0080
MCNAB TOWNSHIP ()	18 387504 5037238ᵂ	2007/05 4879	06	0068	015 / 080 / :40	NU		7045853 (Z55051) A054432 BRWN SHLE 0001 BRWN LMSN 0080
MCNAB TOWNSHIP ()	18 386985 5036832ᵂ	2007/05 4879	06		002 / 040 001 / 1:0	NU		7045856 (Z55052) A054439 BRWN LMSN 0040
MCNAB TOWNSHIP ()	18 387490 5037241ᵂ	2007/05 4879	06		019 / 040 / :40	NU		7045858 (Z55053) A054431 BRWN SHLE 0001 BRWN LMSN 0040
MCNAB TOWNSHIP ()	18 386571 5036496ᵂ	2007/05 4879	06		011 / 038 / :30	NU		7045852 (Z55055) A054437 BRWN CLAY DNSE 0016 GREY CLAY SOFT 0019 BRWN LMSN 0040
BRAESIDE VILLAGE A (016)	18 387020 5036818ᵂ	2009/02 7423	04 01					7125075 (Z099061) A077798 GREY DLMT FCRD 0018 GREY DLMT 0040
BRAESIDE VILLAGE A (016)	18 387502 5035926ᵂ	2009/02 7423	04 01					7125072 (Z099058) A073995 GREY DLMT FCRD 0035 GREY CLAY DNSE 0102
BRAESIDE VILLAGE A (016)	18 387912 5036596ᵂ	2009/02 7423	04 01					7125073 (Z099059) A077796 GREY DLMT FCRD 0041 GREY CLAY DNSE 0043 GREY DLMT 0051
BRAESIDE VILLAGE A (016)	18 387398 5036815ᵂ	2009/02 7423	04 01					7125074 (Z099060) A077797 GREY DLMT FCRD 0049 GREY CLAY DNSE 0049 GREY DLMT 0095
BRAESIDE VILLAGE A (016)	18 386814 5036404ᵂ	2009/02 7423	04 01					7125076 (Z099062) A077799 GREY DLMT FCRD 0021 GREY CLAY DNSE 0022 GREY DLMT 0035
BRAESIDE VILLAGE (MC (028)	18 387809 5037518ᵂ	2007/07 4879	06	0059 0211 0238	093 / 102 011 / 1:0	DO		7047324 (Z55048) A054559 BRWN SAND FILL 0002 BLCK 0003 BRWN LMSN LYRD 0014 GREY LMSN LYRD SHLE 0245

Appendix G
Well Test Data and Analysis (TW 1 – 8)

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

AQUIFER TEST DATA

PROJ. NO: 02180
WELL NO: TW 1
TEST NO: 1

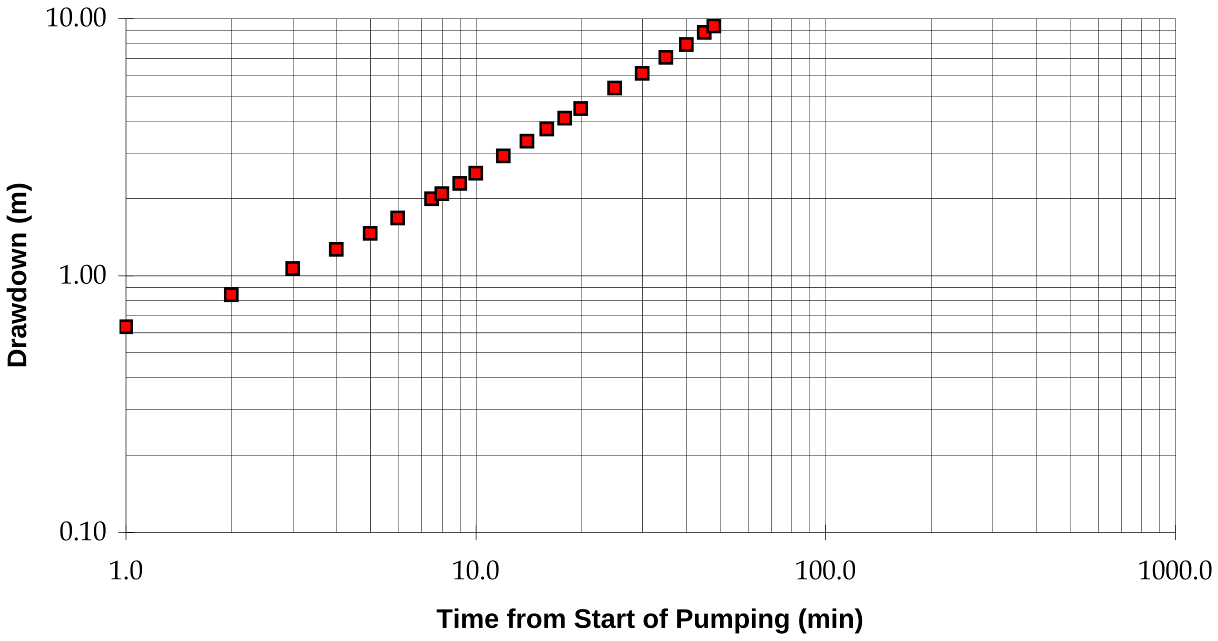
Date: 30-Jul-02
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.32
Well Depth: 19.3

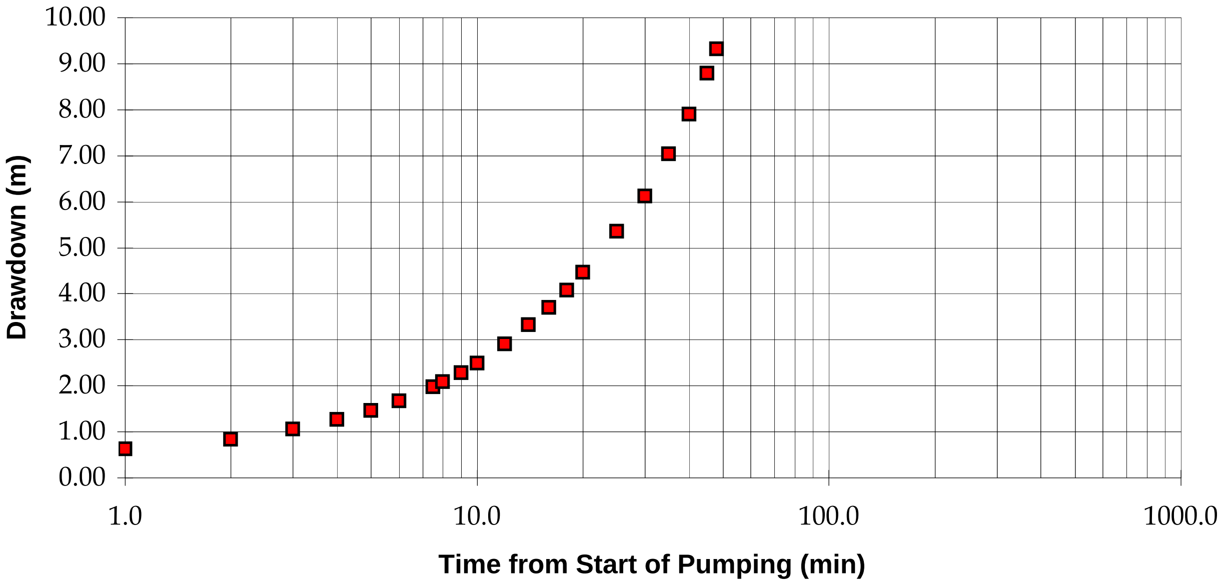
Depth of Intake: 17.70 m
Pump on: 10:20
Pump off: 11:08
Duration: 0:48 hours:min
Pump Rate: 3.8 L/min
Recovery Time: N/A hours:min

TIME			WATER LEVEL DATA					
t= 48 at t'=0			SWL= 7.74 m					
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
1.0	8.37	0.63	49.0	1.0	16.62	49.00	8.88	no cascading evident
2.0	8.58	0.84	50.0	2.0	16.58	25.00	8.84	
3.0	8.80	1.06	51.0	3.0	16.56	17.00	8.82	
4.0	9.00	1.26	52.0	4.0	16.55	13.00	8.81	
5.0	9.20	1.46	53.0	5.0	16.54	10.60	8.80	
6.0	9.41	1.67	54.0	6.0	16.53	9.00	8.79	
7.5	9.72	1.98	55.0	7.0	16.52	7.86	8.78	
8.0	9.82	2.08	56.0	8.0	16.51	7.00	8.77	
9.0	10.02	2.28	57.0	9.0	16.50	6.33	8.76	
10.0	10.23	2.49	58.0	10.0	16.50	5.80	8.76	
12.0	10.65	2.91	60.0	12.0	16.48	5.00	8.74	
14.0	11.07	3.33	62.0	14.0	16.47	4.43	8.73	
16.0	11.44	3.70	64.0	16.0	16.46	4.00	8.72	
18.0	11.82	4.08	66.0	18.0	16.45	3.67	8.71	
20.0	12.20	4.46	68.0	20.0	16.43	3.40	8.69	
25.0	13.10	5.36	288.0	240.0	15.27	1.20	7.53	
30.0	13.86	6.12						Water was milky for
35.0	14.78	7.04						duration of pumping
40.0	15.64	7.90						
45.0	16.53	8.79						Soft silty sediment and
48.0	17.06	9.32						cuttings in base of well
								prior to pumping
					19.2	% recovery		
					80.62	% of total available drawdown		

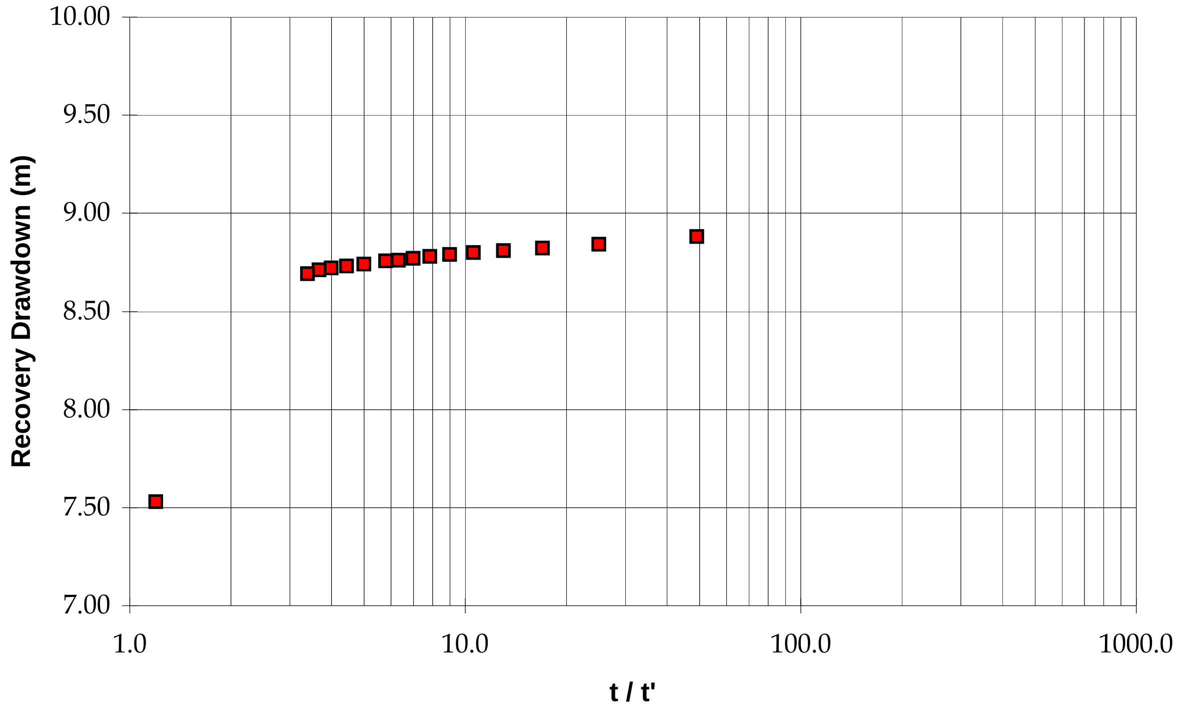
Theis Analysis, TW 1



Jacob Analysis, TW 1



Theis Recovery Analysis, TW 1



Analysis of Aquifer Test Data

TW 1

$Q = 5.47\ m^3/day$

Jacob Analysis

$\Delta s = 13\ m$

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 5.47}{4\pi\ * 13.0} = 0.08\ m^2/day$$

Theis Recovery Analysis

$\Delta s = 9.4\ m$

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 5.47}{4\pi\ * 9.4} = 0.11\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 02180
WELL NO: TW 2
TEST NO: 1

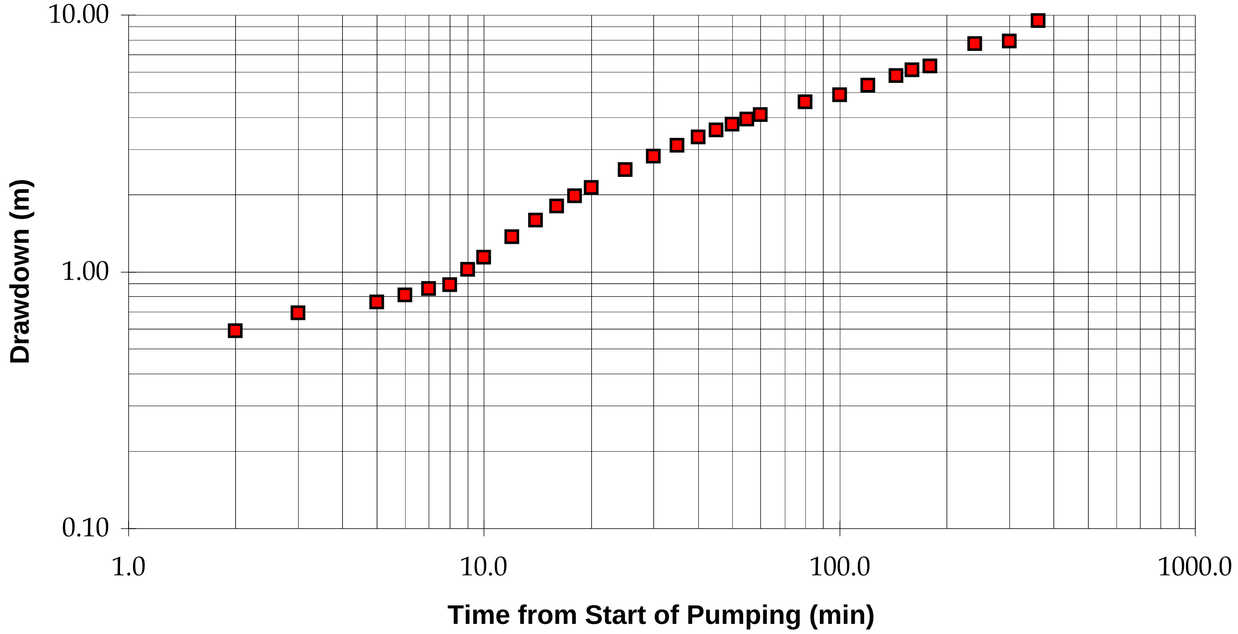
Date: 29-Jul-02
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.4
Well Depth: 19.8

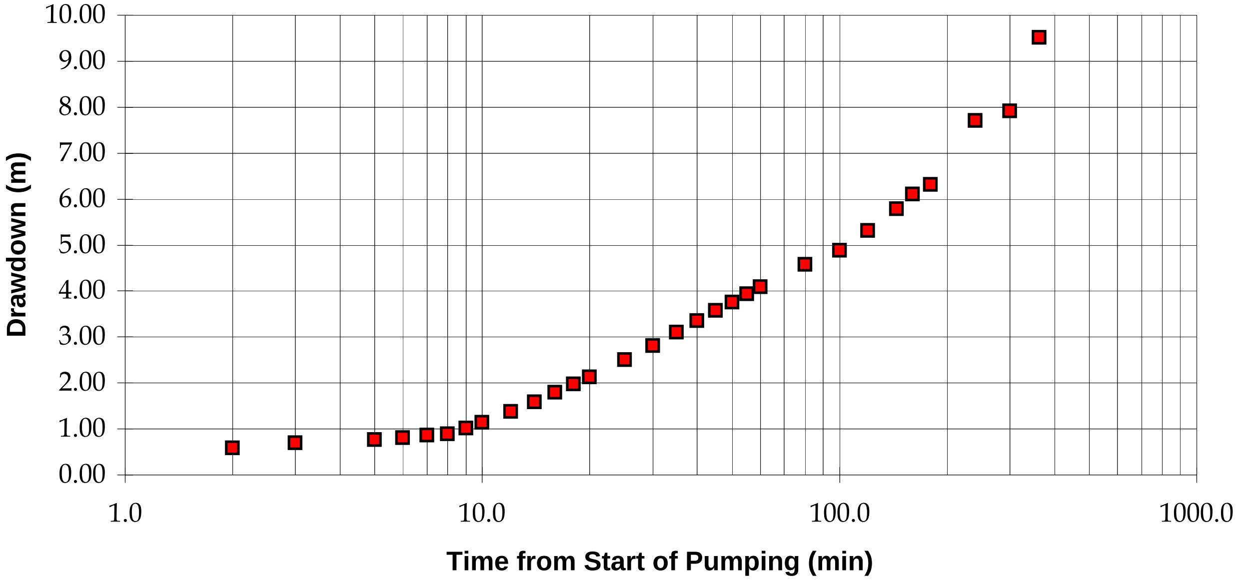
Depth of Intake: 18.50 m
Pump on: 11:20
Pump off: 17:22
Duration: 6:02 hours:min
Pump Rate: 2.85 L/min
Recovery Time: N/A hours:min

	TIME		WATER LEVEL DATA					
t=	362	at t'=0	SWL=	7.86	m			
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
1.0	8.30	0.44	363.0	1.0	16.75	363.00	8.89	
2.0	8.45	0.59	364.0	2.0	16.62	182.00	8.76	
3.0	8.55	0.69	365.0	3.0	16.51	121.67	8.65	
4.0	8.58	0.72	366.0	4.0	16.40	91.50	8.54	
5.0	8.62	0.76	367.0	5.0	16.28	73.40	8.42	
6.0	8.67	0.81	368.0	6.0	16.17	61.33	8.31	
7.0	8.72	0.86	369.0	7.0	16.05	52.71	8.19	
8.0	8.75	0.89	370.0	8.0	15.94	46.25	8.08	
9.0	8.88	1.02	371.0	9.0	15.82	41.22	7.96	
10.0	9.00	1.14	372.0	10.0	15.71	37.20	7.85	
12.0	9.23	1.37	374.0	12.0	15.50	31.17	7.64	
14.0	9.45	1.59	376.0	14.0	15.28	26.86	7.42	light cascading from 15.4
16.0	9.66	1.80	378.0	16.0	15.06	23.63	7.20	
18.0	9.83	1.97	380.0	18.0	14.90	21.11	7.04	
20.0	9.99	2.13	382.0	20.0	14.50	19.10	6.64	
25.0	10.36	2.50	387.0	25.0	13.88	15.48	6.02	
30.0	10.67	2.81	392.0	30.0	13.67	13.07	5.81	
35.0	10.96	3.10	397.0	35.0	13.20	11.34	5.34	
40.0	11.21	3.35	402.0	40.0	12.75	10.05	4.89	
45.0	11.43	3.57	407.0	45.0	12.39	9.04	4.53	
50.0	11.62	3.76	412.0	50.0	12.04	8.24	4.18	
55.0	11.79	3.93	417.0	55.0	11.71	7.58	3.85	
60.0	11.95	4.09	422.0	60.0	11.34	7.03	3.48	
80.0	12.44	4.58	443.0	81.0	10.63	5.47	2.77	
100.0	12.74	4.88	462.0	100.0	10.19	4.62	2.33	
120.0	13.17	5.31	482.0	120.0	9.89	4.02	2.03	
144.5	13.65	5.79						
160.0	13.96	6.10						discharge constricted with
180.0	14.17	6.31						sediment around 240 min,
240.0	15.57	7.71			78.7	% recovery		PR dropped significantly
300.0	15.77	7.91			79.65	% of total available		
362.0	17.37	9.51				drawdown		Sampled at 355 min

Theis Analysis, TW 2

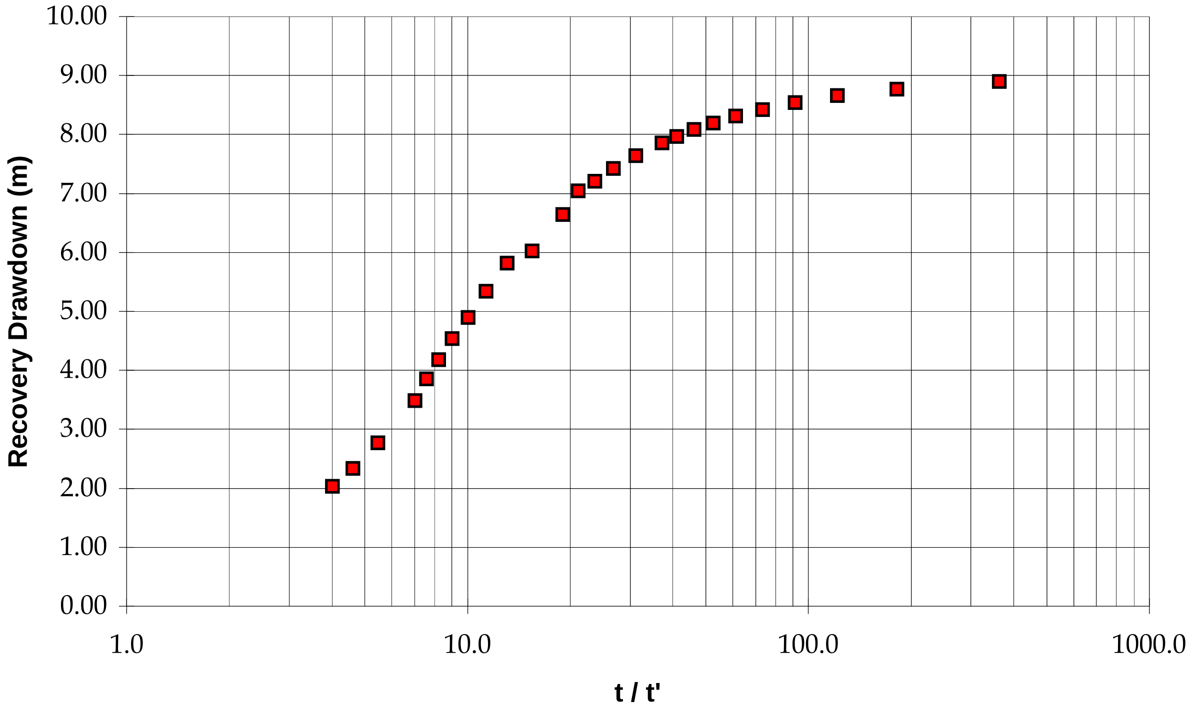


Jacob Analysis, TW 2



Gorrell Resource Investigations

Theis Recovery Analysis, TW 2



Gorrell Resource Investigations

Analysis of Aquifer Test Data

TW 2

Q = 4.10m^3/day

Jacob Analysis

$\Delta s =$ 4.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 4.10}{4\pi * 4.5} = 0.17\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 8m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 4.10}{4\pi * 8} = 0.09\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 3-1
TEST NO: 2

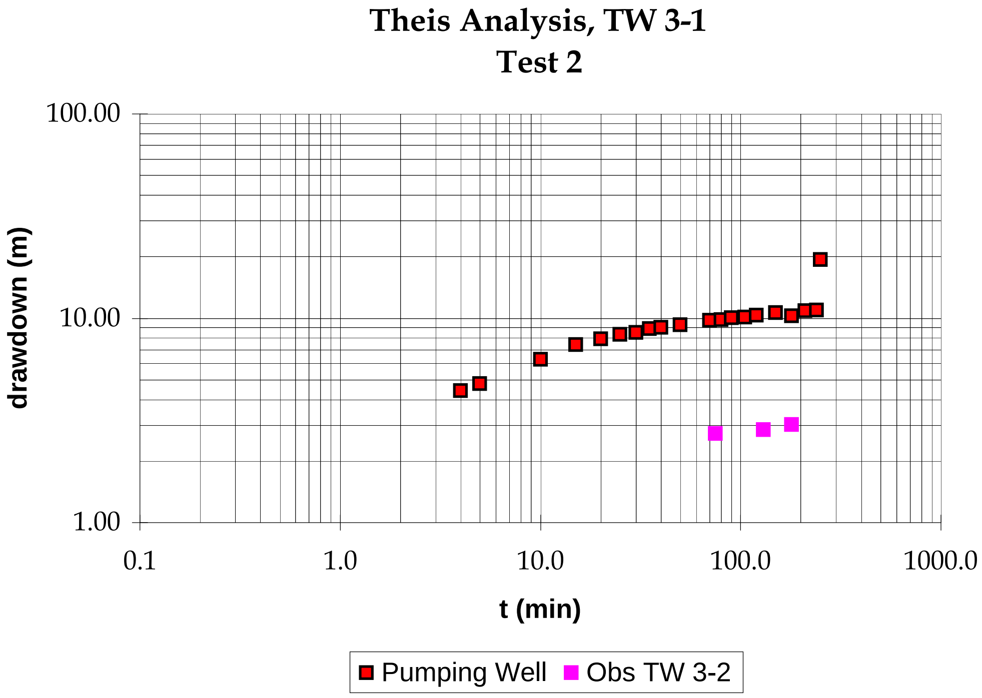
Date: 01-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

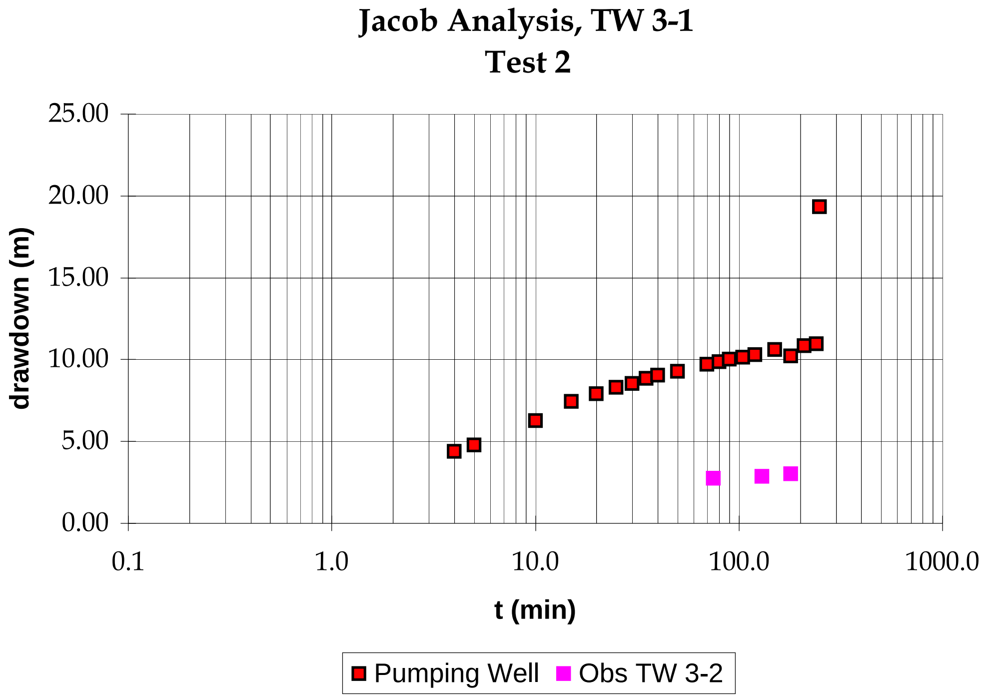
How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.5
Well Depth: 25

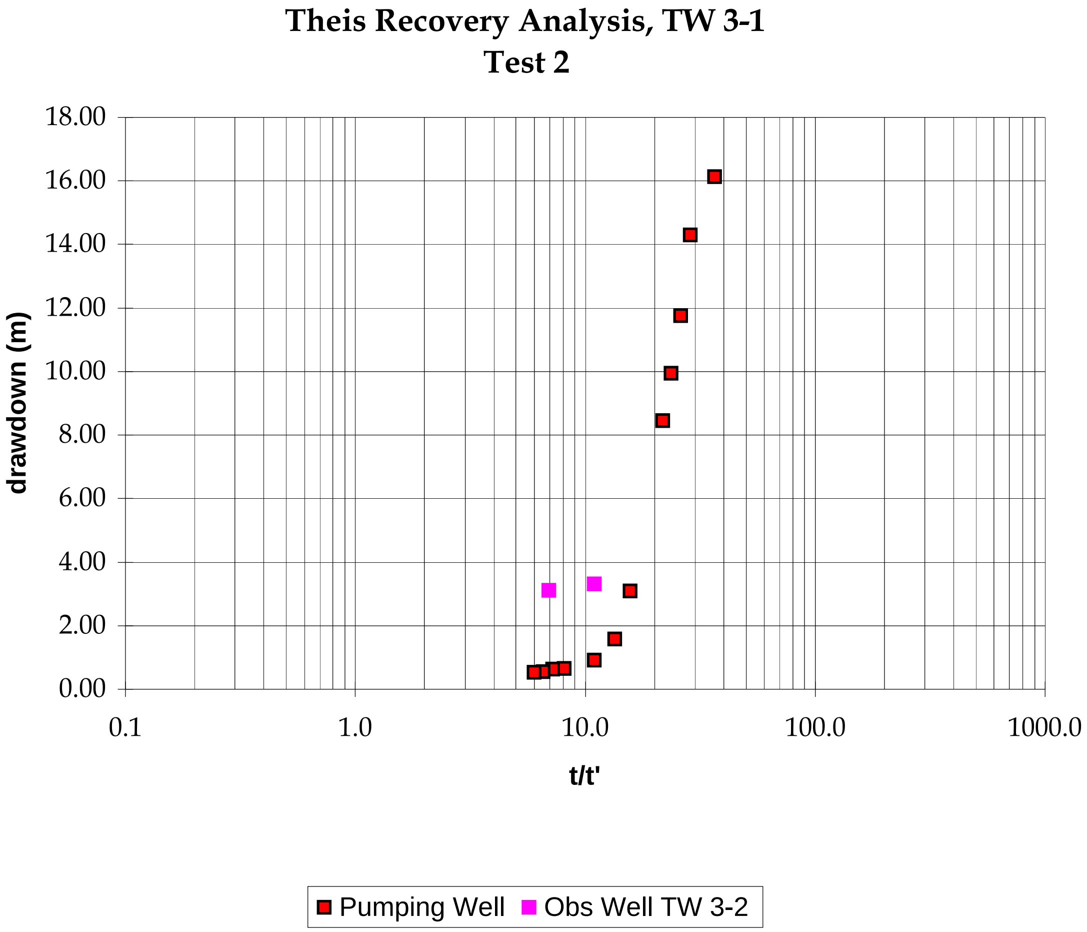
Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 4:10 hours:min
Pump Rate: 49.5 L/min
Recovery Time: hours:min

	TIME		WATER LEVEL DATA					
t=	250	at t'=0	SWL=	5.45 m				
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 3-2 = 2.47 m
4.0	9.85	4.40	257.0	7.0	21.57	36.71	16.12	T - 8.8 oC, D.O. = 5.37 mg/L
5.0	10.23	4.78	259.0	9.0	19.75	28.78	14.30	
10.0	11.71	6.26	260.0	10.0	17.20	26.00	11.75	
15.0	12.89	7.44	261.0	11.0	15.38	23.73	9.93	
20.0	13.37	7.92	262.0	12.0	13.89	21.83	8.44	
25.0	13.75	8.30	267.0	17.0	8.53	15.71	3.08	
30.0	13.97	8.52	270.0	20.0	7.02	13.50	1.57	
35.0	14.31	8.86	275.0	25.0	6.35	11.00	0.90	
40.0	14.49	9.04	285.0	35.0	6.09	8.14	0.64	
50.0	14.71	9.26	290.0	40.0	6.07	7.25	0.62	
70.0	15.17	9.72	295.0	45.0	5.99	6.56	0.54	
80.0	15.30	9.85	300.0	50.0	5.97	6.00	0.52	
90.0	15.46	10.01						
105.0	15.58	10.13						
120.0	15.75	10.30						
150.0	16.07	10.62						
180.0	15.67	10.22						
210.0	16.29	10.84						
240.0	16.41	10.96						Q up to 20 IGPM
250.0	24.77	19.32						cascading at +/- 24 m

97.3 **% recovery**
98.82 **% of total available drawdown**


Theis Analysis, TW 3-1
Test 2
100.00
10.00
1.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 3-2


Jacob Analysis, TW 3-1
Test 2
25.00
20.00
15.00
10.00
5.00
0.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 3-2



Theis Recovery Analysis, TW 3-1
Test 2

AQUIFER TEST DATA
Installed piezometers

Project No. 05460
Test No. 2
Location TW 3-1

Date: 01/05/2007
Recovery time: 50 min
Type of Data: Pumping and Recovery

Surface Elevation
Distance from well

Piezometer No. TW 3-1
Elevation Meas. Point
Static Water Level 2.47
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
75	2.73	0.26						
130	2.85	0.38						
180	3.01	0.54						
275	3.31	0.84						
292	3.1	0.63						

Analysis of Aquifer Test Data

TW 3-1

Q = 71.28 m^3/day

Jacob Analysis

$\Delta s =$ 11 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 71.28}{4\pi * 11.0} = 1.03\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 43.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 71.28}{4\pi * 43.5} = 0.29\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 3-2
TEST NO: 1

Date: 27-Apr-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 12.5

Depth of Intake: 12.40 m
Pump on:
Pump off:
Duration: 1:40 hours:min
Pump Rate: 3.6 L/min
Recovery Time: 2:00 hours:min

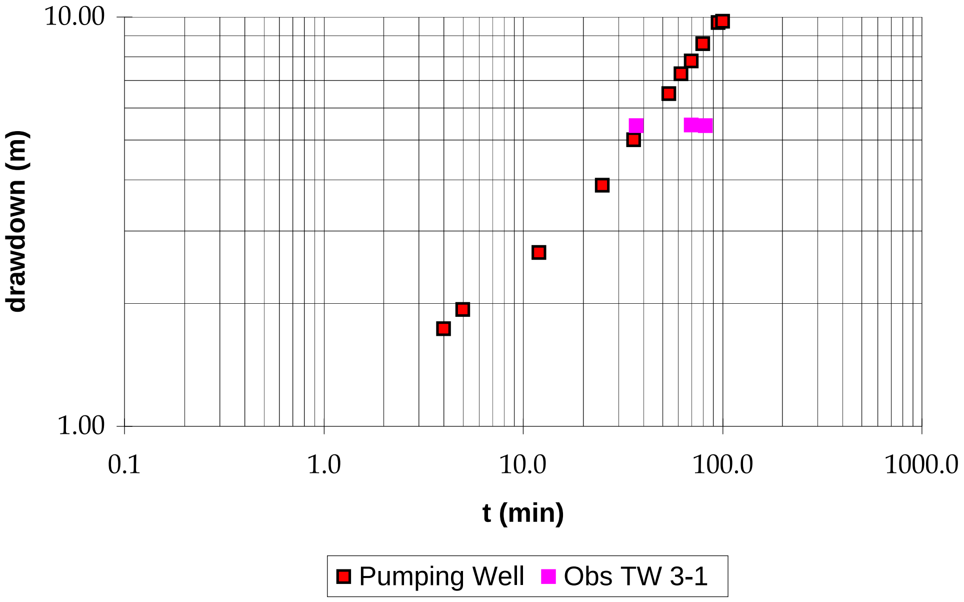
TIME
t= 100 **at t'=0**

WATER LEVEL DATA
SWL= 2.67 **m**

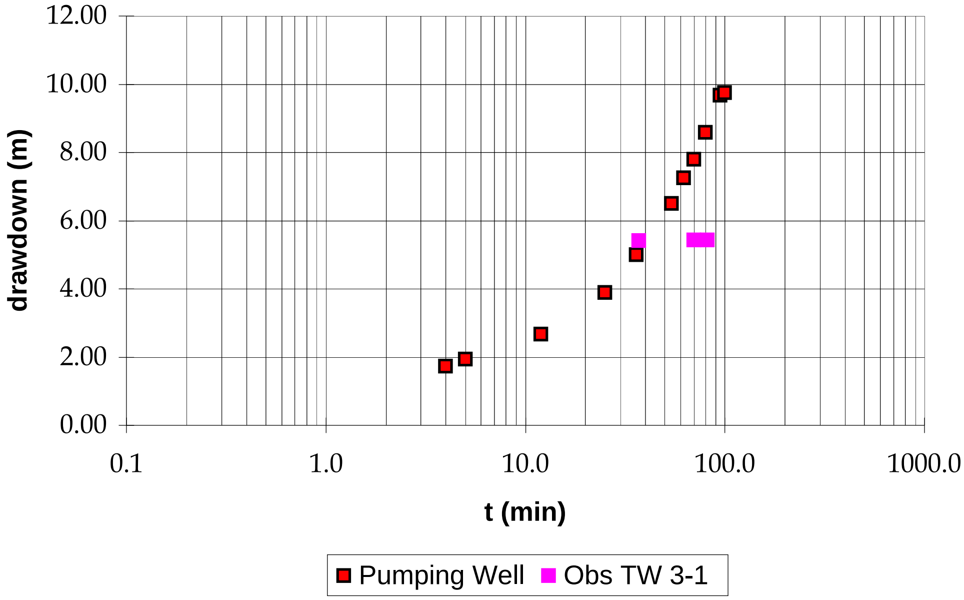
Pumping			Recovery					COMMENTS
t	**Reading**	**Drawdown**	**t**	**t'**	**Reading**	**t/t'**	**Drawdown**	**SWL 3-1 = 5.39 m**
4.0	4.40	1.73	102.0	2.0	11.72	51.00	9.05	
5.0	4.60	1.93	105.0	5.0	11.65	21.00	8.98	
12.0	5.33	2.66	110.0	10.0	11.42	11.00	8.75	
25.0	6.55	3.88	115.0	15.0	11.18	7.67	8.51	
36.0	7.67	5.00	122.0	22.0	10.89	5.55	8.22	
54.0	9.17	6.50	130.0	30.0	10.61	4.33	7.94	
62.0	9.92	7.25	160.0	60.0	9.82	2.67	7.15	
70.0	10.47	7.80	200.0	100.0	8.77	2.00	6.10	
80.0	11.26	8.59	220.0	120.0	8.37	1.83	5.70	
95.0	12.34	9.67						
100.0	12.42	9.75						

41.5 **% recovery**
99.19 **% of total available drawdown**

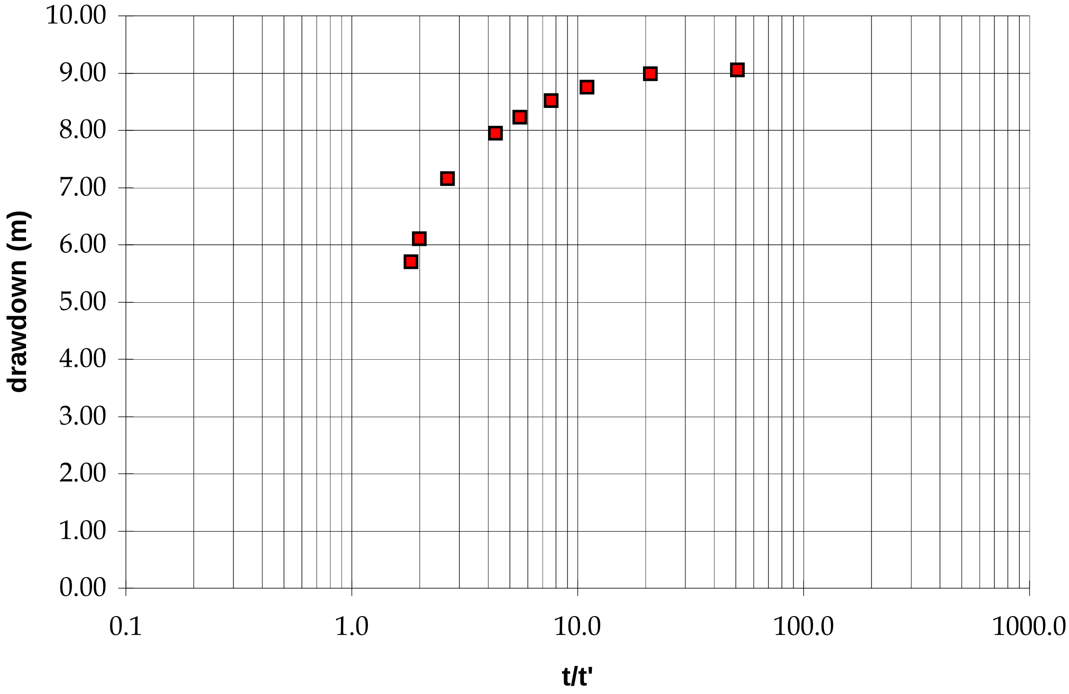
Theis Analysis, TW 3-2
Test 1



Jacob Analysis, TW 3-2
Test 1



Theis Recovery Analysis, TW 3-2
Test 1



AQUIFER TEST DATA
Installed piezometers

Project No. 05460 **Date:** 27/04/2007
Test No. 1 **Recovery time:** 2:00
Location **Type of Data:** Pumping and Recovery

Surface Elevation
Distance from well

Piezometer No. TW 3-2
Elevation Meas. Point 0.5
Static Water Level 5.39
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
37	5.41	0.02						
70	5.43	0.04						
82	5.42	0.03						

Analysis of Aquifer Test Data

TW 3-2

Q = 5.18 m^3/day

Jacob Analysis

$\Delta s =$ 10.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 5.18}{4\pi * 10.5} = 0.09\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 9 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 5.18}{4\pi * 9} = 0.11\ m^2/day$$

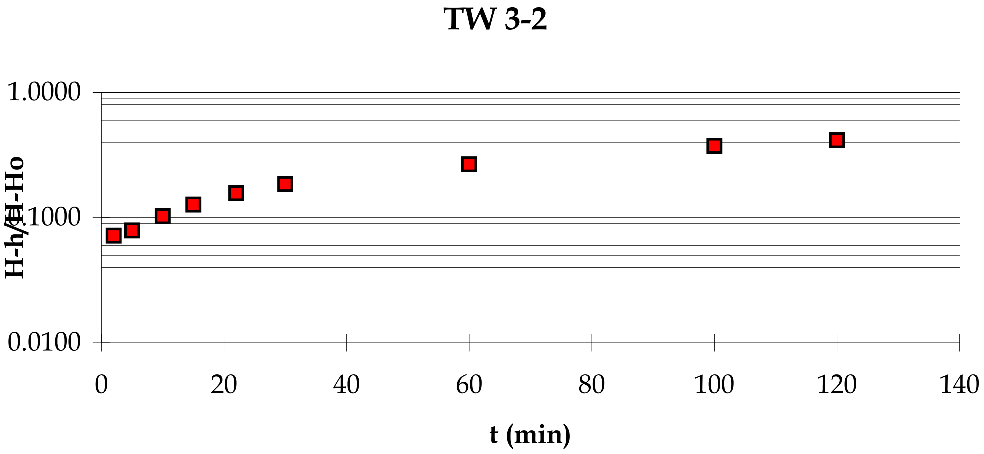
Hydraulic Conductivity Test Data and Analysis

Job:		**Date:**	27-Apr-07
Test Hole No:	TW 3-2		

H:	**12.42**	**H - Ho:**	9.75
Ho:	**2.67**	**To:**	9.71E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
2	11.720		11.72	0.70	0.0718
5	11.650		11.65	0.77	0.0790
10	11.420		11.42	1.00	0.1026
15	11.180		11.18	1.24	0.1272
22	10.890		10.89	1.53	0.1569
30	10.610		10.61	1.81	0.1856
60	9.820		9.82	2.60	0.2667
100	8.770		8.77	3.65	0.3744
120	8.370		8.37	4.05	0.4154

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
6.10	0.08	5.87E-04	9.71E+01	1.01E-07



Gorrell Resource
Investigations

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 4-1
TEST NO: 2

Date: 24-Apr-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

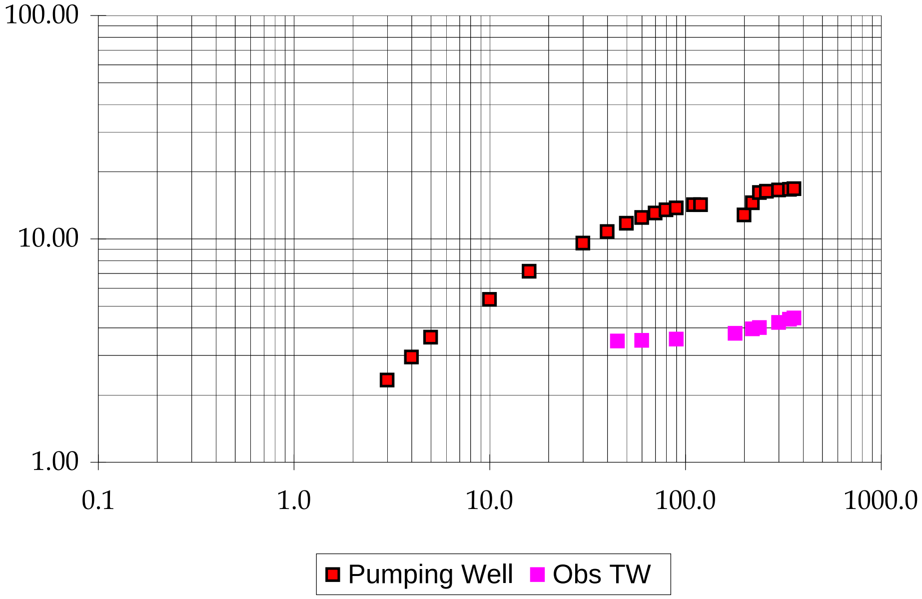
How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.63
Well Depth: 25

Depth of Intake: 24.00 m
Pump on: 8:20
Pump off: 13:00
Duration: 2:10 hours:min
Pump Rate: 16.65 L/min
Recovery Time: 1:40 hours:min

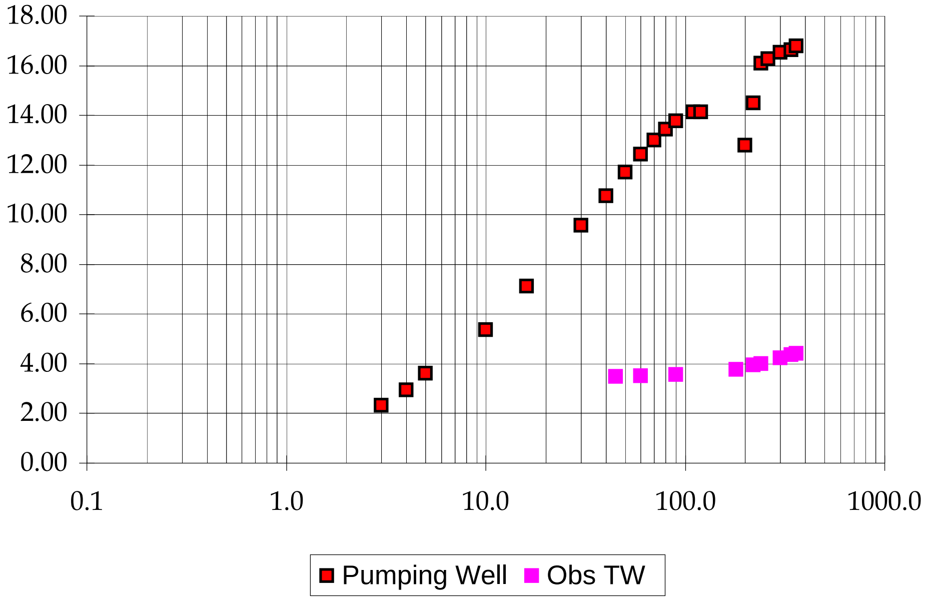
TIME t= 360 at t'=0
WATER LEVEL DATA SWL= 3.35 m

Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 4-2 = 3.16 m
1.0			361.0	1.0	17.82	361.00	14.47	
2.0			362.0	2.0	15.87	181.00	12.52	
3.0	5.67	2.32	367.0	7.0	13.56	52.43	10.21	
4.0	6.30	2.95	374.0	14.0	11.87	26.71	8.52	
5.0	6.96	3.61	380.0	20.0	10.97	19.00	7.62	
10.0	8.71	5.36	385.0	25.0	9.91	15.40	6.56	
16.0	10.47	7.12	390.0	30.0	9.05	13.00	5.70	
30.0	12.91	9.56	395.0	35.0	7.38	11.29	4.03	
40.0	14.11	10.76	410.0	50.0	6.55	8.20	3.20	
50.0	15.05	11.70	420.0	60.0	5.94	7.00	2.59	
60.0	15.78	12.43	430.0	70.0	5.64	6.14	2.29	
70.0	16.36	13.01	440.0	80.0	5.29	5.50	1.94	Q checked
80.0	16.79	13.44	450.0	90.0	4.99	5.00	1.64	
90.0	17.11	13.76	460.0	100.0	4.32	4.60	0.97	
110.0	17.49	14.14	611.0	251.0	3.61	2.43	0.26	
120.0	17.49	14.14						
180.0	16.15	12.80						
200.0	17.83	14.48						
220.0	19.44	16.09						
240.0	19.62	16.27						
260.0	19.87	16.52						
300.0	19.98	16.63						
340.0	20.13	16.78						
360.0	20.14	16.79						

98.5 **% recovery**
77.55 **% of total available drawdown**

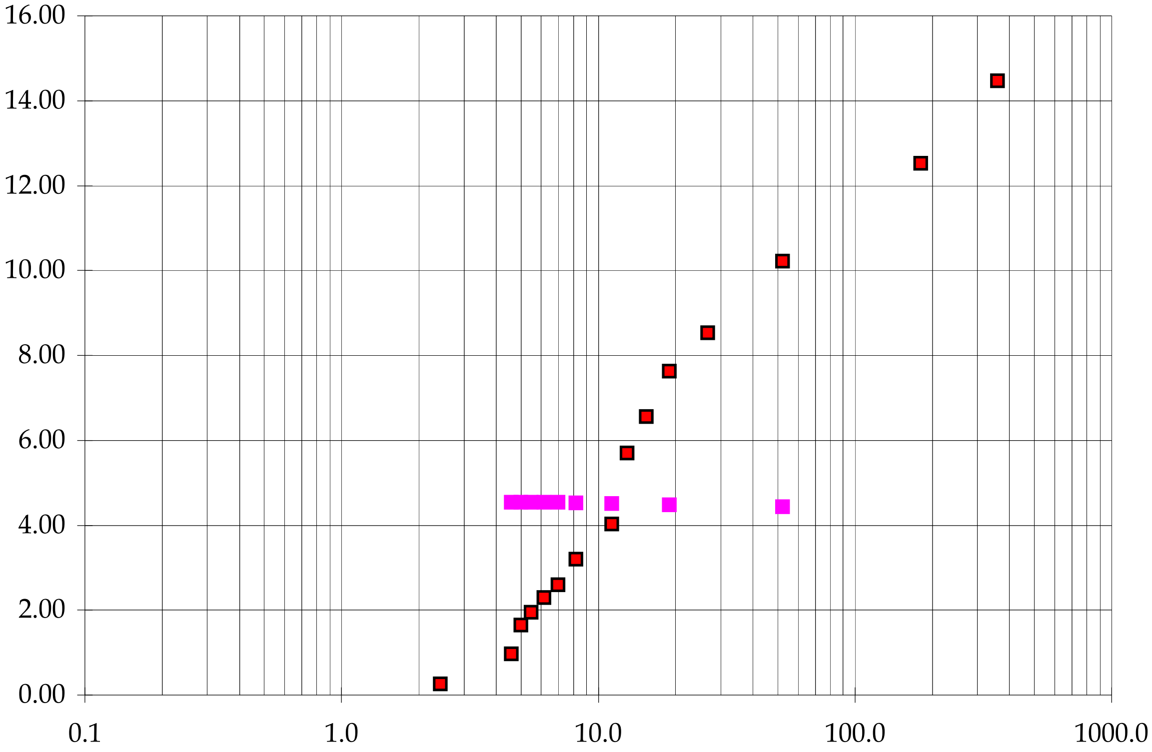


Theis Analysis, TW 4-1
Test 2



Jacob Analysis, TW 4-1,
Test 2

Theis Recovery Analysis, TW 4-1, Test 2



AQUIFER TEST DATA
Installed piezometers

Project No. **05460**
Test No. **TW 4-1**
Location **1**

Date: **23/04/2007**
Recovery time: **2:57**
Type of Data: **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No. **TW 4-2**
Elevation Meas. Point
Static Water Level 3.47
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**
45	3.47	0.00						
60	3.51	0.04						
90	3.55	0.08						
180	3.77	0.30						
220	3.95	0.48						
240	4.00	0.53						
300	4.22	0.75						
340	4.35	0.88						
360	4.41	0.94						
367	4.43	0.96						
380	4.47	1.00						
395	4.50	1.03						
410	4.52	1.05						
420	4.53	1.06						
430	4.54	1.07						
440	4.54	1.07						
450	4.54	1.07						
460	4.54	1.07						

Analysis of Aquifer Test Data

TW 4-1

Q = 23.98 m^3/day

Jacob Analysis

Δs = 17 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 23.98}{4\pi * 17.0} = 0.26\ m^2/\text{day}$$

Theis Recovery Analysis

Δs = 11.0 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 23.98}{4\pi * 11} = 0.40\ m^2/\text{day}$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 4-2
TEST NO: 1

Date: 25-Apr-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.58
Well Depth: 12.5

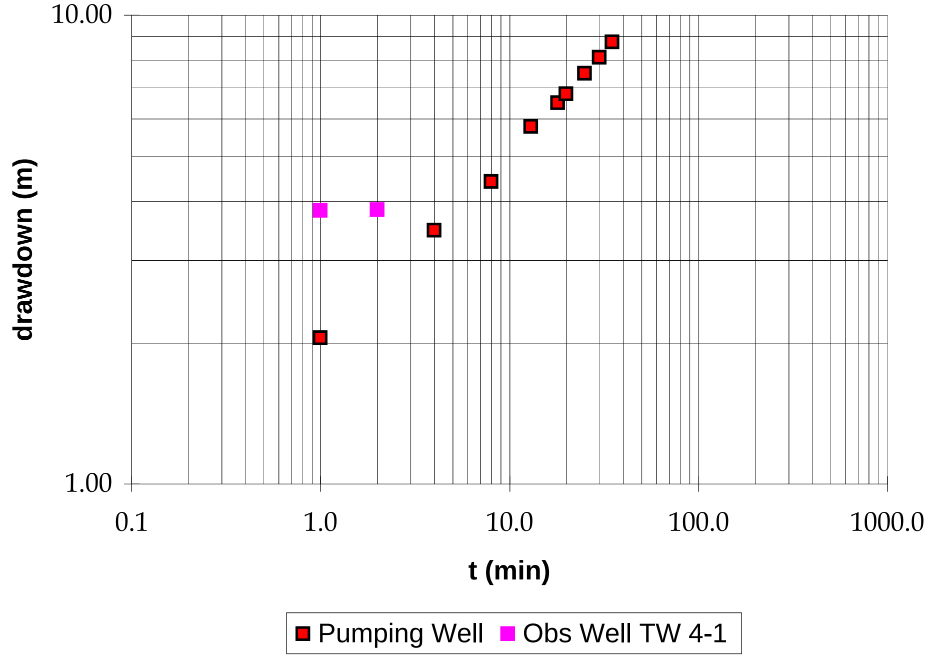
Depth of Intake: 12.18 m
Pump on:
Pump off:
Duration: 0:35 hours:min
Pump Rate: 2.03 L/min
Recovery Time: 2:40 hours:min

TIME t= 35 at t'=0

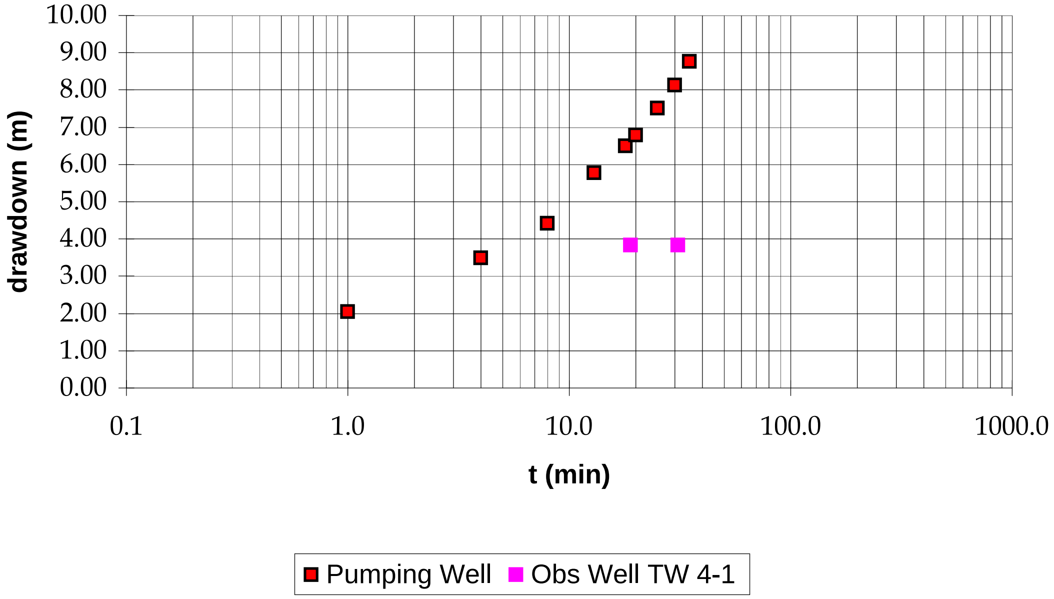
WATER LEVEL DATA SWL= 3.42 m

Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 4-1 = 3.77 m
1.0	5.47	2.05	38.0	3.0	11.27	12.67	7.85	
4.0	6.90	3.48	40.0	5.0	11.25	8.00	7.83	
8.0	7.83	4.41	55.0	20.0	11.12	2.75	7.70	
13.0	9.20	5.78	65.0	30.0	11.03	2.17	7.61	
18.0	9.92	6.50	75.0	40.0	10.98	1.88	7.56	
20.0	10.21	6.79	85.0	50.0	10.89	1.70	7.47	
25.0	10.93	7.51	95.0	60.0	10.80	1.58	7.38	
30.0	11.54	8.12	120.0	85.0	10.65	1.41	7.23	
35.0	12.18	8.76	135.0	100.0	10.54	1.35	7.12	
			155.0	120.0	10.43	1.29	7.01	
			185.0	150.0	10.22	1.23	6.80	
			195.0	160.0	10.15	1.22	6.73	

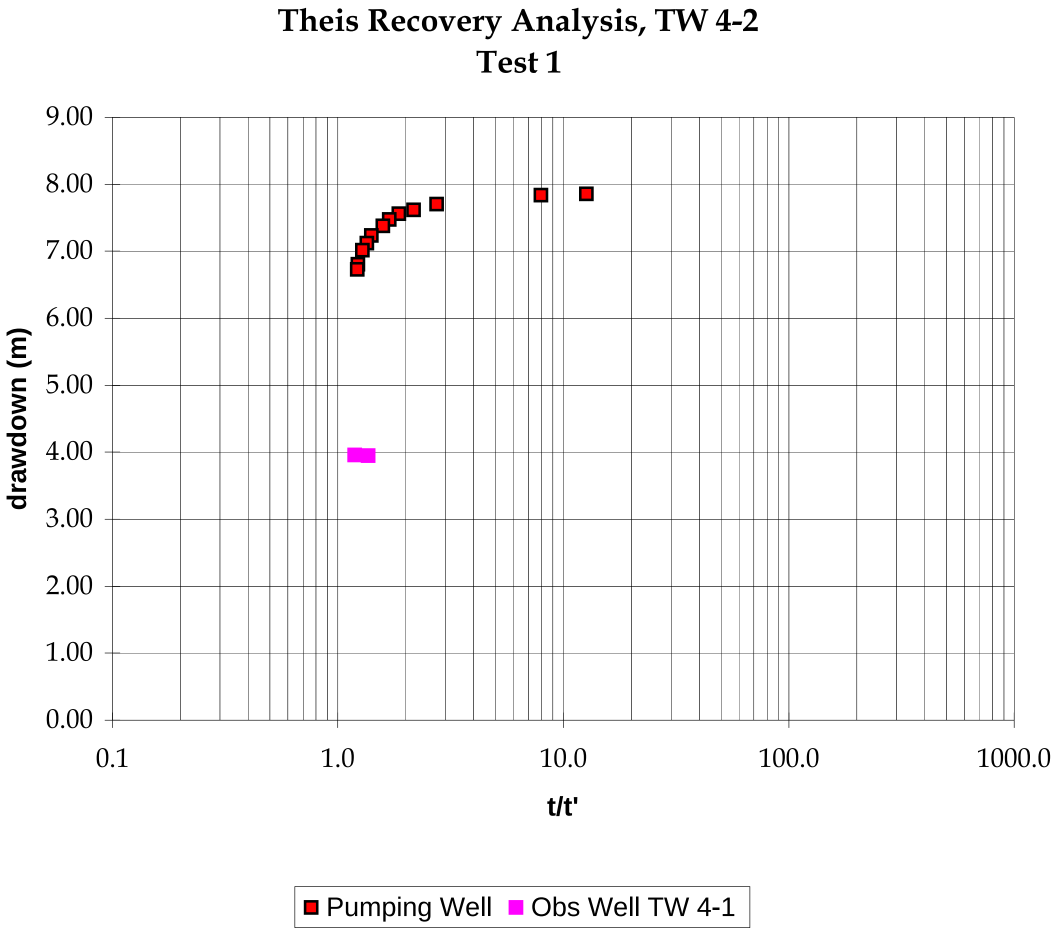
23.2 **% recovery**
96.48 **% of total available drawdown**



Theis Analysis, TW 4-2
Test 1



Jacob Analysis, TW 4-2
Test 1



Theis Recovery Analysis, TW 4-2
Test 1
drawdown (m)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.1
1.0
10.0
100.0
1000.0
t/t'
Pumping Well
Obs Well TW 4-1

AQUIFER TEST DATA
Installed piezometers

Project No. **05460** **Date:** **23/04/2007**
Test No. **TW 4-2** **Recovery time:** **2:57**
Location **1** **Type of Data:** **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No. **TW 4-1**
Elevation Meas. Point
Static Water Level 3.77
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**
19	3.83	0.06						
31	3.84	0.07						
95	3.95	0.18						
185	3.96	0.19						

Analysis of Aquifer Test Data

TW 4-2

Q = 2.92 m^3/day

Jacob Analysis

Δs = 7 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 2.92}{4\pi * 7.0} = 0.08\ m^2/day$$

Theis Recovery Analysis

Δs = 4.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 2.92}{4\pi * 3.3} = 0.12\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 5-1
TEST NO: 2

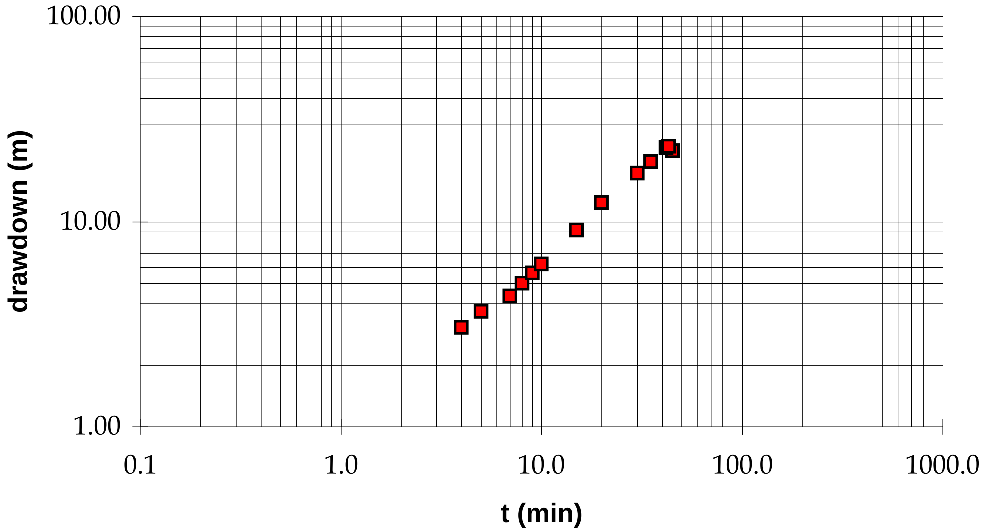
Date: 09-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25.0

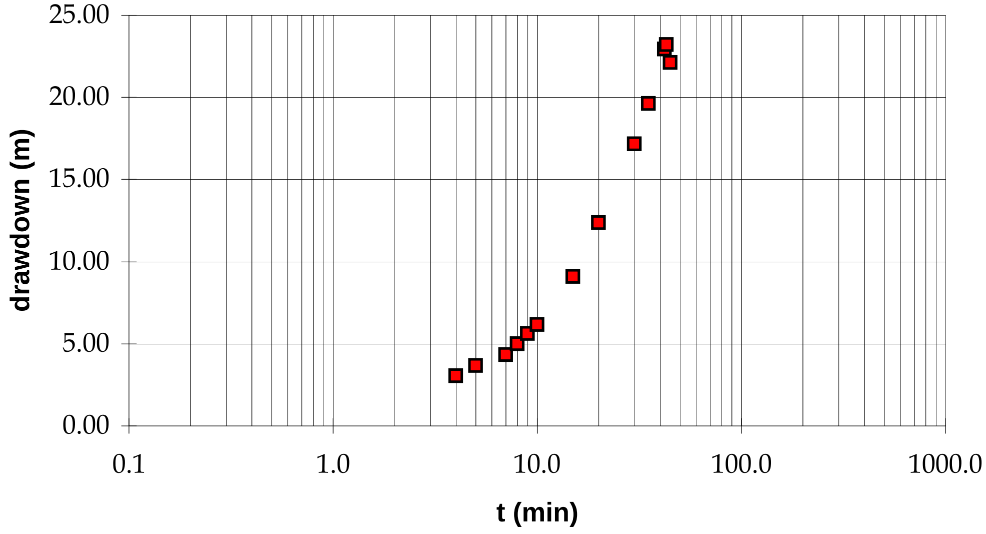
Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 0:43 hours:min
Pump Rate: 12.38 L/min
Recovery Time: 3:17 hours:min

TIME			WATER LEVEL DATA					
t=	43	at t'=0	SWL=	1.43 m				
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 5-2 = 0.62 m
4.0	4.47	3.04	45.0	2.0	23.64	22.50	22.21	
5.0	5.08	3.65	50.0	7.0	23.55	7.14	22.12	
7.0	5.77	4.34	53.0	10.0	23.55	5.30	22.12	
8.0	6.42	4.99	58.0	15.0	23.55	3.87	22.12	
9.0	7.04	5.61	63.0	20.0	23.52	3.15	22.09	
10.0	7.61	6.18	68.0	25.0	23.51	2.72	22.08	
15.0	10.51	9.08	73.0	30.0	23.51	2.43	22.08	
20.0	13.78	12.35	177.0	134.0	23.38	1.32	21.95	
30.0	18.58	17.15	240.0	197.0	23.32	1.22	21.89	
35.0	21.04	19.61						
45.0	23.54	22.11						
42.0	24.38	22.95						
43.0	24.64	23.21						
					5.7	% recovery		
					98.47	% of total available		

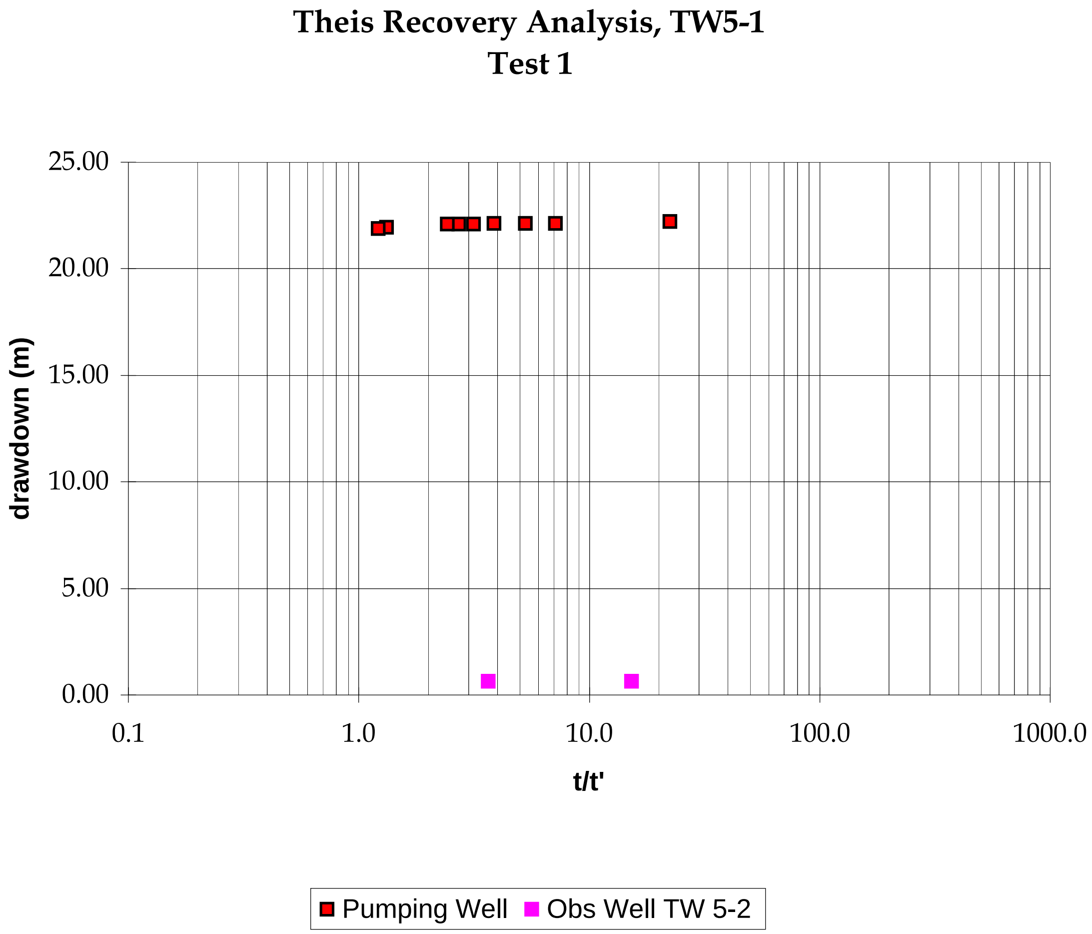
drawdown



Theis Analysis, TW 5-1
Test 1



Jacob Analysis, TW5-1
Test 1


Theis Recovery Analysis, TW5-1
Test 1
drawdown (m)
25.00
20.00
15.00
10.00
5.00
0.00
0.1
1.0
10.0
100.0
1000.0
t/t'
Pumping Well
Obs Well TW 5-2

AQUIFER TEST DATA
Installed piezometers

Project No. **05460**
Test No. **TW 5-1**
Location

Date: **09/05/2007**
Recovery time: **3:17**
Type of Data: **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No.	**TW 5-2**							
Elevation Meas. Point								
Static Water Level	0.62							
Depth of Intake (sur.)								
Depth of Intake (m.a.s.l.)								
t	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**
46	0.63	0.01						
73	0.63	0.01						

Analysis of Aquifer Test Data

TW 5-1

Q = 17.86 m^3/day

Jacob Analysis

Δs = 29 m

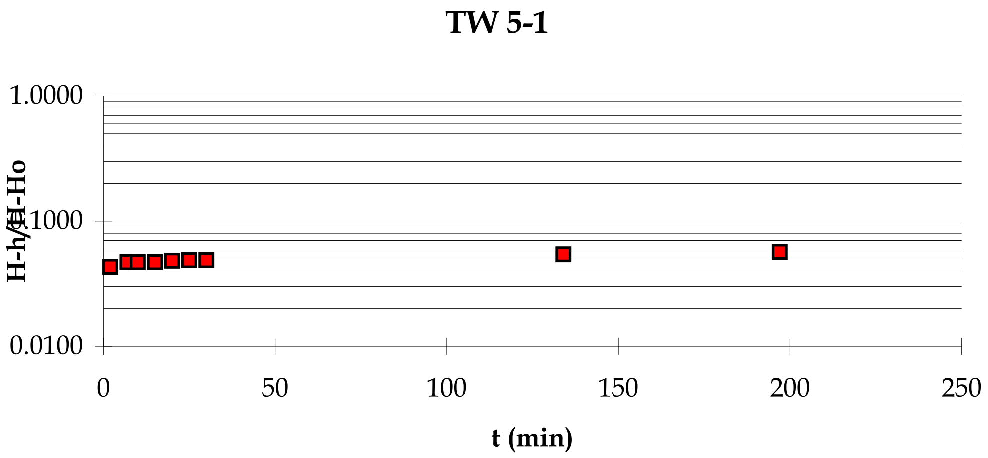
$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 17.86}{4\pi * 29} = 0.11\ m^2/day$$

Hydraulic Conductivity Test Data and Analysis

Job:		**Date:**	09-May-07
Test Hole No:	TW 5-1		
H:	**24.64**	**H - Ho:**	23.21
Ho:	**1.43**	**To:**	8.02E+40

t	Reading	Correction	h	H - h	H - h/H - Ho
2	23.640		23.64	1.00	0.0431
7	23.550		23.55	1.09	0.0470
10	23.550		23.55	1.09	0.0470
15	23.550		23.55	1.09	0.0470
20	23.520		23.52	1.12	0.0483
25	23.510		23.51	1.13	0.0487
30	23.510		23.51	1.13	0.0487
134	23.380		23.38	1.26	0.0543
197	23.320		23.32	1.32	0.0569

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
18.30	0.08	2.38E-04	8.02E+40	4.95E-47



Gorrell Resource
Investigations

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 5-2
TEST NO: 1

Date: 08-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 0:55 hours:min
Pump Rate: 4.5 L/min
Recovery Time: 2:00 hours:min

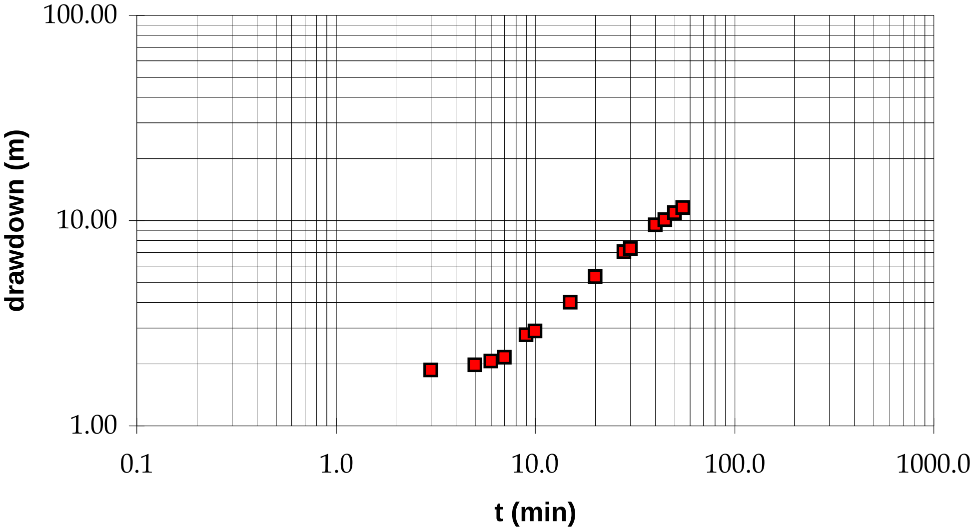
TIME t= 55 at t'=0

WATER LEVEL DATA SWL= 0.62 m

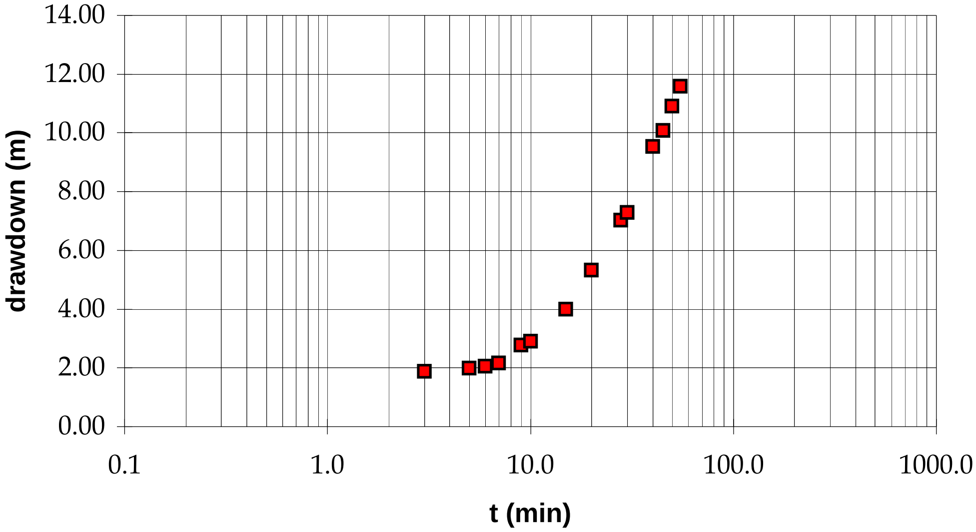
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
3.0	2.49	1.87	56.0	1.0	11.45	56.00	10.83	
5.0	2.60	1.98	58.0	3.0	11.29	19.33	10.67	
6.0	2.68	2.06	60.0	5.0	11.23	12.00	10.61	
7.0	2.77	2.15	65.0	10.0	11.14	6.50	10.52	
9.0	3.38	2.76	70.0	15.0	11.05	4.67	10.43	
10.0	3.51	2.89	85.0	30.0	10.80	2.83	10.18	
15.0	4.61	3.99	90.0	35.0	10.74	2.57	10.12	
20.0	5.93	5.31	95.0	40.0	10.66	2.38	10.04	
28.0	7.65	7.03	100.0	45.0	10.59	2.22	9.97	
30.0	7.90	7.28	105.0	50.0	10.52	2.10	9.90	
40.0	10.15	9.53	110.0	55.0	10.45	2.00	9.83	
45.0	10.70	10.08	120.0	65.0	10.31	1.85	9.69	
50.0	11.53	10.91	145.0	90.0	9.94	1.61	9.32	
55.0	12.19	11.57	175.0	120.0	9.61	1.46	8.99	

22.3 **% recovery**
47.46 **% of total available drawdown**

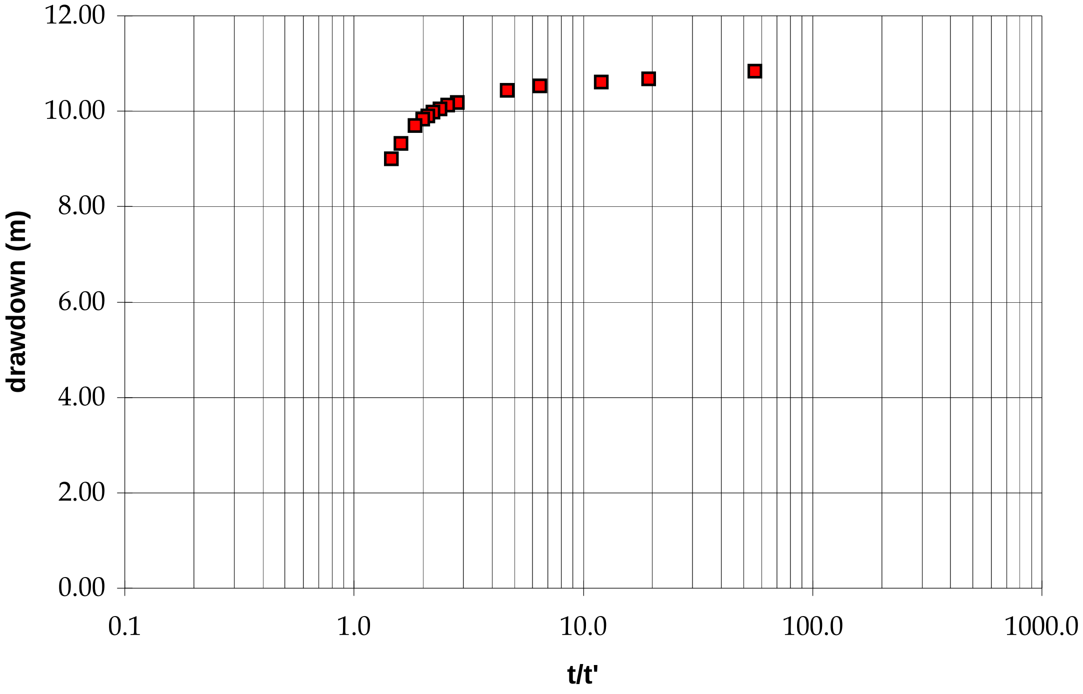
Theis Analysis, TW 5-2



Jacob Analysis, TW 5-2



Theis Recovery Analysis, TW 5-2



Analysis of Aquifer Test Data

TW 5-2

Q = 6.48 m^3/day

Jacob Analysis

$\Delta s =$ 14 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 6.48}{4\pi * 14} = 0.08\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 7.3 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 6.48}{4\pi * 7.3} = 0.16\ m^2/day$$

Hydraulic Conductivity Test Data and Analysis

Job:

Date: 08-May-07

Test Hole No: TW 5-2

H: **12.20**

Ho: **0.62**

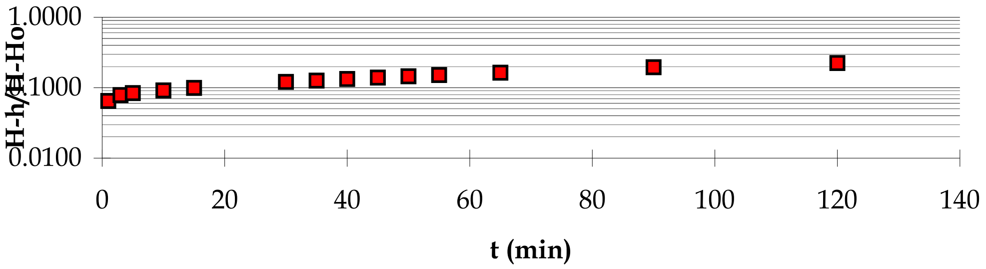
H - Ho: 11.58

To: 4.06E+03

t	Reading	Correction	h	H - h	H - h/H - Ho
1	11.450		11.45	0.75	0.0648
3	11.290		11.29	0.91	0.0786
5	11.230		11.23	0.97	0.0838
10	11.140		11.14	1.06	0.0915
15	11.050		11.05	1.15	0.0993
30	10.800		10.80	1.40	0.1209
35	10.740		10.74	1.46	0.1261
40	10.660		10.66	1.54	0.1330
45	10.590		10.59	1.61	0.1390
50	10.520		10.52	1.68	0.1451
55	10.450		10.45	1.75	0.1511
65	10.310		10.31	1.89	0.1632
90	9.940		9.94	2.26	0.1952
120	9.61		9.61	2.59	0.2237

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
6.10	0.08	5.87E-04	4.06E+03	2.41E-09

TW 5-2



AQUIFER TEST DATA

PROJ. NO:	**05460**	**Date:**	**08-May-07**
WELL NO:	**TW 6-1**	**TYPE OF WELL:**	**Pumping**
TEST NO:	**1**	**TYPE OF DATA:**	**Pumping and Recovery**

How Q measured:	**pail**	**Depth of Intake:**	**24.80 m**
How WL Measured:	**tape**	**Pump on:**	
Rad./Dist. of Pumping Well:	**0.076 m**	**Pump off:**	
Measuring Point for WL:	**top of casing**	**Duration:**	**0:40 hours:min**
Elev. Meas. Point:		**Pump Rate:**	**10.35 L/min**
Well Depth:	**25**	**Recovery Time:**	**2:00 hours:min**

TIME t= **40 at t'=0**

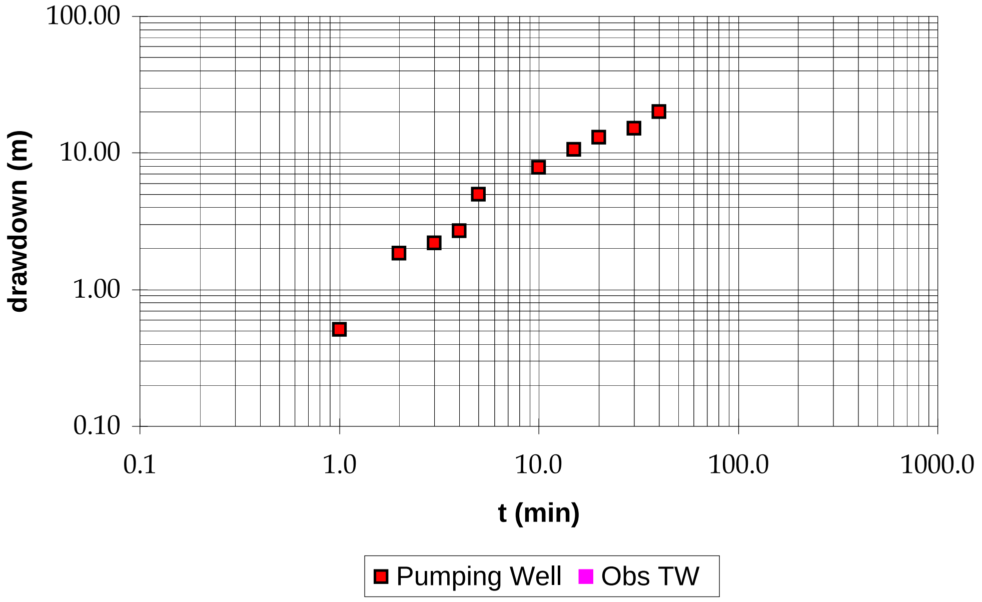
WATER LEVEL DATA SWL= **4.62 m**

Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 6-2 = 11.5 m
1.0	5.13	0.51	42.0	2.0	23.65	21.00	19.03	
2.0	6.47	1.85	45.0	5.0	23.65	9.00	19.03	
3.0	6.82	2.20	55.0	15.0	23.63	3.67	19.01	
4.0	7.31	2.69	70.0	30.0	23.62	2.33	19.00	
5.0	9.60	4.98	90.0	50.0	23.61	1.80	18.99	
10.0	12.45	7.83	100.0	60.0	23.60	1.67	18.98	
15.0	15.25	10.63	160.0	120.0	23.54	1.33	18.92	
20.0	17.57	12.95						
30.0	19.80	15.18						
40.0	24.60	19.98						

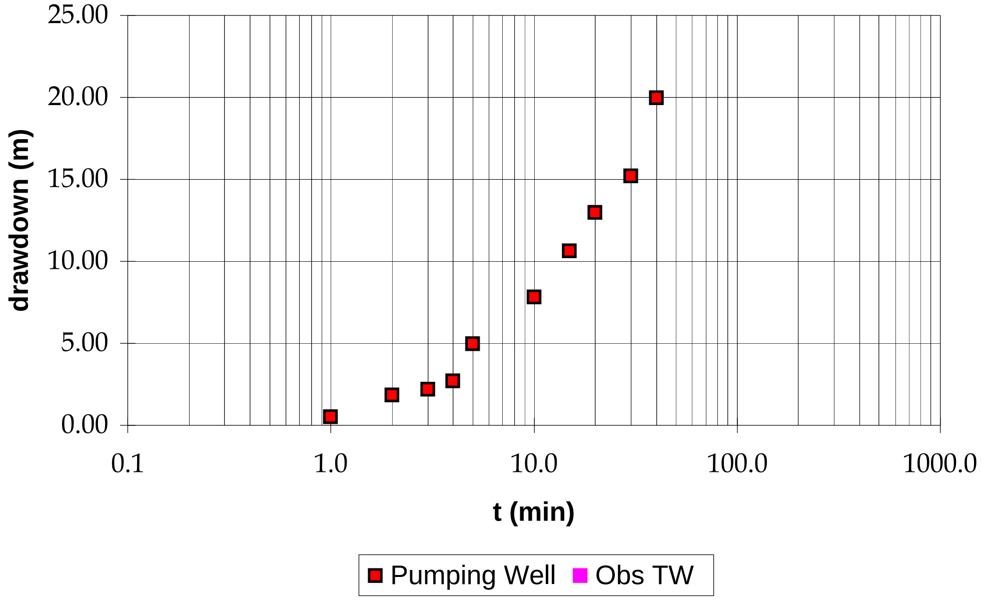
5.3 **% recovery**

98.04 **% of total available drawdown**

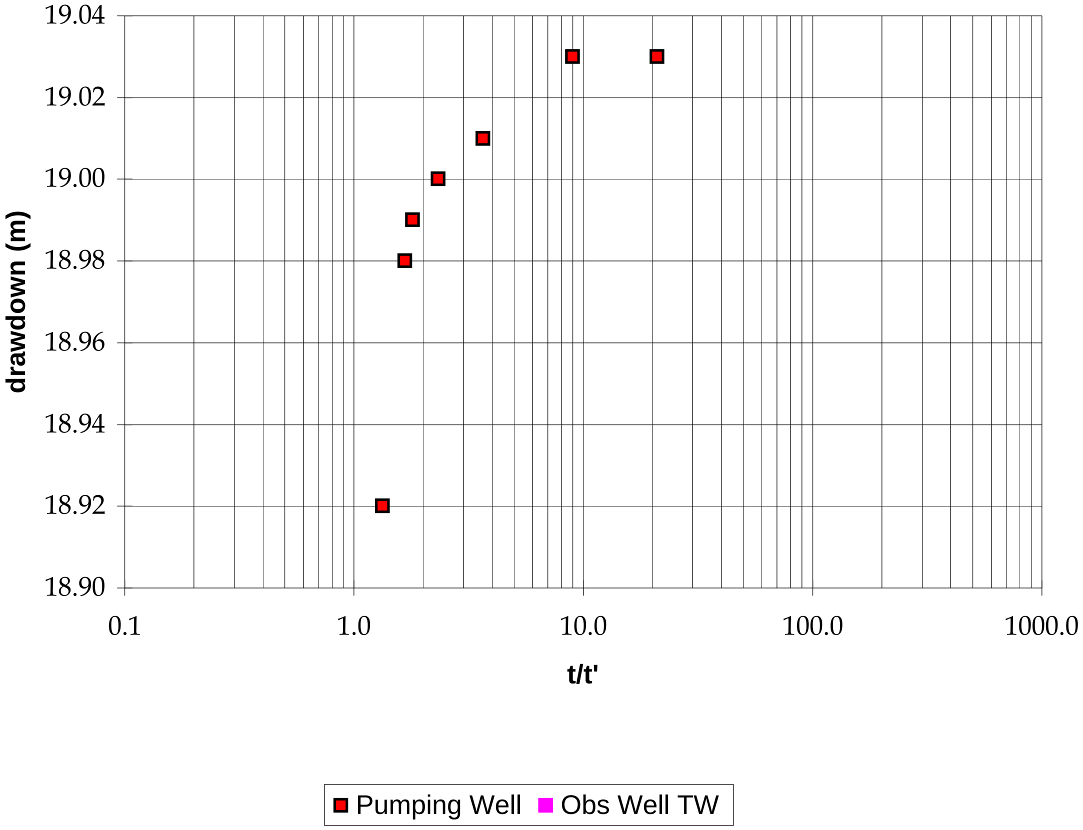
Theis Analysis, TW 6-1



Jacob Analysis, TW 6-1



Theis Recovery Analysis, TW 6-1



Analysis of Aquifer Test Data

TW 6-1

Q = 14.9 m^3/day

Jacob Analysis

$\Delta s =$ 15 m

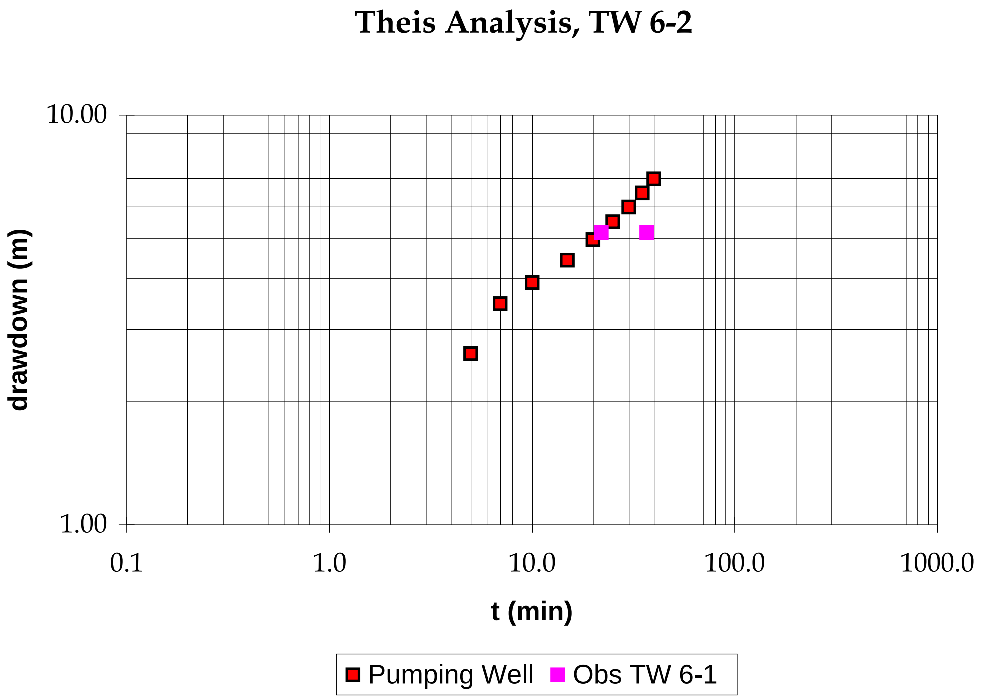
$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 14.9}{4\pi * 15} = 0.18\ m^2/day$$

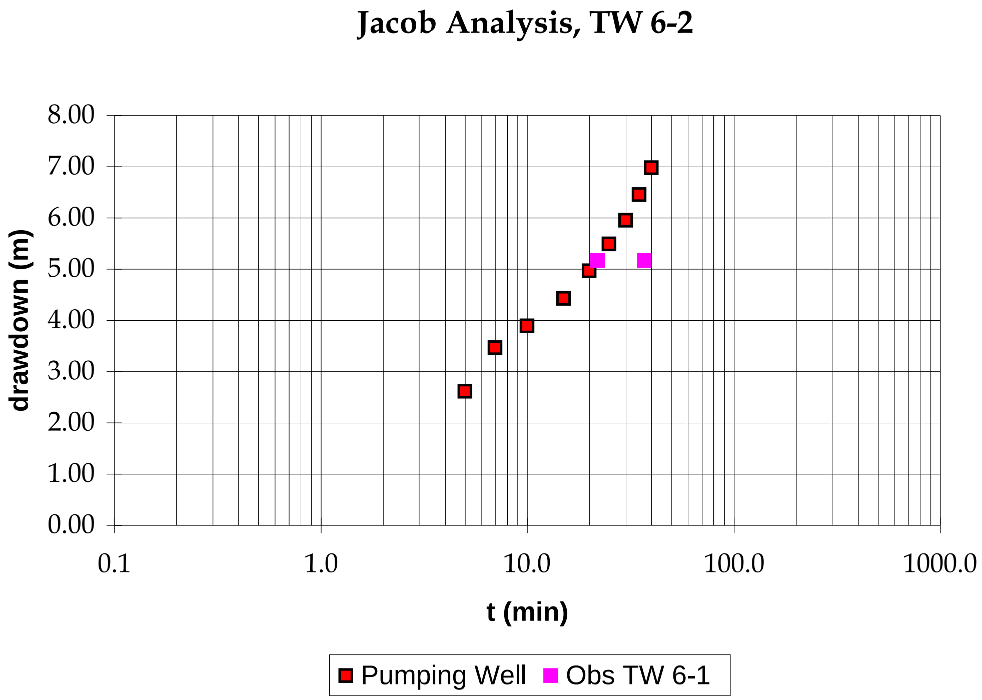
AQUIFER TEST DATA

PROJ. NO:	**05460**	**Date:**	**07-May-07**
WELL NO:	**TW 6-2**	**TYPE OF WELL:**	**Pumping**
TEST NO:	**1**	**TYPE OF DATA:**	**Pumping and Recovery**

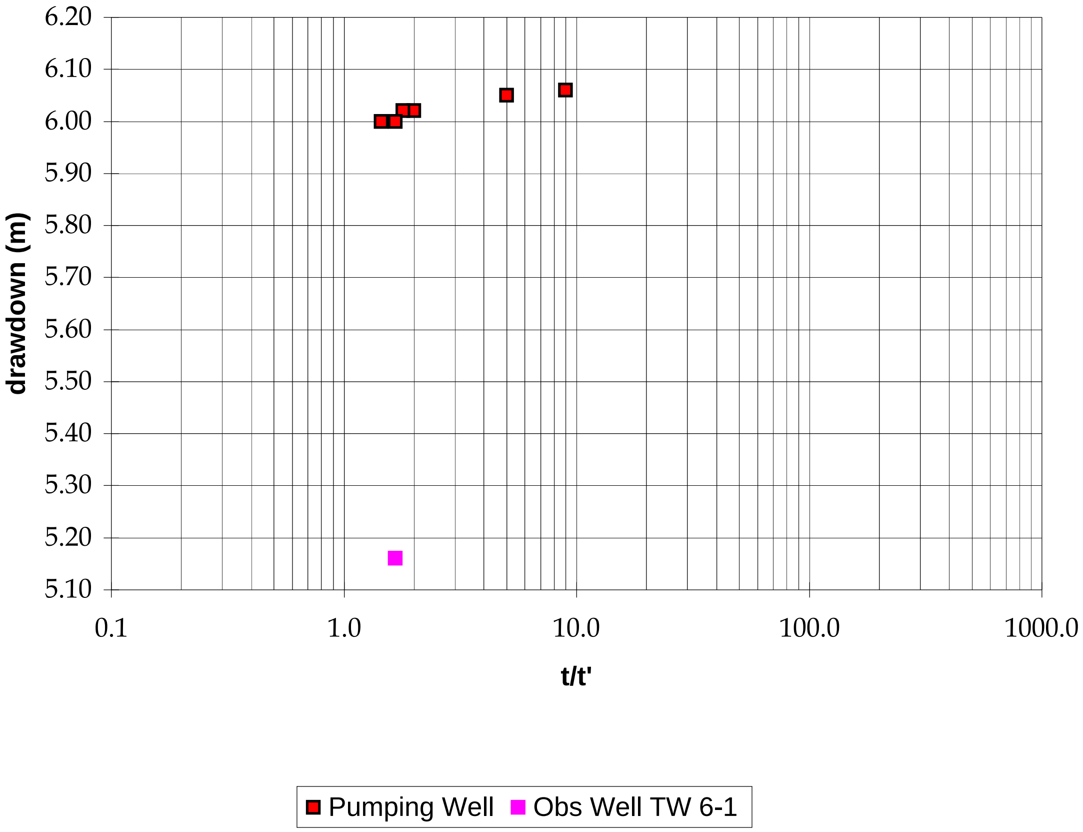
How Q measured:	**pail**	**Depth of Intake:**	**12.70 m**
How WL Measured:	**tape**	**Pump on:**	
Rad./Dist. of Pumping Well:	**0.076 m**	**Pump off:**	
Measuring Point for WL:	**top of casing**	**Duration:**	**0:40 hours:min**
Elev. Meas. Point:		**Pump Rate:**	**0.75 L/min**
Well Depth:	**12.8**	**Recovery Time:**	**2:10 hours:min**

TIME			WATER LEVEL DATA					
t= 40 at t'=0			SWL= 5.65 m					
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 6-1 = 5.18 m
5.0	8.26	2.61	45.0	5.0	11.71	9.00	6.06	
7.0	9.11	3.46	50.0	10.0	11.70	5.00	6.05	
10.0	9.54	3.89	80.0	40.0	11.67	2.00	6.02	
15.0	10.07	4.42	90.0	50.0	11.67	1.80	6.02	
20.0	10.61	4.96	100.0	60.0	11.65	1.67	6.00	
25.0	11.14	5.49	130.0	90.0	11.65	1.44	6.00	
30.0	11.60	5.95						
35.0	12.10	6.45						
40.0	12.62	6.97						
					13.9	% recovery		
					97.48	% of total available drawdown		


Theis Analysis, TW 6-2
10.00
1.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 6-1


Jacob Analysis, TW 6-2
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 6-1

Theis Recovery Analysis, TW 6-2



AQUIFER TEST DATA
Installed piezometers

Project No.	**05460**	**Date:**	**07/05/2007**
Test No.	**TW 6-2**	**Recovery time:**	**1:30**
Location		**Type of Data:**	**Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No.								
Elevation Meas. Point								
Static Water Level		5.18						
Depth of Intake (sur.)								
Depth of Intake (m.a.s.l.)								
t	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**
22	5.16	-0.02						
37	5.16	-0.02						
100	5.16	-0.02						

Analysis of Aquifer Test Data

TW 6-2

Q = 1.08 m^3/day

Jacob Analysis

Δs = 9 m

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 1.08}{4\pi\ * 9} = 0.02\ m^2/day$$

Hydraulic Conductivity Test Data and Analysis

Job:

Date: 07-May-07

Test Hole No: TW 6-2

H: **12.62**

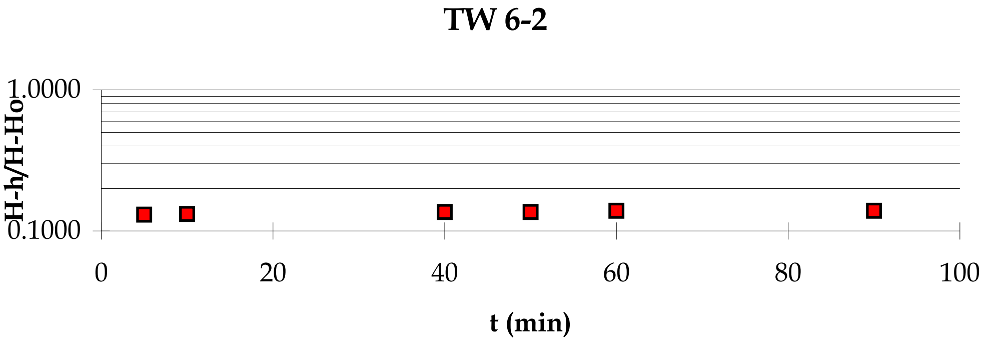
Ho: **5.65**

H - Ho: 6.97

To: 1.92E+29

t	Reading	Correction	h	H - h	H - h/H - Ho
5	11.710		11.71	0.91	0.1306
10	11.700		11.70	0.92	0.1320
40	11.670		11.67	0.95	0.1363
50	11.670		11.67	0.95	0.1363
60	11.650		11.65	0.97	0.1392
90	11.650		11.65	0.97	0.1392

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
6.10	0.08	5.87E-04	1.92E+29	5.08E-35



Gorrell Resource
Investigations

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 7
TEST NO: 1

Date: 10-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

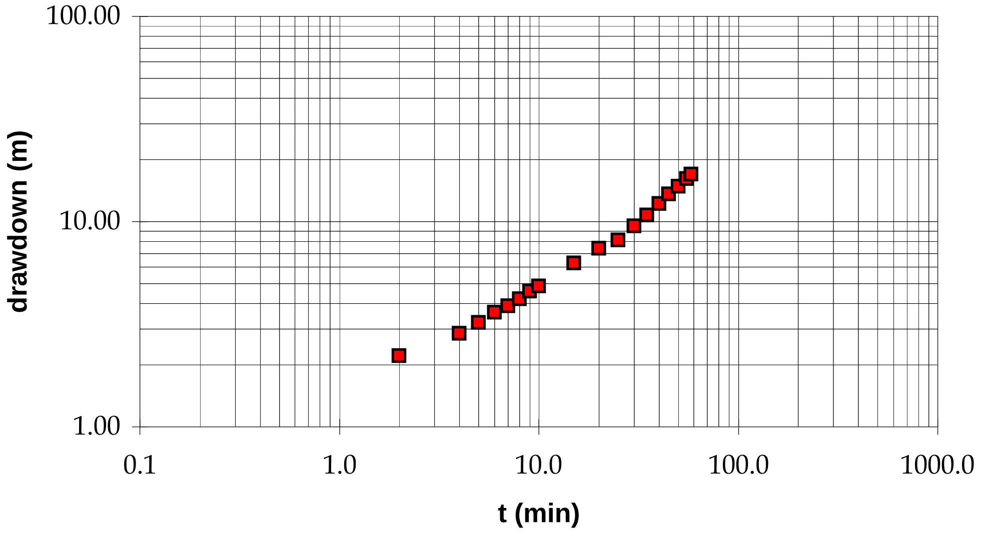
Depth of Intake: 24.60 m
Pump on:
Pump off:
Duration: 0:58 hours:min
Pump Rate: 7.2 L/min
Recovery Time: 2:00 hours:min

TIME t= 58 at t'=0

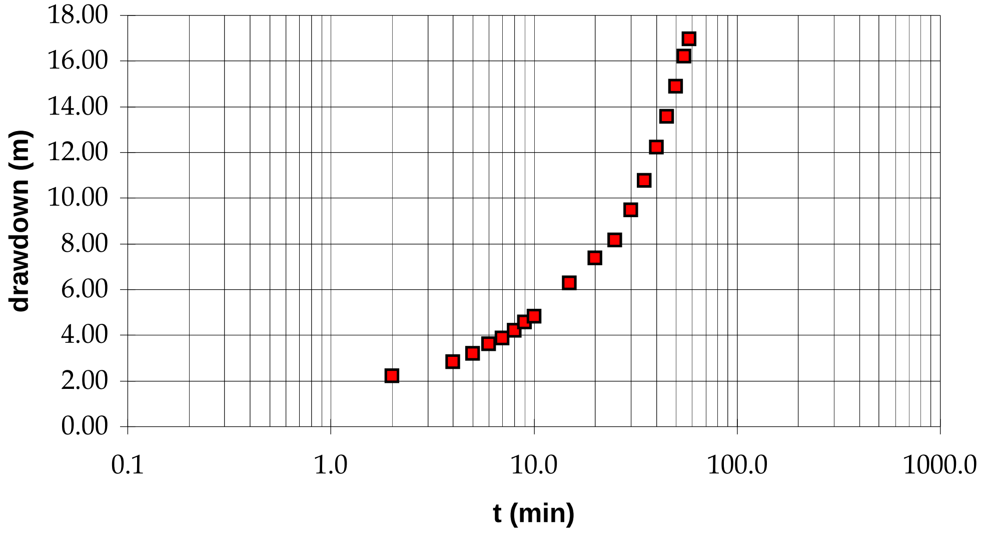
WATER LEVEL DATA SWL= 7.20 m

Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
2.0	9.42	2.22	60.0	2.0	23.12	30.00	15.92	
4.0	10.04	2.84	63.0	5.0	23.05	12.60	15.85	
5.0	10.41	3.21	64.0	6.0	22.99	10.67	15.79	
6.0	10.81	3.61	65.0	7.0	22.92	9.29	15.72	
7.0	11.08	3.88	66.0	8.0	22.87	8.25	15.67	
8.0	11.40	4.20	67.0	9.0	22.84	7.44	15.64	
9.0	11.76	4.56	68.0	10.0	22.81	6.80	15.61	
10.0	12.03	4.83	73.0	15.0	22.58	4.87	15.38	
15.0	13.48	6.28	78.0	20.0	22.46	3.90	15.26	
20.0	14.58	7.38	98.0	40.0	21.83	2.45	14.63	
25.0	15.35	8.15	136.0	78.0	20.83	1.74	13.63	
30.0	16.69	9.49	178.0	120.0	19.87	1.48	12.67	
35.0	17.98	10.78						
40.0	19.42	12.22						
45.0	20.77	13.57						
50.0	22.09	14.89						
55.0	23.41	16.21						
58.0	24.16	16.96						
					25.3	% recovery		
					95.28	% of total available drawdown		

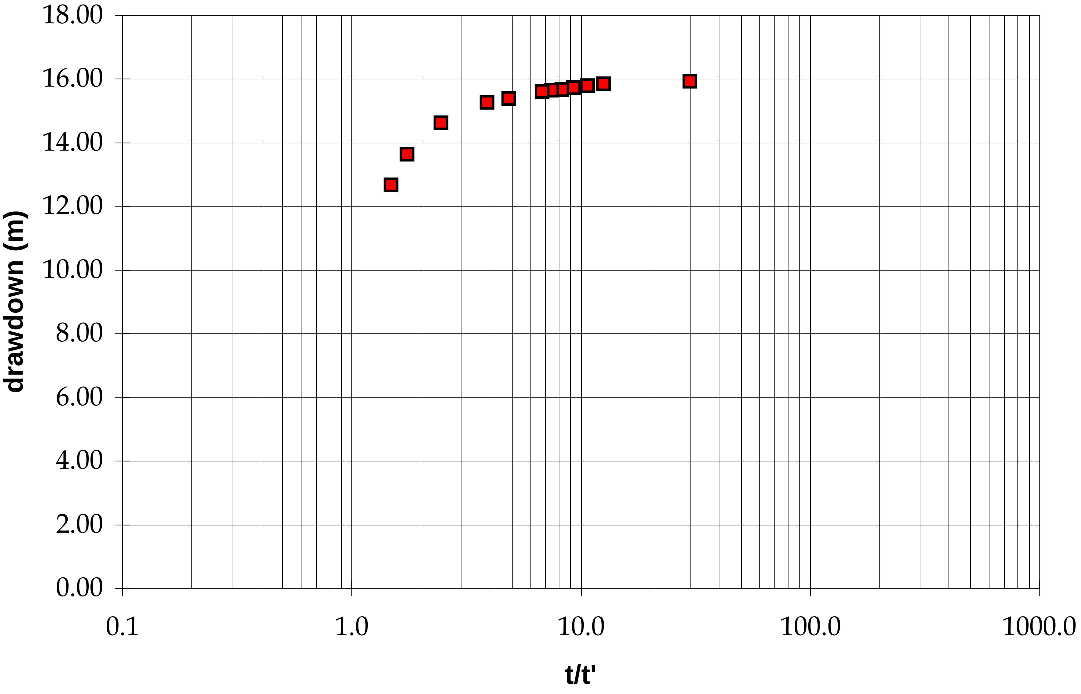
Theis Analysis, TW 7



Jacob Analysis, TW 7



Theis Recovery Analysis, TW 7



Analysis of Aquifer Test Data

TW 7

Q = 10.37 m^3/day

Jacob Analysis

$\Delta s = 9$ m

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 10.37}{4\pi\ * 9} = 0.21\ m^2/day$$

Theis Recovery Analysis

$\Delta s = 5.2$ m

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 10.37}{4\pi\ * 5.2} = 0.37\ m^2/day$$

Hydraulic Conductivity Test Data and Analysis

Job:

Test Hole No: TW 7

Date: 10-May-07

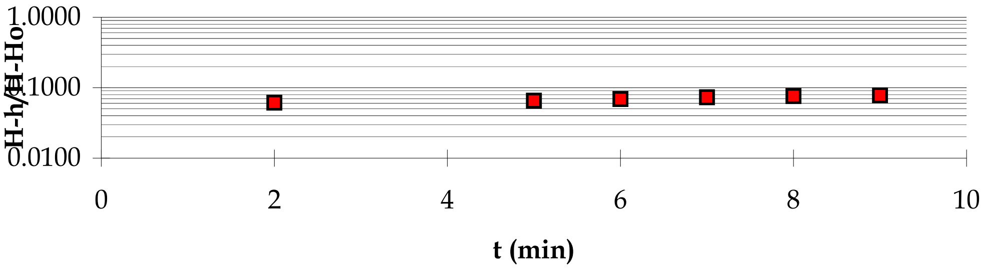
H: **24.16**
Ho: **7.20**

H - Ho: 16.96
To: 1.27E+03

t	Reading	Correction	h	H - h	H - h/H - Ho
2	23.120		23.12	1.04	0.0613
5	23.050		23.05	1.11	0.0654
6	22.990		22.99	1.17	0.0690
7	22.920		22.92	1.24	0.0731
8	22.870		22.87	1.29	0.0761
9	22.840		22.84	1.32	0.0778
10	22.810		22.81	1.35	0.0796
15	22.580		22.58	1.58	0.0932
20	22.460		22.46	1.70	0.1002
40	21.830		21.83	2.33	0.1374
78	20.830		20.83	3.33	0.1963
120	19.870		19.87	4.29	0.2529

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
18.30	0.08	2.38E-04	1.27E+03	3.12E-09

TW 7



Gorrell Resource
Investigations

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 8-1
TEST NO: 1

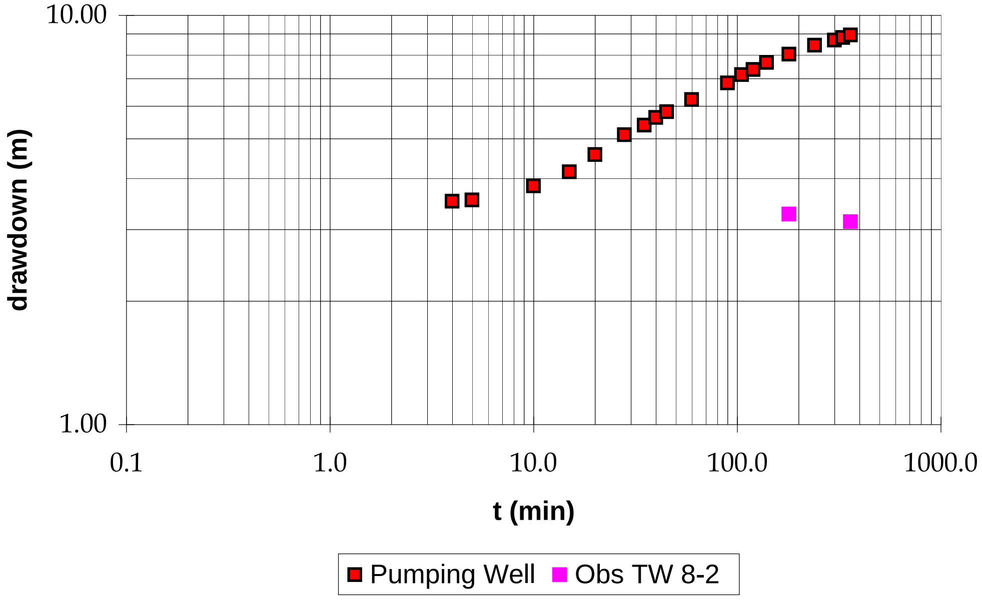
Date: 04-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

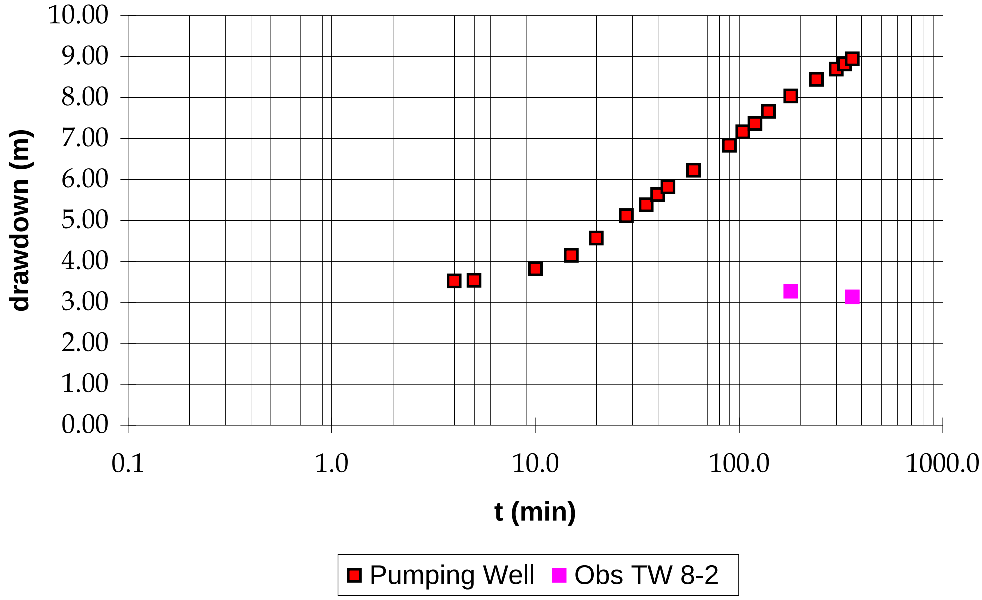
Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 6:00 hours:min
Pump Rate: 15.75 L/min
Recovery Time: 2:00 hours:min

TIME			WATER LEVEL DATA					
t=	360 at t'=0		SWL= 13.32 m					
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 8-2 = 3.35 m
4.0	16.83	3.51	362.0	2.0	20.60	181.00	7.28	
5.0	16.85	3.53	365.0	5.0	20.09	73.00	6.77	
10.0	17.14	3.82	370.0	10.0	19.64	37.00	6.32	
15.0	17.46	4.14	375.0	15.0	19.44	25.00	6.12	
20.0	17.88	4.56	380.0	20.0	19.25	19.00	5.93	
28.0	18.43	5.11	420.0	60.0	18.46	7.00	5.14	
35.0	18.70	5.38	480.0	120.0	17.41	4.00	4.09	
40.0	18.94	5.62						
45.0	19.13	5.81						
60.0	19.54	6.22						
90.0	20.15	6.83						
105.0	20.47	7.15						
120.0	20.68	7.36						
140.0	20.97	7.65						
180.0	21.35	8.03						
240.0	21.75	8.43						
300.0	22.00	8.68						
330.0	22.14	8.82						
360.0	22.26	8.94						
					54.3	% recovery		
					76.54	% of total available drawdown		

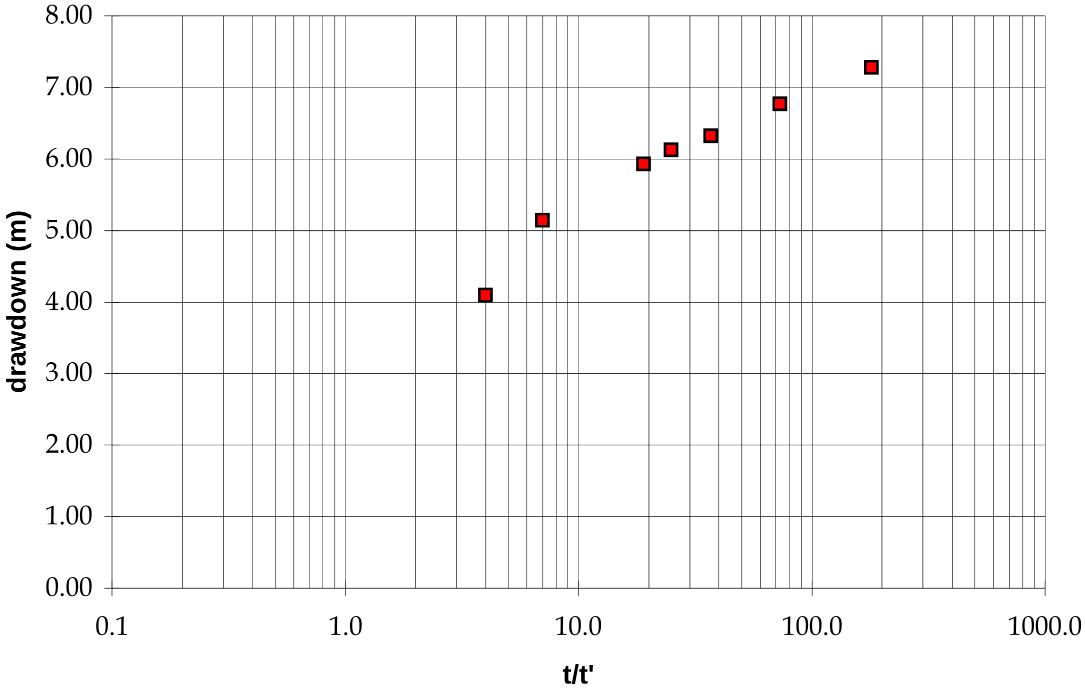
Theis Analysis, TW 8-1



Jacob Analysis, TW 8-1



Theis Recovery Analysis, TW 8-1



AQUIFER TEST DATA
Installed piezometers

Project No. 05460
Test No. TW 8-1
Location

Date: 05/04/2007
Recovery time: 0:00
Type of Data: Pumping and Recovery

Surface Elevation
Distance from well

Piezometer No.	**TW 8-2**							
Elevation Meas. Point								
Static Water Level	3.35							
Depth of Intake (sur.)								
Depth of Intake (m.a.s.l.)								
t	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**
180	3.27	-0.08						
360	3.13	-0.22						

Analysis of Aquifer Test Data

TW 8-1

Q = 22.68 m^3/day

Jacob Analysis

$\Delta s = 7$ m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 22.68}{4\pi * 7} = 0.59\ m^2/day$$

Theis Recovery Analysis

$\Delta s = 5$ m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 22.68}{4\pi * 5} = 0.83\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 8-2
TEST NO: 1

Date: 02-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

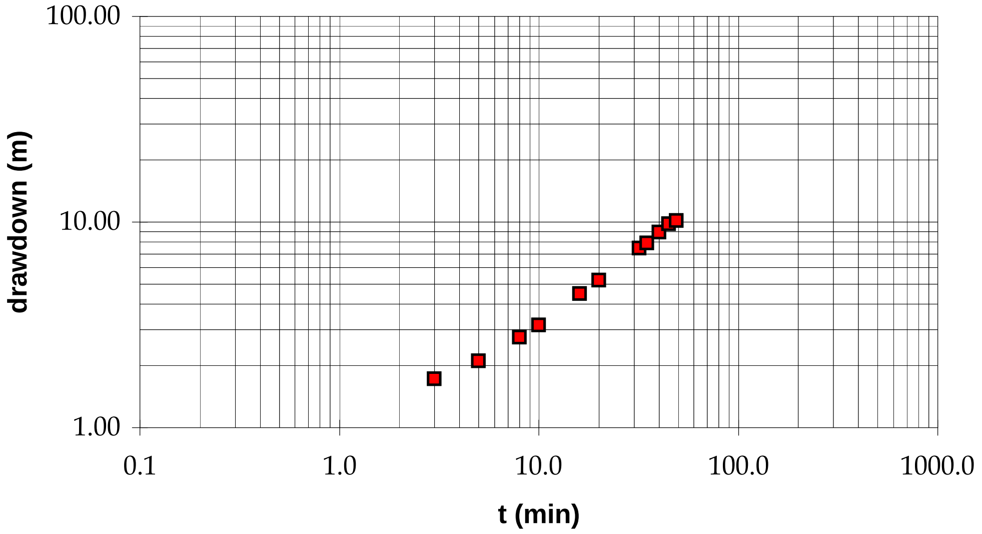
How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 13

Depth of Intake: 12.90 m
Pump on:
Pump off:
Duration: 0:49 hours:min
Pump Rate: 1 L/min
Recovery Time: 2:00 hours:min

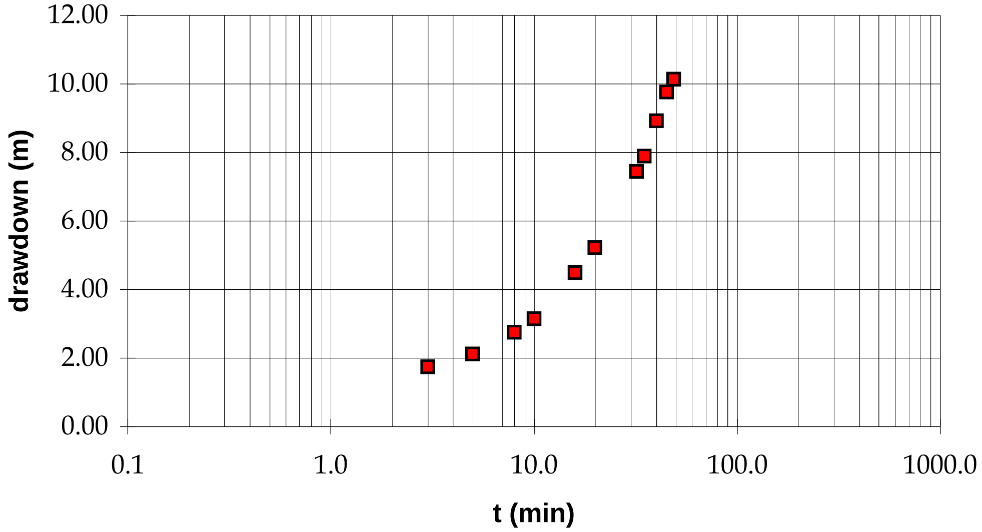
TIME t= 49 at t'=0			WATER LEVEL DATA SWL= 2.61 m					
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 8-1 = 12.14 m
3.0	4.34	1.73	50.0	1.0	12.14	50.00	9.53	T = 14.2 oC, DO = 9.09 mg/L
5.0	4.72	2.11	51.0	2.0	12.03	25.50	9.42	
8.0	5.35	2.74	52.0	3.0	12.01	17.33	9.40	
10.0	5.75	3.14	53.0	4.0	11.97	13.25	9.36	
16.0	7.09	4.48	54.0	5.0	11.95	10.80	9.34	
20.0	7.83	5.22	60.0	11.0	11.84	5.45	9.23	
32.0	10.04	7.43	82.0	33.0	11.66	2.48	9.05	
35.0	10.50	7.89	99.0	50.0	11.54	1.98	8.93	
40.0	11.53	8.92	129.0	80.0	11.39	1.61	8.78	
45.0	12.37	9.76	149.0	100.0	11.26	1.49	8.65	
49.0	12.75	10.14	159.0	110.0	11.20	1.45	8.59	
			169.0	120.0	11.14	1.41	8.53	

15.9 **% recovery**
97.59 **% of total available drawdown**

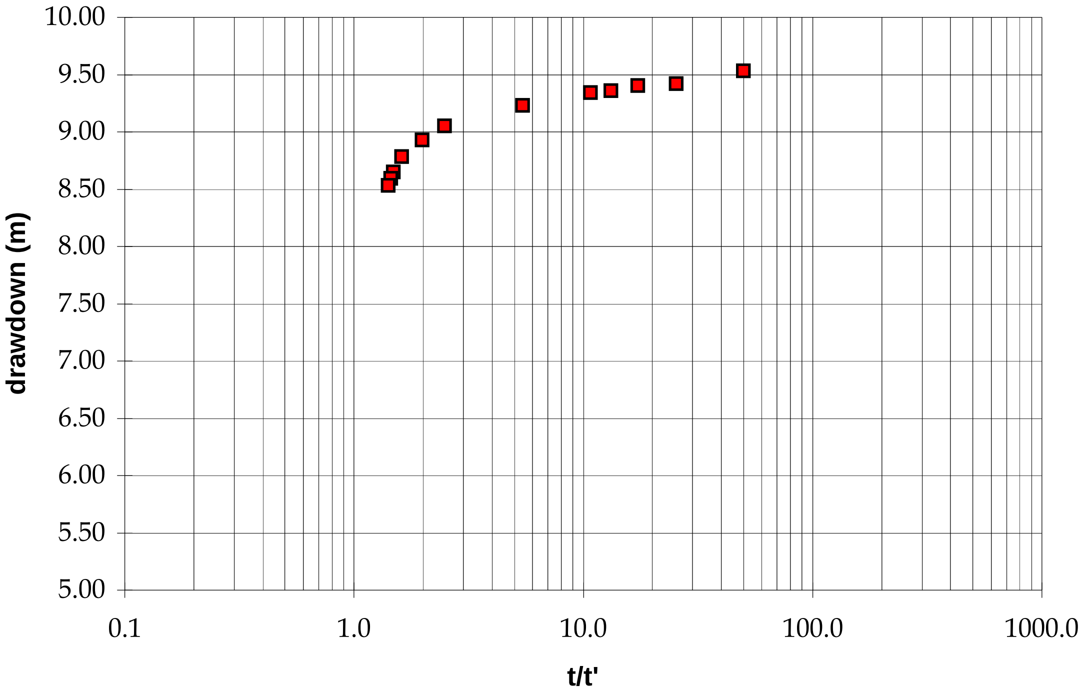
Theis Analysis, TW 8-2



Jacob Analysis, TW 8-2



Theis Recovery Analysis, TW 8-2



Analysis of Aquifer Test Data

TW 8-2

Q = 1.44 m^3/day

Jacob Analysis

$\Delta s =$ 11 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 1.44}{4\pi * 11} = 0.02\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 6.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 1.44}{4\pi * 6.5} = 0.04\ m^2/day$$

Hydraulic Conductivity Test Data and Analysis

Job:

Test Hole No: TW 8-2

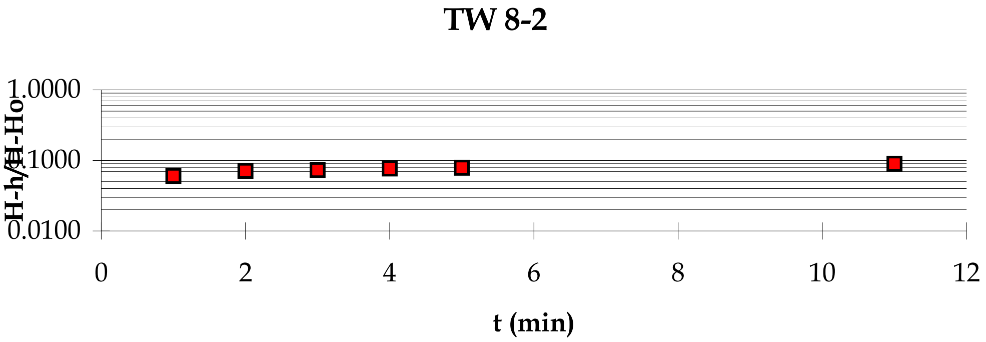
Date: 02-May-07

H: **12.75**
Ho: **2.61**

H - Ho: 10.14
To: 2.82E+06

t	Reading	Correction	h	H - h	H - h/H - Ho
1	12.140		12.14	0.61	0.0602
2	12.030		12.03	0.72	0.0710
3	12.010		12.01	0.74	0.0730
4	11.970		11.97	0.78	0.0769
5	11.950		11.95	0.80	0.0789
11	11.840		11.84	0.91	0.0897
33	11.660		11.66	1.09	0.1075
50	11.540		11.54	1.21	0.1193
80	11.390		11.39	1.36	0.1341
100	11.260		11.26	1.49	0.1469
110	11.200		11.20	1.55	0.1529
120	11.140		11.14	1.61	0.1588

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
6.10	0.08	5.87E-04	2.82E+06	3.47E-12



Gorrell Resource
Investigations

Appendix H
Packer Test Data and Analysis (TW 9 – 13)

Hydrogeological Assessment - Final

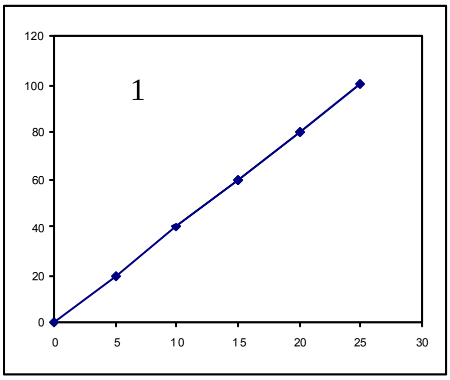
Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

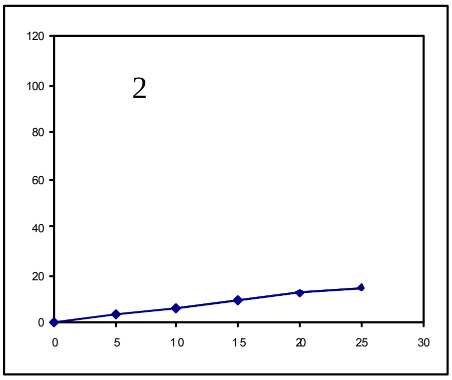
Prepared for:

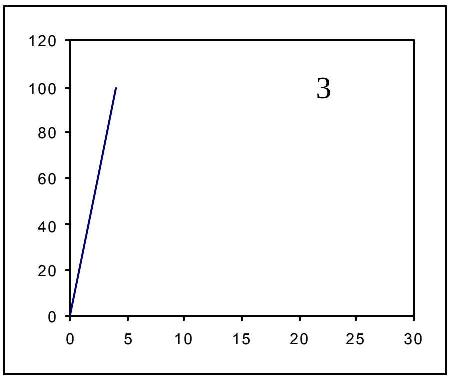
Miller Paving Limited
505 Miller Ave
Markham, ON

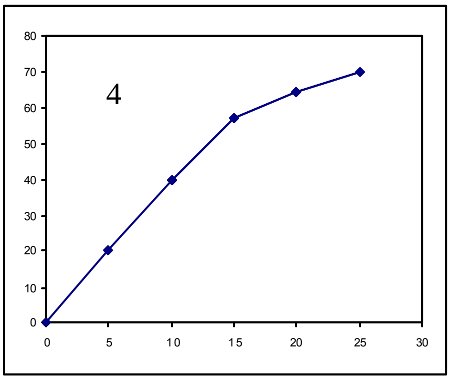
Report No. 08360
December 2011

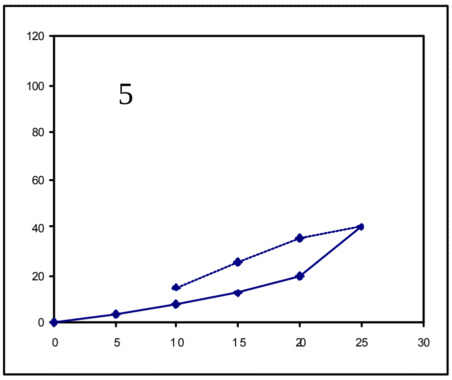
Typical Flow vs. Pressure Curves

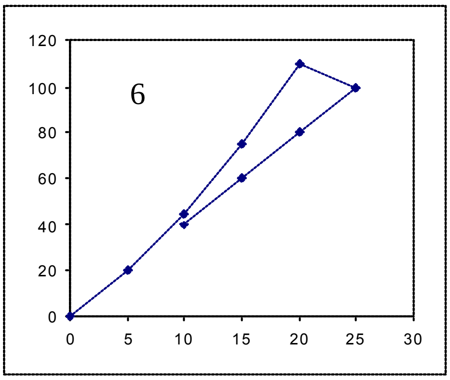


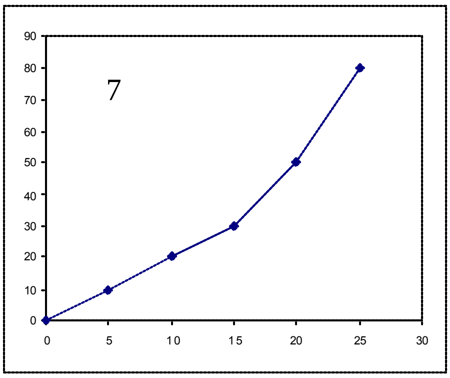


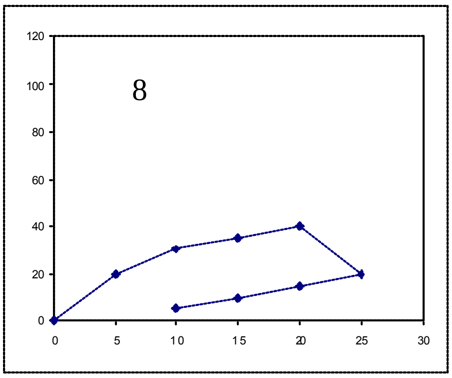


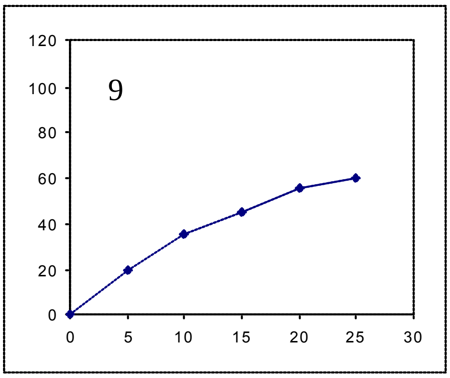












The graphs in Figure 2 illustrate a selection of type curves, which are commonly observed. The following describes each curve. (Note that the recovery curve -reducing pressure curve- is indicated by a dashed line in the plots, otherwise the recovery curve is seen to mimic the ascending pressure curve).

1. Ideal result where flow is laminar, probably on clean fractures, discharge proportional to pressure head.
2. Tight fractures, impermeable material
3. Highly permeable, large open fractures. Water acceptance exceeds capacity of the test system and pressure recorded is due to friction in supply system.
4. Fairly high permeability with a decrease in flow with time due partially to a change from laminar to turbulent flow, as well as partial clogging of fractures with time.
5. Low permeability, but washing out of gouge material from the fractures, increasing the permeability.
6. Laminar flow, moderate permeability but with an increase in flow with pressure. Increasing packer pressure brings the flow back to a linear relationship with pressure, indicating increased flow was previous leakage past the packer.
7. Increase in permeability with increased pressure and the recovery curve follows the same path. This indicates that fractures have been opened up due to excess pressure (hydrofraccing).
8. Progressive decrease in permeability with pressure (and time) indicating incomplete blocking of the fractures by transported material.
9. Moderate permeability and flow rate is not linear. The down turned curve and similar recovery curve indicate that turbulent flow conditions exist beyond 15 bars.

Project No: 08360
Date: 03-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 28.96
Length of Test Section: 2.13

Depth, top of bottom of packer: 31.09
Length of Packer: 2.13

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	6.9710	
1	6.9740	3.00E-03
2	6.9750	1.00E-03
3	6.9760	1.00E-03
4	6.9770	1.00E-03
5	6.9780	1.00E-03
6	6.9790	1.00E-03
7	6.9800	1.00E-03
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	6.6870	
1	6.6890	2.00E-03
2	6.9900	3.01E-01
3	6.9920	2.00E-03
4	6.9930	1.00E-03
5	6.9945	1.50E-03
6	6.9965	2.00E-03
7	6.9985	2.00E-03
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	7.0020	
1	7.0040	2.00E-03
2	7.0050	1.00E-03
3	7.0060	1.00E-03
4	7.0070	1.00E-03
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	7.0150	
1	7.0175	2.50E-03
2	7.0200	2.50E-03
3	7.0230	3.00E-03
4	7.0265	3.50E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	6.0290	
1	6.0310	2.00E-03
2	6.0330	2.00E-03
3	6.0350	2.00E-03
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	7.0350	
1	7.0360	1.00E-03
2	7.0370	1.00E-03
3	7.0380	1.00E-03
4		
5		
6		
7		
8		
9		
10		

Comments

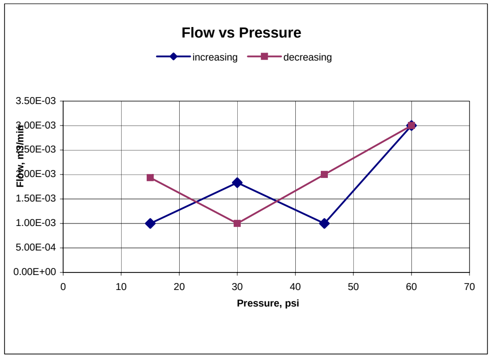
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	7.0358	
1	7.0369	1.10E-03
2	7.0391	2.20E-03
3	7.0410	1.90E-03
4	7.0427	1.70E-03
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 123.23
Bottom (m): 121.10

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.00E-03	4.97E-05
30	1.83E-03	2.90E-05
45	1.00E-03	1.14E-05
60	3.00E-03	2.90E-05
45	2.00E-03	2.38E-05
30	1.00E-03	1.24E-04
15	1.93E-03	4.14E-05



Project No: 08360
Date: 03-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 28.96
Length of Test Section: -3.05

Depth, top of bottom of packer: 25.91
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	11.2000	
1	11.2000	0.00E+00
2	11.2000	0.00E+00
3	11.2000	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	11.2020	
1	11.2022	2.00E-04
2	11.2023	1.00E-04
3	11.2024	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	11.2043	
1	11.2044	1.00E-04
2	11.2045	1.00E-04
3	11.2046	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	11.2058	
1	11.2060	2.00E-04
2	11.2062	2.00E-04
3	11.2064	2.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	11.2065	
1	11.2065	0.00E+00
2	11.2066	1.00E-04
3	11.2067	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	11.2067	
1	11.2067	0.00E+00
2	11.2067	0.00E+00
3	11.2067	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

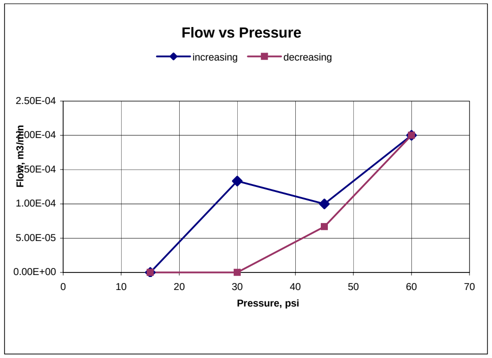
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	11.2067	
1	11.2067	0.00E+00
2	11.2067	0.00E+00
3	11.2067	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 123.23
Bottom (m): 126.28

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	1.33E-04	4.03E-06
45	1.00E-04	2.42E-06
60	2.00E-04	3.02E-06
45	6.67E-05	1.61E-06
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Gorrell Resource Investigations

Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 22.86
Length of Test Section: 3.05

Depth, top of bottom of packer: 25.91
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	12.7450	
1	12.7450	0.00E+00
2	12.7420	-3.00E-03
3	12.7415	-5.00E-04
4	12.7415	0.00E+00
5	12.7415	0.00E+00
6	12.7415	0.00E+00
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	12.7475	
1	12.7479	4.00E-04
2	12.7485	6.00E-04
3	12.7495	1.00E-03
4	12.7505	1.00E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	12.7550	
1	12.7579	2.90E-03
2	12.7602	2.30E-03
3	12.7630	2.80E-03
4	12.7665	3.50E-03
5	12.7700	3.50E-03
6	12.7735	3.50E-03
7		
8		
9		
10		

Comments back pressure reversed gauge

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	12.7770	
1	12.7825	5.50E-03
2	12.7874	4.90E-03
3	12.7924	5.00E-03
4	12.7975	5.10E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	12.7990	
1	12.8024	3.40E-03
2	12.8055	3.10E-03
3	12.8090	3.50E-03
4	12.8120	3.00E-03
5	12.8150	3.00E-03
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	12.8170	
1	12.8188	1.80E-03
2	12.8206	1.80E-03
3	12.8225	1.90E-03
4	12.8244	1.90E-03
5		
6		
7		
8		
9		
10		

Comments

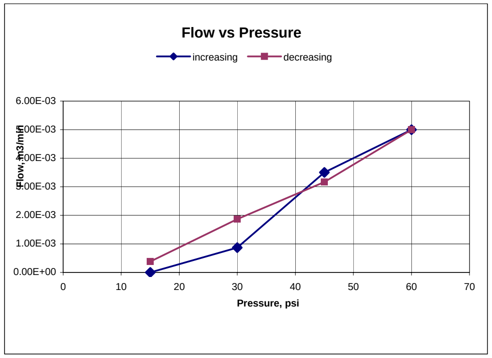
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	12.8225	
1	12.8226	5.00E-05
2	12.8229	3.00E-04
3	12.8232	3.50E-04
4	12.8237	5.00E-04
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 129.33
Bottom (m): 126.28

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	8.67E-04	1.21E-05
45	3.50E-03	3.62E-05
60	5.00E-03	4.03E-05
45	3.17E-03	3.62E-05
30	1.87E-03	3.42E-05
15	3.83E-04	8.45E-06



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 19.81
Length of Test Section: 3.05

Depth, top of bottom of packer: 22.86
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.1037	
1	13.1038	5.00E-05
2	13.1038	0.00E+00
3	13.1042	4.50E-04
4	13.1045	3.00E-04
5	13.1048	2.50E-04
6	13.1050	2.50E-04
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.1102	
1	0.1105	2.50E-04
2	0.1110	5.00E-04
3	0.1115	5.50E-04
4	0.1119	3.50E-04
5	0.1121	2.50E-04
6	0.1124	2.50E-04
7	0.1126	2.50E-04
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.1154	
1	0.1157	2.50E-04
2	0.1159	2.00E-04
3	0.1161	2.00E-04
4	0.1163	2.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.1177	
1	0.1180	3.04E-04
2	0.1185	4.46E-04
3	0.1188	3.00E-04
4	0.1191	3.00E-04
5	0.1194	3.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.1188	
1	0.1188	0.00E+00
2	0.1189	1.30E-04
3	0.1190	1.20E-04
4	0.1192	1.50E-04
5	0.1193	1.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.1177	
1	0.1177	0.00E+00
2	0.1177	0.00E+00
3	0.1177	5.00E-05
4	0.1178	5.00E-05
5	0.1178	5.00E-05
6		
7		
8		
9		
10		

Comments note meter unwound due to backpressure between 45 and 30, 30 and 15

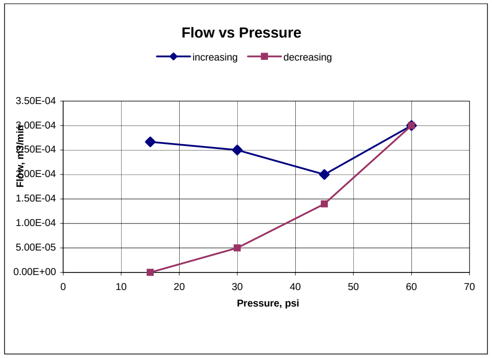
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.1151	
1	0.1151	0.00E+00
2	0.1151	0.00E+00
3	0.1151	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 132.38
Bottom (m): 129.33

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.67E-04	5.43E-06
30	2.50E-04	4.43E-06
45	2.00E-04	2.21E-06
60	3.00E-04	2.82E-06
45	1.40E-04	1.61E-06
30	5.00E-05	5.43E-07
15	0.00E+00	0.00E+00



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 16.76
Length of Test Section: 3.05

Depth, top of bottom of packer: 19.81
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.2962	
1	13.2968	5.50E-04
2	13.2973	5.00E-04
3	13.2978	5.00E-04
4	13.2983	5.50E-04
5	13.2989	5.50E-04
6	13.2995	6.50E-04
7	13.3000	5.00E-04
8	13.3007	7.00E-04
9	13.3013	6.00E-04
10	13.3019	6.00E-04

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.3042	
1	13.3051	9.50E-04
2	13.3060	8.50E-04
3	13.3069	9.00E-04
4	13.3078	9.00E-04
5	13.3087	9.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.3108	
1	13.3125	1.70E-03
2	13.3139	1.35E-03
3	13.3153	1.45E-03
4	13.3168	1.45E-03
5	13.3182	1.40E-03
6	13.3195	1.35E-03
7	13.3209	1.35E-03
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	13.3225	
1	13.3246	2.10E-03
2	13.3266	2.00E-03
3	13.3286	2.00E-03
4	13.3306	2.00E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.3314	
1	13.3331	1.70E-03
2	13.3347	1.60E-03
3	13.3362	1.45E-03
4	13.3377	1.55E-03
5	13.3392	1.50E-03
6	13.3408	1.55E-03
7	13.3422	1.45E-03
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.3421	
1	13.3431	1.05E-03
2	13.3443	1.15E-03
3	13.3454	1.15E-03
4	13.3466	1.15E-03
5		
6		
7		
8		
9		
10		

Comments

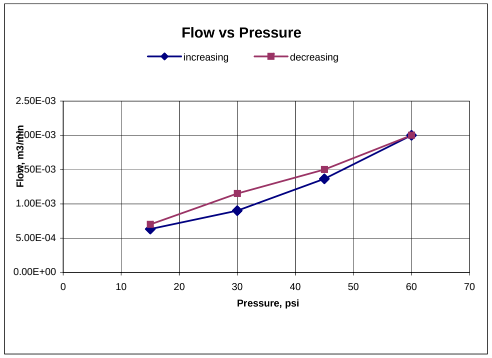
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.3459	
1	13.3463	4.00E-04
2	13.3471	8.50E-04
3	13.3477	6.00E-04
4	13.3484	7.00E-04
5	13.3491	6.50E-04
6	13.3498	7.00E-04
7	13.3505	7.50E-04
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 135.43
Bottom (m): 132.38

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	6.33E-04	1.51E-05
30	9.00E-04	1.21E-05
45	1.37E-03	1.45E-05
60	2.00E-03	1.63E-05
45	1.50E-03	1.57E-05
30	1.15E-03	1.57E-05
15	7.00E-04	1.51E-05



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 13.72
Length of Test Section: 3.05

Depth, top of bottom of packer: 16.76
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.4234	
1	13.4240	6.50E-04
2	13.4243	3.00E-04
3	13.4247	4.00E-04
4	13.4250	2.50E-04
5	13.4250	5.00E-05
6	13.4251	5.00E-05
7	13.4251	5.00E-05
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.4273	
1	13.4276	2.50E-04
2	13.4277	1.00E-04
3	13.4278	1.00E-04
4	13.4279	1.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.4289	
1	13.4292	3.00E-04
2	13.4295	3.00E-04
3	13.4297	2.00E-04
4	13.4299	1.50E-04
5	13.4301	2.50E-04
6	13.4303	2.00E-04
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	13.4311	
1	13.4315	4.00E-04
2	13.4318	2.50E-04
3	13.4321	3.00E-04
4	13.4325	4.00E-04
5	13.4327	2.50E-04
6	13.4330	2.50E-04
7	13.4334	4.00E-04
8	13.4337	3.00E-04
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.4334	
1	13.4334	0.00E+00
2	13.4336	1.50E-04
3	13.4337	1.50E-04
4	13.4339	1.50E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.4332	
1	13.4332	0.00E+00
2	13.4333	5.00E-05
3	13.4334	1.50E-04
4	13.4336	1.50E-04
5	13.4337	1.50E-04
6		
7		
8		
9		
10		

Comments

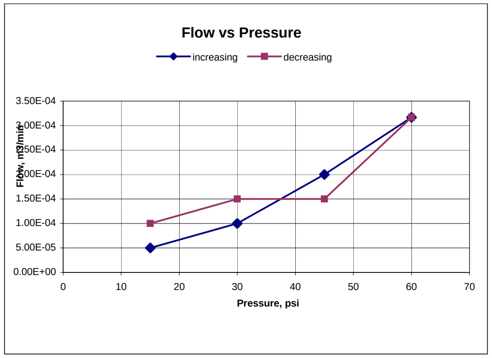
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.4322	
1	13.4322	0.00E+00
2	13.4323	1.00E-04
3	13.4324	1.00E-04
4	13.4325	1.00E-04
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 138.47
Bottom (m): 135.43

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.00E-05	9.06E-07
30	1.00E-04	1.71E-06
45	2.00E-04	1.81E-06
60	3.17E-04	2.82E-06
45	1.50E-04	1.51E-06
30	1.50E-04	2.01E-06
15	1.00E-04	2.42E-06



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 31.09
Test Hole No: 9-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.6
Surface Elevation: 152.19 m ASL
Water Level: 9.62
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 10.67
Depth, top of bottom of packer: 13.72
Length of Test Section: 3.05
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.5316	
1	13.5306	-9.50E-04
2	13.5313	6.50E-04
3	13.5314	1.50E-04
4	13.5316	2.00E-04
5	13.5318	1.50E-04
6	13.5320	2.50E-04
7	13.5322	2.00E-04
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.5360	
1	13.5362	2.00E-04
2	13.5365	3.00E-04
3	13.5367	2.00E-04
4	13.5369	2.00E-04
5	13.5371	2.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.5388	
1	13.5392	4.00E-04
2	13.5396	4.00E-04
3	13.5398	2.00E-04
4	13.5402	4.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	13.5414	
1	13.5418	4.00E-04
2	13.5423	5.50E-04
3	13.5428	4.50E-04
4	13.5433	5.00E-04
5	13.5438	5.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.5436	
1	13.5439	2.50E-04
2	13.5443	4.50E-04
3	13.5447	3.50E-04
4	13.5450	3.50E-04
5	13.5454	3.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.5447	
1	13.5447	2.00E-05
2	13.5458	1.05E-03
3	13.5458	3.00E-05
4	13.5461	2.50E-04
5	13.5463	2.50E-04
6		
7		
8		
9		
10		

Comments

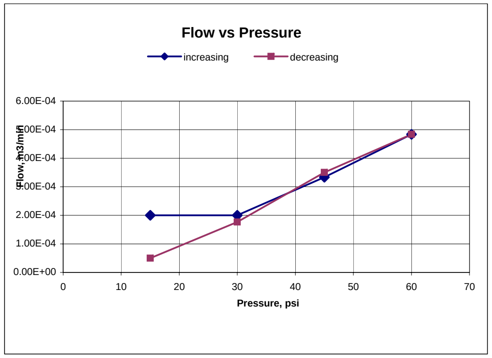
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.5453	
1	13.5453	0.00E+00
2	13.5454	5.00E-05
3	13.5454	5.00E-05
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 141.52
Bottom (m): 138.47

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.00E-04	4.03E-06
30	2.00E-04	2.82E-06
45	3.33E-04	3.72E-06
60	4.83E-04	4.23E-06
45	3.50E-04	3.72E-06
30	1.77E-04	2.82E-06
15	5.00E-05	8.25E-07



Gorrell Resource Investigations

Project No: 08360
Date: 09-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: **152.19** m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 7.62
Length of Test Section: 3.05

Depth, top of bottom of packer: 10.67
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	14.2080	
1	14.3330	1.25E-01
2	14.4470	1.14E-01
3	14.5680	1.21E-01
4	14.6940	1.26E-01
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	14.9800	
1	15.1430	1.63E-01
2	15.3060	1.63E-01
3	15.4710	1.65E-01
4	15.6390	1.68E-01
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	15.8400	
1	15.0400	-8.00E-01
2	15.2350	1.95E-01
3	15.4350	2.00E-01
4	15.6370	2.02E-01
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0		
1		0.00E+00
2		0.00E+00
3		0.00E+00
4		0.00E+00
5		0.00E+00
6		0.00E+00
7		0.00E+00
8		0.00E+00
9		0.00E+00
10		0.00E+00

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0		
1		0.00E+00
2		0.00E+00
3		0.00E+00
4		0.00E+00
5		0.00E+00
6		0.00E+00
7		0.00E+00
8		0.00E+00
9		0.00E+00
10		0.00E+00

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	16.7100	
1	16.8900	1.80E-01
2	17.0680	1.78E-01
3	17.2420	1.74E-01
4	17.4170	1.75E-01
5		
6		
7		
8		
9		
10		

Comments stopped at 45 as one test takes full tanker of water

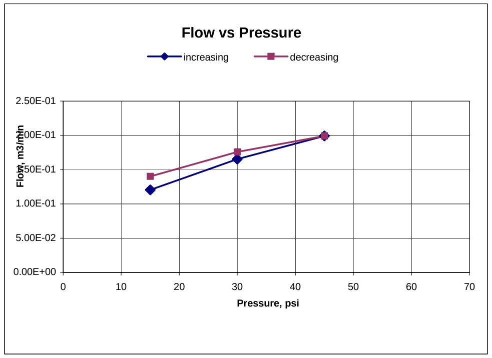
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	17.5500	
1	17.6920	1.42E-01
2	17.8300	1.38E-01
3	17.9700	1.40E-01
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 144.57
Bottom (m): 141.52

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.20E-01	2.62E-03
30	1.65E-01	2.42E-03
45	1.99E-01	2.21E-03
30	1.76E-01	2.62E-03
15	1.40E-01	3.02E-03



Project No: 08360
Date: 09-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 31.09
Test Hole No: 9-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.6
Surface Elevation: 152.19 m ASL
Water Level: 9.62
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 4.57
Depth, top of bottom of packer: 7.62
Length of Test Section: 3.05
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	18.1900	
1	18.3020	0.11
2	18.4040	0.10
3	18.5050	0.10
4	18.6020	0.10
5	18.6970	0.09
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	18.9500	
1	19.0980	0.15
2	19.2430	0.15
3	19.3850	0.14
4	19.5290	0.14
5	19.6710	0.14
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	19.7800	
1	19.9560	0.18
2	20.1120	0.16
3	20.2780	0.17
4	20.4290	0.15
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	20.6000	
1	20.7460	0.15
2	20.8920	0.15
3	21.0380	0.15
4		
5		
6		
7		
8		
9		
10		

Comments stopped at 45 as one test takes full tanker of water

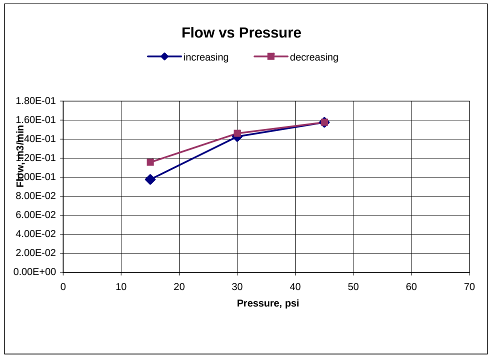
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	21.1200	
1	21.2370	0.12
2	21.3530	0.12
3	21.4670	0.11
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 147.62
Bottom (m): 144.57

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	9.77E-02	5.03E-03
30	1.43E-01	2.01E-03
45	1.58E-01	1.61E-03
30	1.46E-01	2.01E-03
15	1.16E-01	2.52E-03



Project No: 08360
Date: 09-Feb-09

Drillers: All-Terrain Drilling, Darren & Chris
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19

Borehole Depth: **31.09**
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 1.68
Length of Test Section: 2.90

Depth, top of bottom of packer: 4.57
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	21.5492	
1	21.5506	1.40E-03
2	21.5518	1.20E-03
3	21.5530	1.20E-03
4	21.5542	1.20E-03
5		
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 30

Time (min)	Flow Meter	Diff.
0	21.5588	
1	21.5616	2.80E-03
2	21.5652	3.60E-03
3	21.5688	3.60E-03
4	21.5721	3.25E-03
5		
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 45

Time (min)	Flow Meter	Diff.
0	21.5796	
1	21.5868	7.20E-03
2	21.5949	8.10E-03
3	21.6027	7.80E-03
4	21.6107	8.00E-03
5		
6		
7		
8		
9		
10		

Comments

Test No. Test No.
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.6190	
1	0.6337	1.47E-02
2	0.6474	1.37E-02
3	0.6637	1.63E-02
4	0.6799	1.62E-02
5	0.6974	1.75E-02
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.7160	
1	0.7291	1.31E-02
2	0.7418	1.27E-02
3	0.7542	1.24E-02
4	0.7668	1.26E-02
5		
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.7730	
1	0.7812	8.20E-03
2	0.7890	7.80E-03
3	0.7968	7.75E-03
4	0.8042	7.45E-03
5		
6		
7		
8		
9		
10		

Comments

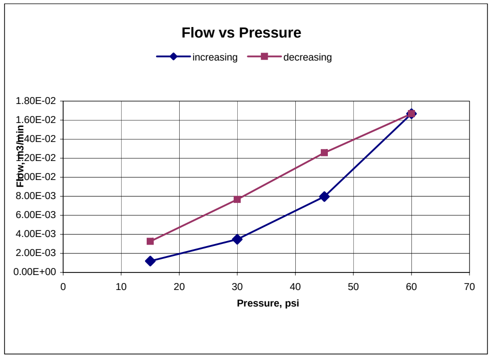
Test No. Test No.
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.8150	
1	0.8187	3.70E-03
2	0.8220	3.30E-03
3	0.8253	3.30E-03
4	0.8285	3.20E-03
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 150.51
Bottom (m): 147.62

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.20E-03	2.62E-05
30	3.48E-03	4.63E-05
45	7.97E-03	8.05E-05
60	1.67E-02	1.41E-04
45	1.26E-02	1.25E-04
30	7.67E-03	1.01E-04
15	3.27E-03	6.04E-05



Gorrell Resource
Investigations

Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.32
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 13.72
Length of Test Section: 1.60

Depth, top of bottom of packer: 15.32
Length of Packer: 1.60

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	21.83060	
1	21.83095	3.50E-04
2	21.83150	5.50E-04
3	21.83230	8.00E-04
4	21.83230	0.00E+00
5	21.83230	0.00E+00
6	21.83230	0.00E+00
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.83295	
1	0.83335	4.00E-04
2	0.83365	3.00E-04
3	0.83410	4.50E-04
4	0.83445	3.50E-04
5	0.83470	2.50E-04
6	0.83495	2.50E-04
7	0.83520	2.50E-04
8	0.83545	2.50E-04
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.83625	
1	0.83665	4.00E-04
2	0.83710	4.50E-04
3	0.83765	5.50E-04
4	0.83810	4.50E-04
5	0.83865	5.50E-04
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.83860	
1	0.83940	8.00E-04
2	0.84010	7.00E-04
3	0.84080	7.00E-04
4	0.84150	7.00E-04
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.84175	
1	1.44175	6.00E-01
2	1.94175	5.00E-01
3	2.59175	6.50E-01
4	3.14175	5.50E-01
5	3.69175	5.50E-01
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.85515	
1	0.85530	1.50E-04
2	0.85565	3.50E-04
3	0.85595	3.00E-04
4	0.85630	3.50E-04
5	0.85665	3.50E-04
6		
7		
8		
9		
10		

Comments

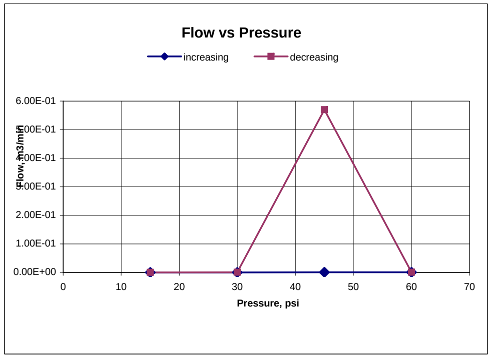
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.85675	
1	0.85695	2.00E-04
2	0.85720	2.50E-04
3	0.85740	2.00E-04
4	0.85755	1.50E-04
5	0.85755	0.00E+00
6	0.85755	0.00E+00
7	0.85755	0.00E+00
8		
9		
10		

Test Hole No: 10-1

<u>Test Interval</u>
Top (m): 132.02
Bottom (m): 130.42

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	2.50E-04	1.09E-05
45	5.17E-04	1.25E-05
60	7.00E-04	1.41E-05
45	5.70E-01	data error
30	3.38E-04	1.41E-05
15	0.00E+00	0.00E+00



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 12.19
Length of Test Section: 3.05

Depth, top of bottom of packer: 15.24
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.04865	
1	0.04865	0.00E+00
2	0.04865	0.00E+00
3	0.04865	0.00E+00
4	0.04865	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.04960	
1	0.04985	2.50E-04
2	0.05025	4.00E-04
3	0.05060	3.50E-04
4	0.05080	2.00E-04
5	0.05115	3.50E-04
6	0.05145	3.00E-04
7	0.05175	3.00E-04
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.05240	
1	0.05285	4.50E-04
2	0.05330	4.50E-04
3	0.05375	4.50E-04
4		
5		
6		
7		
8		
9		
10		

Comments flows higher, meter read to .xxx places

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.05450	
1	0.05510	6.00E-04
2	0.05575	6.50E-04
3	0.05640	6.50E-04
4	0.05695	5.50E-04
5	0.05760	6.50E-04
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.05790	
1	0.05845	5.50E-04
2	0.05885	4.00E-04
3	0.05940	5.50E-04
4	0.05980	4.00E-04
5	0.06030	5.00E-04
6	0.06075	4.50E-04
7	0.06125	5.00E-04
8	0.06175	5.00E-04
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.06175	
1	0.06200	2.50E-04
2	0.06235	3.50E-04
3	0.06265	3.00E-04
4	0.06290	2.50E-04
5	0.06320	3.00E-04
6	0.06355	3.50E-04
7		
8		
9		
10		

Comments

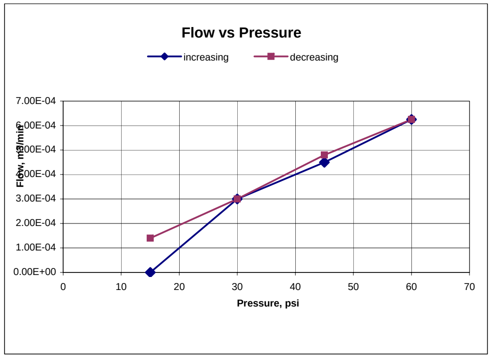
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.06360	
1	0.06365	5.00E-05
2	0.06375	1.00E-04
3	0.06385	1.00E-04
4	0.06410	2.50E-04
5	0.06430	2.00E-04
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 133.55
Bottom (m): 130.50

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	3.00E-04	0.00E+00
45	4.50E-04	6.24E-06
60	6.25E-04	6.04E-06
45	4.80E-04	6.64E-06
30	3.00E-04	6.04E-06
15	1.40E-04	8.05E-06



Project No: 8360
Date: 18-Feb-09
Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74
Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0
Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 9.14
Length of Test Section: 3.05
Depth, top of bottom of packer: 12.19
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.06975	
1	0.07040	6.50E-04
2	0.07050	1.00E-04
3	0.07055	5.00E-05
4	0.07060	5.00E-05
5	0.07060	0.00E+00
6	0.07060	0.00E+00
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87200	
1	0.87245	4.50E-04
2	0.87250	5.00E-05
3	0.87250	0.00E+00
4	0.87250	0.00E+00
5	0.87250	0.00E+00
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87270	
1	0.87270	0.00E+00
2	0.87270	0.00E+00
3	0.87270	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.87280	
1	0.87285	5.00E-05
2	0.87290	5.00E-05
3	0.87295	5.00E-05
4	0.87295	0.00E+00
5	0.87295	0.00E+00
6	0.87295	0.00E+00
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87295	
1	0.87295	0.00E+00
2	0.87295	0.00E+00
3	0.87295	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87295	
1	0.87295	0.00E+00
2	0.87295	0.00E+00
3	0.87295	0.00E+00
4	0.87295	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

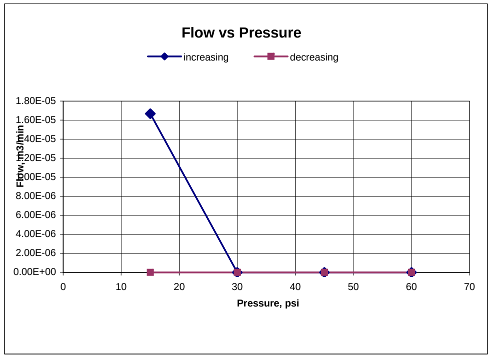
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.87260	
1	0.87260	0.00E+00
2	0.87260	0.00E+00
3	0.87260	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

<u>Test Interval</u>
Top (m): 136.60
Bottom (m): 133.55

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.67E-05	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 6.10
Length of Test Section: 3.05

Depth, top of bottom of packer: 9.14
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.87510	
1	0.87510	0.00E+00
2	0.87510	0.00E+00
3	0.87510	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87540	
1	0.87545	5.00E-05
2	0.87545	0.00E+00
3	0.87545	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87555	
1	0.87555	0.00E+00
2	0.87555	0.00E+00
3	0.87555	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.87560	
1	0.87565	5.00E-05
2	0.87570	5.00E-05
3	0.87570	0.00E+00
4	0.87570	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87570	
1	0.87570	0.00E+00
2	0.87570	0.00E+00
3	0.87570	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87570	
1	0.87570	0.00E+00
2	0.87565	-5.00E-05
3	0.87565	0.00E+00
4	0.87565	0.00E+00
5		
6		
7		
8		
9		
10		

Comments flow reversed in test 2r

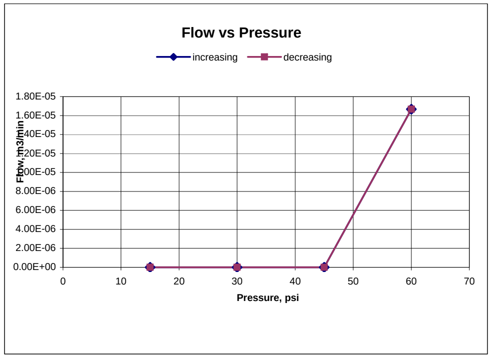
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.87545	
1	0.87545	0.00E+00
2	0.87545	0.00E+00
3	0.87545	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 139.64
Bottom (m): 136.60

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	1.67E-05	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 3.05
Length of Test Section: 3.05

Depth, top of bottom of packer: 6.10
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.09600	
1	0.09950	3.50E-03
2	0.10270	3.20E-03
3	0.10585	3.15E-03
4	0.10895	3.10E-03
5	0.11225	3.30E-03
6	0.11550	3.25E-03
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.11900	
1	0.12390	4.90E-03
2	0.12855	4.65E-03
3	0.13325	4.70E-03
4	0.13780	4.55E-03
5	0.14255	4.75E-03
6	0.14710	4.55E-03
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.15100	
1	0.15870	7.70E-03
2	0.16670	8.00E-03
3	0.17515	8.45E-03
4	0.18445	9.30E-03
5	0.19380	9.35E-03
6	0.20355	9.75E-03
7	0.21315	9.60E-03
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.22300	
1	0.23915	1.62E-02
2	0.25780	1.87E-02
3	0.28200	2.42E-02
flow increase:		
0	0.345	
1	0.404	5.90E-02
2	0.468	6.40E-02
3	0.530	6.20E-02
4	0.588	5.80E-02

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.633	
1	0.680	4.70E-02
2	0.728	4.80E-02
3	0.782	5.40E-02
4	0.840	5.80E-02
5	0.901	6.10E-02
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.947	
1	0.993	4.60E-02
2	1.043	5.00E-02
3	1.095	5.20E-02
4	1.150	5.50E-02
5		
6		
7		
8		
9		
10		

Comments

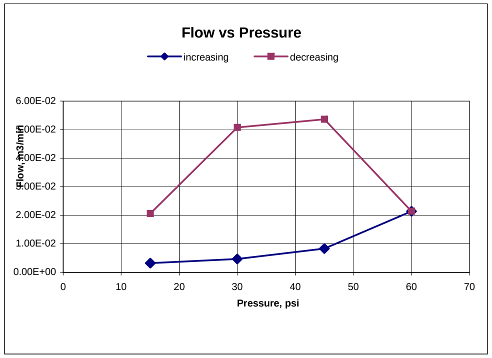
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.1730	
1	0.1948	2.18E-02
2	0.2148	2.00E-02
3	0.2348	2.00E-02
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 142.69
Bottom (m): 139.64

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	3.25E-03	1.23E-04
30	4.70E-03	1.01E-04
45	8.36E-03	1.09E-04
60	2.14E-02	2.01E-04
45	5.36E-02	7.25E-05
30	5.08E-02	1.05E-04
15	2.06E-02	9.86E-04



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 0.91
Length of Test Section: 3.05

Depth, top of bottom of packer: 3.96
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.6460	
1	0.6513	5.30E-03
2	0.6563	5.00E-03
3	0.6612	4.90E-03
4	0.6659	4.70E-03
5		
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Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.6740	
1	0.6887	1.47E-02
2	0.7030	1.43E-02
3	0.7179	1.49E-02
4	0.7332	1.53E-02
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.754	
1	0.786	3.20E-02
2	0.822	3.60E-02
3	0.863	4.10E-02
4	0.912	4.90E-02
5	0.968	5.60E-02
6	1.032	6.40E-02
7	1.107	7.50E-02
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.225	
1	0.355	1.30E-01
2	0.500	1.45E-01
3	0.675	1.75E-01
4	0.855	1.80E-01
5	1.043	1.88E-01
6	1.230	1.87E-01
7	1.422	1.92E-01
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.550	
1	0.734	1.84E-01
2	0.914	1.80E-01
3	1.097	1.83E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.213	
1	0.302	8.90E-02
2	0.394	9.20E-02
3	0.488	9.40E-02
4	0.588	1.00E-01
5		
6		
7		
8		
9		
10		

Comments

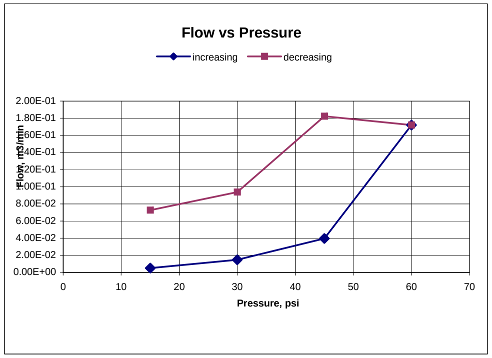
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.664	
1	0.737	7.30E-02
2	0.810	7.30E-02
3	0.882	7.20E-02
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 144.83
Bottom (m): 141.78

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	4.98E-03	2.01E-04
30	1.48E-02	3.02E-04
45	3.95E-02	5.84E-04
60	1.72E-01	1.61E-03
45	1.82E-01	0.00E+00
30	9.38E-02	1.87E-03
15	7.27E-02	3.02E-03



Project No: 8260
Date: 20-Feb-09

Drillers: All Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81

Borehole Depth: 29.08
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 1.52
Length of Test Section: 3.05

Depth, top of bottom of packer: 4.57
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60585	
1	35.60610	0.00025
2	35.60635	0.00025
3	35.60660	0.00025
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60715	
1	35.60735	0.00020
2	35.60755	0.00020
3	35.60770	0.00015
4	35.60780	0.00010
5	35.60795	0.00015
6	35.60810	0.00015
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60825	
1	35.60840	0.00015
2	35.60855	0.00015
3	35.60865	0.00010
4	35.60875	0.00010
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.60890	
1	35.60900	0.00010
2	35.60915	0.00015
3	35.60930	0.00015
4	35.60940	0.00010
5	35.60955	0.00015
6		
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8		
9		
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Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60955	
1	35.60965	0.00010
2	35.60970	0.00005
3	35.60980	0.00010
4	35.60985	0.00005
5	35.60995	0.00010
6		
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8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60995	
1	35.60995	0.00000
2	35.60995	0.00000
3	35.60995	0.00000
4	35.60995	0.00000
5		
6		
7		
8		
9		
10		

Comments

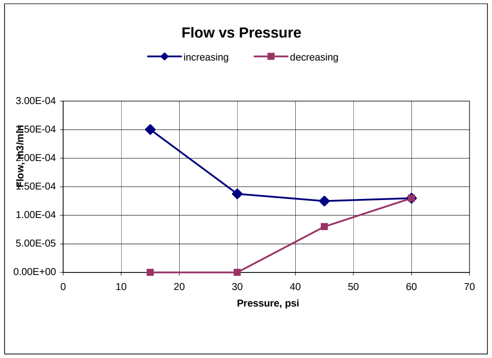
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60985	
1	35.60985	0.00000
2	35.60985	0.00000
3	35.60985	0.00000
4	35.60985	0.00000
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 141.29
Bottom (m): 138.24

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.50E-04	1.01E-05
30	1.37E-04	3.02E-06
45	1.25E-04	1.61E-06
60	1.30E-04	1.41E-06
45	8.00E-05	9.06E-07
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 4.57
Length of Test Section: 3.05

Depth, top of bottom of packer: 7.62
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.69615	
1	35.69620	5.00E-05
2	35.69625	5.00E-05
3	35.69640	1.50E-04
4	35.69655	1.50E-04
5	35.69670	1.50E-04
6		
7		
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9		
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Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.69715	
1	35.69735	2.00E-04
2	35.69755	2.00E-04
3	35.69775	2.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.69800	
1	35.69830	3.00E-04
2	35.69855	2.50E-04
3	35.69875	2.00E-04
4	35.69890	1.50E-04
5	35.69910	2.00E-04
6		
7		
8		
9		
10		

Comments ______

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.69950	
1	35.69975	2.50E-04
2	35.70000	2.50E-04
3	35.70030	3.00E-04
4	35.70060	3.00E-04
5	35.70085	2.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.70085	
1	35.70105	2.00E-04
2	35.70130	2.50E-04
3	35.70155	2.50E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.70160	
1	35.70165	5.00E-05
2	35.70175	1.00E-04
3	35.70185	1.00E-04
4	35.70195	1.00E-04
5		
6		
7		
8		
9		
10		

Comments ______

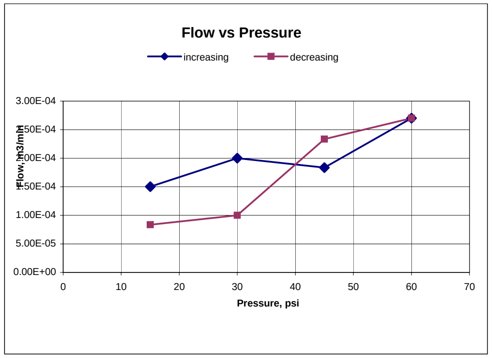
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.70185	
1	35.70190	5.00E-05
2	35.70200	1.00E-04
3	35.70210	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 138.24
Bottom (m): 135.19

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.50E-04	7.45E-06
30	2.00E-04	4.63E-06
45	1.83E-04	3.22E-06
60	2.70E-04	2.82E-06
45	2.33E-04	3.22E-06
30	1.00E-04	2.42E-06
15	8.33E-05	3.22E-06



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 7.62
Length of Test Section: 3.05

Depth, top of bottom of packer: 10.67
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.25010	
1	35.25015	5.00E-05
2	35.25025	1.00E-04
3	35.25035	1.00E-04
4	35.25040	5.00E-05
5	35.25045	5.00E-05
6	35.25055	1.00E-04
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.25075	
1	35.25090	1.50E-04
2	35.25100	1.00E-04
3	35.25120	2.00E-04
4	35.25135	1.50E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.25160	
1	35.25180	2.00E-04
2	35.25200	2.00E-04
3	35.25220	2.00E-04
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.25250	
1	35.25280	3.00E-04
2	35.25320	4.00E-04
3	35.25360	4.00E-04
4	35.25390	3.00E-04
5	35.25430	4.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.25445	
1	35.25475	3.00E-04
2	35.25500	2.50E-04
3	35.25535	3.50E-04
4	35.25565	3.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.25570	
1	35.25580	1.00E-04
2	35.25590	1.00E-04
3	35.25610	2.00E-04
4	35.25625	1.50E-04
5	35.25640	1.50E-04
6		
7		
8		
9		
10		

Comments

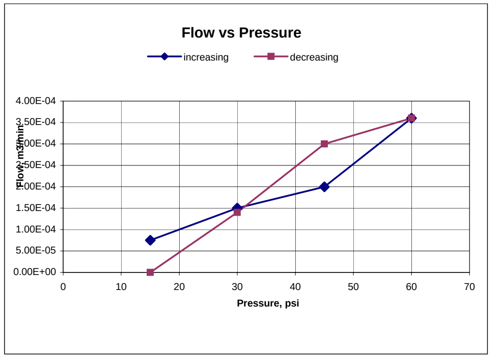
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.25645	
1	35.25645	0.00E+00
2	35.25645	0.00E+00
3	35.25645	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

<u>Test Interval</u>
Top (m): 135.19
Bottom (m): 132.14

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	7.50E-05	3.02E-06
30	1.50E-04	3.02E-06
45	2.00E-04	1.81E-06
60	3.60E-04	4.23E-06
45	3.00E-04	4.23E-06
30	1.40E-04	3.02E-06
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 10.67
Length of Test Section: 3.05

Depth, top of bottom of packer: 13.72
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60255	
1	35.60255	0.00E+00
2	35.60255	0.00E+00
3	35.60255	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60275	
1	35.60285	1.00E-04
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5	35.60285	0.00E+00
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

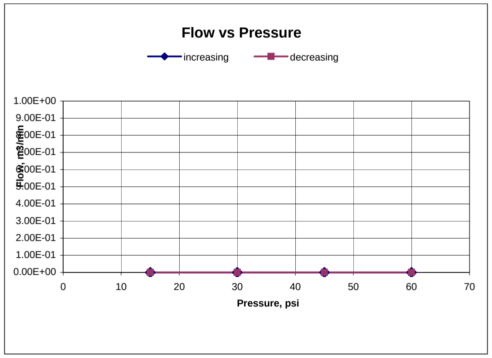
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 132.14
Bottom (m): 129.09

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09
Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL
Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0
Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 13.72
Length of Test Section: 3.05
Depth, top of bottom of packer: 16.76
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.57650	
1	32.57910	2.60E-03
2	32.58165	2.55E-03
3	32.58380	2.15E-03
4	32.58605	2.25E-03
5	32.58815	2.10E-03
6	32.59045	2.30E-03
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.59550	
1	32.60185	6.35E-03
2	32.60750	5.65E-03
3	32.61275	5.25E-03
4	32.61790	5.15E-03
5	32.62290	5.00E-03
6	32.62780	4.90E-03
7	32.63250	4.70E-03
8	32.63720	4.70E-03
9	32.64170	4.50E-03
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.64800	
1	32.65580	7.80E-03
2	32.66300	7.20E-03
3	32.67000	7.00E-03
4	32.67680	6.80E-03
5	32.68365	6.85E-03
6	32.69005	6.40E-03
7	32.69660	6.55E-03
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	32.73000	
1	32.73560	5.60E-03
2	32.74120	5.60E-03
3	32.74680	5.60E-03
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.75100	
1	32.75500	4.00E-03
2	32.75900	4.00E-03
3	32.76300	4.00E-03
4		
5		
6		
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8		
9		
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Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.76600	
1	32.76865	2.65E-03
2	32.77130	2.65E-03
3	32.77390	2.60E-03
4		
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Comments

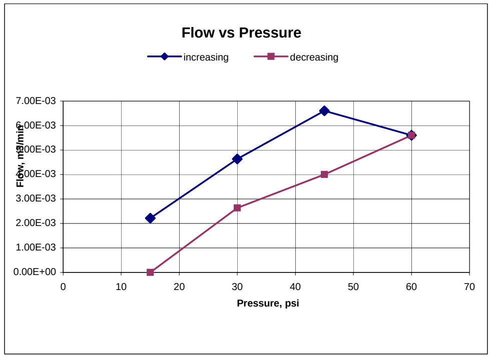
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.77670	
1	32.77770	1.00E-03
2	32.77775	5.00E-05
3	32.77775	0.00E+00
4	32.77775	0.00E+00
5	32.77775	0.00E+00
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 129.09
Bottom (m): 126.05

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.22E-03	8.25E-05
30	4.63E-03	1.05E-04
45	6.60E-03	8.05E-05
60	5.60E-03	5.53E-05
45	4.00E-03	5.64E-05
30	2.63E-03	5.23E-05
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 16.76
Length of Test Section: 3.05

Depth, top of bottom of packer: 19.81
Length of Packer: 3.05

Test No.
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.32240	
1	32.32275	3.50E-04
2	32.32325	5.00E-04
3	32.32370	4.50E-04
4	32.32410	4.00E-04
5	32.32460	5.00E-04
6	32.32400	
7	32.32445	4.50E-04
8	32.32485	4.00E-04
9		
10		

Test No. 0
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.32750	
1	32.32850	1.00E-03
2	32.32940	9.00E-04
3	32.33025	8.50E-04
4	32.33110	8.50E-04
5	32.33195	8.50E-04
6		
7		
8		
9		
10		

Test No. 0
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.33330	
1	32.33460	1.30E-03
2	32.33580	1.20E-03
3	32.33700	1.20E-03
4	32.33725	2.50E-04
5	32.33725	0.00E+00
6	32.33725	0.00E+00
7	32.33725	0.00E+00
8		
9		
10		

Comments

Test No. 0
Pressure: 60

Time (min)	Flow Meter	Diff.
0	32.33725	
1	32.33725	0.00E+00
2	32.33725	0.00E+00
3	32.33725	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 0
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.33725	
1	32.33725	0.00E+00
2	32.33725	0.00E+00
3	32.33725	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 0
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.33725	
1	32.33725	0.00E+00
2	32.33725	0.00E+00
3	32.33725	0.00E+00
4		
5		
6		
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8		
9		
10		

Comments

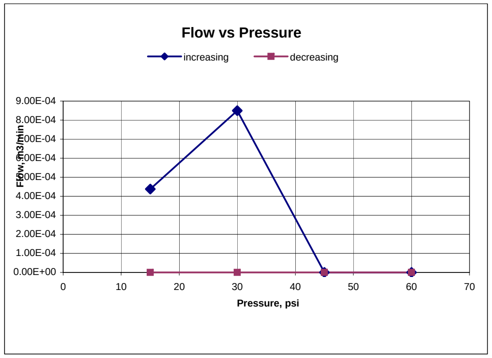
Test No. 0
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.33720	
1	32.33720	0.00E+00
2	32.33720	0.00E+00
3	32.33720	0.00E+00
4	32.33720	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 126.05
Bottom (m): 123.00

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	4.37E-04	1.61E-05
30	8.50E-04	1.61E-05
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 29.08
Test Hole No: 11-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.7
Surface Elevation: 142.81 m ASL
Water Level: 0
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 19.81
Depth, top of bottom of packer: 22.86
Length of Test Section: 3.05
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.18675	
1	32.18680	5.00E-05
2	32.18685	5.00E-05
3	32.18690	5.00E-05
4		
5		
6		
7		
8		
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Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.18745	
1	32.18760	1.50E-04
2	32.18770	1.00E-04
3	32.18790	2.00E-04
4	32.18805	1.50E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.18835	
1	32.18845	1.00E-04
2	32.18845	0.00E+00
3	32.18845	0.00E+00
4	32.18845	0.00E+00
5	32.18845	0.00E+00
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	32.18865	
1	32.18875	1.00E-04
2	32.18875	0.00E+00
3	32.18895	2.00E-04
4	32.18920	2.50E-04
5	32.18945	2.50E-04
6	32.18970	2.50E-04
7		
8		
9		
610		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.18975	
1	32.18990	1.50E-04
2	32.18990	0.00E+00
3	32.18990	0.00E+00
4	32.18990	0.00E+00
5	32.18990	0.00E+00
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.18990	
1	32.18990	0.00E+00
2	32.18990	0.00E+00
3	32.18990	0.00E+00
4	32.18990	0.00E+00
5	32.18990	0.00E+00
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.18990	
1	32.18990	0.00E+00
2	32.18990	0.00E+00
3	32.18990	0.00E+00
4	32.18990	0.00E+00
5	32.18990	0.00E+00
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7		
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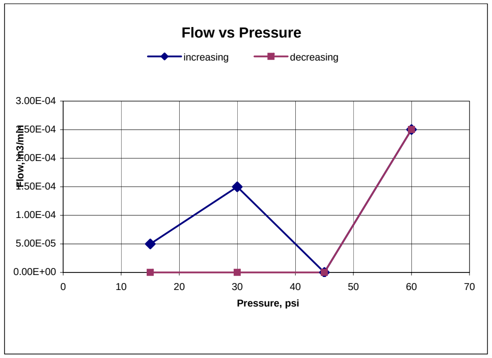
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 123.00
Bottom (m): 119.95

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.00E-05	1.61E-06
30	1.50E-04	3.02E-06
45	0.00E+00	0.00E+00
60	2.50E-04	2.82E-06
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 22.86
Length of Test Section: 3.05

Depth, top of bottom of packer: 25.91
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.16545	
1	30.16575	3.00E-04
2	30.16600	2.50E-04
3	30.16630	3.00E-04
4	30.16650	2.00E-04
5	30.16670	2.00E-04
6	30.16685	1.50E-04
7	30.16705	2.00E-04
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9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.16760	
1	30.16790	3.00E-04
2	30.16820	3.00E-04
3	30.16855	3.50E-04
4	30.16885	3.00E-04
5		
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9		
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Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.16940	
1	30.17000	6.00E-04
2	30.17065	6.50E-04
3	30.17125	6.00E-04
4	30.17185	6.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	30.17250	
1	30.17325	7.50E-04
2	30.17395	7.00E-04
3	30.17475	8.00E-04
4	30.17545	7.00E-04
5	30.17615	7.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.17670	
1	30.17730	6.00E-04
2	30.17790	6.00E-04
3	30.17850	6.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.17880	
1	30.17930	5.00E-04
2	30.17975	4.50E-04
3	30.18020	4.50E-04
4	30.18070	5.00E-04
5	30.18115	4.50E-04
6		
7		
8		
9		
10		

Comments

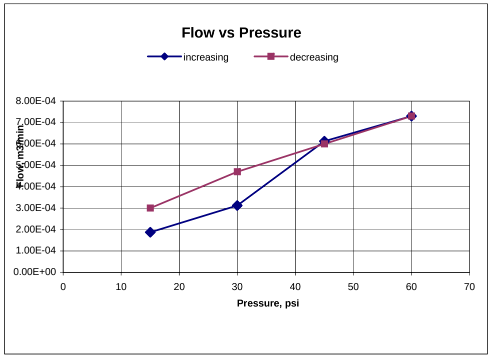
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.18130	
1	30.18155	2.50E-04
2	30.18185	3.00E-04
3	30.18220	3.50E-04
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 119.95
Bottom (m): 116.90

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.88E-04	7.25E-06
30	3.12E-04	6.24E-06
45	6.12E-04	7.45E-06
60	7.30E-04	7.04E-06
45	6.00E-04	7.45E-06
30	4.70E-04	0.00E+00
15	3.00E-04	0.00E+00



Project No: 08360
Date: 00-Jan-00

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 25.91
Length of Test Section: 3.05

Depth, top of bottom of packer: 28.96
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.16030	
1	30.16045	1.50E-04
2	30.16050	5.00E-05
3	30.16060	1.00E-04
4	30.16060	0.00E+00
5	30.16060	0.00E+00
6	30.16070	1.00E-04
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.16085	
1	30.16095	1.00E-04
2	30.16110	1.50E-04
3	30.16120	1.00E-04
4	30.16120	0.00E+00
5	30.16120	0.00E+00
6	30.16120	0.00E+00
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.16145	
1	30.16150	5.00E-05
2	30.16150	0.00E+00
3	30.16160	1.00E-04
4	30.16175	1.50E-04
5	30.16190	1.50E-04
6	30.16210	2.00E-04
7	30.16210	0.00E+00
8	30.16210	0.00E+00
9	30.16230	2.00E-04
10	30.16245	1.50E-04

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	30.16265	
1	30.16290	2.50E-04
2	30.16320	3.00E-04
3	30.16350	3.00E-04
4	30.16375	2.50E-04
5	30.16400	2.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.16410	
1	30.16430	2.00E-04
2	30.16455	2.50E-04
3	30.16475	2.00E-04
4	30.16495	2.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.16500	
1	30.16515	1.50E-04
2	30.16515	0.00E+00
3	30.16515	0.00E+00
4	30.16515	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

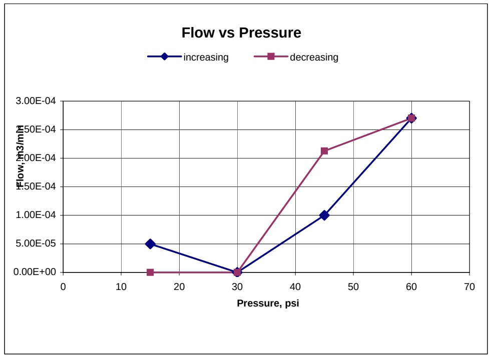
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.16515	
1	30.16515	0.00E+00
2	30.16515	0.00E+00
3	30.16515	0.00E+00
4	30.16515	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 116.90
Bottom (m): 113.85

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.00E-05	1.71E-06
30	0.00E+00	0.00E+00
45	1.00E-04	1.51E-06
60	2.70E-04	2.82E-06
45	2.12E-04	3.22E-06
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 00-Jan-00
Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 29.08
Test Hole No: 11-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.6
Surface Elevation: 142.81 m ASL
Water Level: 0
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 27.43
Depth, top of bottom of packer: 29.08
Length of Test Section: 1.65
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	29.94700	
1	29.94770	7.00E-04
2	29.94790	2.00E-04
3	29.94810	2.00E-04
4	29.94830	2.00E-04
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	29.94935	
1	29.94965	3.00E-04
2	29.94990	2.50E-04
3	29.95015	2.50E-04
4	29.95030	1.50E-04
5	29.95040	1.00E-04
6	29.95055	1.50E-04
7	29.95070	1.50E-04
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	29.95100	
1	29.95115	1.50E-04
2	29.95135	2.00E-04
3	29.95155	2.00E-04
4	29.95170	1.50E-04
5	29.95180	1.00E-04
6	29.95195	1.50E-04
7	29.95215	2.00E-04
8	29.95230	1.50E-04
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	29.95270	
1	29.95295	2.50E-04
2	29.95320	2.50E-04
3	29.95350	3.00E-04
4	29.95370	2.00E-04
5	29.95370	0.00E+00
6	29.95370	0.00E+00
7	29.95370	0.00E+00
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	29.95370	
1	29.95370	0.00E+00
2	29.95370	0.00E+00
3	29.95370	0.00E+00
4	29.95370	0.00E+00
5	29.95370	0.00E+00
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	29.95370	
1	29.95370	0.00E+00
2	29.95370	0.00E+00
3	29.95370	0.00E+00
4	29.95370	0.00E+00
5		
6		
7		
8		
9		
10		

Comments flow reversed between 2r and 1r

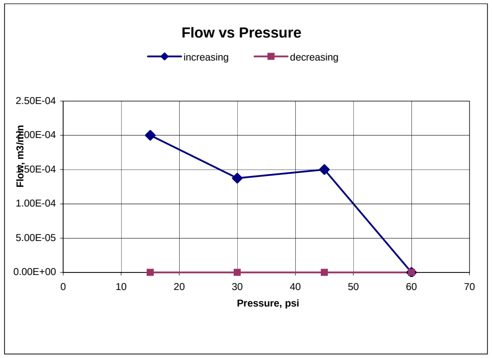
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	29.95350	
1	29.95350	0.00E+00
2	29.95350	0.00E+00
3	29.95350	0.00E+00
4	29.95350	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 115.38
Bottom (m): 113.73

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.00E-04	1.45E-05
30	1.38E-04	6.04E-06
45	1.50E-04	3.82E-06
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 10.67
Length of Test Section: 1.52

Depth, top of bottom of packer: 12.19
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.6155	
1	35.6157	2.00E-04
2	35.6158	1.00E-04
3	35.6160	2.00E-04
4	35.6162	1.50E-04
5	35.6163	1.50E-04
6	35.6165	1.50E-04
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.61770	
1	35.61785	1.50E-04
2	35.61795	1.00E-04
3	35.61815	2.00E-04
4	35.61825	1.00E-04
5	35.61840	1.50E-04
6	35.61855	1.50E-04
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.61895	
1	35.61915	2.00E-04
2	35.61935	2.00E-04
3	35.61950	1.50E-04
4	35.61950	0.00E+00
5	35.61950	0.00E+00
6	35.61955	5.00E-05
7	35.61970	1.50E-04
8	35.61975	5.00E-05
9	35.61975	0.00E+00
10	35.61980	5.00E-05

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.62015	
1	35.62035	2.00E-04
2	35.62040	5.00E-05
3	35.62040	0.00E+00
4	35.62040	0.00E+00
5	35.62040	0.00E+00
6		
7		
8		
9		
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Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.62040	
1	35.62040	0.00E+00
2	35.62040	0.00E+00
3	35.62040	0.00E+00
4	35.62040	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.62025	
1	35.62025	0.00E+00
2	35.62025	0.00E+00
3	35.62025	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments flow reversed between 3r and 2r

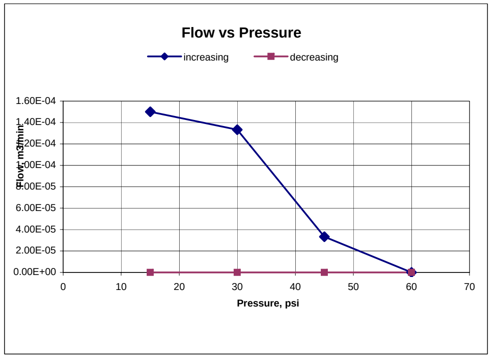
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.61975	
1	35.61975	0.00E+00
2	35.61975	0.00E+00
3	35.61975	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 129.61
Bottom (m): 128.09

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.50E-04	1.21E-05
30	1.33E-04	6.04E-06
45	3.33E-05	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 9.14
Length of Test Section: 1.52

Depth, top of bottom of packer: 10.67
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.6518	
1	35.6518	0.00E+00
2	35.6518	0.00E+00
3	35.6522	4.00E-04
4	35.6529	7.50E-04
5	35.6531	1.50E-04
6	35.6532	1.50E-04
7	35.6533	5.00E-05
8	35.6534	1.00E-04
9	35.6535	1.00E-04
10	35.6536	1.00E-04

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.5543	
1	35.5550	7.00E-04
2	35.5559	9.00E-04
3	35.5568	9.50E-04
4	35.5575	7.00E-04
5	35.5580	4.50E-04
6	35.5589	9.50E-04
7	35.5594	4.50E-04
8	35.5597	3.00E-04
9	35.5600	3.00E-04
10	35.5604	4.50E-04

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.5611	
1	35.5615	3.50E-04
2	35.5618	3.00E-04
3	35.5621	3.00E-04
4	35.5624	3.50E-04
5	35.5627	3.00E-04
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.5630	
1	35.5634	4.00E-04
2	35.5637	3.00E-04
3	35.5641	3.50E-04
4	35.5644	3.50E-04
5	35.5648	3.50E-04
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.5648	
1	35.5652	3.50E-04
2	35.5656	4.00E-04
3	35.5659	3.00E-04
4	35.5663	4.00E-04
5	35.5666	3.50E-04
6	35.5670	3.50E-04
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.5670	
1	35.5673	3.50E-04
2	35.5677	3.50E-04
3	35.5680	3.00E-04
4	35.5683	3.50E-04
5		
6		
7		
8		
9		
10		

Comments

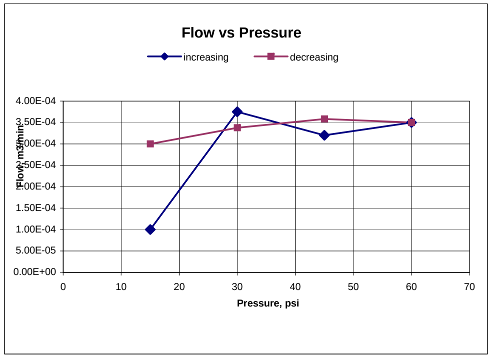
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.5684	
1	35.5685	1.00E-04
2	35.5688	2.50E-04
3	35.5691	3.00E-04
4	35.5694	3.00E-04
5	35.5697	3.00E-04
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 131.14
Bottom (m): 129.61

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.00E-04	9.26E-06
30	3.75E-04	1.65E-05
45	3.20E-04	8.05E-06
60	3.50E-04	6.44E-06
45	3.58E-04	9.26E-06
30	3.38E-04	1.49E-05
15	3.00E-04	2.42E-05



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Test Hole No: 12-1
Surface Elevation: 140.28

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 7.62
Length of Test Section: 1.52

Depth, top of bottom of packer: 9.14
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	37.56965	
1	37.56970	5.00E-05
2	37.56970	0.00E+00
3	37.56970	0.00E+00
4	37.56970	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	37.56995	
1	37.57000	5.00E-05
2	37.57000	0.00E+00
3	37.57000	0.00E+00
4	37.57000	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	37.57020	
1	37.57035	1.50E-04
2	37.57035	0.00E+00
3	37.57035	0.00E+00
4	37.57035	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	37.57050	
1	37.57060	1.00E-04
2	37.57065	5.00E-05
3	37.57065	0.00E+00
4	37.57065	0.00E+00
5	37.57065	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	37.57065	
1	37.57065	0.00E+00
2	37.57065	0.00E+00
3	37.57065	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	37.57065	
1	37.57065	0.00E+00
2	37.57065	0.00E+00
3	37.57065	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

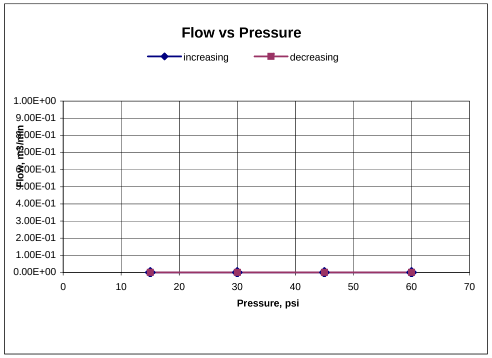
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	37.57065	
1	37.57065	0.00E+00
2	37.57065	0.00E+00
3	37.57065	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 132.66
Bottom (m): 131.14

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Gorrell Resource Investigations

Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 6.10
Length of Test Section: 1.52

Depth, top of bottom of packer: 7.62
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	37.99885	
1	37.99890	5.00E-05
2	37.99890	0.00E+00
3	37.99895	5.00E-05
4	37.99895	0.00E+00
5	37.99895	0.00E+00
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	37.99970	
1	37.99970	0.00E+00
2	37.99970	0.00E+00
3	37.99970	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	37.99980	
1	37.99980	0.00E+00
2	37.99980	0.00E+00
3	37.99980	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	38.00010	
1	38.00015	5.00E-05
2	38.00015	0.00E+00
3	38.00015	0.00E+00
4	38.00015	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.00015	
1	38.00015	0.00E+00
2	38.00015	0.00E+00
3	38.00015	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.00015	
1	38.00015	0.00E+00
2	38.00015	0.00E+00
3	38.00015	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

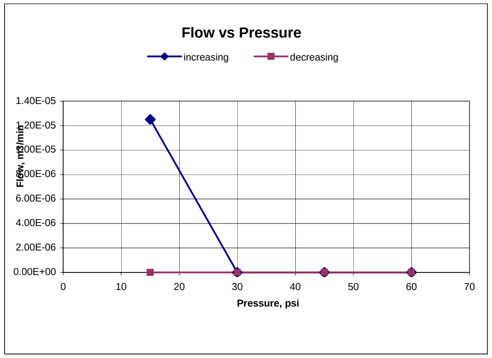
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.00025	
1	38.00025	0.00E+00
2	38.00025	0.00E+00
3	38.00025	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 134.18
Bottom (m): 132.66

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.25E-05	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 1.7

Depth, bottom of top of packer: 4.57
Length of Test Section: 1.52

Depth, top of bottom of packer: 6.10
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48000	
1	38.48000	0.00E+00
2	38.48000	0.00E+00
3	38.48000	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.48030	
1	38.48035	5.00E-05
2	38.48035	0.00E+00
3	38.48035	0.00E+00
4	38.48035	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.48065	
1	38.48065	0.00E+00
2	38.48065	0.00E+00
3	38.48065	0.00E+00
4	38.48065	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	38.48070	
1	38.48070	0.00E+00
2	38.48070	0.00E+00
3	38.48070	0.00E+00
4	38.48070	0.00E+00
5	38.48070	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.58070	
1	38.58070	0.00E+00
2	38.58070	0.00E+00
3	38.58070	0.00E+00
4	38.58070	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.58065	
1	38.58065	0.00E+00
2	38.58065	0.00E+00
3	38.58065	0.00E+00
4	38.58065	0.00E+00
5	38.58065	0.00E+00
6	38.58065	0.00E+00
7		
8		
9		
10		

Comments

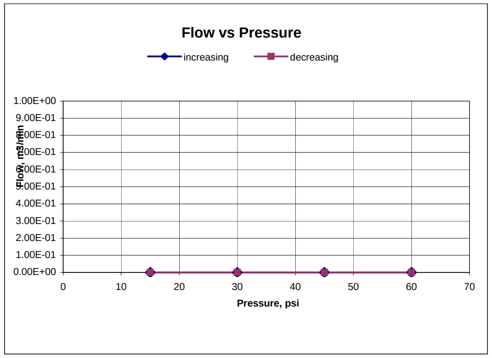
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48030	
1	38.48030	0.00E+00
2	38.48030	0.00E+00
3	38.48030	0.00E+00
4	38.48030	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 135.71
Bottom (m): 134.18

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 3.05
Length of Test Section: 1.52

Depth, top of bottom of packer: 4.57
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48070	
1	38.48070	0.00E+00
2	38.48070	0.00E+00
3	38.48070	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.48020	
1	38.48025	5.00E-05
2	38.48035	1.00E-04
3	38.48035	0.00E+00
4	38.48040	5.00E-05
5	38.48040	0.00E+00
6	38.48040	0.00E+00
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.48165	
1	38.48180	1.50E-04
2	38.48190	1.00E-04
3	38.48195	5.00E-05
4	38.48195	0.00E+00
5	38.48195	0.00E+00
6	38.48195	0.00E+00
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	38.48230	
1	38.48230	0.00E+00
2	38.48230	0.00E+00
3	38.48230	0.00E+00
4	38.48230	0.00E+00
5	38.48230	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.28230	
1	38.28230	0.00E+00
2	38.28230	0.00E+00
3	38.28230	0.00E+00
4	38.28230	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.28230	
1	38.28230	0.00E+00
2	38.28230	0.00E+00
3	38.28230	0.00E+00
4	38.28230	0.00E+00
5	38.28230	0.00E+00
6		
7		
8		
9		
10		

Comments

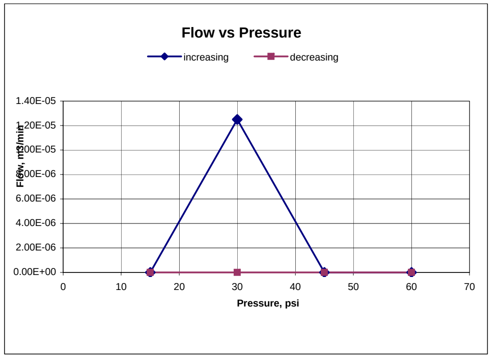
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48215	
1	38.48215	0.00E+00
2	38.48215	0.00E+00
3	38.48215	0.00E+00
4	38.48215	0.00E+00
5	38.48215	0.00E+00
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 137.23
Bottom (m): 135.71

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	1.25E-05	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Gorrell Resource Investigations

Project No: 8360
Date: 24-Feb-09

Drillers: All terrain
Representing GRI: GAG

Test Hole No: 12-1 T1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0.7

Depth, bottom of top of packer: 1.52
Length of Test Section: 1.52

Depth, top of bottom of packer: 3.05
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	39.18105	
1	39.18105	0.00E+00
2	39.18105	0.00E+00
3	39.18105	0.00E+00
4	39.18105	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	39.18135	
1	39.18135	0.00E+00
2	39.18135	0.00E+00
3	39.18135	0.00E+00
4	39.18135	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	39.18165	
1	39.18165	0.00E+00
2	39.18165	0.00E+00
3	39.18165	0.00E+00
4	39.18165	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	39.18200	
1	39.18285	8.50E-04
2	39.18360	7.50E-04
3	39.18500	1.40E-03
4	39.19260	7.60E-03
5	39.22700	3.44E-02
6	39.29300	6.60E-02
7	39.37700	8.40E-02
8		
9		
10		

Test No.
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test No.
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Comments

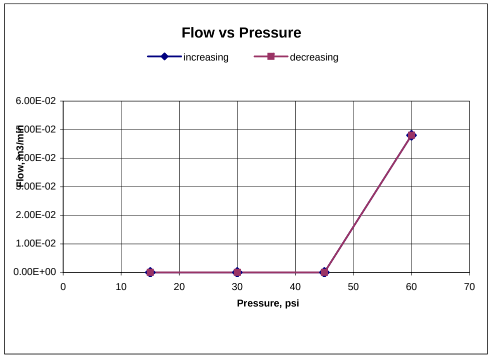
Test No.
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test Hole No: 12-1

Test Interval
Top (m): 138.76
Bottom (m): 137.23

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	4.80E-02	9.26E-04
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: All terrain
Representing GRI: GAG

Test Hole No: 12-1 T2
Surface Elevation: 140.28

Borehole Depth: 12.19
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0.7

Depth, bottom of top of packer: 1.52
Length of Test Section: 1.52

Depth, top of bottom of packer: 3.05
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	40.55000	
1	40.60300	5.30E-02
2	40.65600	5.30E-02
3	40.71200	5.60E-02
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	40.76100	
1	40.87800	1.17E-01
2	40.99500	1.17E-01
3	41.11400	1.19E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	41.19000	
1	41.35900	1.69E-01
2	41.52900	1.70E-01
3	41.69800	1.69E-01
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	41.83000	
1	42.04000	2.10E-01
2	42.25800	2.18E-01
3	42.45700	1.99E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	42.59000	
1	42.71500	1.25E-01
2	42.84000	1.25E-01
3	43.11400	2.74E-01
4	43.28700	1.73E-01
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	43.36000	
1	43.52700	1.67E-01
2	43.66000	1.33E-01
3	43.79600	1.36E-01
4		
5		
6		
7		
8		
9		
10		

Comments

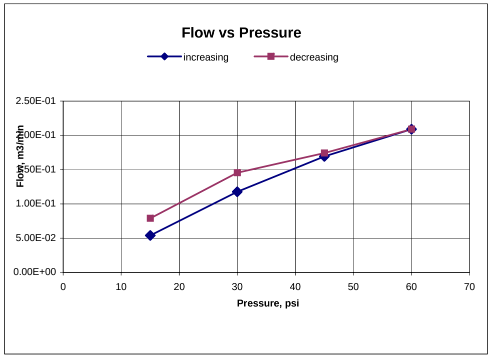
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	43.88000	
1	43.96900	8.90E-02
2	44.03800	6.90E-02
3		
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 138.76
Bottom (m): 137.23

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.40E-02	5.23E-03
30	1.18E-01	5.23E-03
45	1.69E-01	4.83E-03
60	2.09E-01	3.82E-03
45	1.74E-01	5.03E-03
30	1.45E-01	6.04E-03
15	7.90E-02	6.84E-03



Project No: 8360
Date: 26-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 13-1
Surface Elevation: 139.41

Borehole Depth: 10.67
Radius of Borehole: 0
Water Level: 1.267968

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 1.8

Depth, bottom of top of packer: 9.14
Length of Test Section: 1.52

Depth, top of bottom of packer: 10.67
Length of Packer: 1.52

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11460	
1	44.11460	0.00E+00
2	44.11465	5.00E-05
3	44.11465	0.00E+00
4	44.11470	5.00E-05
5	44.11475	5.00E-05
6	44.11480	5.00E-05
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11535	
1	44.11545	1.00E-04
2	44.11545	0.00E+00
3	44.11545	0.00E+00
4	44.11555	1.00E-04
5	44.11560	5.00E-05
6	44.11565	5.00E-05
7	44.11570	5.00E-05
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11605	
1	44.11615	1.00E-04
2	44.11630	1.50E-04
3	44.11635	5.00E-05
4	44.11645	1.00E-04
5	44.11650	5.00E-05
6	44.11655	5.00E-05
7	44.11660	5.00E-05
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.11680	
1	44.11685	5.00E-05
2	44.11690	5.00E-05
3	44.11690	0.00E+00
4	44.11695	5.00E-05
5	44.11700	5.00E-05
6	44.11705	5.00E-05
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11705	
1	44.11705	0.00E+00
2	44.11705	0.00E+00
3	44.11705	0.00E+00
4	44.11705	0.00E+00
5	44.11705	0.00E+00
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11695	
1	44.11695	0.00E+00
2	44.11695	0.00E+00
3	44.11695	0.00E+00
4	44.11695	0.00E+00
5		
6		
7		
8		
9		
10		

Comments flow reversed between 3r and 2r, 2r and 1r

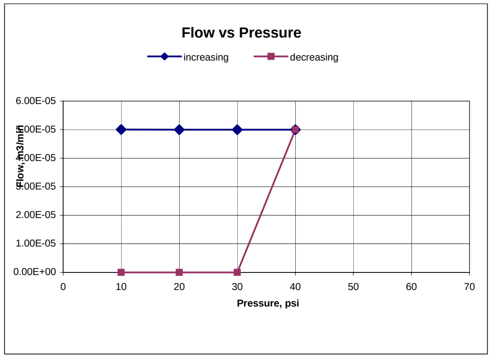
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11685	
1	44.11685	0.00E+00
2	44.11685	0.00E+00
3	44.11685	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 130.27
Bottom (m): 128.74

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	5.00E-05	0.00E+00
20	5.00E-05	0.00E+00
30	5.00E-05	0.00E+00
40	5.00E-05	0.00E+00
30	0.00E+00	0.00E+00
20	0.00E+00	0.00E+00
10	0.00E+00	0.00E+00



Project No: 8360
Date: 26-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 13-1
Surface Elevation: 139.41

Borehole Depth: 10.67
Radius of Borehole: 0
Water Level: 1.267968

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 1.4

Depth, bottom of top of packer: 7.62
Length of Test Section: 1.52

Depth, top of bottom of packer: 9.14
Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11710	
1	44.11720	1.00E-04
2	44.11725	5.00E-05
3	44.11730	5.00E-05
4	44.11735	5.00E-05
5	44.11740	5.00E-05
6		
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11740	
1	44.11740	0.00E+00
2	44.11740	0.00E+00
3	44.11740	0.00E+00
4	44.11745	5.00E-05
5	44.11745	0.00E+00
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11755	
1	44.11765	1.00E-04
2	44.11775	1.00E-04
3	44.11785	1.00E-04
4	44.11795	1.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.11820	
1	44.11830	1.00E-04
2	44.11835	5.00E-05
3	44.11845	1.00E-04
4	44.11850	5.00E-05
5	44.11855	5.00E-05
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11860	
1	44.11860	0.00E+00
2	44.11860	0.00E+00
3	44.11865	5.00E-05
4	44.11870	5.00E-05
5	44.11875	5.00E-05
6	44.11885	1.00E-04
7	44.11895	1.00E-04
8	44.11905	1.00E-04
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11895	
1	44.11895	0.00E+00
2	44.11900	5.00E-05
3	44.11905	5.00E-05
4	44.11910	5.00E-05
5	44.11915	5.00E-05
6		
7		
8		
9		
10		

Comments reverse flow in 2r and 1r

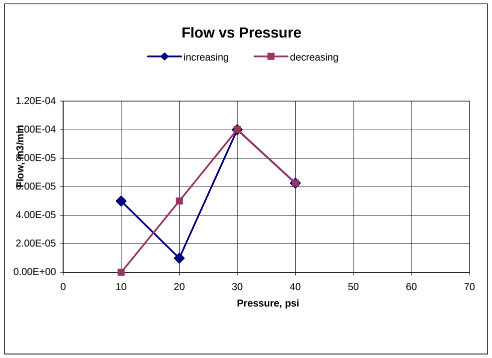
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11905	
1	44.11905	0.00E+00
2	44.11905	0.00E+00
3	44.11905	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 131.79
Bottom (m): 130.27

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	5.00E-05	0.00E+00
20	1.00E-05	0.00E+00
30	1.00E-04	0.00E+00
40	6.25E-05	0.00E+00
30	1.00E-04	0.00E+00
20	5.00E-05	0.00E+00
10	0.00E+00	0.00E+00



Project No: 8360

Date: 26-Feb-09

Drillers: all terrain

Representing GRI: GAG

Test Hole No: 13-1

Surface Elevation: 139.41

Borehole Depth: 10.67

Radius of Borehole: 0

Water Level: 1.277112

Ht Press. Gauge, above G.S: 0.7

Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 6.10

Length of Test Section: 1.52

Depth, top of bottom of packer: 7.62

Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.12065	
1	44.12080	1.50E-04
2	44.12095	1.50E-04
3	44.12115	2.00E-04
4	44.12140	2.50E-04
5	44.12155	1.50E-04
6	44.12170	1.50E-04
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.12280	
1	44.12320	4.00E-04
2	44.12360	4.00E-04
3	44.12400	4.00E-04
4	44.12440	4.00E-04
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.12515	
1	44.12605	9.00E-04
2	44.12685	8.00E-04
3	44.12775	9.00E-04
4	44.12855	8.00E-04
5	44.12940	8.50E-04
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.13050	
1	44.13165	1.15E-03
2	44.13280	1.15E-03
3	44.13395	1.15E-03
4	44.13510	1.15E-03
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.13450	
1	44.13510	6.00E-04
2	44.13580	7.00E-04
3	44.13655	7.50E-04
4	44.13715	6.00E-04
5	44.13785	7.00E-04
6	44.13850	6.50E-04
7	44.13910	6.00E-04
8		
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.13920	
1	44.13960	4.00E-04
2	44.13995	3.50E-04
3	44.14040	4.50E-04
4	44.14075	3.50E-04
5	44.14120	4.50E-04
6		
7		
8		
9		
10		

Comments

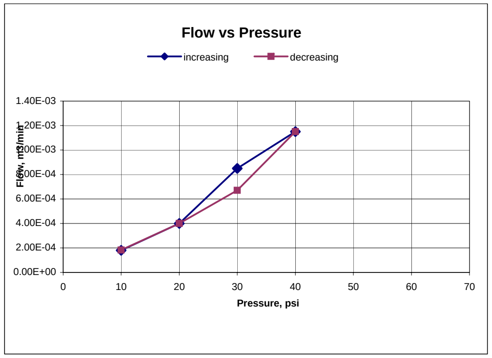
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.14125	
1	44.14155	3.00E-04
2	44.14175	2.00E-04
3	44.14190	1.50E-04
4	44.14210	2.00E-04
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 133.31
Bottom (m): 131.79

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	1.80E-04	2.82E-05
20	4.00E-04	1.85E-05
30	8.50E-04	2.82E-05
40	1.15E-03	3.14E-05
30	6.70E-04	2.33E-05
20	4.00E-04	1.93E-05
10	1.83E-04	2.82E-05



Project No: 8360
Date: 26-Feb-09
Drillers: all terrain
Representing GRI: GAG

Test Hole No: 13-1
Surface Elevation: 139.41
Borehole Depth: 10.67
Radius of Borehole: 0
Water Level: 1.277112
Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 4.57
Length of Test Section: 1.52
Depth, top of bottom of packer: 6.10
Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.14075	
1	44.14075	0.00E+00
2	44.14080	5.00E-05
3	44.14080	0.00E+00
4	44.14080	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.14155	
1	44.14155	0.00E+00
2	44.14155	0.00E+00
3	44.14155	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.14200	
1	44.14200	0.00E+00
2	44.14200	0.00E+00
3	44.14200	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.14240	
1	44.14245	5.00E-05
2	44.14245	0.00E+00
3	44.14245	0.00E+00
4	44.14245	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.14230	
1	44.14220	-1.00E-04
2	44.14220	0.00E+00
3	44.14220	0.00E+00
4	44.14220	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.14180	
1	44.14180	0.00E+00
2	44.14180	0.00E+00
3	44.14180	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments back pressure in 1r

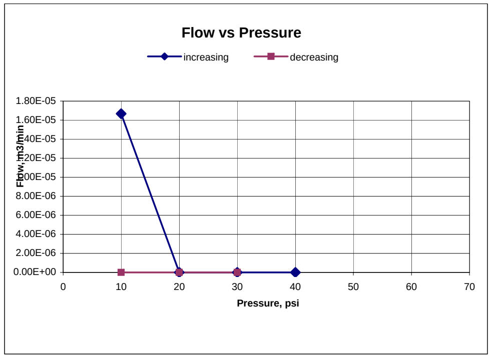
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.14130	
1	44.14130	0.00E+00
2	44.14130	0.00E+00
3	44.14125	-5.00E-05
4	44.14125	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 134.84
Bottom (m): 133.31

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	1.67E-05	0.00E+00
20	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
40	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
20	0.00E+00	0.00E+00
10	0.00E+00	0.00E+00



Project No: 08360
Date: 26-Feb-09
Drillers: All terrain
Representing GRI: GAG

Test Hole No: 13-1
Surface Elevation: 139.41
Borehole Depth: 9.14
Radius of Borehole: 0
Water Level: 1.267968
Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 3.05
Length of Test Section: 1.52
Depth, top of bottom of packer: 4.57
Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.25000	
1	44.36900	1.19E-01
2	44.48900	1.20E-01
3	44.60500	1.16E-01
4	44.72300	1.18E-01
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.81200	
1	44.97100	1.59E-01
2	45.12300	1.52E-01
3	45.27200	1.49E-01
4	45.42500	1.53E-01
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.60000	
1	44.77800	1.78E-01
2	44.95100	1.73E-01
3	45.13400	1.83E-01
4	45.30000	1.66E-01
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	46.50000	
1	46.70000	2.00E-01
2	46.90800	2.08E-01
3	47.11200	2.04E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Comments

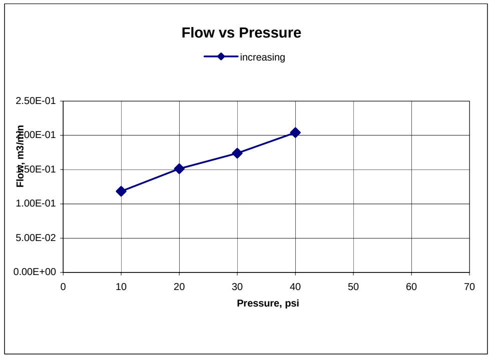
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 136.36
Bottom (m): 134.84

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	1.18E-01	1.05E-02
20	1.51E-01	6.44E-03
30	1.74E-01	6.04E-03
40	2.04E-01	6.04E-03



Appendix I
Hvorslev Test Data and Analysis
(TW 9 – 13)

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 04-May-09

Test Hole No: 09 BH 9-1

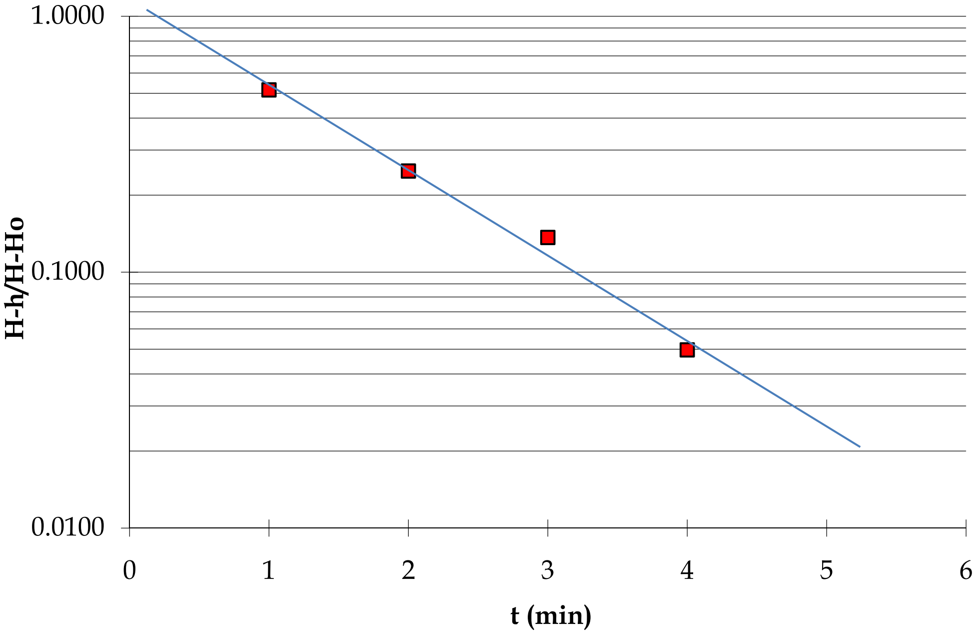
H: **23.51** **H - Ho:** -1.61

Ho: **25.12** **To:** 1.50E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	25.120		25.12	-1.61	1.0000
1	24.340		24.34	-0.83	0.5155
2	23.910		23.91	-0.40	0.2484
3	23.730		23.73	-0.22	0.1366
4	23.590		23.59	-0.08	0.0497
5	23.520		23.52	-0.01	0.0062

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.50E+00	2.09E-06

BH 9-1



Gorrell Resource
Investigations

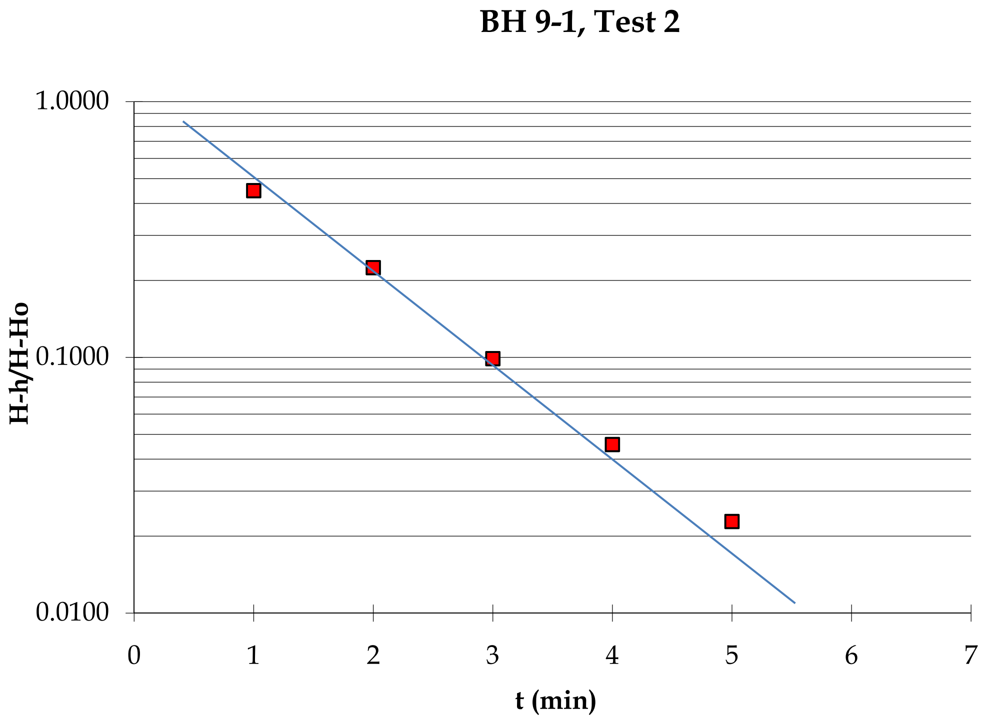
Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 04-May-09
Test Hole No: 09 BH 9-1

H: **23.51** **H - Ho:** -2.63
Ho: **26.14** **To:** 1.23E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	26.140		26.14	-2.63	1.0000
1	24.690		24.69	-1.18	0.4487
2	24.100		24.10	-0.59	0.2243
3	23.770		23.77	-0.26	0.0989
4	23.630		23.63	-0.12	0.0456
5	23.570		23.57	-0.06	0.0228
6	23.520		23.52	-0.01	0.0038
7	23.510		23.51	0.00	0.0000

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.23E+00	2.54E-06



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

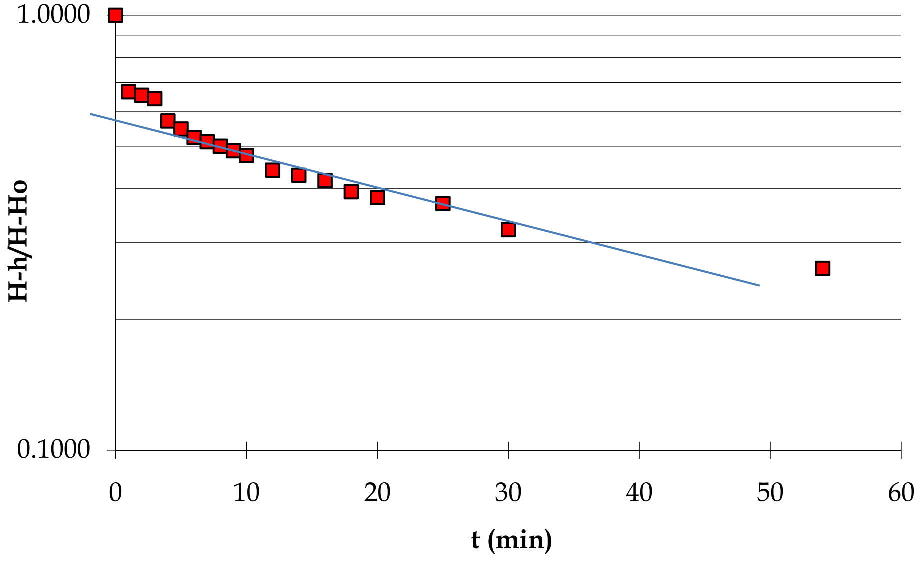
Job:	08360	**Date:**	04-May-09
Test Hole No:	09 BH 9-2		

H:	**11.56**	**H - Ho:**	-0.84
Ho:	**12.40**	**To:**	2.22E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	12.400		12.40	-0.84	1.0000
1	12.120		12.12	-0.56	0.6667
2	12.110		12.11	-0.55	0.6548
3	12.100		12.10	-0.54	0.6429
4	12.040		12.04	-0.48	0.5714
5	12.020		12.02	-0.46	0.5476
6	12.000		12.00	-0.44	0.5238
7	11.990		11.99	-0.43	0.5119
8	11.980		11.98	-0.42	0.5000
9	11.970		11.97	-0.41	0.4881
10	11.960		11.96	-0.40	0.4762
12	11.930		11.93	-0.37	0.4405
14	11.920		11.92	-0.36	0.4286
16	11.910		11.91	-0.35	0.4167
18	11.890		11.89	-0.33	0.3929
20	11.880		11.88	-0.32	0.3810
25	11.870		11.87	-0.31	0.3690
30	11.830		11.83	-0.27	0.3214
54	11.780		11.78	-0.22	0.2619

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.22E+01	1.41E-07

BH 9-2



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

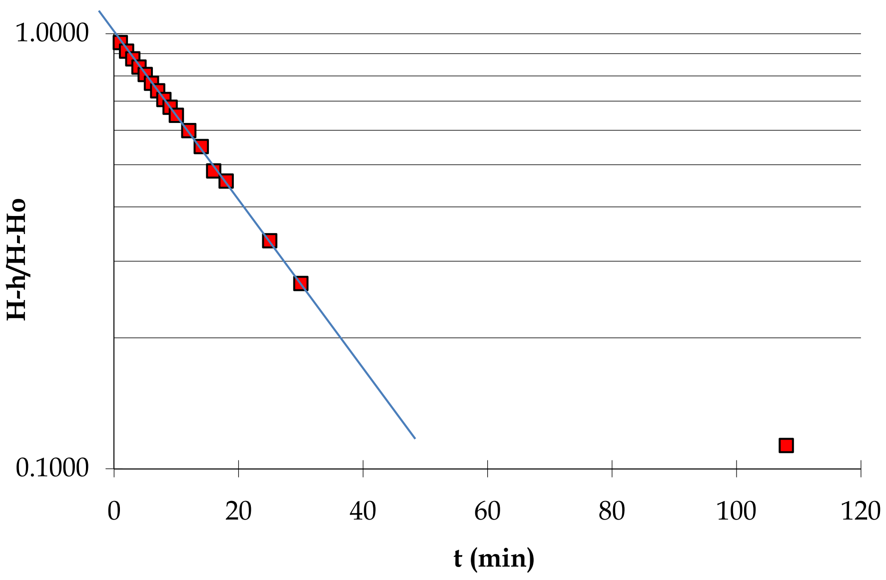
Job: 08360 **Date:**
Test Hole No: 09 BH 10-1

H: **1.40** **H - Ho:** -9.90
Ho: **11.30** **To:** 2.71E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	11.300		11.30	-9.90	1.0000
1	10.850		10.85	-9.45	0.9545
2	10.430		10.43	-9.03	0.9121
3	10.070		10.07	-8.67	0.8758
4	9.700		9.70	-8.30	0.8384
5	9.380		9.38	-7.98	0.8061
6	9.020		9.02	-7.62	0.7697
7	8.720		8.72	-7.32	0.7394
8	8.390		8.39	-6.99	0.7061
9	8.110		8.11	-6.71	0.6778
10	7.830		7.83	-6.43	0.6495
12	7.330		7.33	-5.93	0.5990
14	6.850		6.85	-5.45	0.5505
16	6.190		6.19	-4.79	0.4838
18	5.940		5.94	-4.54	0.4586
25	4.710		4.71	-3.31	0.3343
30	4.040		4.04	-2.64	0.2667
108	2.520		2.52	-1.12	0.1131

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.71E+01	1.15E-07

BH 10-1



Gorrell Resource
Investigations

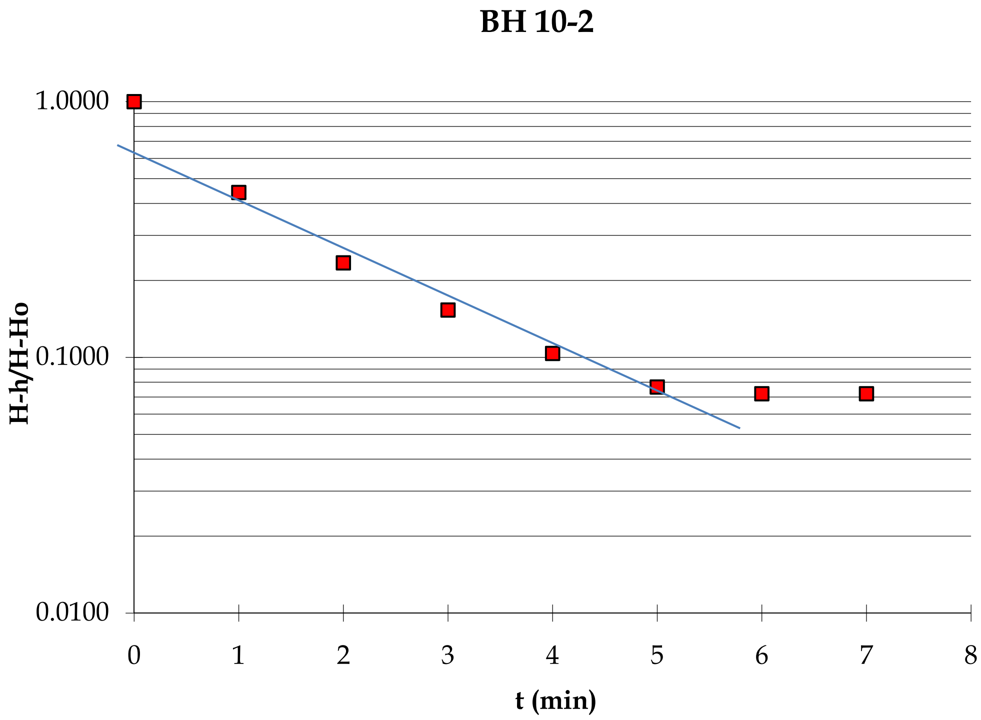
Hydraulic Conductivity Test Data and Analysis

Job: 08360
Test Hole No: 09 BH 10-2
Date: 04-May-09
Test 1

H: **1.38**
Ho: **3.60**
H - Ho: -2.22
To: 1.24E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	3.600		3.60	-2.22	1.0000
1	2.360		2.36	-0.98	0.4414
2	1.900		1.90	-0.52	0.2342
3	1.720		1.72	-0.34	0.1532
4	1.610		1.61	-0.23	0.1036
5	1.550		1.55	-0.17	0.0766
6	1.540		1.54	-0.16	0.0721
7	1.540		1.54	-0.16	0.0721

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.24E+00	2.51E-06



Gorrell Resource Investigations

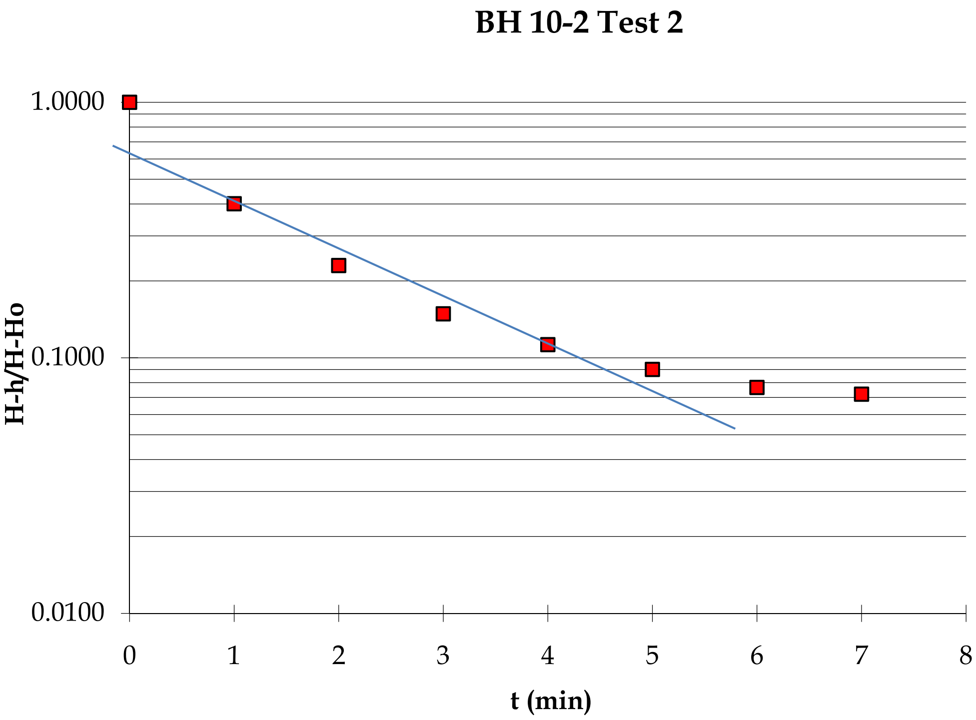
Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 04-May-09
Test Hole No: 09 BH 10-2 **Test 2**

H: **1.38** **H - Ho:** -2.22
Ho: **3.60** **To:** 1.05E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	3.600		3.60	-2.22	1.0000
1	2.270		2.27	-0.89	0.4009
2	1.890		1.89	-0.51	0.2297
3	1.710		1.71	-0.33	0.1486
4	1.630		1.63	-0.25	0.1126
5	1.580		1.58	-0.20	0.0901
6	1.550		1.55	-0.17	0.0766
7	1.540		1.54	-0.16	0.0721

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.05E+00	2.98E-06



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

Job: 08360

Date:

Test Hole No: 09 BH 11-1

H: **12.19**

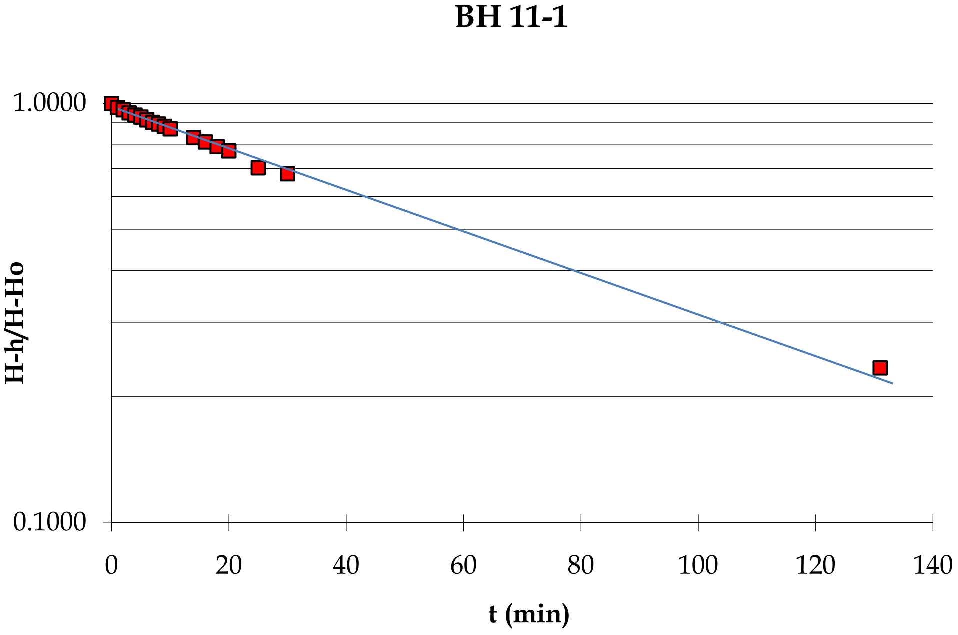
Ho: **21.97**

H - Ho: -9.78

To: 8.58E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	21.970		21.97	-9.78	1.0000
1	21.760		21.76	-9.57	0.9785
2	21.640		21.64	-9.45	0.9663
3	21.480		21.48	-9.29	0.9499
4	21.370		21.37	-9.18	0.9387
5	21.270		21.27	-9.08	0.9284
6	21.130		21.13	-8.94	0.9141
7	21.010		21.01	-8.82	0.9018
8	20.930		20.93	-8.74	0.8937
9	20.820		20.82	-8.63	0.8824
10	20.700		20.70	-8.51	0.8701
14	20.300		20.30	-8.11	0.8292
16	20.110		20.11	-7.92	0.8098
18	19.910		19.91	-7.72	0.7894
20	19.730		19.73	-7.54	0.7710
25	19.060		19.06	-6.87	0.7025
30	18.840		18.84	-6.65	0.6800
131	14.480		14.48	-2.29	0.2342

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	8.58E+01	3.64E-08



Gorrell Resource Investigations

Hydraulic Conductivity Test Data and Analysis

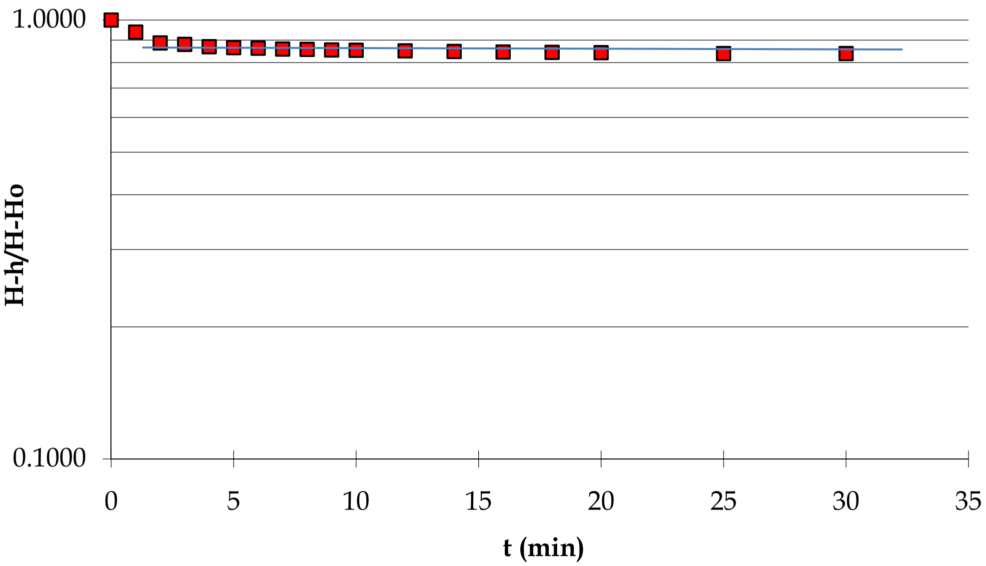
Job:	08360	**Date:**	30-Apr-09
Test Hole No:	09 BH 11-2		

H:	**1.19**	**H - Ho:**	-7.51
Ho:	**8.70**	**To:**	8.34E+12

t	Reading	Correction	h	H - h	H - h/H - Ho
0	8.700		8.70	-7.51	1.0000
1	8.240		8.24	-7.05	0.9387
2	7.850		7.85	-6.66	0.8868
3	7.800		7.80	-6.61	0.8802
4	7.720		7.72	-6.53	0.8695
5	7.690		7.69	-6.50	0.8655
6	7.670		7.67	-6.48	0.8628
7	7.640		7.64	-6.45	0.8589
8	7.630		7.63	-6.44	0.8575
9	7.610		7.61	-6.42	0.8549
10	7.600		7.60	-6.41	0.8535
12	7.580		7.58	-6.39	0.8509
14	7.560		7.56	-6.37	0.8482
16	7.540		7.54	-6.35	0.8455
18	7.530		7.53	-6.34	0.8442
20	7.520		7.52	-6.33	0.8429
25	7.490		7.49	-6.30	0.8389
30	7.490		7.49	-6.30	0.8389

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	8.34E+12	3.74E-19

BH 11-2



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

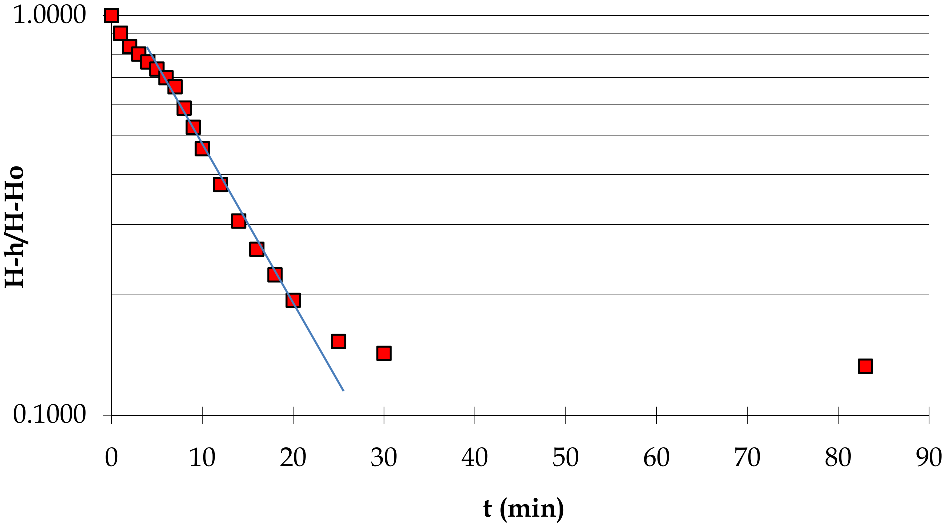
Job: 08360 **Date:** 30-Apr-09
Test Hole No: 09-BH 12-1

H: **1.27** **H - Ho:** -1.96
Ho: **3.23** **To:** 1.27E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	3.230		3.23	-1.96	1.0000
1	3.040		3.04	-1.77	0.9031
2	2.910		2.91	-1.64	0.8367
3	2.840		2.84	-1.57	0.8010
4	2.770		2.77	-1.50	0.7653
5	2.710		2.71	-1.44	0.7347
6	2.640		2.64	-1.37	0.6990
7	2.570		2.57	-1.30	0.6633
8	2.420		2.42	-1.15	0.5867
9	2.300		2.30	-1.03	0.5255
10	2.180		2.18	-0.91	0.4643
12	2.010		2.01	-0.74	0.3776
14	1.870		1.87	-0.60	0.3061
16	1.780		1.78	-0.51	0.2602
18	1.710		1.71	-0.44	0.2245
20	1.650		1.65	-0.38	0.1939
25	1.570		1.57	-0.30	0.1531
30	1.550		1.55	-0.28	0.1429
83	1.53		1.53	-0.26	0.1327

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.27E+01	2.45E-07

BH 12-1



Gorrell Resource Investigations

Hydraulic Conductivity Test Data and Analysis

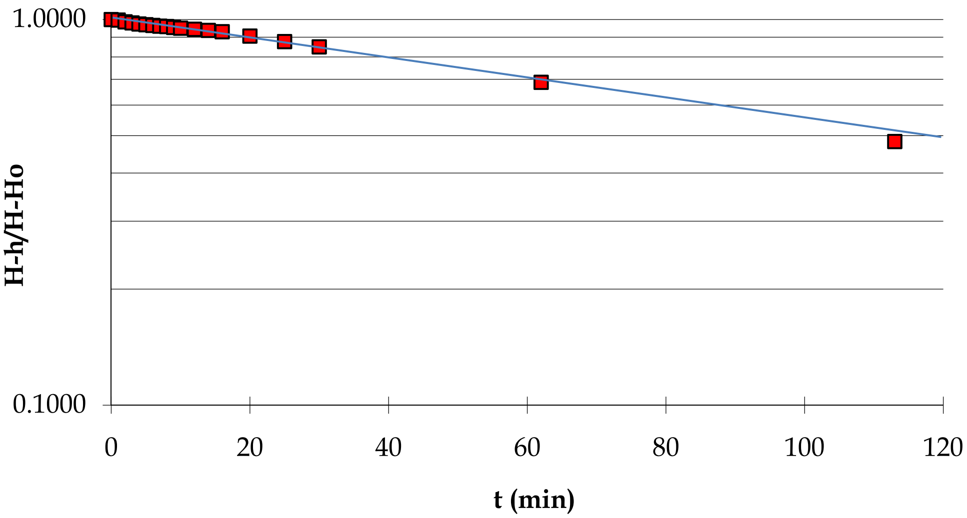
Job: 08360 **Date:** 30-Apr-09
Test Hole No: 09-BH 12-2

H: **1.45** **H - Ho:** -9.57
Ho: **11.02** **To:** 2.14E+02

t	Reading	Correction	h	H - h	H - h/H - Ho
0	11.020		11.02	-9.57	1.0000
1	10.990		10.99	-9.54	0.9969
2	10.890		10.89	-9.44	0.9864
3	10.830		10.83	-9.38	0.9801
4	10.770		10.77	-9.32	0.9739
5	10.730		10.73	-9.28	0.9697
6	10.690		10.69	-9.24	0.9655
7	10.650		10.65	-9.20	0.9613
8	10.630		10.63	-9.18	0.9592
9	10.580		10.58	-9.13	0.9540
10	10.540		10.54	-9.09	0.9498
12	10.480		10.48	-9.03	0.9436
14	10.420		10.42	-8.97	0.9373
16	10.350		10.35	-8.90	0.9300
20	10.120		10.12	-8.67	0.9060
25	9.840		9.84	-8.39	0.8767
30	9.580		9.58	-8.13	0.8495
62	8.030		8.03	-6.58	0.6876
113	6.070		6.07	-4.62	0.4828

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.14E+02	1.46E-08

BH 12-2



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

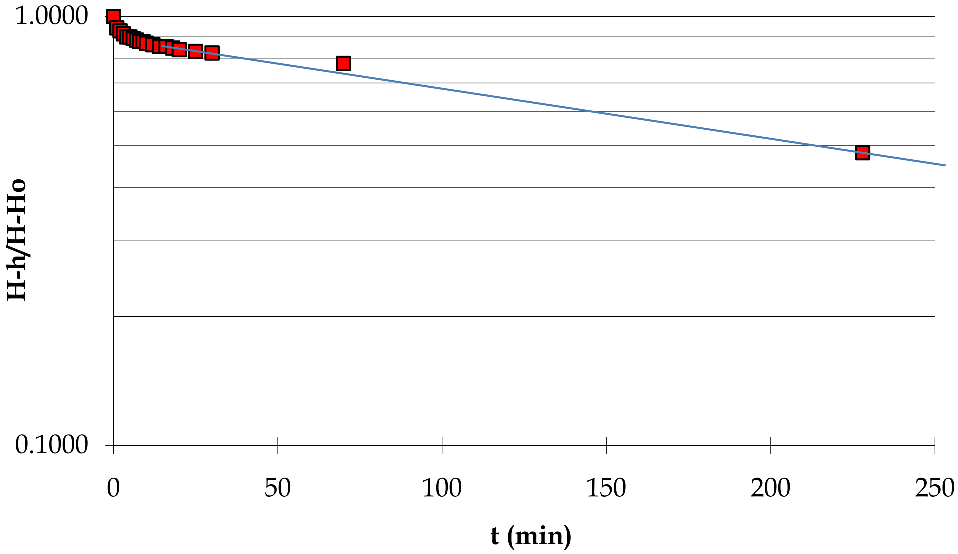
Job: 08360 **Date:** 30-Apr-09
Test Hole No: 09 BH 13-1

H: **3.77** **H - Ho:** -1.35
Ho: **5.12** **To:** 6.62E+02

t	Reading	Correction	h	H - h	H - h/H - Ho
0	5.120		5.12	-1.35	1.0000
1	5.040		5.04	-1.27	0.9407
2	5.020		5.02	-1.25	0.9259
3	5.000		5.00	-1.23	0.9111
4	4.980		4.98	-1.21	0.8963
5	4.980		4.98	-1.21	0.8963
6	4.970		4.97	-1.20	0.8889
7	4.960		4.96	-1.19	0.8815
8	4.950		4.95	-1.18	0.8741
9	4.950		4.95	-1.18	0.8741
10	4.940		4.94	-1.17	0.8667
12	4.930		4.93	-1.16	0.8593
14	4.920		4.92	-1.15	0.8519
16	4.920		4.92	-1.15	0.8519
18	4.910		4.91	-1.14	0.8444
20	4.900		4.90	-1.13	0.8370
25	4.890		4.89	-1.12	0.8296
30	4.880		4.88	-1.11	0.8222
70	4.820		4.82	-1.05	0.7778
228	4.42		4.42	-0.65	0.4815

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
2.13	0.032	2.89E-04	6.62E+02	7.28E-09

BH 13-1



Gorrell Resource
Investigations

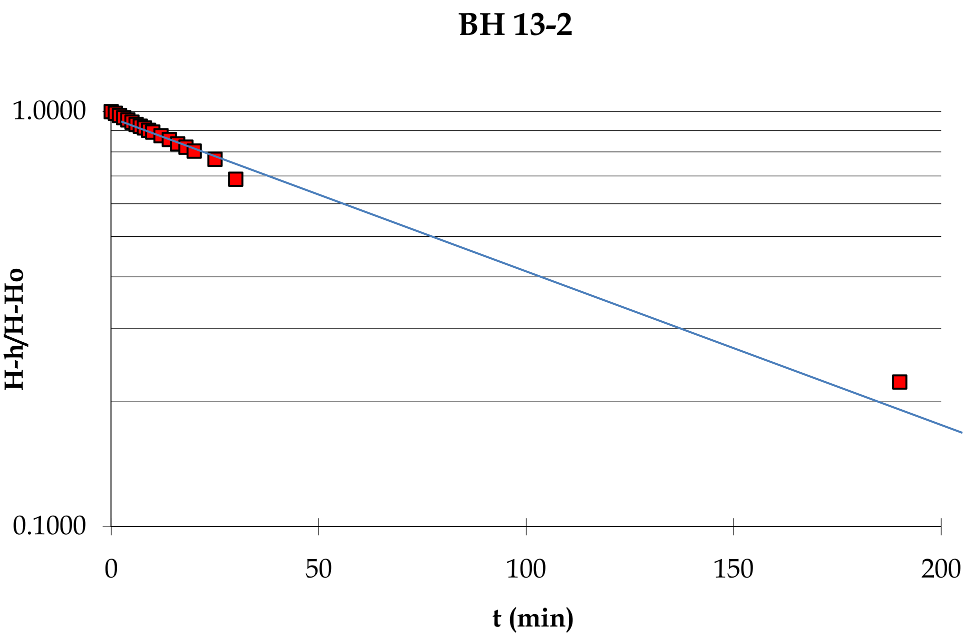
Hydraulic Conductivity Test Data and Analysis

Job:	08360	**Date:**	
Test Hole No:	09 BH 13-2		

H:	**3.90**	**H - Ho:**	-3.36
Ho:	**7.26**	**To:**	1.07E+02

t	Reading	Correction	h	H - h	H - h/H - Ho
0	7.260		7.26	-3.36	1.0000
1	7.230		7.23	-3.33	0.9911
2	7.190		7.19	-3.29	0.9792
3	7.150		7.15	-3.25	0.9673
4	7.110		7.11	-3.21	0.9554
5	7.070		7.07	-3.17	0.9435
6	7.030		7.03	-3.13	0.9315
7	7.000		7.00	-3.10	0.9226
8	6.970		6.97	-3.07	0.9137
9	6.930		6.93	-3.03	0.9018
10	6.900		6.90	-3.00	0.8929
12	6.840		6.84	-2.94	0.8750
14	6.780		6.78	-2.88	0.8571
16	6.710		6.71	-2.81	0.8363
18	6.660		6.66	-2.76	0.8214
20	6.600		6.60	-2.70	0.8036
25	6.480		6.48	-2.58	0.7679
30	6.210		6.21	-2.31	0.6875
190	4.650		4.65	-0.75	0.2232

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.07E+02	2.91E-08



Gorrell Resource
Investigations

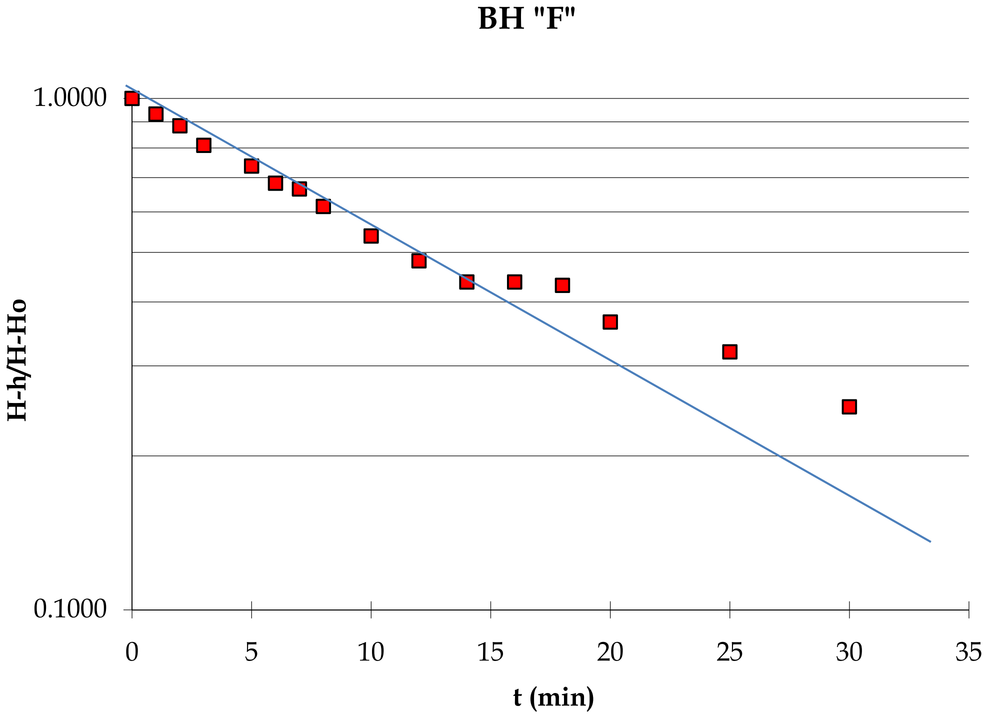
Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 07-May-09
Test Hole No: F

H: **1.43** **H - Ho:** -4.57
Ho: **6.00** **To:** 2.39E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	6.000		6.00	-4.57	1.0000
1	5.690		5.69	-4.26	0.9322
2	5.470		5.47	-4.04	0.8840
3	5.130		5.13	-3.70	0.8096
5	4.800		4.80	-3.37	0.7374
6	4.550		4.55	-3.12	0.6827
7	4.470		4.47	-3.04	0.6652
8	4.240		4.24	-2.81	0.6149
10	3.890		3.89	-2.46	0.5383
12	3.630		3.63	-2.20	0.4814
14	3.430		3.43	-2.00	0.4376
16	3.430		3.43	-2.00	0.4376
18	3.400		3.40	-1.97	0.4311
20	3.100		3.10	-1.67	0.3654
25	2.890		2.89	-1.46	0.3195
30	2.570		2.57	-1.14	0.2495

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.39E+01	1.31E-07



Gorrell Resource
Investigations

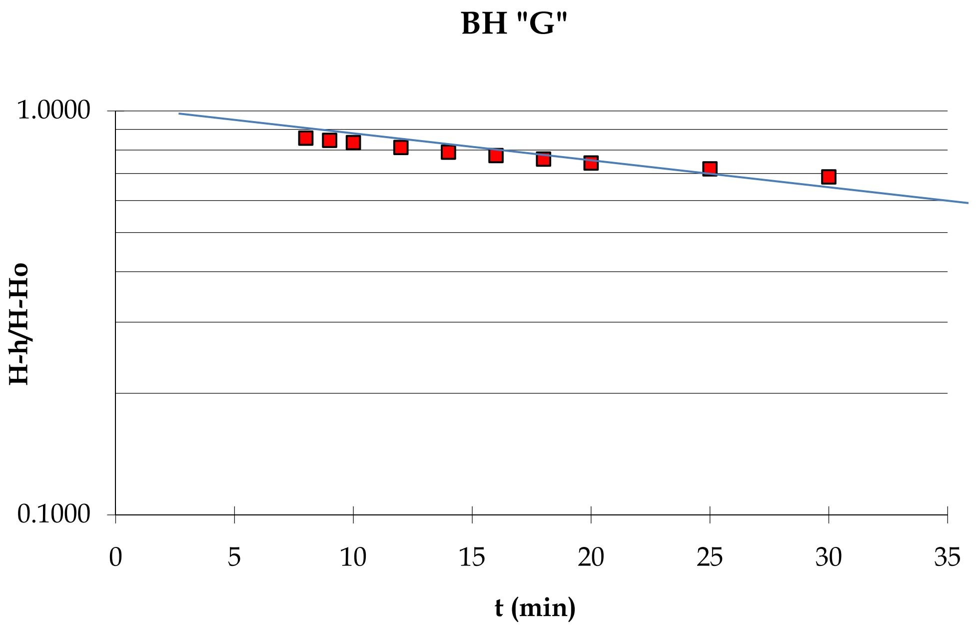
Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 07-May-09
Test Hole No: G

H: **2.38** **H - Ho:** -6.54
Ho: **8.92** **To:** 2.64E+03

t	Reading	Correction	h	H - h	H - h/H - Ho
0	8.920		8.92	-6.54	1.0000
1	8.600		8.60	-6.22	0.9511
2	8.500		8.50	-6.12	0.9358
3	8.410		8.41	-6.03	0.9220
4	8.330		8.33	-5.95	0.9098
5	8.250		8.25	-5.87	0.8976
6	8.160		8.16	-5.78	0.8838
7	8.070		8.07	-5.69	0.8700
8	7.980		7.98	-5.60	0.8563
9	7.910		7.91	-5.53	0.8456
10	7.840		7.84	-5.46	0.8349
12	7.690		7.69	-5.31	0.8119
14	7.550		7.55	-5.17	0.7905
16	7.450		7.45	-5.07	0.7752
18	7.350		7.35	-4.97	0.7599
20	7.240		7.24	-4.86	0.7431
25	7.080		7.08	-4.70	0.7187
30	6.870		6.87	-4.49	0.6865

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.64E+03	1.18E-09



Gorrell Resource Investigations

Appendix J
Laboratory Reports – General Groundwater and Surface Water Quality

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

ACCUTEST LABORATORIES - A New Bodycote Company **REPORT OF ANALYSIS**

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2915792
Date: 2009-07-07
Date Submitted: 2009-07-03
Project: 08160
P.O. Number:
Matrix: Water

Chain of Custody Number: **98448**

		LAB ID:	727038	727039	727041			**GUIDELINE**		
		Sample Date:	2009-07-03	2009-07-03	2009-07-03					
		Sample ID:	9-2	10-1	13-1					
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	228	262	221					
Chloride	mg/L	1	13	7	2					
Conductivity	uS/cm	5	1020	538	455					
Fluoride	mg/L	0.10	0.16	0.58	0.26					
N-NH3 (Ammonia)	mg/L	0.02	<0.02	0.11	0.07					
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10	<0.10					
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10	<0.10					
pH			7.78	7.93	8.02					
Sulphate	mg/L	1	322	24	28					
Total Dissolved Solids (COND - CALC)	mg/L	5	714	350	296					
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10	0.41	0.34					
Total Suspended Solids	mg/L	2	6280	22	6130					
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH	N/A-PH					
Hardness as CaCO3	mg/L	1	558	263	224					
HCO3 as CaCO3	mg/L	5	228	262	221					
Ion Balance		0.01	1.01	1.02	1.04					
Calcium	mg/L	1	189	64	70					
Magnesium	mg/L	1	21	25	12					
Potassium	mg/L	1	4	7	3					
Sodium	mg/L	2	11	15	16					
Aluminum	mg/L	0.01	0.04	<0.01	0.06					
Antimony	mg/L	0.0001	0.0009	0.0002	0.0008					
Arsenic	mg/L	0.001	0.001	0.001	0.001					
Barium	mg/L	0.01	0.04	0.02	0.05					
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001					
Boron	mg/L	0.01	0.03	0.18	0.05					
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001					
Chromium	mg/L	0.001	0.003	0.003	0.002					
Cobalt	mg/L	0.0002	0.0010	0.0003	0.0002					
Copper	mg/L	0.001	<0.001	<0.001	0.002					

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

727038: N/A-PH = Not Available - pH < 8.3 calculations not available.
727039: N/A-PH = Not Available - pH < 8.3 calculations not available.

727041: Sample was filtered prior to analysis for Metals. N/A-PH = Not Available - pH < 8.3 calculations not available.

APPROVAL: ____________
Ewan McRobbie
Inorganic Lab Supervisor

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2915792
Date: 2009-07-07
Date Submitted: 2009-07-03
Project: 08160
P.O. Number:
Matrix: Water

Chain of Custody Number: **98448**

LAB ID:			727038	727039	727041			**GUIDELINE**		
Sample Date:			2009-07-03	2009-07-03	2009-07-03					
Sample ID:			9-2	10-1	13-1					
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Iron	mg/L	0.03	<0.03	0.03	0.06					
Lead	mg/L	0.001	<0.001	<0.001	<0.001					
Manganese	mg/L	0.01	0.03	0.02	0.01					
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001					
Molybdenum	mg/L	0.005	<0.005	0.009	0.007					
Nickel	mg/L	0.005	<0.005	<0.005	<0.005					
Selenium	mg/L	0.001	<0.001	<0.001	<0.001					
Silicon	mg/L	0.1	2.8	4.3	3.4					
Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001					
Strontium	mg/L	0.001	0.932	3.11	0.487					
Thallium	mg/L	0.0001	0.0002	<0.0001	<0.0001					
Titanium	mg/L	0.01	<0.01	<0.01	<0.01					
Vanadium	mg/L	0.001	0.007	0.006	0.004					
Zinc	mg/L	0.01	0.02	0.01	<0.01					

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: ____________________
Ewan McRobbie
Inorganic Lab Supervisor

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2915793
Date: 2009-07-07
Date Submitted: 2009-07-03
Project: 08160
P.O. Number:
Matrix: Water

Chain of Custody Number: **98448**

		LAB ID:	727042	727043				**GUIDELINE**		
		Sample Date:	2009-07-03	2009-07-03						
		Sample ID:	9-1	10-2						
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Calcium	mg/L	1	143	64						
Magnesium	mg/L	1	18	26						
Potassium	mg/L	1	2	5						
Sodium	mg/L	2	5	3						
Aluminum	mg/L	0.01	0.54	0.19						
Antimony	mg/L	0.0001	<0.0001	<0.0001						
Arsenic	mg/L	0.001	0.004	<0.001						
Barium	mg/L	0.01	0.08	0.13						
Beryllium	mg/L	0.001	<0.001	<0.001						
Boron	mg/L	0.01	0.12	0.06						
Cadmium	mg/L	0.0001	0.0002	<0.0001						
Chromium	mg/L	0.001	0.006	0.002						
Cobalt	mg/L	0.0002	0.0073	<0.0002						
Copper	mg/L	0.001	0.007	<0.001						
Iron	mg/L	0.03	3.82	0.22						
Lead	mg/L	0.001	0.005	0.002						
Manganese	mg/L	0.01	0.16	<0.01						
Mercury	mg/L	0.0001	<0.0001	<0.0001						
Molybdenum	mg/L	0.005	<0.005	<0.005						
Nickel	mg/L	0.005	0.008	<0.005						
Selenium	mg/L	0.001	<0.001	0.003						
Silicon	mg/L	0.1	4.5	5.0						
Silver	mg/L	0.0001	<0.0001	<0.0001						
Strontium	mg/L	0.001	29.1	2.89						
Thallium	mg/L	0.0001	0.0001	<0.0001						
Titanium	mg/L	0.01	<0.01	0.01						
Vanadium	mg/L	0.001	0.009	0.006						
Zinc	mg/L	0.01	0.24	<0.01						

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: ________________
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES - A New Bodycote Company

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2916040
Date: 2009-07-09
Date Submitted: 2009-07-07
Project: 08160
P.O. Number:
Matrix: Water

Chain of Custody Number: 98713

LAB ID:			727577	727578				**GUIDELINE**		
Sample Date:			2009-07-06	2009-07-06				ODWSOG		
Sample ID:			9-1	10-2						
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	250	250				OG	500	mg/L
Chloride	mg/L	1	2	2				AO	250	mg/L
Conductivity	uS/cm	5	480	479						
Fluoride	mg/L	0.10	0.46	0.46				MAC	1.5	mg/L
N-NH3 (Ammonia)	mg/L	0.02	0.11	0.07						
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10				MAC	1.0	mg/L
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10				MAC	10.0	mg/L
pH			8.07	8.08					6.5-8.5	
Sulphate	mg/L	1	78	14				AO	500	mg/L
Total Dissolved Solids (COND - CALC)	mg/L	5	312	311				AO	500	mg/L
Total Kjeldahl Nitrogen	mg/L	0.10	0.34	0.16						
Total Suspended Solids	mg/L	2	306	133						
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH						
Hardness as CaCO3	mg/L	1	315	235				OG	100	mg/L
HCO3 as CaCO3	mg/L	5	250	250						
Ion Balance		0.01	0.97	0.92						
Calcium	mg/L	1	93	56						
Magnesium	mg/L	1	20	23						
Potassium	mg/L	1	2	5						
Sodium	mg/L	2	4	3				MAC	20	mg/L
Iron	mg/L	0.03	0.23	0.24				AO	0.3	mg/L
Manganese	mg/L	0.01	0.09	<0.01				AO	0.05	mg/L

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:
N/A-PH = Not Available - pH < 8.3 calculations not available.

APPROVAL: ____________
Ewan McRobbie
Inorganic Lab Supervisor

Appendix K
Qualifications

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

GORRELL RESOURCE
INVESTIGATIONS

20 Years
gri
1988 - 2008

Jennifer B. Gorrell M.Sc. P. Geo.

Education:

1981: B.Sc. (Eng.), Queen's University, Kingston, Geological Engineering (Geotechnical)
1986: M.Sc. (Eng.), Queen's University, Kingston, Civil Engineering (Geotechnical)

Professional Affiliations:

Association of Professional Engineers of Ontario, Member 1984.
Association of Geoscientists of Ontario, Member 2002.

Work Experience:

October 1988 - present:	Gorrell Resource Investigations; Owner/Partner, Senior Project Manager, Hydrogeologist and Engineer.
May 1984 - June 1988:	Water and Earth Science Associates Ltd., Carp, Ontario; Senior Project Manager and Intermediate Engineer.
Sept 1983 - May 1984:	Department of Civil Engineering, Queen's University; Graduate Student, Teaching Assistant.
May 1982 - Sept 1983:	Water and Earth Science Associates Ltd., Carp, Ontario; Project Hydrogeologist.
May 1981 - May 1982:	Department of Mines, Ministry of Natural Resources, Kemptville, Ontario; Junior Geotechnical Engineer.

Project History

Gorrell Resource Investigations has completed over 1200 projects in the fields of geology, hydrogeology and related engineering services since it’s inception in 1988, and I have had input into every project. The projects I have worked on are in the following areas of expertise.

Aggregate Resource Investigations

- Site investigation of proposed pit and quarry sites to evaluate suitability and design criteria with respect to geological and hydrogeological conditions

- Conduct investigations to support applications for aggregate licensing, Permit to Take Water and Certificate of Approval for Industrial Wastewater Systems (Section 53, OWRA)

- Professional management of Site Plan applications through the ARA process and municipal planning changes.

Hydrogeologic Testing

- Design and installation of groundwater monitoring systems in stratified and fractured deposits for various applications;

- Design and supervision of test well construction

Groundwater Modeling

- Design and completion of field testing programs to provide site information for conceptual model

- Design of hydrostratigraphic conceptual models

- Completion of numerical models for a variety of hydrostratigraphic settings.

Waste Management Studies

- Hydrogeological and geological site investigations, development of waste management plans, operation plans and contingency plans for municipal and industrial waste disposal sites throughout Eastern Ontario.

- Annual monitoring, impact analysis and assessment of site requirements for select waste management sites in Eastern Ontario.

Environmental Assessment and Rehabilitation

- Project management of Private Services Grant Program studies.

- Environmental Audits

- Site Decommissioning studies

Environmental Planning and Management

- Environmental Assessment of solid waste management plans.

- Regional hydrogeological investigations for management and planning purposes;

- Development feasibility studies for residential, commercial and industrial projects.

Reasonable Use Analysis

- Investigation of proposed or existing contaminant sources for conformity to Ministry of the Environment Guideline B-7 at sites across Eastern Ontario.

On-Site Wastewater Systems

- Site suitability studies for disposal of biosolids and hauled sewage
- Design of on-site waste wastewater systems of various scales and technologies across Eastern Ontario

Terrain Analysis

- Field mapping for geologic, hydrogeologic and engineering features;
- Planning and supervision of subsurface testing programs.

Geotechnical Engineering

- Evaluation of slope stability along Ottawa River from City of Ottawa to Hawkesbury;
- Calculation of Setback Distances for slopes of Factor of Safety less than 1.5 in the South Nation River Basin;
- Design of shoreline protection for various clients;
- Erosion Study and Shoreline Management Plan along the Lake St. Lawrence-St. Lawrence River-Lake St. Francis (Raisin Region Conservation Authority).

Expert Witness

- Provision of expert testimony before the Ontario Municipal Board since 1989.
- Provision of expert testimony before the Environmental Appeal Board since 1993
- Provision of expert testimony before the Ontario Provincial Court since 1994.

Presentations

- Presentation on Geology and Hydrogeology of Westbrook Quarry to Aggregate Producers of Ontario, 2004.

GORRELL RESOURCE
INVESTIGATIONS

GEORGE A. GORRELL M.SC. P.GEO. F.G.A.C.

Education

1979: B.A.(Hon), University of Waterloo, Geography (Terrain Evaluation).
1986: M.Sc., Queen's University, Kingston.

Affiliations

Geological Association of Canada, Fellow, 1990
Association of Professional Geoscientists of Ontario - 2003
Canadian Sedimentology Research Group, 1989
Ontario Water Well Technician

Work Experience

March 1989 to present:	Gorrell Resource Investigations; Partner, Senior Project Manager, Geologist and Hydrogeologist.
November, 1987 - March 1989:	Ministry of Northern Development and Mines; working out of Ministry of Natural Resources office, Kemptville; Geologist.
August 1987 - November 1987:	Consulting geologist for the Multi-disciplinary Agency investigating Neo-tectonics in Eastern Canada (MAGNEC).
June, 1986 - August 1987,	Ministry of Northern Development and Mines; working out of Ministry of Natural Resources office, Kemptville; Geologist;
September, 1984 - June 1986:	Queen's University, Kingston, Teaching Assistant.
May, 1984 - September, 1984:	Consultant for the South Nation Conservation Authority, Berwick, Ontario.
May, 1979 - May, 1984:	Ministry of Natural Resources, Kemptville; Geologist and Senior Party Chief.

Project History

Gorrell Resource Investigations has completed over 1200 projects in the fields of geology, hydrogeology and related engineering services since its inception in late 1988, and I have had input into every project. Specifically, the projects I have worked on are in the following areas of expertise.

Resource and Source Water Protection Mapping

- Review of Areas of Natural and Scientific Interest – Earth Science ANSIs. Projects completed for Ministry of Natural Resources in Oak Ridges Moraine Study Area, Champlain Sea, Lake Ontario and Kemptville District. Also have conducted development-related site-specific reviews for clients to address requests for assessment to determine how sites may best be protected under development pressures as a liaison between clients and MNR.

- Assessment of granular deposits for their aggregate potential on the Oak Ridges Moraine, in Eastern Ontario (for Northern Development and Mines) and in parts of the Provinces of Nova Scotia, New Brunswick and Quebec

- Sedimentological mapping of buried granular deposits within Eastern Ontario with assessment of their use for blending sand and as communal aquifers. Emphasis was placed on bedform structure and sequences, which was applied to the usability of the sediment.

- Geological Survey of Canada; Hydrogeology of the Oak Ridges Moraine, Rice Lak, Van Dorf, Nobleton, Aurora, King City, Caledon, Credit River, Schomberg, and Pontypool Holes – deep hole logging.

- Geological Survey of Canada; geological mapping, Rice Lake map sheet.

- Geological Survey of Canada; Potential Neotectonic Earth Quakes in Ottawa Valley; Deep Surficial Drilling, Alfred Ontario, 2002

- South Nation Conservation Authority, Geological Survey of Canada, Ontario Geological Survey, Source Water Protection, Kars to Chesterville - Supervised drilling project

Sedimentology Studies

- Micro-scale sedimentological mapping of deep boreholes from various locations on the Oak Ridges Moraine for Natural Resources Canada

- Detailed analysis of the surficial materials and features of parts of Prince Edward County, Ontario to determine whether any of the features are due to neo-tectonic movement.

- Detailed sedimentological investigation of portions of the Mattagami River, Moose River Basin, Parts of Gardiner and Morrow Townships, District of Cochrane

- Detailed geological investigation of portions of the South Nation River to delineate areas susceptible to earthflow based on depositional history.

- Geological investigation of the Groveton Bog, County of Grenville as a possible reservoir of water for the South Nation River. The study examined the surficial materials, hydrological regime and ramifications of the project.

- Investigation of sedimentological causes of earthflows and other types of slope failure in

Champlain Sea deposits of Eastern Ontario (for South Nation River Conservation Authority, Mississippi River Conservation Authority).

- Investigation of possible neo-tectonic movement in Prince Edward County, Ontario.

Hydrogeologic Testing

- Design and installation of groundwater monitoring systems in stratified and fractured deposits for various applications;
- Design and supervision of test well construction.
- Hydrogeological evaluation of the Groveton Bog, County of Grenville (South Nation River Conservation Authority).

Quarry Investigations

- Analysis of proposed quarry sites to evaluate potential impacts on hydrogeological regime.

Waste Management Studies

- Hydrogeological and geological site investigations, development of waste management plans, operation plans and contingency plans for municipal and industrial waste disposal sites.

Environmental Planning and Management

- Development feasibility studies for residential, commercial and industrial projects.

Terrain Analysis

- Aerial photograph interpretation and field mapping for geological, hydrogeological and engineering features;
- Planning and supervision of soil testing programs.

Presentations

- Ontario Geoscience Seminar (1986, 1987)
- Canadian Sedimentology Research Group (1987)
- Geological Association of Canada, (1989)
- Field Trip Leader, INQUA XII Congress
- Field Trip Leader, Canadian Sedimentology Research Group, 1989
- Oak Ridges Moraine field trip, 2003
- Oak Ridges Moraine field trip, 2004

- Field trip, INQUA 2007
- Field trip, IAH CGS 2007
- Field Trip Leader, 60th Canadian Geotechnical Conference and 8th Joint, 2007
- Field Trip Leader, Canqua, Ottawa 2007

Publications

Barnett, P.J., Sharpe, D.R., Russell, H., Brennand, T.A., Gorrell, G., Pullan, S. and Kenny, F.M. 1997. On the origin of the Oak Ridges Moraine; Geological Association of Canada, Program with Abstracts, Ottawa'97

Barnett, P.J., Sharpe, D.R., Brennand, T.A., Russell. H.A.J., Gorrell, G., Kenny, F. in press. On the Origin of the Oak Ridges Moraine, Canadian Journal of Earth Sciences, submitted.

Geological Survey of Canada; Oak Ridges Moraine, NTS map C/4 Surficial Geology of the Trenton Area, Open File 3333

Geological Survey of Canada; Oak Ridges Moraine, NTS map D/1 Surficial Geology of the Rice lake Area, Open File 3332

Gorrell, G.A. and J. Shaw. 1991. *Development of an esker, bead and fan complex, Lanark, Ontario,* Sedimentary Geology 72, 285-314

Gorrell, G., and Brennand, T.A. 1997. Surficial Geology of the Rice Lake (31 D/1) 1:50 000 NTS map sheet, southern Ontario; Geological Survey of Canada Open File 3332.

Gorrell, G. and McCrae, M. 1992. Aggregate Resource Inventory of Haldimand and Alnwick Townships, Northumberland County. Ontario Geological Survey, Aggregate Resource Inventory Paper 143, 73 p.

Gorrell, G., 1997. Surficial Geology of the Trenton Area, NTS 31C/4, southern Ontario; Geological Survey of Canada, Open File 3333, scale 1:50,000

Gorrell, G. and Sharpe, D.R. 1994. Stop 20, Oak Ridges Moraine. *In* R. Gilbert (compiler), A Field Guide to the Glacial and Postglacial Landscape of Southeastern Ontario and Part of Quebec. Geological Survey of Canada, Bulletin 453, pp. 42-43.

Gorrell, G.A. 1991a. *Buried sand and Gravel Features and blending sands in Eastern Ontario.* Open File report 5801, Ontario Geological Survey

Gorrell, G.A. 1991b. *Buried sand and gravel in the Stirling, Trenton and Campbellford areas*, Open file report 5815, Ontario Geological Survey

Gorrell, G.A.; *Investigation and Documentation of the Neotectonic Record of Prince Edward County, Ontario*; GSC Open File Report 2062, 1988.

Gorrell, G.A. and J. Shaw. 1991. *Deposition in an esker, bead and fan complex, Lanark, Ontario,* Sedimentary Geology 72, 285-314

Gorrell, G.A., S. Van Haaften and T.W. Fletcher. *Aggregate Assessment for the County of Lanark, Southern Ontario*. Ontario Geological Survey Open File Report 5550, Part 1, 67p., Part 2 27p., 19 tables, 4 appendices, 2 figures, 4 maps. 1985.

Gorrell, G.A., A. F.Young and T. W. Fletcher and M. A. Klugman. *Sand and Gravel Assessment for the*

United Counties of Leeds and Grenville, Ontario Geological Survey, Open File Report 5432, 61p., 1 fig., 21 tables and 3 maps. 1983.

Gorrell, G. A. and T. W. Fletcher. *Sand and Gravel Assessment for the United Counties of Prescott and Russell*, Ontario Geological Survey, Open File Report 5433, 38p., 1 fig., 11 tables and 2 maps. 1983.

Gorrell, G. A. and T. W. Fletcher. *Sand and Gravel Assessment for the United Counties of Stormont, Dundas, and Glengarry*, Ontario Geological Survey, Open File Report 5434, 54p., 1 fig., 16 tables and 3 maps. 1983.

Gorrell, G. A., T.W. Fletcher and S. Van Haaften; *Aggregate Assessment for the County of Lanark, Southern Ontario*, Ontario Geological Survey, Open File Report 5550, Part 1, 67p., part 2 27p., 19 tables, 4 appendices, 2 figures and 4 maps, 1985.

Gorrell, G. A. and T. W. Fletcher; *Mineral Aggregate Resource Inventory of the County of Lennox and Addington; Southern Ontario*. Ontario Geological Survey, Open File Report 5580, 72pp., 2 figures, 19 tables, 4 appendices, and Maps P.2973 to P.2976, scale 1:50,000. 1987.

Gorrell, G. A. and T. W. Fletcher; *Mineral Aggregate Resources Inventory of the County of Hastings; Southern Ontario.* Ontario Geological Survey, Open File Report 5582, 120pp., 2 figures, 31 tables, 4 appendices and Maps P.2977 to P.2982, scale 1:50,000. 1987.

Gorrell Resource Investigations, *Areas of Natural and Scientific Interest, South Central Region*; 1999.

Gorrell Resource Investigations, *Reconnaissance Earth Science Inventory of Representative Quaternary Sites, Kemptville Administrative District*; March 2001.

Gorrell Resource Investigations, *Earth Science Areas of Natural and Scientific Interest, Oak Ridges Moraine*; 2002.

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Appendix L
Peer Review

Hydrogeological Assessment - Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A
Township of McNab-Braeside

Prepared for:

Miller Paving Limited
505 Miller Ave
Markham, ON

Report No. 08360
December 2011

Golder Associates Ltd.

32 Steacie Drive
Kanata, Ontario, Canada K2K 2A9
Telephone 613-592-9600
Fax 613-592-9601

September 11, 2008 08-1122-0216

County of Renfrew
9 International Drive
Pembroke, Ontario
K8A 6W5

Attention: Mr. Bruce Howarth, MCIP, RPP, Senior Planner

RE: REVIEW OF REPORT ENTITLED HYDROGEOLOGICAL INVESTIGATION, BRAESIDE QUARRY EXPANSION, PREPARED BY GORRELL RESOURCE INVESTIGATIONS, DATED SEPTEMBER 2007

Dear Sir:

The County of Renfrew has retained Golder Associated Ltd. (Golder Associates) to conduct a technical review of various reports related to a proposed quarry expansion. These reports were prepared in support of an application for Zoning By-Law Amendment (associated with the expansion of a quarry) under the Township of McNab/Braeside Official Plan (Section 9.3(3)) as well as an application to the Ministry of Natural Resources ("MNR") for a quarry license with extraction below the water table. This submission comprises Golder Associates' technical review of the hydrogeological investigation report referenced above, prepared by Gorrell Resource Investigations (Gorrell) for the Miller Group Inc.. As requested, this letter has also been provided in PDF format.

The hydrogeological investigation report was authored by George A. Gorrell, M.Sc., P.Geo, F.G.A.C. and Jennifer B. Gorrell, M.Sc., P.Geo., P.Eng. On August 28, 2008, Golder Associates contacted Gorrell to advise them that Golder Associates had been retained by the County of Renfrew to conduct a technical review of the hydrogeological investigation report.

In addition to the above referenced report, Golder Associates also examined the following two documents specifically for the purpose of understanding the surface water features on, and in the vicinity of, the Braeside Quarry:

> *Braeside Quarry Expansion, Hydrological Investigation, Township of McNab/Braeside, County of Renfrew, Prepared by Skelton, Brumwell & Associates Inc.,*

dated October 2007. Natural Environment Report Level I & II, Braeside Quarry Expansion, Township of McNab/Braeside, County of Renfrew, Prepared by Skelton, Brumwell & Associates Inc., dated November 21, 2007.

Golder Associates did not conduct a technical review of these later two documents in the context of the peer review of the hydrogeological investigation.

To assist with the review of the hydrogeological investigation, Golder Associates was also provided with a copy of the Site Plans dated November 2007. The Site Plans consisted of the following sheets: Site Environs, Existing Features & Cross Sections, Operational Plan, Progressive & Final Rehabilitation Plan, Monitoring & Mitigation. These Site Plans are referenced herein, where appropriate.

SCOPE AND FORMAT OF TECHNICAL REVIEW

Within designated parts of the Province of Ontario, the licensing requirements for quarries are outlined under the Bill 52 amendment to the *Aggregate Resources Act*. The Township of McNab/Braeside has been designated under the *Aggregate Resources Act* (refer to Section 9.1 of the Official Plan). The proposed quarry expansion is a Category 2, Class "A" licence application which would permit the extraction of more than 20,000 tonnes of aggregate material per year.

The technical aspects for a hydrogeological and hydrological assessment associated with a proposed quarry are outlined in the document entitled **Aggregate Resources Act of Ontario, Provincial Standards, Version 1.0** (hereafter referred to as the "Provincial Standards"). In the context of the Provincial Standards, the hydrogeological and hydrological assessments of a proposed quarry are referred to as a Hydrogeological Level 1 study and, in some cases, a Hydrogeological Level 2 study. Excerpts from the Provincial Standards that describe the information to be addressed in a Hydrogeological Level 1 study (Section 2.2.1) and Hydrogeological Level 2 study (Section 2.2.2) are summarized in Attachment A. This review focuses on a determination as to whether or not the hydrogeological investigation report addresses the requirements of the Official Plan and Provincial Standards for a quarry below the established water table.

Golder Associates has reviewed the hydrogeological investigation report (referred to herein as "the Gorrell Report") from the following perspectives:

1. Has the surficial and bedrock geological and hydrogeological settings of the site and surrounding areas been adequately characterized with respect to the bedrock stratigraphy, groundwater levels, hydraulic gradients, hydraulic conductivity/transmissivity characteristics

of the various hydrostratigraphic units, etc. so that the influence of the quarry on groundwater levels can be assessed?

2. Have the effects of the existing quarry (if any) on the local groundwater system been defined?
3. Have the various potential groundwater receptors (typically private wells in the vicinity of a quarry development) and surface water receptors (surface water drainage course and water bodies, wetlands, etc.) been identified and characterized within the anticipated zone of influence of the quarry?
4. Based on the full development of both the existing approved quarry and the proposed quarry expansion, has the degree of potential groundwater level lowering in the various hydrostratigraphic units been predicted?
5. Based on the predicted degree of potential groundwater level lowering, will these quarry-induced hydrogeological effects affect the potential receptors (impact assessment)?
6. If the potential exists for quarry-induced hydrogeological effects to impact receptors, is the degree of impact acceptable? If the degree of impact on receptors is unacceptable, have appropriate, site-specific mitigation measures been proposed?
7. Have appropriate monitoring programs been developed to measure and evaluate the actual effects on water resources associated with long term quarry development, and to allow a comparison between the actual effects measured during the operational monitoring program with those predicted as part of the impact assessment (Item #5 above)?

These questions are answered in this review. The results of our review are presented in the following sections of this submission:

- Site Description
- Stated Objectives of The Gorrell Hydrogeological Investigation
- Scope of The Gorrell Hydrogeological Investigation
- Summary of Conclusions from The Gorrell Hydrogeological Investigation Report
- General Comments on The Gorrell Hydrogeological Assessment
- Compliance with Provincial Standards, Official Plan and Overall Summary of Peer Review

SITE DESCRIPTION

Site Location, Proposed Quarry Development Plan and Topographic Setting

The proposed quarry expansion site is located adjacent to the existing, operational Miller Braeside Quarry (MNR License #16173) and is located on Part of Lots 16 and 17, Concession A, Municipality of McNab/Braeside, Renfrew County. The existing licensed area comprises 29.7 hectares (ha) with a disturbed area of 17. 1 ha. The additional area to be licensed as per the expansion application, is 103.0 ha which would result in a total licensed area of 132.8 ha. Within this 132.8 ha parcel of land, the licensed extraction area will be 68.4 ha with the remaining 64.4

ha being a protected area within the setbacks (based on Operational Plan). The base elevation of the proposed licensed extraction area will be 125 metres above sea level (m ASL) and annual extraction will not exceed 1,000,000 tonnes. According to the rehabilitation plan, it is expected that the rehabilitated quarry will flood to a final lake level of approximately 132 m ASL.

The Miller property is located approximately 3 kilometres northwest of the Village of Braeside and is situated on a bedrock plateau that runs parallel to the Ottawa River. The majority of the plateau is undeveloped and covered with trees. The plateau is characterized by relief on the order of 30 to 40 metres with sharply dropping faces south to south-westward onto a clay plain and north to north-eastward into the Ottawa River. From this location, the surface slopes gently to the north and northwest, and more steeply to the west. Regionally, the crest of the bedrock ridge has an elevation of 153 m ASL, and the base of the ridge is approximately 125 m ASL (i.e., the same elevation as the base of the proposed licensed extraction area). At the base of the ridge, the gradient drops to less than 10% and the ground surface slopes gently towards Ryan Creek which lies at an approximate elevation of 113 m ASL. On the site, the maximum elevation is approximately 150 m ASL (southeast corner of the site), sloping down to approximately 130 m ASL in the northwest corner of the site.

Geological and Hydrogeological Setting

The site has minimal overburden cover. The upper bedrock unit at the site consists of limestone of the Bobcaygeon Formation. The contact between the Bobcaygeon Formation and the underlying Gull River Formation is reported to be at approximately 125 m ASL. Gorrell reports that large open fractures are common in the area and that they extend from surface to appreciable depth. From the MOE water well records, Gorrell concluded that the Braeside Plateau is potentially a zone of local recharge to the bedrock aquifer and that regional groundwater flow (Figure 4 in the Gorrell Report) is from the Braeside Plateau towards the Ottawa River to the northeast and to the southwest towards Dochart Creek.

Local Groundwater Users (Groundwater Receptors)

Gorrell reviewed the MOE water well records (22 records had sufficient information for detailed analysis) and conducted a door-to-door of 17 residences within a 500 metres radius of the existing quarry. Results of the door-to-door survey indicated that the area groundwater users rely on two aquifers, namely the upper unconfined weathered bedrock and the deeper confined or semi-confined bedrock aquifer. Wells completed in the deeper bedrock reportedly obtain their water from two distinct water bearing zones, between approximate elevations 120 and 110 m ASL and at 80 m ASL. Section 6.5 of the Gorrell Report refers to an additional door-to-door survey conducted in October 2007 along Golf Course Road but the information from this survey was not included in the Gorrell Report. The minimum separation distance between private water supply wells at residences along Golf Club Road and the proposed extraction area appears to be in the order of 300 metres (based on examination of the Operational Plan).

Local Surface Water Features (Surface Water Receptors)

Based on examination of the Natural Environment Report Level I & II, aquatic features on, and in the vicinity of the site, are as follows:

- The MNR staff stated that to their knowledge there were no watercourses on the subject property but groundwater discharge from the subject property at the base of the Braeside Plateau contributes water to Ryan Creek, which drains into Dochart Creek, a known cold-water fishery. [Note: Ryan Creek and Dochart Creek are located approximately 500 metres west and southwest of the Miller property and the Hydrological Investigation Report states that, "Ryan Creek is a marginal cold-water fishery due to heavy clay substrate, minimal in-stream cover and turbid waters".]
- Two on-site wetland communities were identified on the northwest part of the Miller property. These on-site wetland communities were identified as a white cedar-conifer organic swamp (SWC3) and mixed organic swamp (SWM), the latter of which "includes standing water and flowing water from seepages at the base of the Braeside Plateau". Section 4.3 of the report indicates that these "two wetland communities are the result of groundwater seepage at the base of the Braeside Plateau and are fairly isolated and contained". Both of these wetland communities are within 250 metres of the licensed extraction area and SWC3 appears to be immediately adjacent to the licensed extraction area.
- County of Renfrew Official Plan mapping, OBM and orthophotography all indicate a wetland within approximately 120 metres southeast of the proposed quarry expansion (although the distance is reported as 128 metres in the Natural Environment Report). The Draft Official Plan Schedule 2.1, shown on Figure 6 (County of Renfrew, 2006) indicates that this wetland is an "Area of Concern". The NHIC database does not indicate this wetland as Provincially Significant. The Hydrological Investigation Report identified a drainage area of approximately 80 ha for this wetland, of which, approximately 1 ha or 1% is located on the subject property.

STATED OBJECTIVES OF THE GORRELL HYDROGEOLOGICAL INVESTIGATION

Section 1 of the Gorrell Report states that the purpose of the hydrogeological investigation was to, "examine an area for a proposed quarry and to provide documentation on the hydrogeological setting and to provide an impact analysis of the proposed operation".

SCOPE OF THE GORRELL HYDROGEOLOGICAL INVESTIGATION

The Gorrell hydrogeological investigation included the following components:

- Review of existing data and published information for the site including the MOE water well records;
- Drilling of thirteen (13) 154 mm (6 inch) diameter test wells (between 2002 and 2006) to base elevations ranging from 108.0 m ASL (TW3-1) to 129.9 m ASL (TW1) for the deeper test wells and 120.5 m ASL (TW3-2) to 134.5 m ASL (TW8-2) for the shallower test wells. Test wells TW1 and TW2 were completed with a steel casing grouted into place with benseal (bentonite). The steel casings in these two wells extended to depths of 1.2 and 1.5 metres below ground surface, respectively. For all other test wells, the steel casings in these test wells extended to depths of 6.09 metres below ground surface;
- An aquifer testing program consisting of constant rate pumping tests on the test wells; and,
- Door-to-door surveys of private wells conducted in the summer of 2006 and October 2007 to collect available information on neighbouring groundwater users. [Note; the Gorrell Report did not include information related to the October 2007 door-to-door survey.]

SUMMARY OF CONCLUSIONS FROM THE GORRELL HYDROGEOLOGICAL INVESTIGATION REPORT

Gorrell provides the following key conclusions based on the hydrogeological investigation:

- Three potential aquifers were identified in the area: the overburden aquifer, the weathered bedrock aquifer and the deeper bedrock aquifer. Area groundwater users rely on the shallow weathered bedrock aquifer and the deeper bedrock aquifer for water supply. The overburden is discontinuous on the site, whereas the shallow bedrock aquifer has a high degree of connectivity to the surface and is influenced by precipitation events and runoff. The deeper "semi-confined to confined" bedrock aquifer has water bearing zones not directly connected to the local surface and this aquifer discharges from the escarpment (south to south-eastward and north to north-eastward) via springs at approximate elevation of 125 m ASL. These springs provide some recharge to the surface water systems and the overburden aquifer.
- The analysis of site conditions shows that the proposed excavation will not impact the local groundwater setting due to topography and geology. The escarpment on which the property is situated is a major influence on the hydrogeological regime of the area, controlling the potentiometric surface of the deeper bedrock aquifer at 125 m ASL. The expansion of the quarry, which will remain at least 5 metres above the significant water bearing zones in the area, will not have additional impact. The continued management of discharge from the quarry in the manner currently used at the site will maintain the natural surface water and shallow groundwater regime.

GENERAL COMMENTS ON HYDROGEOLOGICAL ASSESSMENT

The stated objective of the Gorrell investigation was to "provide an impact analysis of the proposed operation". However, in our opinion, the scope of the hydrogeological investigation and the investigation methods were such that the objective was not satisfied. The construction of the test wells (the majority of which were cased to 6 metres depth and completed as open holes below 6 metres depth) did not permit an assessment of shallow bedrock conditions (the upper weathered bedrock) or the variation in hydrogeological parameters with depth. Due to the site conditions and the designs of the test wells, vertical hydraulic gradients are not easily interpreted, and the identification and testing of the hydraulic conductivity of distinct bedrock zones (by means of constant rate pumping tests) is not possible. Pumping tests from open hole test wells are useful for investigation of the bulk properties of aquifers, but cannot produce the data required to characterize complex fractured rock systems.

The interpretation of the constant rate pumping test results was, in many instances, founded on unsubstantiated assumptions, which lead to questionable conclusions. For example,

- in Section 6.3.11, Gorrell indicates that changes in rates of drawdown in a pumping well are related only to water bearing zones intersected by the well. This is but one possible factor that would effect observed drawdown.
- Gorrell's analysis of each pumping test includes reporting of volumes of groundwater that were pumped from the well and that subsequently entered the well after the pump was shut off. This data is for of little value as it cannot be used to calculate hydraulic properties.
- Hvorslev's method is used to calculate hydraulic conductivity from constant rate test data. Hvorslev's method is not appropriate for this type of analysis.
- Gorrell assumed that several of the pumping tests were affected by well-bore storage of adjacent wells, groundwater filled voids, or recirculation of pump discharge. Thus, Gorrell often suggests that the hydraulic conductivity of the bedrock is less than indicated by the results of the pumping tests. Gorrell's assumptions were not proven and are not likely, (except for the possible occurrence of recirculation of pump discharge (pumping test at TW 8-1). Gorrell did not use the monitoring well results to calculate aquifer parameters (using a two well solution) as might be expected.

The Gorrell report presents information on local wells and potential impact to local wells but does not discuss potential impacts of quarry development to surface water and biological features. Surface water and biological features that could be impacted by quarry development are presented in the Natural Environment Report Level I & II; however, neither report comments about potential quarry-related impacts associated with groundwater level drawdown as a result of quarry dewatering.

On page 20 (Section 7.3.2), the Gorrell report states that, "The potentiometric surface of the upper water bearing zones in the deeper confined (aquifer) will not be affected by the proposed quarry." Gorrell further states that the potentiometric surface of the upper water bearing zones (between elevation 117 m ASL and 120 m ASL) is controlled by the surrounding escarpment. However, the fact that the potentiometric surface of this aquifer is controlled by the escarpment beyond the site boundaries does not mean that the quarry would not affect hydraulic heads in the underlying aquifer. Gorrell presents a calculation of vertical seepage of groundwater from the deeper semi-confined aquifer into the proposed quarry (Section 7.4), and states the calculations indicate that "negligible" vertical seepage will occur. The seepage value calculated is low (3 m^3/day). However, Gorrell does not discuss the implications of potentially higher hydraulic conductivity of the confining layer (1 or 2 orders of magnitude higher than assumed should be anticipated), and Gorrell does not compare the upward seepage under the full quarry development scenario to the pre-development seepage (which is presumably downward), nor does Gorrell discuss the effect on the deeper aquifer of the removal of this recharge (i.e., lowering of hydraulic head in the aquifer and potential decrease in groundwater discharge at the escarpment face).

Gorrell has not evaluated the extent of groundwater level drawdown in the upper weathered bedrock or in the deeper aquifers based on the existing quarry operation nor have they made any prediction on the expected extent of groundwater level lowering for the expanded quarry at full development. Gorrell states that the quarry will be developed below the water table and the potentiometric elevation of the deeper confined/semi-confined aquifers (page 21). Therefore, groundwater level lowering at the water table and depressurization of the deeper aquifers would be expected; however, the Gorrell Report does not include a prediction as to what this change will be. Without a prediction regarding the extent of groundwater level lowering, it is not possible to assess potential adverse impact (e.g., to wells or to nearby sensitive surface water features), and it is not possible to determine whether or not mitigation will be required to address potential adverse impacts.

Gorrell states that the radius of influence at similar sites has been measured to be up to 450 m (page 19). This information is useful in a general sense, but it cannot substitute for site-specific data and predictions (the similarity of this site and other site is also not directly discussed or proven).

Gorrell states that the Hydrology Investigation Report determined that the proposed quarry expansion would result in negligible reduction in the drainage areas to various surface water feature (page 19). This may be true, however there is no discussion regarding propagation of groundwater level drawdown beneath area surface water features resulting in loss of groundwater baseflow or increased leakage from the surface water features.

Gorrell provides a prediction of the final water level in the quarry excavation after the quarry operation is complete (Page 22). Gorrell states that, "There will be groundwater flow induced through the shallow weathered bedrock aquifer where it is submerged below the lake level." The potential impacts associated with this induced groundwater flow are not discussed.

The Gorrell Report includes a groundwater monitoring plan, a trigger mechanism and contingency plan. However, in the absence of a prediction regarding the extent of groundwater level lowering, it is not possible to evaluate their appropriateness and it is not possible to determine whether or not mitigation will be required to address potential adverse impacts. Gorrell states that only three of the test wells "represent true potentiometric conditions" (page 20), but the adequacy of the existing test wells for the purposes of groundwater level monitoring is not discussed.

On page 25 of the Gorrell Report, Gorrell implies that ongoing management of sump discharge water being pumped into this area will maintain natural surface water flow. It is not clear if Gorrell is proposing that the discharge of sump water be used as a potential mitigative measure. If so, the requirement for mitigation is also not clearly stated.

COMPLIANCE WITH PROVINCIAL STANDARDS, OFFICIAL PLAN AND OVERALL SUMMARY OF PEER REVIEW

The Gorrell report does not adequately address the potential for adverse impacts to surface water and groundwater resources; therefore, in our opinion it does not meet the requirements associated with a Hydrogeological Level 1 study and Hydrogeological Level 2 study as per Sections 2.2.1 and 2.2.2 of the Provincial Standards (Attachment A). Based on Golder Associates' review of the Gorrell Report, there are several key issues which have yet to be addressed. These issues relate to the definition of the potential zone of groundwater lowering associated with the dewatering of the proposed quarry excavation and the potential impacts on groundwater users and the local surface water regime; the implications of the lowering of groundwater levels in the upper weathered bedrock during the period of quarry flooding after quarry development is complete; and, the development of reasonable and effective mitigation measures to address potential future adverse impacts (if the results of the impact assessments indicate this is required).

Regarding the County of Renfrew Official Plan, it requires regulation of pit and quarry operations so that, "disturbance to the environment is limited to the site, social disruption is prevented and rehabilitation to an acceptable after-use is achieved". In our opinion, the Gorrell report does not adequately address the potential for adverse impacts to surface water and groundwater resources; therefore, it is not known if disturbance to the environment will be limited to the site.

As was stated above, it is our opinion that the scope of the hydrogeological investigation and the investigation methods did not meet the overall investigation objective: that being to "provide an impact analysis of the proposed operation". In the absence of a prediction related to the zone around the proposed quarry excavation that would be subjected to groundwater level lowering (drawdown) as a result of quarry dewatering, it is not possible to determine the potential effects of groundwater level lowering on receptors (i.e., groundwater users and surface water features) or the need for mitigation measures. In addition, it is not possible to develop a technically defensible monitoring program to measure and evaluate the actual effects on water resources in comparison to those predicted as part of the impact assessment.

LIMITATIONS

This technical review was conducted by Golder Associates on behalf of the Renfrew County. The objective of the review was to assess the Gorrell Report in terms of compliance with the requirements of the Provincial Standards and Official Plan and to derive an opinion as to whether the Gorrell Report has adequately characterized the hydrogeological environment in the area of the proposed Braeside Quarry in terms of assessing the potential for adverse effects of the quarry operation on groundwater and surface water resources. The scope of the review was based on the review of documentation as referenced herein. The review was based on the information provided in the Gorrell Report; Golder Associates did not conduct any independent field investigations, analysis, or testing.

GORRELL RESOURCE
INVESTIGATIONS

8 December 2009

Miller Group Inc.
505 Miller Ave
Markham, ON L6G 1B2

Attention: Tom Jones

RE: Reply to Golder Associates Peer Review dated September 11 2008

Dear Mr. Jones;

Golder Associates Ltd. (Golders) prepared a peer review of Gorrell Resource Investigations (GRI) hydrogeological assessment of the proposed Braeside expansion (GRI Report 05460 dated November 2007) for the County of Renfrew and the Township of McNab/Braeside. A number of questions and comments were raised. Additional detail was requested on portions of the study.

The reviewers were satisfied with most of the concepts and information and even predictions provided in the original report. However, they suggested that there was not enough scientific validation and suggested more was required. To address this comment, GRI completed supplemental work on the site and surrounding area, and organized the original data in a manner that better supports the conclusions.

We have supplemented the data to provide evidence of the interactions between surface water and groundwater. The additional data has, in our opinion, substantiated the interpretations of the earlier report and has in some areas resulted in less severe predictions than were originally provided. While this does not result in any changes to the proposed plan of operation, it does benefit Miller Group Inc. (Miller) by providing you with a higher level of security in the operation. It also provides additional information on the geological formations that are present in the area as it relates to your operations and products.

Specific points are not numbered in the Golder review, but the comments are found in Appendix A with the identified points from the main part of the September 11, 2008 document highlighted. The assigned reference numbers to the highlights are matched below with the reply.

Review Procedure

An initial meeting was held in Arnprior with Miller staff, Skelton Brumwell representatives, a GRI representative and professional consultants and Golder review consultants on November 6, 2008. At the meeting, the Golder hydrology and hydrogeology reviews were discussed and questions and points were clarified. General reply approaches were agreed upon. The Miller team consultants returned to prepare the replies.

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To provide a thorough reply to the questions and comments in the peer review, an additional field program was undertaken. Input into the proposed additional work program was provided to Miller and GRI by Gartner Lee Associates/ AECOM. The proposed work program was reviewed with Golder Associates hydrogeologists before it was completed at a meeting at Golder offices in Kanata on December 4, 2008. The purpose of the meeting was to ensure that the work program was appropriate in the opinion of Golder professionals to provide the requested additional detail. The initial feedback from the Golder hydrogeologists at this meeting was surprise with the detail of the originally proposed supplementary work plan, so the plan was scaled back and revised. The revised plan was presented Golder hydrogeologists once more through inter-office correspondence (dated December 15) asking if they would like a further meeting to discuss the changes. The final acknowledgement received by GRI was that Golder had no issues with modifying the program as long as the data was sufficient to support site predictions and that they felt no need to meet again.

Report 08360

The new report, GRI Report 08360 dated December 2009 integrates the data and updates the interpretation and conclusions from GRI Report 05460. It supersedes any interpretations and conclusions of GRI Report 05460 and updates, but does not negate the information from, earlier documents. Section references are to GRI Report 08360.

Key Issues

The Golder Associates review concluded that there are several key issues which had not been completely addressed:

- definition of the potential zone of groundwater lowering associated with the dewatering of the proposed quarry excavation and the potential impacts on groundwater users and the local surface water regime;
- implications of the lowering of groundwater levels in the upper weathered bedrock during quarry operation and during the period of quarry flooding after quarry development is complete;
- development of reasonable and effective mitigation measures to address potential future adverse impacts if required.

We believe that the explanations in this reply letter in conjunction with the additional testing, analysis and interpretation in GRI Report 08360 satisfactorily addresses the Golder peer review issues.

Review Points/ Issues (see Appendix A for numbering and context)

The following points noted in the Golder September 11, 2008 letter (Appendix A) were identified for clarification, additional information or discussion:

1. Site and Regional Topography

The review is correct for the west side of the site, but off site on the east side of the plateau (site directional reference), the face slopes down to approximately 70 m at the Ottawa River. Please refer to Section 5.1 [Sec 5.1]

2. Geology interpretations

Although the review states that the original report stated that "large open fractures are common", the report actually says that the large fractures are readily apparent; there is a difference. The further investigation defined clearly the areas of weathered bedrock. The opened joints are only found in the weathered bedrock zone. The additional data shows that the existing quarry is not only within the weathered zone, it is within the most highly weathered portion of the zone. The second lift shows clearly that the open fractures extend down to the contact between the Bobcaygeon and Gull River Formations. [Sec 5.3]

3. Additional door-to-door (D2D) survey

The reference to the additional (D2D) survey in the October 2007 report was unfortunate and has caused some widespread confusion. Although the intentions were fully to have it completed in that time frame, through a variety of circumstances it was not actually completed until spring 2009. The results are discussed and analysed in GRI Report 08360. [Sec 10]

4. Distance of proposed operation from receptor wells

Extraction in the expanded quarry will have a 300 m separation distance from existing residences as defined in the Zoning By-Law. Some well locations are within the 300 m range, but depending on an individual lot the position may vary slightly. The available information indicates that wells may be positioned between approximately 200 m (south-west corner, site directional reference) to 350 m from the proposed extraction boundary.

5. Clarification of locations of Ryan Creek and Dochart Creek

Ryan Creek is approximately 600 m south of the site property boundary (by true geographical reference) at the closest point. Dochart Creek is approximately 1900 m east to south-east of the site by true geographical reference but west to south-west using site directional references.

The geological setting changes from till veneer at the base of the Braeside plateau to clay on the flat lying plain below. There are approximately 500 m of clay terrain between the base of the plateau and Ryan Creek. [Sec 4]

6. Wetland Features identified on and near site

The review reference is to the natural environment report. The investigation found that springs contribute to a small degree to the maintenance of the features, but there are additional contributions to the features other than the springs. The wetland features are at the topographically lower part of the Miller properties, but they are not at the base of the plateau on a regional scale. The wetland features located in the north-west part of the site and off-site to the south-east of the property were examined and the potential impact of the proposed operation on them was evaluated. The reviewers are directed to Sections 8 and 12 for the details.

The field mapping that was conducted by GRI through the spring month confirms that the off-site wetland feature in the south-east corner is greater than 120 m from the Miller property boundary.

7. Construction of the test wells with 6 m of casing did not permit evaluation of the shallow bedrock conditions or variation in hydrogeological parameters with depth. Vertical hydraulic gradients are not easily interpreted; identification of distinct bedrock zones is not possible. Pumping tests in open holes provide bulk parameters

While we agree that the site parameters were not measured at the time test wells 3 to 8 were constructed, visual observations on the geology and hydrogeological characteristics were made, which were used in interpretation of subsequent test results. Testing of specific zones was not completed at the time of construction. Part of the reason was the objectives of the installation and testing: the initial analysis focused on potential impacts to surrounding groundwater users. The wells, as potential monitors, were constructed in the same manner as residential wells for this reason and would therefore encounter the same responses conditions that the wells would encounter. However, vertical gradients could still easily be measured from the installations.

While it is true that the pumping tests provide bulk, or average hydrogeological parameters, the ideal analyses that are usually completed also assume homogeneity of the medium. Therefore an average value over a section would provide a better average representation in this situation. This is another statement where the assumption is that a numerical model is required for impact assessment. Neither Golder Associates in the review or discussions afterward, or the MOE in verbal feedback indicate that a numerical model is a requirement.

Even in numerical modeling of fracture flow, it is rare that a specific fracture model is used for projects of this scope (to our knowledge). Rather, assumptions are made regarding the scale of the hydrogeological system that allow the saturated flow algorithm to be used. Again, using the average characteristics would provide as good a starting point to this application as potential values for discrete bedrock zones.

8. Unsubstantiated assumptions:

The unsubstantiated assumptions were described as:

- *Rates of drawdown in pumping wells related to water bearing zones intersected by the well.*

In the original analysis, we were aware that there are a number of factors affect rate of drawdown – most notably boundary conditions in the aquifer. In the analysis we did anticipate other effects. However the interpretation of the data, which evaluated various possible explanations and observed factors such as similar behaviour at different holes, the geological setting, the knowledge of the levels of water-bearing zone positions in the boreholes combined to result in the professional opinion that the explanation provided was the correct interpretation.

The additional borehole logging at DH 9-1 and DH 11-1 substantiated this interpretation by providing visual "proof" of the location of the identified fractures inferred from the earlier tests.

- *Value of including quantities of water pumped vs. quantities recharged of "little value"*

The relative value of this information is the personal opinion of the reviewer. The data may not provide a number that can be plugged into an interpretive numerical model, but it is our opinion that the information still has value. It illustrates that little groundwater is actually present through most of the hydrostratigraphic profile. This is an important factor in the analysis and impact assessment, particularly for a lay person reading the report and trying to gain an understanding of just what happens during the testing process – similar to explaining the difference between in-situ versus potential site characteristics. The calculation provides a real example of this.

- *Use of Hvorslev method on recovery data from constant rate test inappropriate analysis*

The Hvorslev method was used on the recovery data. The recovery portion of the test is exactly the same as a rising head test, and using the Hvorslev analysis is quite appropriate. If the assumptions of Hvorslev's analysis are valid, which they were, then the analysis is a good representation of in-situ hydraulic conductivity, not potential.

- *Assumptions that results affected by well bore storage, groundwater voids and re-circulating water unproven and unlikely*

In analysis, site observations were used in conjunction with the data to provide an interpretation. In our small organization continuity is a key and valuable factor: senior-experience staff are involved hands-on from field investigation through analysis and report. The advantage is that the people completing the testing can make relevant field observations that are applied to the interpretation.

These assumptions were clearly illustrated in the packer test results, as presented in Section 7.4 and Appendix D.

- *Did not use 2-well analysis to calculate aquifer parameters*

The analysis was not completed either because there was insufficient data or it was felt that there was too much deviation from the analytical assumptions. Also, we agree that we tended to use the techniques that we use more commonly or we have found to be more successful.

9. Report does not discuss potential impacts of quarry development to surface water and biological features; potential quarry-related impacts associated with groundwater level drawdown as a result of quarry dewatering.

We acknowledge that this particular component was not given as much attention in the original report. This was partly due to confusion about the mandates of the various experts. Our original focus (as stated in the objectives) was on potential impact to groundwater users, similar to (in our opinion) the general state of the industry at the time the project was initiated. However, we agree that in the time since that original field work was completed, attention is now being focussed on the importance of interaction with the natural environment and in particular the interaction between the weathered bedrock zone and site and near-site surface water features. The additional report has examined these potential interactions, which are found in Section 12.

The analysis of potential impact on the natural features was evaluated by refining the boundaries of the weathered bedrock zone and by determining/mapping the local shallow groundwater recharge pattern. The geology and morphology of the site has resulted in the formation of shallow system, but the existing quarry operation has also been responsible for both maintaining the local flow patterns and also in contributing to the development of them.

The discussion of the surface water/ shallow groundwater interactions are found throughout the report, but specifically the reviewers are directed to Section 12 for analysis and interpretation.

10. Analysis of impacts of quarry operation (with reference to vertical seepage through quarry floor) on underlying significant water bearing zone.

- Further to the above, no discussion is given of potential impacts of variability in assumed hydraulic conductivity of the confining layer (i.e. sensitivity analysis)
- Gorrell did not compare the change in gradient between pre-development and post development.
- Gorrell did not discuss the effect on the deeper aquifer of the removal of the discharge (lowering of hydraulic head, potential decrease in discharge at escarpment face)

The reviewers will find this analysis in Section 11.3. The vertical seepage will not affect the underlying significant water bearing zone.

11. Gorrell did not evaluate the extent of groundwater level drawdown in the upper weathered bedrock or in the deeper aquifers, nor made a prediction on the extent of groundwater level lowering for the expanded quarry at full development.

We can respectfully disagree with this statement, and clarify our position. We referred to the "extent of groundwater level lowering" as the radius of influence. We direct the reviewer to p 19 of the original report where we stated for the weathered bedrock zone, *"The radius of influence has been measured to be up to 450 m on other similar settings, and this coincides with theoretical calculations for this site."*, and on p 20, where we stated for the confined bedrock aquifer, *"The potentiometric elevation of the upper water bearing zones in the deeper confined[aquifer] will not be affected by the proposed quarry."*

The report stated that the radius of influence, or extent of groundwater lowering for the quarry at full development, would be up to 450 m for the weathered bedrock zone, and that there would be no effect on the deeper confined aquifer.

In subsequent discussions, the comment was made by the reviewer that the 450 m radius would expand as the excavation increased. Again, we respectfully disagree. The weathered bedrock zone is fully penetrated by the quarry. The radius of influence will not change – using the figure of the original report; it would remain at 450 m. The area influenced would increase proportionally with the excavation to a maximum of 450 m around the excavation. Additionally, all analyses assumed the "worst" case, that is, full quarry development.

Notwithstanding, the additional data acquired in the 2009 investigation on the weathered bedrock zone was used to refine the analysis of radius of influence and the result is that the predicted radius of influence in the weathered bedrock zone has been reduced to approximately 180 m from the originally stated 450 m. The analysis is presented and discussed in Section 11.2.

Perhaps the reviewers mean that the extent of impact was not shown. To address this concern, a potential influence area at full development (revised per additional data) that shows the weathered zone is found on Figure 19. The influence area for weathered bedrock reflects the broadest influence area of the different aquifers on the site.

12. Use of weathered bedrock data from other sites not relevant.

The extent of weathered bedrock across Eastern Ontario where our work over the past 25 years has been focussed is dependent on the geological history. The original study reported 450 m as a worst case possibility and also noted that this was not the case observed in the Braeside study area where the impact appeared to be less. So what was presented was a worst case possibility, based on statistical evidence (which we agree was not presented in the report, but which we thought the reviewers would also be privy to) from Eastern Ontario.

Evidence from the door to door survey was then provided to show that this worst case situation was not in fact occurring in this particular setting and a plausible explanation was provided: the decrease was attributed to the mitigation effect of the existing quarry dewatering system. In fact, the additional investigation shows that in addition to this effect, the hydraulic characteristics of the specific setting are less permeable than the "worst case" provided which provided additional accuracy for the site but did not change any of the report conclusions.

The additional mapping and subsurface investigation show that the weathered bedrock zone was much less prevalent than originally assumed, and is confined to the flanks of the plateau. The theoretical calculation shows that the extent of the quarry influence in the weathered zone could extend up to 200 m from the excavation. The weathered zone does not always even extend this far on the properties. [Sec 11.2]

13. There is no discussion regarding propagation of groundwater level drawdown beneath area surface water features resulting in loss of groundwater base flow or increased leakage from the surface water features.

The reviewers will find the discussion in particular in Section 12 of GRI Report 08360. The surface water features receive no baseflow contribution from the competent bedrock that underlies them. The features are recharged from surface water sources.

14. Discussion of potential impacts of induced groundwater flow due to quarry filling following quarry decommissioning.

The conclusion of the original report was that there would not be an impact to the underlying significant water bearing zones, and that consequently the surrounding wells will not be impacted. To clarify this, the reviewers will find additional discussion and analysis in Section 11.3.12 of the report.

15. Only three of the test wells represent true potentiometric conditions; adequacy of the wells for purposes of groundwater monitoring.

The review of GRI Report 08360 will show that test wells 3 to 8 were re-evaluated in light of the new testing information and the additional potentiometric data that was collected over the past 1 to 1.5 years during the peer reviews and additional investigation. The reviewers will find that of the test wells, only 4 have no monitoring value at this time; the rest, although providing variable groundwater production value do provide representative potentiometric data through the hydrostratigraphic profile. In addition, the supplementary testing added one specific well (DH 9-1 targeted to provide advance warning of potential impacts to nearby off-site residential wells.

16. Use of management of sump water not discussed as mitigation measure or requirement.

The use of the sump management as a mitigation measure was not discussed as it was an existing practice in the operation. However, the continuation of the practice through the life of the operation is recommended to buffer potential surface water impacts in the north-west part of the site. The recommendation has been included in GRI Report 08360 [Section 12.2 and 14.1].

17. Report did not meet requirements of Level 2 under *ARA* because of outstanding issues

With the provided supplementary information and analysis, we believe the reviewers will find the components of the Level 2 study have been addressed with the supplementary data on the surface water/ groundwater interaction data and analysis.

18. Report did not meet requirements of Official Plan because of insufficient potential impacts analysis

With the additional information in GRI Report 08360 and the explanations provided both within it and in the above reply, the reviewers should find that the requirements of the Official Plan have been met.

If you have any questions about this reply, please feel free to contact me. If the Golder reviewers have any questions, we ask them to contact us directly.

Yours truly;

Jennifer Gorrell

Jennifer B. Gorrell M.Sc. P.Geo.

GORRELL RESOURCE
INVESTIGATIONS

20 Years
gri
1988 - 2008

Appendix A
Golder Associates Peer Review Letter – September 11 2008 (Main Text) with Identified Points

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Reply to September 11 2008 Golder Associates Ltd. Peer Review of GRI 05460

Prepared for:

Miller Group Inc.
505 Miller Ave
Markham, ON L6G 1B2

05 August 2009

Golder Associates Ltd.

32 Steacie Drive
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Telephone 613-592-9600
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September 11, 2008 08-1122-0216

County of Renfrew
9 International Drive
Pembroke, Ontario
K8A 6W5

Attention: Mr. Bruce Howarth, MCIP, RPP, Senior Planner

RE: REVIEW OF REPORT ENTITLED HYDROGEOLOGICAL INVESTIGATION, BRAESIDE QUARRY EXPANSION, PREPARED BY GORRELL RESOURCE INVESTIGATIONS, DATED SEPTEMBER 2007

Dear Sir:

The County of Renfrew has retained Golder Associated Ltd. (Golder Associates) to conduct a technical review of various reports related to a proposed quarry expansion. These reports were prepared in support of an application for Zoning By-Law Amendment (associated with the expansion of a quarry) under the Township of McNab/Braeside Official Plan (Section 9.3(3)) as well as an application to the Ministry of Natural Resources ("MNR") for a quarry license with extraction below the water table. This submission comprises Golder Associates' technical review of the hydrogeological investigation report referenced above, prepared by Gorrell Resource Investigations (Gorrell) for the Miller Group Inc.. As requested, this letter has also been provided in PDF format.

The hydrogeological investigation report was authored by George A. Gorrell, M.Sc., P.Geo, F.G.A.C. and Jennifer B. Gorrell, M.Sc., P.Geo., P.Eng. On August 28, 2008, Golder Associates contacted Gorrell to advise them that Golder Associates had been retained by the County of Renfrew to conduct a technical review of the hydrogeological investigation report.

In addition to the above referenced report, Golder Associates also examined the following two documents specifically for the purpose of understanding the surface water features on, and in the vicinity of, the Braeside Quarry:

> *Braeside Quarry Expansion, Hydrological Investigation, Township of McNab/Braeside, County of Renfrew, Prepared by Skelton, Brumwell & Associates Inc.,*

dated October 2007. Natural Environment Report Level I & II, Braeside Quarry Expansion, Township of McNab/Braeside, County of Renfrew, Prepared by Skelton, Brumwell & Associates Inc., dated November 21, 2007.

Golder Associates did not conduct a technical review of these later two documents in the context of the peer review of the hydrogeological investigation.

To assist with the review of the hydrogeological investigation, Golder Associates was also provided with a copy of the Site Plans dated November 2007. The Site Plans consisted of the following sheets: Site Environs, Existing Features & Cross Sections, Operational Plan, Progressive & Final Rehabilitation Plan, Monitoring & Mitigation. These Site Plans are referenced herein, where appropriate.

SCOPE AND FORMAT OF TECHNICAL REVIEW

Within designated parts of the Province of Ontario, the licensing requirements for quarries are outlined under the Bill 52 amendment to the *Aggregate Resources Act*. The Township of McNab/Braeside has been designated under the *Aggregate Resources Act* (refer to Section 9.1 of the Official Plan). The proposed quarry expansion is a Category 2, Class "A" licence application which would permit the extraction of more than 20,000 tonnes of aggregate material per year.

The technical aspects for a hydrogeological and hydrological assessment associated with a proposed quarry are outlined in the document entitled **Aggregate Resources Act of Ontario, Provincial Standards, Version 1.0** (hereafter referred to as the "Provincial Standards"). In the context of the Provincial Standards, the hydrogeological and hydrological assessments of a proposed quarry are referred to as a Hydrogeological Level 1 study and, in some cases, a Hydrogeological Level 2 study. Excerpts from the Provincial Standards that describe the information to be addressed in a Hydrogeological Level 1 study (Section 2.2.1) and Hydrogeological Level 2 study (Section 2.2.2) are summarized in Attachment A. This review focuses on a determination as to whether or not the hydrogeological investigation report addresses the requirements of the Official Plan and Provincial Standards for a quarry below the established water table.

Golder Associates has reviewed the hydrogeological investigation report (referred to herein as "the Gorrell Report") from the following perspectives:

1. Has the surficial and bedrock geological and hydrogeological settings of the site and surrounding areas been adequately characterized with respect to the bedrock stratigraphy, groundwater levels, hydraulic gradients, hydraulic conductivity/transmissivity characteristics

of the various hydrostratigraphic units, etc. so that the influence of the quarry on groundwater levels can be assessed?

2. Have the effects of the existing quarry (if any) on the local groundwater system been defined?
3. Have the various potential groundwater receptors (typically private wells in the vicinity of a quarry development) and surface water receptors (surface water drainage course and water bodies, wetlands, etc.) been identified and characterized within the anticipated zone of influence of the quarry?
4. Based on the full development of both the existing approved quarry and the proposed quarry expansion, has the degree of potential groundwater level lowering in the various hydrostratigraphic units been predicted?
5. Based on the predicted degree of potential groundwater level lowering, will these quarry-induced hydrogeological effects affect the potential receptors (impact assessment)?
6. If the potential exists for quarry-induced hydrogeological effects to impact receptors, is the degree of impact acceptable? If the degree of impact on receptors is unacceptable, have appropriate, site-specific mitigation measures been proposed?
7. Have appropriate monitoring programs been developed to measure and evaluate the actual effects on water resources associated with long term quarry development, and to allow a comparison between the actual effects measured during the operational monitoring program with those predicted as part of the impact assessment (Item #5 above)?

These questions are answered in this review. The results of our review are presented in the following sections of this submission:

- Site Description
- Stated Objectives of The Gorrell Hydrogeological Investigation
- Scope of The Gorrell Hydrogeological Investigation
- Summary of Conclusions from The Gorrell Hydrogeological Investigation Report
- General Comments on The Gorrell Hydrogeological Assessment
- Compliance with Provincial Standards, Official Plan and Overall Summary of Peer Review

SITE DESCRIPTION

Site Location, Proposed Quarry Development Plan and Topographic Setting

The proposed quarry expansion site is located adjacent to the existing, operational Miller Braeside Quarry (MNR License #16173) and is located on Part of Lots 16 and 17, Concession A, Municipality of McNab/Braeside, Renfrew County. The existing licensed area comprises 29.7 hectares (ha) with a disturbed area of 17. 1 ha. The additional area to be licensed as per the expansion application, is 103.0 ha which would result in a total licensed area of 132.8 ha. Within this 132.8 ha parcel of land, the licensed extraction area will be 68.4 ha with the remaining 64.4

ha being a protected area within the setbacks (based on Operational Plan). The base elevation of the proposed licensed extraction area will be 125 metres above sea level (m ASL) and annual extraction will not exceed 1,000,000 tonnes. According to the rehabilitation plan, it is expected that the rehabilitated quarry will flood to a final lake level of approximately 132 m ASL.

The Miller property is located approximately 3 kilometres northwest of the Village of Braeside
and is situated on a bedrock plateau that runs parallel to the Ottawa River. The majority of the
plateau is undeveloped and covered with trees. The plateau is characterized by relief on the order
of 30 to 40 metres with sharply dropping faces south to south-westward onto a clay plain and
north to north-eastward into the Ottawa River. From this location, the surface slopes gently to the
north and northwest, and more steeply to the west. Regionally, the crest of the bedrock ridge has
1 an elevation of 153 m ASL, and the base of the ridge is approximately 125 m ASL (i.e., the same
elevation as the base of the proposed licensed extraction area). At the base of the ridge, the
gradient drops to less than 10% and the ground surface slopes gently towards Ryan Creek which
lies at an approximate elevation of 113 m ASL. On the site, the maximum elevation is
approximately 150 m ASL (southeast corner of the site), sloping down to approximately 130 m
ASL in the northwest corner of the site.

Geological and Hydrogeological Setting

The site has minimal overburden cover. The upper bedrock unit at the site consists of limestone
of the Bobcaygeon Formation. The contact between the Bobcaygeon Formation and the
2 underlying Gull River Formation is reported to be at approximately 125 m ASL. Gorrell reports
that large open fractures are common in the area and that they extend from surface to appreciable
depth. From the MOE water well records, Gorrell concluded that the Braeside Plateau is
potentially a zone of local recharge to the bedrock aquifer and that regional groundwater flow
(Figure 4 in the Gorrell Report) is from the Braeside Plateau towards the Ottawa River to the
northeast and to the southwest towards Dochart Creek.

Local Groundwater Users (Groundwater Receptors)

Gorrell reviewed the MOE water well records (22 records had sufficient information for detailed
analysis) and conducted a door-to-door of 17 residences within a 500 metres radius of the existing
quarry. Results of the door-to-door survey indicated that the area groundwater users rely on two
aquifers, namely the upper unconfined weathered bedrock and the deeper confined or semi-
confined bedrock aquifer. Wells completed in the deeper bedrock reportedly obtain their water
from two distinct water bearing zones, between approximate elevations 120 and 110 m ASL and
3 at 80 m ASL. Section 6.5 of the Gorrell Report refers to an additional door-to-door survey
conducted in October 2007 along Golf Course Road but the information from this survey was not
4 included in the Gorrell Report. The minimum separation distance between private water supply

wells at residences along Golf Club Road and the proposed extraction area appears to be in the order of 300 metres (based on examination of the Operational Plan).

Local Surface Water Features (Surface Water Receptors)

Based on examination of the Natural Environment Report Level I & II, aquatic features on, and in the vicinity of the site, are as follows:

- The MNR staff stated that to their knowledge there were no watercourses on the subject
  property but groundwater discharge from the subject property at the base of the Braeside
  Plateau contributes water to Ryan Creek, which drains into Dochart Creek, a known cold-
  5 water fishery. [Note: Ryan Creek and Dochart Creek are located approximately 500 metres
  west and southwest of the Miller property and the Hydrological Investigation Report states
  that, "Ryan Creek is a marginal cold-water fishery due to heavy clay substrate, minimal in-
  stream cover and turbid waters".]
- Two on-site wetland communities were identified on the northwest part of the Miller
  property. These on-site wetland communities were identified as a white cedar-conifer
  organic swamp (SWC3) and mixed organic swamp (SWM), the latter of which "includes
  standing water and flowing water from seepages at the base of the Braeside Plateau". Section
  6 4.3 of the report indicates that these "two wetland communities are the result of groundwater
  seepage at the base of the Braeside Plateau and are fairly isolated and contained". Both of
  these wetland communities are within 250 metres of the licensed extraction area and SWC3
  appears to be immediately adjacent to the licensed extraction area.
- County of Renfrew Official Plan mapping, OBM and orthophotography all indicate a wetland
  within approximately 120 metres southeast of the proposed quarry expansion (although the
  6 distance is reported as 128 metres in the Natural Environment Report). The Draft Official
  Plan Schedule 2.1, shown on Figure 6 (County of Renfrew, 2006) indicates that this wetland
  is an "Area of Concern". The NHIC database does not indicate this wetland as Provincially
  Significant. The Hydrological Investigation Report identified a drainage area of
  approximately 80 ha for this wetland, of which, approximately 1 ha or 1% is located on the
  subject property.

STATED OBJECTIVES OF THE GORRELL HYDROGEOLOGICAL INVESTIGATION

Section 1 of the Gorrell Report states that the purpose of the hydrogeological investigation was to, "examine an area for a proposed quarry and to provide documentation on the hydrogeological setting and to provide an impact analysis of the proposed operation".

SCOPE OF THE GORRELL HYDROGEOLOGICAL INVESTIGATION

The Gorrell hydrogeological investigation included the following components:

- Review of existing data and published information for the site including the MOE water well records;
- Drilling of thirteen (13) 154 mm (6 inch) diameter test wells (between 2002 and 2006) to base elevations ranging from 108.0 m ASL (TW3-1) to 129.9 m ASL (TW1) for the deeper test wells and 120.5 m ASL (TW3-2) to 134.5 m ASL (TW8-2) for the shallower test wells. Test wells TW1 and TW2 were completed with a steel casing grouted into place with benseal (bentonite). The steel casings in these two wells extended to depths of 1.2 and 1.5 metres below ground surface, respectively. For all other test wells, the steel casings in these test wells extended to depths of 6.09 metres below ground surface;
- An aquifer testing program consisting of constant rate pumping tests on the test wells; and,
- Door-to-door surveys of private wells conducted in the summer of 2006 and October 2007 to collect available information on neighbouring groundwater users. [Note; the Gorrell Report did not include information related to the October 2007 door-to-door survey.]

SUMMARY OF CONCLUSIONS FROM THE GORRELL HYDROGEOLOGICAL INVESTIGATION REPORT

Gorrell provides the following key conclusions based on the hydrogeological investigation:

- Three potential aquifers were identified in the area: the overburden aquifer, the weathered bedrock aquifer and the deeper bedrock aquifer. Area groundwater users rely on the shallow weathered bedrock aquifer and the deeper bedrock aquifer for water supply. The overburden is discontinuous on the site, whereas the shallow bedrock aquifer has a high degree of connectivity to the surface and is influenced by precipitation events and runoff. The deeper "semi-confined to confined" bedrock aquifer has water bearing zones not directly connected to the local surface and this aquifer discharges from the escarpment (south to south-eastward and north to north-eastward) via springs at approximate elevation of 125 m ASL. These springs provide some recharge to the surface water systems and the overburden aquifer.
- The analysis of site conditions shows that the proposed excavation will not impact the local groundwater setting due to topography and geology. The escarpment on which the property is situated is a major influence on the hydrogeological regime of the area, controlling the potentiometric surface of the deeper bedrock aquifer at 125 m ASL. The expansion of the quarry, which will remain at least 5 metres above the significant water bearing zones in the area, will not have additional impact. The continued management of discharge from the quarry in the manner currently used at the site will maintain the natural surface water and shallow groundwater regime.

GENERAL COMMENTS ON HYDROGEOLOGICAL ASSESSMENT

7 The stated objective of the Gorrell investigation was to "provide an impact analysis of the proposed operation". However, in our opinion, the scope of the hydrogeological investigation and the investigation methods were such that the objective was not satisfied. The construction of the test wells (the majority of which were cased to 6 metres depth and completed as open holes below 6 metres depth) did not permit an assessment of shallow bedrock conditions (the upper weathered bedrock) or the variation in hydrogeological parameters with depth. Due to the site conditions and the designs of the test wells, vertical hydraulic gradients are not easily interpreted, and the identification and testing of the hydraulic conductivity of distinct bedrock zones (by means of constant rate pumping tests) is not possible. Pumping tests from open hole test wells are useful for investigation of the bulk properties of aquifers, but cannot produce the data required to characterize complex fractured rock systems.

The interpretation of the constant rate pumping test results was, in many instances, founded on unsubstantiated assumptions, which lead to questionable conclusions. For example,

8
- in Section 6.3.11, Gorrell indicates that changes in rates of drawdown in a pumping well are related only to water bearing zones intersected by the well. This is but one possible factor that would effect observed drawdown.
- Gorrell's analysis of each pumping test includes reporting of volumes of groundwater that were pumped from the well and that subsequently entered the well after the pump was shut off. This data is for of little value as it cannot be used to calculate hydraulic properties.
- Hvorslev's method is used to calculate hydraulic conductivity from constant rate test data. Hvorslev's method is not appropriate for this type of analysis.
- Gorrell assumed that several of the pumping tests were affected by well-bore storage of adjacent wells, groundwater filled voids, or recirculation of pump discharge. Thus, Gorrell often suggests that the hydraulic conductivity of the bedrock is less than indicated by the results of the pumping tests. Gorrell's assumptions were not proven and are not likely, (except for the possible occurrence of recirculation of pump discharge (pumping test at TW 8-1). Gorrell did not use the monitoring well results to calculate aquifer parameters (using a two well solution) as might be expected.

9 The Gorrell report presents information on local wells and potential impact to local wells but does not discuss potential impacts of quarry development to surface water and biological features. Surface water and biological features that could be impacted by quarry development are presented in the Natural Environment Report Level I & II; however, neither report comments about potential quarry-related impacts associated with groundwater level drawdown as a result of quarry dewatering.

10 On page 20 (Section 7.3.2), the Gorrell report states that, "The potentiometric surface of the upper water bearing zones in the deeper confined (aquifer) will not be affected by the proposed quarry." Gorrell further states that the potentiometric surface of the upper water bearing zones (between elevation 117 m ASL and 120 m ASL) is controlled by the surrounding escarpment. However, the fact that the potentiometric surface of this aquifer is controlled by the escarpment beyond the site boundaries does not mean that the quarry would not affect hydraulic heads in the underlying aquifer. Gorrell presents a calculation of vertical seepage of groundwater from the deeper semi-confined aquifer into the proposed quarry (Section 7.4), and states the calculations indicate that "negligible" vertical seepage will occur. The seepage value calculated is low (3 m^3/day). However, Gorrell does not discuss the implications of potentially higher hydraulic conductivity of the confining layer (1 or 2 orders of magnitude higher than assumed should be anticipated), and Gorrell does not compare the upward seepage under the full quarry development scenario to the pre-development seepage (which is presumably downward), nor does Gorrell discuss the effect on the deeper aquifer of the removal of this recharge (i.e., lowering of hydraulic head in the aquifer and potential decrease in groundwater discharge at the escarpment face).

11 Gorrell has not evaluated the extent of groundwater level drawdown in the upper weathered bedrock or in the deeper aquifers based on the existing quarry operation nor have they made any prediction on the expected extent of groundwater level lowering for the expanded quarry at full development. Gorrell states that the quarry will be developed below the water table and the potentiometric elevation of the deeper confined/semi-confined aquifers (page 21). Therefore, groundwater level lowering at the water table and depressurization of the deeper aquifers would be expected; however, the Gorrell Report does not include a prediction as to what this change will be. Without a prediction regarding the extent of groundwater level lowering, it is not possible to assess potential adverse impact (e.g., to wells or to nearby sensitive surface water features), and it is not possible to determine whether or not mitigation will be required to address potential adverse impacts.

12 Gorrell states that the radius of influence at similar sites has been measured to be up to 450 m (page 19). This information is useful in a general sense, but it cannot substitute for site-specific data and predictions (the similarity of this site and other site is also not directly discussed or proven).

13 Gorrell states that the Hydrology Investigation Report determined that the proposed quarry expansion would result in negligible reduction in the drainage areas to various surface water feature (page 19). This may be true, however there is no discussion regarding propagation of groundwater level drawdown beneath area surface water features resulting in loss of groundwater baseflow or increased leakage from the surface water features.

14 Gorrell provides a prediction of the final water level in the quarry excavation after the quarry operation is complete (Page 22). Gorrell states that, "There will be groundwater flow induced through the shallow weathered bedrock aquifer where it is submerged below the lake level." The potential impacts associated with this induced groundwater flow are not discussed.

15 The Gorrell Report includes a groundwater monitoring plan, a trigger mechanism and contingency plan. However, in the absence of a prediction regarding the extent of groundwater level lowering, it is not possible to evaluate their appropriateness and it is not possible to determine whether or not mitigation will be required to address potential adverse impacts. Gorrell states that only three of the test wells "represent true potentiometric conditions" (page 20), but the adequacy of the existing test wells for the purposes of groundwater level monitoring is not discussed.

16 On page 25 of the Gorrell Report, Gorrell implies that ongoing management of sump discharge water being pumped into this area will maintain natural surface water flow. It is not clear if Gorrell is proposing that the discharge of sump water be used as a potential mitigative measure. If so, the requirement for mitigation is also not clearly stated.

COMPLIANCE WITH PROVINCIAL STANDARDS, OFFICIAL PLAN AND OVERALL SUMMARY OF PEER REVIEW

17 The Gorrell report does not adequately address the potential for adverse impacts to surface water and groundwater resources; therefore, in our opinion it does not meet the requirements associated with a Hydrogeological Level 1 study and Hydrogeological Level 2 study as per Sections 2.2.1 and 2.2.2 of the Provincial Standards (Attachment A). Based on Golder Associates' review of the Gorrell Report, there are several key issues which have yet to be addressed. These issues relate to the definition of the potential zone of groundwater lowering associated with the dewatering of the proposed quarry excavation and the potential impacts on groundwater users and the local surface water regime; the implications of the lowering of groundwater levels in the upper weathered bedrock during the period of quarry flooding after quarry development is complete; and, the development of reasonable and effective mitigation measures to address potential future adverse impacts (if the results of the impact assessments indicate this is required).

18 Regarding the County of Renfrew Official Plan, it requires regulation of pit and quarry operations so that, "disturbance to the environment is limited to the site, social disruption is prevented and rehabilitation to an acceptable after-use is achieved". In our opinion, the Gorrell report does not adequately address the potential for adverse impacts to surface water and groundwater resources; therefore, it is not known if disturbance to the environment will be limited to the site.

As was stated above, it is our opinion that the scope of the hydrogeological investigation and the investigation methods did not meet the overall investigation objective: that being to "provide an impact analysis of the proposed operation". In the absence of a prediction related to the zone around the proposed quarry excavation that would be subjected to groundwater level lowering (drawdown) as a result of quarry dewatering, it is not possible to determine the potential effects of groundwater level lowering on receptors (i.e., groundwater users and surface water features) or the need for mitigation measures. In addition, it is not possible to develop a technically defensible monitoring program to measure and evaluate the actual effects on water resources in comparison to those predicted as part of the impact assessment.

LIMITATIONS

This technical review was conducted by Golder Associates on behalf of the Renfrew County. The objective of the review was to assess the Gorrell Report in terms of compliance with the requirements of the Provincial Standards and Official Plan and to derive an opinion as to whether the Gorrell Report has adequately characterized the hydrogeological environment in the area of the proposed Braeside Quarry in terms of assessing the potential for adverse effects of the quarry operation on groundwater and surface water resources. The scope of the review was based on the review of documentation as referenced herein. The review was based on the information provided in the Gorrell Report; Golder Associates did not conduct any independent field investigations, analysis, or testing.

March 9, 2010 Project No. 08-1122-0216

Jennifer B. Gorrell, M.Sc., P.Geo.
Gorrell Resource Investigations
Rural Route 1
Oxford Mills, Ontario
K0G 1S0

PRELIMINARY REVIEW OF GORRELL RESOURCE INVESTIGATIONS CONSOLIDATED 2006 – 2009 HYDROGEOLOGICAL INVESTIGATION PROPOSED BRAESIDE QUARRY EXPANSION

Dear Jennifer:

Golder Associates Ltd. (Golder) has completed an initial review of the following documents which were provided to Golder in January 2010 by Gorrell Resource Investigations (GRI):

- Report: Consolidated 2006 – 2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion, GRI, November 2009; (referred to hereafter as the “GRI Report”); and,
- Letter: Reply to Golder Associates Peer Review dated September 11, 2008, GRI, November 2009 (referred to hereafter as the “GRI Letter”).

Golder is also in receipt of the Skelton Brumwell and Associates (SBA) responses to the initial Golder peer reviews of the Hydrological Report and Natural Environment Report. The Golder technical leads in these two disciplines have not commenced their review of the SBA documents because it was felt that these reviews would be more efficiently undertaken once a site-specific, technically defensible hydrogeological impact assessment was completed and peer reviewed.

This letter has been divided into three sections. The first section provides some general comments on the above documents; the second section presents specific technical comments/questions regarding the above documents; and, the final section suggests the proposed next step in the peer review process.

GENERAL COMMENTS

These general comments pertain to the GRI Letter.

Page 4, Item 7, Paragraphs 3 and 4

This text makes reference to numerical modelling and states that “Neither Golder Associates in the review or discussions afterward, or the MOE in verbal feedback indicate that a numerical model is a requirement”. The overall objective of a hydrogeological investigation of a quarry site, for the purpose of a license application or a permit to take water application, is to define the geological and hydrogeological system such that a defensible conceptual model can be developed. This conceptual model is then used in undertaking an impact assessment of the proposed quarry development scenario on the surrounding natural environment, surface water systems, and groundwater users (i.e., the receptors). There are a number of approaches that can be used to conduct an impact assessment, one approach being through the development of a numerical model. It is Golder's position that the selection of the most suitable, technically defensible approach for conducting a hydrogeological impact assessment at a specific property is that of the applicant's consultant and not the peer reviewer or regulatory agency. It is not Golder's role as peer reviewer to "recommend" a specific approach as to how the impact assessment should be conducted for the proposed Braeside Quarry expansion. It is Golder's opinion that the complexity of the site conditions does have an influence on the appropriate approach and preferred methodology adopted for the purpose of conducting an impact assessment at a proposed quarry site. The manner in which the site-specific field data is collected, analyzed and used in the development of the conceptual hydrogeological model of the site, and how the site-specific data is subsequently integrated into the impact assessment with due recognition of the assumptions that are made, is the key issue.

Page 6, Item 11, Paragraph 2 and Page 7, Item 12, Paragraph 1

These sections speak to the extent of groundwater level lowering associated with the development of the existing quarry and proposed quarry expansion.

In the original hydrogeological report (which was reviewed by Golder), GRI stated that the radius of influence at similar sites has been measured to be up to 450 metres. Site-specific predictions of the potential radius of influence at the Braeside Quarry were not presented in the original hydrogeological report. In the GRI Letter, it states with reference to the "450 m radius of influence" issue, that *"what was presented was a worst case possibility, based on statistical evidence (which we agree was not presented in the report, but which we thought the reviewers would also be privy to) from Eastern Ontario"*.

While previous experience at other sites in similar geological settings is useful, it is not a substitute for site-specific data and predictions based on that data. GRI should not assume that Golder has had the same experience on such matters or that our previous experiences on similar projects elsewhere are relevant to this project. The hydrogeological report in support of the proposed expansion of the Braeside Quarry should be a standalone document. In fact, Golder's recent experience would suggest that the radius of influence with respect to groundwater lowering around a quarry in the same geological formations (as the Braeside Quarry property) can be significantly greater than 450 metres.

Specific Technical Comments/Questions

Based on our review of the GRI Report, the following technical comments and questions are provided:

1) Page 18, Figure 7: The figure title indicates weather data from 2007, the x-axis label indicates data from 2008, and the first paragraph of section 6.1, above the figure, makes reference to 2006 data. GRI should clarify the dates;

2) Page 23, Section 7.2.1: GRI states that Hvorslev's method was used to interpret pumping test recovery data. Golder previously explained to GRI that Hvorslev's method is not appropriate for analysis of pumping test data. Hvorslev's method is based on the assumption that a slug of water is added or removed from a piezometer instantly, so that the potentiometric level of the aquifer is not affected. If the potentiometric level of the aquifer is affected to the degree that it is during a pumping test, the use of the Hvorslev method will provide erroneous results. The Hvorslev method also assumes that the piezometer intake (the screened interval) is below the groundwater level in the well for the duration of the test. This is not the case during a pumping test, and also leads to erroneous results, if the Hvorslev method is used to calculate hydraulic

conductivity. GRI should use industry standard methods to calculate transmissivity (T) and hydraulic conductivity (K) from pump test recovery data. Golder would be pleased to discuss these methods with GRI;

3) Page 23, Section 7.2.1.1: GRI states that 6.8 L/min of water was produced from fractures and the remaining 12,375 litres of water removed during pumping came from well bore storage and the surrounding rock. This interpretation is not supported by the data, and it is not clear how this interpretation affects the calculation of the hydraulic conductivity of the bedrock. As above, GRI should use industry standard methods to calculate T and K;

4) Page 23, Section 7.2.1.1: GRI states that TW 3-1 affected the pumping test conducted in TW 3-2. Golder disagrees with this interpretation and suggests that GRI attempt to interpret their pumping test data based on the simplifying assumption that the bedrock is behaving as an equivalent porous media. GRI can choose the appropriate aquifer thickness based on their understanding of the site hydrostratigraphy;

5) Page 26, Section 7.2.4: The T of TW 6-2 is reported to be 0.02 m^2/day (calculated using the Jacob method), and the K is reported to be 5.1 x 10^{-35} m/s (calculated using the Hvorslev method). GRI concludes that, “This means that the zone (from 6 m to 12.2 m) is impermeable.” This is a clear indication that GRI is basing its hydrogeological interpretation on erroneous calculations. GRI should use standard methods of data interpretation and develop a site hydrogeological conceptual model that incorporates properly calculated K’s;

6) Page 30, Section 7.4: There is a lack of detail regarding the packer testing. In Golder’s opinion, many of the results are indicative of possible packer leakage during the test. GRI should provide further details on the test method and who carried out the tests. GRI states that, “the final tests in each hole were not used in any analysis.” GRI should explain why these results were not considered valid. In Golder’s experience, properly conducted and interpreted packer tests provide a good representation of the hydraulic characteristics of bedrock zones;

7) Page 39, Section 8.5: GRI states that surface water samples were taken at three locations and that, “The connection between three levels was inferred from site observations and the topography.” Golder requires further explanation in order to understand what GRI is attempting to explain. Also, there is a reference to laboratory data found in Table 2. Should this be Table 5? We also note that the units of measurement are not indicated on Table 5;

8) Page 42, Section 9.2: GRI states that Figure 11 shows the contact between the Bobcaygeon and Gull River Formations. Figure 11 does not show this information (it is a plot of flow vs. pressure). Should this be Figure 3?

9) Page 46, Section 9.2.2: GRI states that the weathered bedrock aquifer is only found on the west side of the site. However, Figure 3 shows it on the east and west parts of the site. GRI should clarify the location and extent of the various hydrostratigraphic units on-site and in the vicinity of the site;

10) Page 46, Section 9.2.2: Regarding packer testing at TW 13, GRI states that the packer test results indicate the presence of voids within the bedrock, voids that apparently do not contribute to the hydraulic conductivity of the bedrock. Such isolated voids would not affect the results of a properly run constant pressure packer test. GRI should review the packer test methods and results and revise its interpretation of the data accordingly.

11) Page 62, Section 11.2.1: GRI states that the spring zone is 2 m thick, and calculates the radius of influence using this thickness. GRI should justify the assumed aquifer thickness. The calculation also assumes that the discharge from the expanded quarry will be the same as the existing quarry, based on water surplus calculations. GRI should consider using monitoring well data to calculate groundwater inflow to the existing quarry and to predict groundwater inflow of the expanded quarry;

12) Page 66, Table 8: This zone of influence calculation assumes unconfined conditions, an aquifer thickness of 1 metre, a K of 6.2 x 10^{-7} m/d, and groundwater inflow of 10 m^3/day. The sources of these data are not clear;

13) Page 67, Section 11.3.2.1: GRI calculates the groundwater inflow through the quarry floor using a vertical hydraulic conductivity (K_v) that is 100 times less than the interpreted horizontal hydraulic conductivity (K_h) of 1.18 x 10^{-7} m/s. Elsewhere in the report, GRI reports that the K_h at 121.0 to 123.1 masl is approximately 2.6 x 10^{-6} m/s. GRI should assess the rate of groundwater inflow for the higher K_h, and should more conservatively assume that K_v is 10 times less than K_h or equal to K_h; and,

14) Page 69, Section 11.3.2.2: GRI indicates that the lack of vertical fractures in vertical cores provides assurance regarding its assumption regarding K_v. GRI should not rely on vertical cores to provide information regarding vertical fractures or K_v.

In addition to the above technical issues, there are many instances of typographical errors and awkward sentences in the GRI report that should be corrected or revised for the benefit of the reader. For example, see pages 23, 26, 27, 44, 46, 51, 61, 74 and 80.

We also note that the report has not been signed and stamped, as is conventional practice.

Proposed Next Step

It is proposed that the above noted technical questions/comments serve as the basis of discussion for a meeting between GRI and Golder. This would allow GRI the opportunity to respond directly to the questions/comments, with the intent for Golder and GRI to agree on approaches and methodology.

As is evident from the above noted technical questions/comments, we are experiencing difficulty understanding how GRI analyzed some of the field data, developed the conceptual model from the available data and subsequently integrated the available data into the impact assessment. To assist in this discussion, it is suggested that GRI prepare a series of larger (e.g., D size) figures in advance of the meeting. It is suggested by Golder that the following figures would be useful:

Plan View of Site and Surrounding Area – It is suggested that this figure encompass the area shown on Figure 8 on the GRI Report and that the following items be shown on this figure:

- Miller property line;
- limits of existing licensed quarry;
- limit of proposed expansion area;
- local surficial and bedrock geology including areas where weathered bedrock has been mapped at surface (separate figures indicating surficial and bedrock geology may be useful);
- boreholes/monitoring wells;

- relevant groundwater (local water supply wells) and surface water receptors (including springs, wetlands, etc.);
- topography;
- predicted zone of influence (groundwater level lowering) associated with quarry dewatering in the hydrostratigraphic units of interest; and,
- groundwater elevations and flow direction in hydrostratigraphic units of interest (see Figure 14 in GRI report, although much of the data on the figure is not legible).

Cross-Sections – It is suggested that two figures would be appropriate, with one oriented north-south (project defined directions) and the other east-west. These figures should traverse the area illustrated on the Plan View described above and would be somewhat similar to Figure 3 in the GRI Report. These figures should illustrate the following features/data

- the same items noted above for the Plan View; plus,
- the conceptual hydrogeological model for the site and surrounding area including the pertinent hydrostratigraphic units and their physical properties (hydraulic conductivities, piezometric data).

Some of the figures in the GRI Report include data and symbols which are not legible, thus we feel that the above noted figures would help us (and others) better understand the thought process followed by GRI in developing their conceptual hydrogeological model of the site based on the site-specific data, and subsequently how these data were used in conducting the impact assessment.

We look forward to the opportunity to meet and discuss these issues. If you have any questions, please contact the undersigned at your convenience.

Yours truly,

GOLDER ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

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BTB/KAM/PAS/am

CC: Bruce Howarth, MCIP, RPP, Senior Planner, County of Renfrew
Tom Jones, Property Manager, Miller Paving Limited
Gary Bell, Skelton, Brumwell and Associates Inc.

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GORRELL RESOURCE
INVESTIGATIONS
20 Years
gri
1988 - 2008

31 July 2010

Miller Group Inc.
505 Miller Ave
Markham, ON L6G 1B2

Attention: Tom Jones

RE: Golder Preliminary Review of Gorrell Resource Investigations Consolidated 2006 – 2009 Hydrogeological Investigation Proposed Braeside Quarry Expansion, March 9, 2010

Dear Mr. Jones;

Gorrell Resource Investigations (GRI) were provided with comments from Golder Associates Ltd. (Golder) in a March 9, 2010 letter captioned "Preliminary Review of Gorrell Resource Investigations Consolidated 2006 – 2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion". The letter provided comments on the Consolidated 2006-2009 Hydrogeological Report prepared by GRI, dated December 2009.

Following receipt of the comments and further discussions including a meeting held April 26, 2010, a further report was prepared to summarize critical conclusions of the hydrogeological work completed to date and incorporate responses to the March 9 review comments. This summary report also includes information associated with surface and ground water interaction requested in the Golder April 28, 2009 comments on the hydrological report (Skelton Brumwell Associates, October 2007).

In an email from Brian Byerley dated July 16, 2001, he requested *"Also please ensure that all of the specific technical questions in our March 9th review letter are addressed. "* To ensure this question has been addressed, we have provided below the technical comments of the March 9 letter, highlighted in bold text. Editorial comments have been listed as well, highlighted in italics. These editorial comments, which are will be addressed in the finalized consolidated report once the peer review process has been completed.

1) *Page 18, Figure 7: The figure title indicates weather data from 2007, the x-axis label indicates data from 2008, and the first paragraph of section 6.1, above the figure, makes reference to 2006 data. GRI should clarify the dates*;

    - Corrections have been made; the data was from 2007 as indicated in the title.

2) **Page 23, Section 7.2.1: GRI states that Hvorslev's method was used to interpret pumping test recovery data.** Golder previously explained to GRI that Hvorslev's method is not appropriate for analysis of pumping test data. Hvorslev's method is based on the assumption that a slug of water is added or removed from a piezometer instantly, so that the potentiometric level of the aquifer is not

affected. If the potentiometric level of the aquifer is affected to the degree that it is during a pumping test, the use of the Hvorslev method will provide erroneous results. The Hvorslev method also assumes that the piezometer intake (the screened interval) is below the groundwater level in the well for the duration of the test. This is not the case during a pumping test, and also leads to erroneous results, if the Hvorslev method is used to calculate hydraulic conductivity. GRI should use industry standard methods to calculate transmissivity (T) and hydraulic conductivity (K) from pump test recovery data. Golder would be pleased to discuss these methods with GRI;

- The pumping test data analysis using the Hvorslev method for wells TW5-1, TW5-2, TW6-2, TW7 and TW8-2 will not be included in the final version of the report once the peer review process is completed.

3) **Page 23, Section 7.2.1.1: GRI states that 6.8 L/min of water was produced from fractures and the remaining 12,375 litres of water removed during pumping came from well bore storage and the surrounding rock.** This interpretation is not supported by the data, and it is not clear how this interpretation affects the calculation of the hydraulic conductivity of the bedrock. As above, GRI should use industry standard methods to calculate T and K;

   - This statement was provide for information only and was not used in data analysis. It has no effect on the estimation of the hydraulic conductivity of the bedrock.

4) **Page 23, Section 7.2.1.1: GRI states that TW 3-1 affected the pumping test conducted in TW 3-2. Golder disagrees with this interpretation** and suggests that GRI attempt to interpret their pumping test data based on the simplifying assumption that the bedrock is behaving as an equivalent porous media. GRI can choose the appropriate aquifer thickness based on their understanding of the site hydrostratigraphy;

   - The suggested analysis was considered and is found in Section 5 of the June 2010 Summary Report.

5) **Page 26, Section 7.2.4: The T of TW 6-2 is reported to be 0.02 m2/day (calculated using the Jacob method), and the K is reported to be 5.1 x 10-35 m/s (calculated using the Hvorslev method). GRI concludes that, “This means that the zone (from 6 m to 12.2 m) is impermeable.”** This is a clear indication that GRI is basing its hydrogeological interpretation on erroneous calculations. GRI should use standard methods of data interpretation and develop a site hydrogeological conceptual model that incorporates properly calculated K’s;

   - The pumping test data analysis with the Hvorslev method will be removed from the revised consolidated report once the peer review process is completed. Only hydraulic conductivity values calculated using the agreed-upon method have been used in the summary report for impact assessment in Section 5 of the same report.

6) **Page 30, Section 7.4: There is a lack of detail regarding the packer testing.** In Golder’s opinion, many of the results are indicative of possible packer leakage during the test. GRI should provide further details on the test method and who carried out the tests. GRI states that, “the final tests in each hole were not used in any analysis.” GRI should explain why these results were not considered

valid. In Golder's experience, properly conducted and interpreted packer tests provide a good representation of the hydraulic characteristics of bedrock zones;

- The packer test method and field information was provided reviewed independently by AECOM on behalf of Miller Group Inc. who concluded that the procedure was completed correctly by the drilling subcontractor, and that there was no leaking around the packers. The packer test method reference was provided to Golder separately, and the description of the procedure was expanded in Section 2 of the Summary Report.

- The last paragraph of Section 7.4 on Page 30 of the consolidated report states that "the final tests in each hole were not used in any analysis". This meant that test data from the lowest test interval at the base of each hole were not used in any data analysis. After discussing the possible reasons for the higher measured K in these lowest tests with other peers, GRI has concluded that the single packer tests only most probably experienced some leakage. For that reason these single packer tests only, one per hole tested, were not used in the assessment.

- AECOM advises that the highest hydraulic conductivity in the order of 10^{-5} m/s from the packer tests on the shallow weathered bedrock has been used to assess potential radius of influence in the weathered bedrock as shown in Appendix I of the consolidated report.

7) **Page 39, Section 8.5: GRI states that surface water samples were taken at three locations and that, "The connection between three levels was inferred from site observations and the topography."** Golder requires further explanation in order to understand what GRI is attempting to explain. Also, there is a reference to laboratory data found in Table 2. Should this be Table 5? We also note that the units of measurement are not indicated on Table 5;

- This sampling information was not included in the summary report. The intent was to use geochemistry of the different levels of surface water at the site to help correlate connections through the hydrogeological system. The results, while interesting to GRI, did not appear to contribute significantly to the conceptual model in others' view and was therefore not included in the summary of critical conclusions.

8) *Page 42, Section 9.2: GRI states that Figure 11 shows the contact between the Bobcaygeon and Gull River Formations. Figure 11 does not show this information (it is a plot of flow vs. pressure). Should this be Figure 3?*

- Correct, the referenced figure should be Figure 3.

9) **Page 46, Section 9.2.2: GRI states that the weathered bedrock aquifer is only found on the west side of the site. However, Figure 3 shows it on the east and west parts of the site. GRI should clarify the location and extent of the various hydrostratigraphic units on-site and in the vicinity of the site;**

- As shown in Figures 1, 4 and 6 of the summary report, the weathered bedrock occurs within and on the west side of the existing quarry excavation as well as on the east side of the proposed quarry excavation. The location and extent of the weathered bedrock have been shown correctly in these figures. The text should have indicated that the weathered bedrock aquifer is found **mainly** on the west side of the property. As shown in the geological cross section A-A' (Figure 4), the rock weathering developed on the flanks of the plateau. It is accurate to say, and it is the point that we wanted to make, that the weathered bedrock aquifer will only be influenced by the proposed operation on the west side of the site. While there is weathered bedrock on the Miller property on the east side, with a small exception in the south-east corner, it is beyond the proposed excavation area.

10) **Page 46, Section 9.2.2: Regarding packer testing at TW 13, GRI states that the packer test results indicate the presence of voids within the bedrock, voids that apparently do not contribute to the hydraulic conductivity of the bedrock.** Such isolated voids would not affect the results of a properly run constant pressure packer test. GRI should review the packer test methods and results and revise its interpretation of the data accordingly.

    - As noted above in item 6, the packer test method and results have been verified independently by AECOM and other professional peers.

11) **Page 62, Section 11.2.1: GRI states that the spring zone is 2 m thick, and calculates the radius of influence using this thickness.** GRI should justify the assumed aquifer thickness. The calculation also assumes that the discharge from the expanded quarry will be the same as the existing quarry, based on water surplus calculations. GRI should consider using monitoring well data to calculate groundwater inflow to the existing quarry and to predict groundwater inflow of the expanded quarry;

    - The thickness of the spring zone was estimated by GRI based on field observations, and is close to the average saturated thickness of the weathered bedrock zone (2.5 m) estimated by AECOM based on borehole and static level information from shallow wells at locations 9, 10, 12 and 13, found in Calculation Sheet 1 in Appendix A of the summary report.

    - AECOM indicates that the calculation for radius of influence in the weathered bedrock aquifer (spring zone), previously presented in Appendix I of the consolidated report will be revised using the discharge from the full quarry development and presented in the revised consolidated report once the peer review process is completed. Nevertheless, the radius of influence for the weathered bedrock zone has been further assessed in Section 5.1 of the summary report with supplemental assessment on the radius of influence in the weathered bedrock zone provided by AECOM and presented in Appendix A of the summary report.

12) **Page 66, Table 8: This zone of influence calculation assumes unconfined conditions, an aquifer thickness of 1 metre, a K of 6.2 x 10-7 m/d, and groundwater inflow of 10 m3/day.** The sources of these data are not clear;

    - The radius of influence for the weathered bedrock zone has been further assessed in Section 5.1 of the summary report with supplemental assessment on the radius of influence in the weathered bedrock zone provided by AECOM and presented in Appendix A of the summary report. Table 8 on Page 66 of the consolidated report will be removed from the final version of the consolidated report.

13) **Page 67, Section 11.3.2.1: GRI calculates the groundwater inflow through the quarry floor using a vertical hydraulic conductivity (Kv) that is 100 times less than the interpreted horizontal hydraulic conductivity (Kh) of 1.18 x 10-7 m/s. Elsewhere in the report, GRI reports that the Kh at 121.0 to 123.1 masl is approximately 2.6 x 10-6 m/s.** GRI should assess the rate of groundwater inflow for the higher Kh, and should more conservatively assume that Kv is 10 times less than Kh or equal to Kh; and,

    - The suggested analysis has been discussed in Section 5.2.3 of the summary report. The detailed supplemental assessment, using a vertical K_v being 10 times lower than the horizontal K_h, is found in Section 3.3 of Appendix A of the summary report.

    - Please note that the referenced K value (2.6 x 10^{-6} m/s) for the test interval (121.0 to 123.1 masl) was derived from hydraulic conductivity testing on TW 9-1 (Table 2 of the summary report). The K- value does not represent the competent bedrock below the quarry floor but the significant water bearing fracture zone at 121.0 m ASL intercepted by borehole 9-1 (Table 2, Appendix A of the summary report), as shown in the lowest core photo found in the borehole log (Appendix B, the Consolidated Report).

14) **Page 69, Section 11.3.2.2: GRI indicates that the lack of vertical fractures in vertical cores provides assurance regarding its assumption regarding Kv.** GRI should not rely on vertical cores to provide information regarding vertical fractures or Kv.

    - The interpretation of vertical fractures was based on observations within the quarry excavation and surrounding area exposures. The core was not used in this interpretation.

In addition to the above technical issues, there are many instances of typographical errors and awkward sentences in the GRI report that should be corrected or revised for the benefit of the reader. For example, see pages 23, 26, 27, 44, 46, 51, 61, 74 and 80.

We also note that the report has not been signed and stamped, as is conventional practice.

- These items have been addressed.

If you have any questions, please feel free to contact me.

Yours truly;

Jennifer Gorrell

Jennifer B. Gorrell M.Sc. P.Eng. P.Geo.

Golder Associates

CELEBRATING 50 YEARS in 2010

November 5, 2010

Project No. 08-1122-0216

Bruce Howarth, MCIP, RPP, Senior Planner
County of Renfrew
9 International Drive
Pembroke, Ontario
K8A 6W5

REVIEW OF GORRELL RESOURCE INVESTIGATIONS
JUNE 2010 SUMMARY REPORT - HYDROGEOLOGICAL INVESTIGATIONS
PROPOSED BRAESIDE QUARRY EXPANSION
MUNICIPALITY OF MCNAB/BRAESIDE, ONTARIO

Dear Mr. Howarth:

The County of Renfrew has retained Golder Associates Ltd. (Golder) to conduct a technical review of various reports related to a proposed quarry expansion. These reports were prepared in support of an application for Zoning By-Law Amendment (associated with the expansion of a quarry) under the Township of McNab/Braeside Official Plan (Section 9.3(3)) as well as an application to the Ministry of Natural Resources ("MNR") for a quarry license with extraction below the water table. This submission comprises Golder Associates' technical review of the most recent hydrogeological investigation report for the above referenced site, prepared by Gorrell Resource Investigations (Gorrell) for the Miller Group Limited. As requested, this letter has also been provided in PDF format.

Hydrogeological Investigation Reports

This technical review is the third review conducted by Golder of a hydrogeological investigation report prepared by Gorrell concerning the proposed quarry expansion. In September 2008, Golder completed a technical review of the report entitled: "Hydrogeological Investigation – Braeside Quarry Expansion", dated September 2007. Gorrell subsequently prepared a second report entitled: "Consolidated 2006 – 2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion", dated November 2009. Golder completed a technical review of this second report, and provided review comments in a letter addressed to Gorrell dated March 9, 2010. In response to the second review by Golder, Gorrell prepared a third report – the subject of this letter.

The title of the third hydrogeological investigation report is: "Summary Report – Hydrogeological Investigations, Proposed Breaside Quarry, Part Lots 16 and 17, Concession A, Municipality of McNab-Braeside", dated June 2010. This report (referred to herein as "the Gorrell report"), authored by George A. Gorrell, M.Sc., P.Geo., F.G.A.C. and Jennifer B. Gorrell, M.Sc., P.Geo., P.Eng., was provided to Golder in August 2010.

In addition to the above referenced reports, Golder Associates also examined the following two documents specifically for the purpose of understanding the surface water features on, and in the vicinity of, the Braeside Quarry:

> *Braeside Quarry Expansion, Hydrological Investigation, Township of McNab/Braeside, County of Renfrew, Prepared by Skelton, Brumwell & Associates Inc., dated October 2007.*
>
> *Natural Environment Report Levels I & II, Braeside Quarry Expansion, Township of McNab/Braeside, County of Renfrew, Prepared by Skelton, Brumwell & Associates Inc., dated November 21, 2007.*

Golder Associates did not conduct a technical review of these later two documents in the context of the peer review of the hydrogeological investigations.

To assist with the review of the hydrogeological investigation, Golder Associates was also provided with a copy of the Site Plans dated November 2007. The Site Plans consisted of the following sheets: Site Environs, Existing Features & Cross Sections, Operational Plan, Progressive & Final Rehabilitation Plan, Monitoring & Mitigation.

Scope and Format of Technical Review

Within designated parts of the Province of Ontario, the licensing requirements for quarries are outlined under the Bill 52 amendment to the *Aggregate Resources Act*. The Township of McNab/Braeside has been designated under the *Aggregate Resources Act* (refer to Section 9.1 of the Official Plan). The proposed quarry expansion is a Category 2, Class "A" licence application which would permit the extraction of more than 20,000 tonnes of aggregate material per year.

The technical aspects for a hydrogeological and hydrological assessment associated with a proposed quarry are outlined in the document entitled, "Aggregate Resources Act of Ontario, Provincial Standards, Version 1.0" (hereafter referred to as the "Provincial Standards"). In the context of the Provincial Standards, the hydrogeological assessment of a proposed quarry is referred to as a Hydrogeological Level 1 study and, in some cases, a Hydrogeological Level 2 study. This review focuses on a determination as to whether or not the Gorrell report addresses the requirements of the Official Plan and Provincial Standards for a quarry below the established water table.

Golder Associates has reviewed the Gorrell report from the following perspectives:

1) Has the surficial and bedrock geological and hydrogeological settings of the site and surrounding areas been adequately characterized with respect to the bedrock stratigraphy, groundwater levels, hydraulic gradients, hydraulic conductivity/transmissivity characteristics of the various hydrostratigraphic units, etc. so that the influence of the quarry on groundwater levels can be assessed?

2) Have the effects of the existing quarry (if any) on the local groundwater system been defined?

3) Have the various potential groundwater receptors (typically private wells in the vicinity of a quarry development) and surface water receptors (surface water drainage course and water bodies, wetlands, etc.) been identified and characterized within the anticipated zone of influence of the quarry?

4) Based on the full development of both the existing approved quarry and the proposed quarry expansion, has the degree of potential groundwater level lowering in the various hydrostratigraphic units been predicted?

5) Based on the predicted degree of potential groundwater level lowering, will these quarry-induced hydrogeological effects affect the potential receptors (impact assessment)?

6) If the potential exists for quarry-induced hydrogeological effects to impact receptors, is the degree of impact acceptable? If the degree of impact on receptors is unacceptable, have appropriate, site-specific mitigation measures been proposed?

7) Have appropriate monitoring programs been developed to measure and evaluate the actual effects on water resources associated with long term quarry development, and to allow a comparison between the actual effects measured during the operational monitoring program with those predicted as part of the impact assessment (Item #5 above)?

In general, in Golder's opinion the above questions can now be answered in the affirmative. Although Golder is not in complete agreement with the interpretations and recommendations put forth by Gorrell, the information presented by Gorrell concerning the site hydrogeology and the proposed quarry expansion indicates that unacceptable impacts to the identified groundwater and surface water receptors are not likely to occur due to the expansion and/or could be mitigated, if necessary. Groundwater and surface water monitoring is recommended in order record groundwater and surface water conditions in the vicinity of the quarry and to determine if actions may be required to mitigate impacts or possible future impacts. Gorrell has proposed a monitoring program and Golder proposes some additional monitoring requirements, as detailed below.

During the course of Golder's review of the Gorrell report, a number of inconsistencies were noted between the text of the report and associated figures, tables and appendices. This submission does not discuss these inconsistencies but rather focuses on formulating an opinion on whether the Gorrell report addresses the seven questions noted above.

Zone of Influence and Identified Receptors

Gorrell has calculated and illustrated the "radius of influence" of the expanded quarry, i.e., the zone around the proposed quarry excavation that could be subjected to groundwater level lowering as a result of quarry dewatering. The radius of influence in the upper weathered bedrock and in the deeper bedrock aquifer (referred to as the "significant water-bearing zone") were calculated separately using analytical techniques, and are illustrated on Figures 6 and 7, respectively, of the Gorrell report.

Weathered Bedrock

Figure 6 includes a "theoretical radius of influence" of the weathered bedrock and a "maximum potential zone of influence" of the weathered bedrock. The extent of the theoretical radius of influence is supported by the data and calculations presented in the Gorrell report. A number of water supply wells are located within the theoretical radius of influence along Usborne Street, with several more water wells within or close to the theoretical radius of influence along Golf Course Road. Two wetlands (northwest wetland and southeast wetland) are also indicated to be within or partially within the theoretical radius of influence. Figure 6 indicates that the lateral extent of the weathered bedrock zone does not extend under the wetlands and may only include two water supply wells. It appears that the delineation of the extent of the weathered bedrock was based on limited borehole data, thus the actual extent of the weathered bedrock is fairly uncertain. Figure 6 also indicates that a 7 metre thick deposit of clay is present under the wetland located on the northwest portion of the property. The source of this information is not readily apparent, and we note that minimal overburden is reported to be present at TW3-1 and TW3-2, located on the boundary of the clay deposit identified by Gorrell.

In order to address potential impact to receptors, the monitoring program should include monitoring of groundwater levels in the weathered bedrock in the vicinity of the wetlands and between the quarry and the water wells. Surface water monitoring in the wetlands is also recommended.

Significant Water-Bearing Zone

Figure 7 includes a radius of influence for the significant water bearing zone, calculated by assuming that the quarry sump will be located in the north-east part of the excavated area, and that the sump will intercept the significant water-bearing zone, interpreted by Gorrell to be located between 117 and 120 metres above sea level (masl), approximately 3 metres below the designed depth of the sump (bottom elevation of 123 masl). The radius of influence is supported by the data and calculations presented in the Gorrell report. A number of water supply wells are located within the sump radius of influence along Usborne Street and Golf Course Road. The northwest wetland is also within the radius of influence of the sump; the southeast wetland is not. Although the predicted off-site drawdown is minor (between 1 and 1.5 metres) and impacts to water supply wells due to the drawdown associated with the sump would not be expected, the Gorrell report does not clearly indicate the available drawdown in the nearby water supply wells.

In order to address potential impact to receptors, the monitoring program should include monitoring of groundwater levels in the significant water-bearing zone in the vicinity of the northwest wetland and between the quarry and the water supply wells. The available drawdown in nearby water wells should also be tabulated for future reference.

Recommended Monitoring Program

As stated above, monitoring of groundwater and surface water is recommended in order to address the potential impact to receptors due to drawdown in the weathered bedrock and the significant water-bearing zone. Gorrell has developed a groundwater monitoring plan that includes all groundwater monitors installed for the hydrogeological investigation. Golder agrees that the groundwater monitoring program proposed by Gorrell will provide useful information for a qualified hydrogeologist to assess groundwater level impacts related to the quarry. However, many of the groundwater monitors are located in close proximity to the current limit of extraction or in close proximity to the proposed extraction boundary. Groundwater monitors located further from the extraction boundary would provide better monitoring data once extraction operations approach the boundary.

Golder recommends that monitors TW 9-1, TW 9-2, TW 10-1, TW 10-2, TW 12-1, TW 12-2, TW 13-1 and TW 13-2 should be replaced with new monitors further from the extraction boundary if and when groundwater level drawdown in excess of 1 metre (maximum yearly drawdown), is indicated to have occurred as a result of extraction (at a given monitor). We suggest that the monitors that would replace TW10-1 and TW10-2 should be located further to the south, to be between the extraction boundary and the southeast wetland. We also note that more than 1 metre of drawdown has likely occurred at TW 9-1 and TW 9-2 (located in close proximity to the existing limit of extraction). Therefore, we recommend replacing TW9-1 and TW9-2 as soon as possible.

Gorrell has not recommended a surface water monitoring plan. Golder recommends water level monitoring within the two wetlands identified by Gorrell. The frequency of the water level monitoring should be the same as the groundwater level monitoring. Correlation of groundwater levels and surface water levels would allow for evaluation of potential effects due to quarry dewatering.

Mitigation and Contingency Plan

Golder is in general agreement with the mitigation and contingency plan proposed by Gorrell concerning nearby water supply wells. With respect to the northwest wetland, Gorrell states that discharge from the quarry sump, "contributes to the maintenance of the wetland", and further states, "Continuation of the practice through the quarry operation will provide the necessary mitigation of potential impacts to the weathered bedrock zone from the proposed excavation." However, concerning the post-operational stage when the quarry will be filling with water, Gorrell states that, "this area is already within the radius of influence of the existing quarry with no natural heritage impacts evident. Monitoring and mitigation will not be required for this stage." Based on the information presented by Gorrell, it is our opinion that Gorrell has not demonstrated that impacts to the wetland will not occur if discharge from the quarry sump is halted. Therefore, Golder recommends that Gorrell develop a mitigation and contingency plan in relation to the northwest wetland. Continuation of pumping into the wetland during the period when the quarry will be filling with water (at a reduced rate), could be considered in order to maintain current conditions.

Compliance with Provincial Standards and Official Plan

Due to the deficiencies noted by Golder concerning the monitoring program and the mitigation and contingency plan, in our opinion the Gorrell report does not adequately address the potential for adverse impacts to surface water and groundwater resources, and thus does not meet the requirements associated with a Hydrogeological Level 1 study and Hydrogeological Level 2 study as per Sections 2.2.1 and 2.2.2 of the Provincial Standards. However, we would consider the hydrogeological studies to be adequate if our recommended changes to monitoring program and the mitigation and contingency plan are adopted by Gorrell.

Regarding the County of Renfrew Official Plan, it requires regulation of pit and quarry operations so that, "disturbance to the environment is limited to the site, social disruption is prevented and rehabilitation to an acceptable after-use is achieved". If the changes to monitoring program and the mitigation and contingency plan recommend by Golder are adopted by Gorrell, it is our opinion, off-site impacts could be controlled, thus preventing associated social disruption. Golder has not reviewed the proposed rehabilitation plan, and does not know what the County would consider "acceptable after-use", therefore we offer no comment on this aspect of the application.

Limitations

This technical review was conducted by Golder Associates on behalf of the County Renfrew County. The objective of the review was to assess the Gorrell report in terms of compliance with the requirements of the Provincial Standards and Official Plan and to derive an opinion as to whether the Gorrell report has adequately characterized the hydrogeological environment in the area of the proposed Braeside Quarry in terms of assessing the potential for adverse effects of the quarry operation on groundwater and surface water resources. The scope of the review was based on the review of documentation as referenced herein. The review was based on the information provided in the Gorrell report; Golder Associates did not conduct any independent field investigations, analysis, or testing.

Any use of which a third party makes of this report, any reliance on the report, or decisions based on the report, are the responsibility of those third parties unless authorized by Golder Associates in writing. Golder Associates accepts no responsibility for damages suffered by any unauthorized third parties as a result of decisions make or actions taken based on this report.

Yours truly,

GOLDER ASSOCIATES LTD.GOLDER ASSOCIATES LTD.

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CC: Bruce Howarth, MCIP, RPP, Senior Planner, County of Renfrew
Tom Jones, Property Manager, Miller Paving Limited
Gary Bell, Skelton, Brumwell and Associates Inc.

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March 17, 2011

Project No. 0910-006

Mr. Tom Jones
Miller Group Inc.
505 Miller Ave
Markham ON L6G 1B2

Dear Mr. Jones,

Re: Response to Golder Associates Ltd. Letter dated November 5, 2010 Review of Gorrell Resource Investigations (GRI) June 2010 Summary Report- Hydrogeological Investigations, Proposed Braeside Quarry Expansion, Municipality of McNab/ Braeside, Ontario

Golder Associates Ltd. (Golder) has provided a peer review of the above referenced hydrogeological investigation. The Golder review indicates that the seven questions used as the basis of its evaluation of the study have been answered positively. Golder agrees that the provided information indicates that it is unlikely that unacceptable impacts to the identified groundwater and surface water receptors will occur due to the expansion, or that they can be mitigated if necessary.

In mid-2010, Gorrell Resource Investigations (GRI) joined BGC Engineering Inc. (BGC). From this point forward, BGC will be addressing the hydrogeological components of the Braeside Quarry Expansion project, with continued support and internal peer review by AECOM.

The GRI June 2010 summary report was prepared at the request of Golder to highlight the study findings that provided the answers to its specific questions and review objectives. Golder subsequently provided comment on the summary report in a letter dated November 5, 2010. Please find below a summary of the November 5, 2010 Golder comments and our response. The Golder comments are shown in italics.

1. *P3, 1st para below bullets; "Inconsistencies between text and figures, tables and appendices" were noted by Golder.*

We will resolve any identified remaining inconsistencies in the final report.

2. *Weathered Bedrock; Extent of weathered bedrock is fairly uncertain*

The extent of the weathered bedrock was defined using a number of field methods, including detailed ground mapping where surface water bodies and open fractures were identified. The map points were correlated with the landmarks on the current aerial map of the site. The weathered bedrock does vary in depth and consistency around the site, but the boundary was conservatively mapped. Once the extents of these areas were identified, the character was then confirmed and refined with the boreholes. In our opinion, the extent of the weathered bedrock has been adequately and accurately mapped, and is shown on Figures 1 and 4.

3. *Source of information for clay beneath wetland not readily apparent*

We will revise our reported maximum thickness of clay to read 5.8 m, to reflect the borehole data from TW4-1, (MOE Well Record #A 054436).

4. *The monitoring program should include monitoring of groundwater levels in the weathered bedrock in the vicinity of the wetlands and between the quarry and the water wells*

Wells TW 9-2, TW 10-1, TW 10-2, TW 13-1, TW 13-2 all represent groundwater monitors in the weathered bedrock. These monitors are situated at the critical locations between the excavation and the local wetlands and/or between the excavation and off-site water supply wells.

5. *Surface water monitoring in the wetlands is also recommended*

Golder has recommended surface water monitoring accompany the groundwater level monitoring program. A monitoring program that included surface water monitoring was not included by any of the environmental study team members in the recommendations for the quarry expansion for several reasons, primary among them that the local wetlands located north-west, and south-east of the proposed quarry expansion are <u>not</u> provincially significant wetlands (PSW). The natural environment study indicated that local wetlands were not classified as significant by the Ministry of Natural Resources before work on this project began, and ecologists for Miller determined that neither of these wetlands (the Northwest Wetland close to Usbourne Street by the quarry entrance and the Southeast Wetland beyond the Miller Property towards Braeside) have significant natural environment values.

Finally, since the hydrological investigations have made it clear that the hydrogeological impacts (e.g. loss of seepage flow) are minimal (ca. 1%) in the south-east wetland, and low to moderate (approximately 17%) in the north-west wetland, the proposed quarry expansion poses no significant implications for either wetland area.

Therefore, because there are:

1) no significant natural environment features in either local wetland;

2) no significant ecological function contributions in either on-site or in adjacent landscapes; and

3) no significant long term hydrological or hydrogeological implications for either local wetland from the proposed expansion,

there is no ecological need or rationale for monitoring of water flows or levels at either local wetland. This is particularly clear in the case of the Southeast Wetland for which only a tiny portion (approximately 1%) of the sub-watershed will be affected by the Braeside Quarry property.

6. *Significant Water-Bearing Zone; the Gorrell report does not clearly indicate available drawdown in the nearby water supply wells*

The available private water supply well information collected during the door-to-door survey has been compiled to assess available drawdown within wells that may theoretically be affected by the proposed quarry.

The following information (Table 1) was compiled from data previously presented in the November 2009 GRI report entitled “Consolidated 2006-2009 Hydrogeological Investigation; Proposed Braeside Quarry Expansion, Part Lots 16 and 17, Conc. A, Township of McNab-Braeside.” A statistical evaluation was completed first on all the previously analyzed water well records for the study area, and next locally on the identified water well records within the theoretical radius of influence that was presented in the June 2010 report. The water well records were used to calculate the available drawdown in the wells from the well depth and the reported static level data.

Table 1. Analysis of Available Drawdown in Water Wells from MOE Water Well Records

Available Drawdown (m)	**Previously Analysed Well Records***		**Identified Well Records within Radius of Influence**	
	# of records	**% of records**	**# of records**	**% of records**
< 10	0	0	0	0
10 - 15	3	4.2	2	13.2
15 - 20	8	11.3	3	20.0
20 – 25	11	15.5	3	20.0
25 – 30	8	11.3	0	0
30 - 35	5	7.0	2	13.3
>35	36	50.7	5	33.3
Total records analysed	71		15	

*Gorrell Resource Investigations, November 2007

The analysis also found that the maximum available drawdown was 78.3 m for all previously analyzed well records, and 63.1 m for identified well records within the radius of influence. The minimum available drawdown was 11.3 m, according to the analyzed well record data for all records analysed.

The calculation by AECOM provided as Appendix A of the GRI Executive Summary Report dated August 2010 indicated a maximum predicted drawdown of 1.0 m within the identified radius of influence. Comparing the predicted drawdown to the available well data indicates that this predicted drawdown would comprise at most 10% of the available drawdown.

7. *Monitoring program should include monitoring of groundwater levels in the significant water-bearing zone in the vicinity of the north-west wetland and between the quarry and the supply wells*

Monitoring wells TW 2, TW 3-1, TW 4-1, TW 4-2, TW 6-1, TW 7, TW 8-1, TW 9-1 and TW 11-1 all represent the competent bedrock aquifer that encountered the significant water-bearing zone, and are situated between the proposed excavation and off-site water supply wells. Wells TW 3-1, TW 4-1, TW 4-2 are all appropriately situated near the north-west local wetland. These wells will all be monitored as part of the proposed monitoring program.

8. *The available drawdown in nearby water wells should be tabulated for future reference*

A statistical analysis of the available drawdown has been tabulated in Table 1 above, which will be included in the final report.. Well-specific information will be kept on file by Miller for use in future evaluations.

9. *Recommended Monitoring Program; Monitors TW 9-1, TW 9-2, TW 10-1, TW 10-2, TW 12-1, TW 12-2, TW 13-1, TW 13-2 should be replaced with new monitors further from the extraction boundary if a groundwater level drawdown in excess of 1 metre (maximum yearly drawdown) is indicated to have occurred as a result of extraction.*

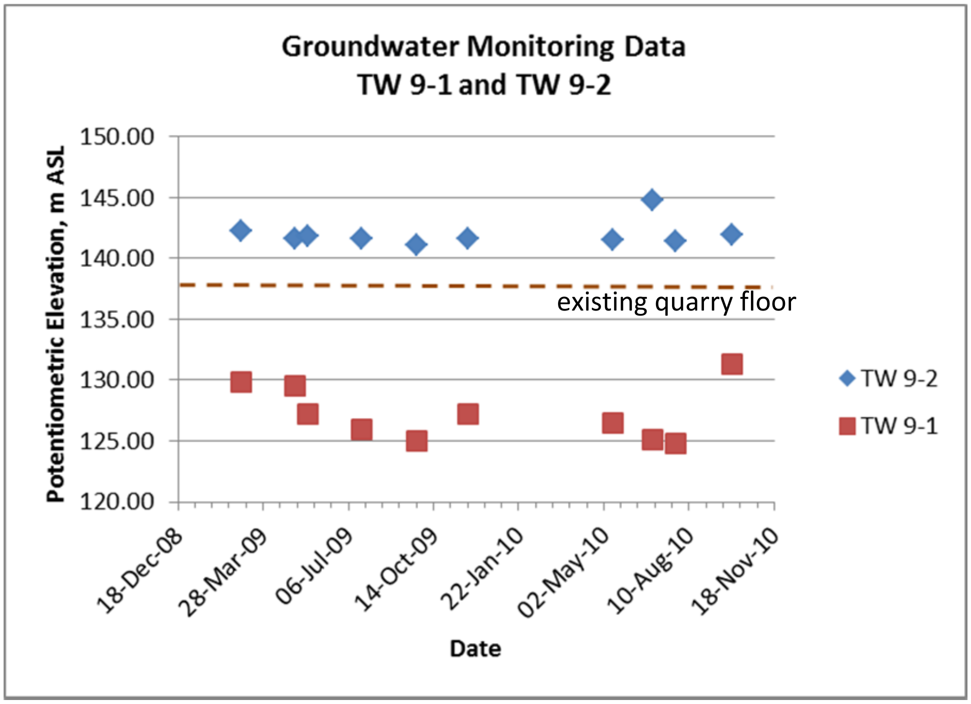
We agree with the recommendation that any of these monitors should be replaced if a groundwater level drawdown in excess of 1 metre below the maximum yearly drawdown is indicated to have occurred as a result of extraction. This trigger and mitigation will be added to the mitigation and contingency plan.

10. *More than 1 metre of drawdown has likely occurred at TW 9-1 and TW 9-2 and Golder recommends replacing these monitors as soon as possible*

First, we believe that groundwater levels in TW 9-1 and TW 9-2 are influenced by the natural setting. Golder assumes that there has been an impact due to the fact that the well is located adjacent to the existing excavation. The bedrock on the surface in that area shows some of the most highly developed dissolution features in the examined study area. The diamond drilling at this location indicated that plant roots extended to at least 12 m below the surface. Grikes on the surface in this area commonly are 1 to 2 m in diameter. These are additional indicators that the water levels in this area reflect the natural conditions and are not impacted from the existing excavation. An analysis of the static elevations in water well records constructed before a quarry existed show that the natural groundwater elevation is below the base of the existing quarry excavation in this area due to the presence of the escarpment. Consequently the groundwater levels in TW 9-1 and TW 9-2 represent the natural area conditions, not an impact from the existing quarry.

Second, the purpose of the proposed groundwater monitoring program is to evaluate impacts of the *proposed* operation. The wells were installed and have measured existing conditions that include the quarry setting. Figure 1 shows the potentiometric data collected on the referenced wells. TW 9-2 is installed within the weathered bedrock zone. The base of the well is above the existing quarry floor, and the well maintains a water level above the quarry floor elevation. The potentiometric elevation has been consistent through the introduction of the second lift of the quarry later in 2009. Therefore, this well has not yet been impacted by the quarry operation. TW 9-1 is installed in the significant water bearing zone in the confined bedrock aquifer. The potentiometric level does show a consistent seasonal variation in the available data, but does not show an influence from the quarry operation. The presence of the quarry has not affected the groundwater level in the confined bedrock aquifer as the existing (and proposed) quarry floor will remain above the water bearing zone itself and the confined bedrock aquifer's potentiometric elevation. A longer monitoring record will provide additional data from which a statistical assessment can be made.

Figure 1: Groundwater Monitoring Data, TW 9-1 and TW 9-2



Based on the regional analysis and other site data, it is our interpretation that the water levels measured in these wells represent the natural condition, as described above.

Therefore the need to replace the wells should be evaluated on a going-forward basis. If the expansion is approved, there will be no extraction along the Usborne Street quarry boundary. Therefore, no additional impacts, should any have already occurred from the operation, are predicted in this area. Using the trigger criteria recommended by Golder above, TW 9-1 and TW 9-2 would be replaced if a groundwater level drawdown in excess of 1 metre below the maximum yearly drawdown is indicated to have occurred as a result of extraction.

11. *Golder recommends a water level monitoring program within the two wetlands identified by Gorrell with a frequency the same as the groundwater level monitoring. Golder recommends that Gorrell develop a mitigation and contingency plan in relation to the north-west wetland.*

In point 5, BGC pointed out that because there are:

1) no significant natural environment features in either local wetland;

2) no significant ecological function contributions in either on-site or in adjacent landscapes; and

3) no significant long term hydrological or hydrogeological implications for either local wetland from the proposed expansion,

the conclusion of the study team was that there is no ecological need or rationale for monitoring of water flows or levels at either local wetland.

CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of Miller Group Inc. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

As a mutual protection to our client, the public, and ourselves, all documents and drawings are submitted for the information of our client for a specific project. Authorization for any use and/or publication of this document or any data, statements, conclusions or abstracts from or regarding our documents and drawings, through any form of print or electronic media, including without limitation, posting or reproduction of same on any website, is conditionally provided subject to BGCs written approval, as we understand that this document will be submitted to the Township of Braeside and Golder for review as part of application for municipal planning approval of the proposed quarry expansion. If this document is issued in an electronic format, an original paper copy is on file at BGC and that copy is the primary reference with precedence over any electronic copy of the document, or any extracts from our documents published by others.

Yours sincerely,

BGC ENGINEERING INC.
per:

Jennifer Gorrell
Jennifer B. Gorrell M.Sc., P.Eng. P.Geo.
Senior Hydrogeologist

cc. AECOM
Skelton Brumwell and Associates Inc.

May 10, 2010 Project No. 08-1122-0216

Bruce Howarth, MCIP, RPP, Senior Planner
County of Renfrew
9 International Drive
Pembroke, Ontario
K8A 6W5

NATURAL ENVIRONMENT, HYDROLOGY AND HYDROGEOLOGY REVIEW COMMENTS
PROPOSED BRAESIDE QUARRY EXPANSION
MUNICIPALITY OF MCNAB/BRAESIDE, ONTARIO

Dear Mr. Howarth:

The County of Renfrew has retained Golder Associated Ltd. (Golder) to conduct a technical review of various reports related to a proposed quarry expansion in the municipality of McNab/Braeside. These reports were prepared in support of an application for Zoning By-Law Amendment under the Township of McNab/Braeside Official Plan (Section 9.3(3)) as well as an application to the Ministry of Natural Resources ("MNR") for a quarry license with extraction below the water table. The owner and operator of the quarry is Miller Group Inc. (Miller).

Golder has previously completed technical reviews of documents dealing with three major areas of potential impacts arising from the proposed quarry expansion: (1) hydrogeology; (2) hydrology; and, (3) biology, including ecology, referred to as natural heritage features. This submission comprises Golder Associates' technical review of the most recent documents dealing with natural environment, hydrology and hydrogeology. Those documents are as follows:

- Supplemental submission on natural heritage issues, dated March 21, 2011 by Skelton Brumwell & Associates;
- Responses to Golder's April 28, 2009 hydrology comments provided by Skelton Brumwell in a letter dated December 9, 2009;
- BGC Engineering Inc. (BGC) letter dated March 15, 2011 regarding a reply to Golder comments on inconsistencies in the Gorrell Resource Investigations (GRI) report, dated June 2010); and
- BGC letter Dated March 17, 2011, regarding a response to Golder's review of the June 2010 GRI report (Golder Letter dated November 5, 2010)

The Official Plans for the County of Renfrew and the Municipality of McNab/Braeside, as well as documents previously submitted by the proponent were also considered during our review.

Most of our previous comments have been adequately addressed in the most recent submissions; however, we have identified a number of outstanding issues and we have requested clarification of some of the information presented. Golder has also recommend additional monitoring (in addition to that proposed by the proponent's consultants) in order to address some of the issues we have identified.

Natural Environment

Miller's consultants have addressed Golder's concerns about the plant community mapping, the discussion of plant community characteristics and features and the areas of each plant community-type that will be eliminated and conserved. We recognize that the main focus of site work was on the subject property and that access to adjacent lands may have been limited or fully restricted. The two issues that we requested be more directly and completely considered were (1) the potential impacts upon the wetland to the southeast of the of the proposed expansion and (2) the character and qualities of the Significant Wildlife Protection Area (SWPA) that had been proposed on the north and east sides of the proposed expansion. These matters are discussed below.

(1): The concerns that we raised about the wetland to the southeast of the proposed expansion was not based upon any particular knowledge of its features, qualities or ecological functions, but was based upon its 'environmental area' designations in both the County of Renfrew Official Plan (2009) and the McNab/Braeside Official Plan (2008). The policies of both the County and Township OP require that it be demonstrated that there will be no negative impacts to such designated features from development(s) on adjacent lands. The Braeside Quarry project team has provided some clarification on the features and qualities of this area. However, the effect of the quarry expansion on the water balance of the wetland is still in question (as detailed in the following Hydrology Section). The magnitude and importance of the surface water and groundwater contribution to this wetland remain unclear and Golder is still of the opinion that some monitoring of groundwater levels beyond the proposed extraction zone is prudent to assess the potential impact on the wetland as a result of groundwater level drawdown associated with quarry development.

(2): The Significant Wildlife Protection Area (SWPA) was asserted to include a full representation of the most important natural heritage features of the Miller property, as well as the largest proportion of the populations of rare plants that were identified on the site. However, that assertion was not evident from the information provided in the Natural Environment Report Level 1 & 2 (NEL; Skelton, Brumwell & Associates 2007) and the letter of December 8, 2009 did not provide any supplemental data to support the assertion. Brunton (pers. comm. Feb 28, 2011) made it clear that the distribution mapping for ram's-head lady-slipper (*Cypripedium arietinum*) and Coopers milkvetch (*Astragalus neglectus*) that appeared in the NEL was a considerable under-representation of the distribution of those two species across the site and, particularly, in the SWPA, where he believed some of the largest clusters were present. He also reported that the alvar community in the SWPA was the equal of or superior to any comparable habitat elsewhere on the site and that the SWPA would conserve the features, qualities and species populations that were present on the site.

Golder has no reason to doubt this information. However, Golder is of the opinion that the features and condition of the SWPA should be re-assessed in the post-licensing period. Assuming that land clearing will only occur in those areas to be opened for extraction, Golder recommends that two natural feature re-assessments be conducted in the SWPA; one within five years of the first land clearing operation following licensing of the expansion lands; and a second within three years of the final land clearing operation. During the first re-assessment, Golder recommends that a semi-quantitative inventory of the ram's-head lady-slipper and Coopers milkvetch populations be made to provide comparisons with the population numbers that appear in the NEL. Golder also recommends that if significant population losses are identified, i.e., declines of more than 33%, measures be identified and implemented to halt or reverse these declines, if possible. The second re-assessment should use similar semi-quantitative methods to evaluate the success of any remediation measures that were implemented after the first re-assessment.

Hydrology

The following comments regarding hydrology are provided for your consideration.

Discussion

We note that the northwest wetland has been evaluated and agree that the potential for significant impacts to this feature is limited because quarry discharge will be directed to this feature, thereby effectively mitigating any potential effect of groundwater level drawdown under the wetland *during operation*. We further note; however, that there is no planned discharge to the southeast wetland to provide it with the same level of protection. After reviewing the June 2010 GRI report, our level of confidence in the exact extent of the zone of influence of the proposed quarry is not sufficient for Golder to agree that no effects on this wetland are likely.

On page 11 of the GRI report, last paragraph, the discharge of 248 m^3/day is reported to be the average of the water surplus calculated for the existing quarry. How does this flow rate compare to recorded pumping from the existing quarry?

In the table at the bottom of page 17 and top of page 18 of the GRI report, the reported velocities seem to be too high; for example, the reported 15.5 m/s is approximately 56 km/h, which seems very fast for a 15 cm deep creek. Should the reported velocities have been in cm/s?

The southeast wetland is reported to be perched on competent bedrock, and affected by beaver activity; however, based on the information presented in the GRI report, we are not confident that it will not be affected by the proposed expansion. With reference to Figures 4 (Section A-A’) and 5, we note the following:

- The southeast wetland is lower in elevation than both the upper and lower springs along the east side of the site. Under existing conditions, these springs likely represent a significant part of the wetland water balance;
- The proposed expanded quarry base elevation is lower in elevation than the upper and lower springs as well as the southeast wetland. As such, we feel it is likely that much if not all existing groundwater discharge to the southeast wetland will be diverted to the quarry. The anticipated zone of influence in the weathered bedrock zone, as shown on Figure 6, encroaches right up to the delineated edge of the wetland. In our opinion, the level of certainty associated with the analysis of this zone of influence is not high enough to be confident that the wetland will not be under-drained; and,
- Based on the (possibly new) topographical information presented on Figure 5, the drainage area contributing runoff to the southeast wetland appears to be overestimated, specifically to the west and southwest of the wetland. The drainage area shown in the original Hydrology Report appears to have been delineated from different topographical information. The reported minor change in the surface drainage area to this feature due to expansion of the quarry would be more significant if the existing drainage area was in fact overestimated. The drainage area contributing to the southeast wetland and the potential change in drainage area should be confirmed using the best currently available mapping.

In addition to the springs feeding the southeast wetland, there are five additional springs, shown on Figure 5 of the GRI Report along the east side of the plateau. For the same reasons listed above, it is likely that groundwater discharging at these springs will be diverted to the proposed quarry. We expect that this discharge to surface water features to the east would quickly become insignificant as one moves further east; however, the

GRI report offers no assessment of the ecological value of the springs on a local scale. The GRI report states that no monitoring of the springs is required. Golder would only agree with this statement if it can be demonstrated that the springs have no significant local ecological function.

Recommended Monitoring Program

GRI has not recommended a surface water monitoring plan. Golder recommends water level monitoring within the northwest wetland. The frequency of the water level monitoring should be the same as the groundwater level monitoring. Correlation of groundwater levels and surface water levels would allow for evaluation of potential effects due to quarry dewatering. We also recommend that the east side springs be observed quarterly for presence or absence of flow and a photographic record of them be developed.

With respect to the southeast wetland, if the 1% reduction in drainage area contributing to it can be confirmed, the potential effects of the proposed quarry on the wetland should be monitored by monitoring groundwater levels close to, and upgradient of, the wetland (i.e., on the Miller property). If the reduction in drainage area is found to be significantly larger than 1%, monitoring in the wetland may also be warranted.

Mitigation and Contingency Plan

With respect to the northwest wetland, GRI states that discharge from the quarry sump, “contributes to the maintenance of the wetland”, and further states, “Continuation of the practice through the quarry operation will provide the necessary mitigation of potential impacts to the weathered bedrock zone from the proposed excavation.” However, concerning the post-operational stage when the quarry will be filling with water, GRI states that, “this area is already within the radius of influence of the existing quarry with no natural heritage impacts evident. Monitoring and mitigation will not be required for this stage.” Based on the information presented by GRI, it is our opinion that GRI has not demonstrated that impacts to the wetland will not occur if discharge from the quarry sump is halted. Therefore, Golder recommends that GRI develop a mitigation and contingency plan for the northwest wetland during the period when the lake is filling to its final elevation. Continuation of pumping (at a reduced rate) into the wetland, during the closure period when the quarry will be filling with water could be considered in order to maintain current conditions. With respect to the southeast wetland and east side springs, Miller should develop a contingency plan to mitigate effects on these features if it becomes necessary based on the results of the monitoring program.

Hydrogeology

The BGC letter of March 15, 2011 addresses certain inconsistencies in the June 2010 GRI report that were identified by Golder and communicated to GRI in an e-mail sent on November 26, 2010. Many of the BGC responses include a commitment to address the issues in a subsequent report. The responses by BGC are generally satisfactory to Golder; however, four of them warrant a brief response from Golder.

1) Regarding the first Golder statement and BGC reply: Golder perceives the statements regarding the lateral and vertical extent of weathered bedrock to be contradictory. The label on Figure 4 indicates that the degree of dissolution increases with depth. If this statement is accurate, BGC should also indicate the depth at which dissolution features are not present.

2) Regarding the fifth Golder statement and BGC reply: BGC is correct – groundwater flow direction is indicated on our copy of Figure 2

3) Regarding the seventh Golder statement and BGC reply: The words “Upper Springs” do not appear on our copies of Figures 1 and 6.

4) Regarding the eighth Golder statement and BGC reply: Our copy of Figure 1 does not include a grey area, marking the edge of the weathered bedrock zone; the grey area is included on Figure 6.

The BGC letter of March 17, 2011 addresses the comments in the Golder review letter, dated November 5, 2010 (review of the June 2010 GRI report). Except where noted below, Golder considers the responses by BGC to be generally satisfactory. Following are our specific comments, numbered in accordance with the numbering of the BGC report.

3) BGC has indicated that the reported thickness of the clay beneath the northwest wetland will be revised to indicate a maximum thickness of 5.8 metres. Because the well record for TW3-1 indicates 0 metres of clay at that location, Golder suggests that the description of clay thickness beneath the northwest wetland should indicate a range of clay thickness between approximately 5.8 and 0 metres.

4) Golder notes that TW13-1 is reportedly not completed in the weathered bedrock.

5) See discussion in Hydrology Section.

6) Golder requests that BGC tabulate well depth and available drawdown data for each well (individually) located within 800 metres of the proposed lower sump. The statistical information presented in Table 1 of the BGC letter is informative, but it is not adequate in terms of identifying possibly vulnerable water supply wells. The November 2009 GRI report includes some well information (well IDs 1 – 32), however, Figure 7 of the June 2010 GRI report shows many more than 32 wells (up to well ID 81, and several wells without IDs). BGC also incorrectly states that the maximum drawdown predicted by AECOM is 1.0 metre. The maximum predicted drawdown is actually 3.0 metres (at the lower lift sump).

10) BGC believes that the groundwater levels at TW9-1 and TW9-2 are not influenced by the existing quarry, and therefore these monitors do not need to be replaced at this time. BGC also states that the existing and proposed quarry floor will remain above the potentiometric elevation of the significant water bearing zone (SWB). This is incorrect, as the quarry is reportedly licensed to extract to 125 masl. The existing quarry sump is reportedly at 125.5 masl and the proposed elevation for the lower sump is 123 masl, while the potentiometric elevation of the SWB is reportedly 127 masl. Based on the information presented by BGC, it is not clear whether or not TW9-1 and TW9-2 are influenced by the existing quarry. Therefore, Golder requests the following additional information:

    i) Available data for water supply wells located within 800 metres of the proposed lower sump, including total depth and static water level elevations at the time of drilling, as requested above (see comment #6); and

    ii) Chronology of the quarry development, indicating the depth and extent of the quarry and the depth of the quarry sump over time.

Based on our review of this additional information and the historical record of groundwater levels at TW9-1 and TW9-2, we will be better able to ascertain whether or not the groundwater levels at these monitors have been influenced by the existing quarry and if Golder would recommend additional monitors in this area of the site.

Limitations

This technical review was conducted by Golder Associates on behalf of the County Renfrew County. The objective of the review was to assess the referenced documents in terms of compliance with the requirements of the Provincial Standards and Official Plan and to derive an opinion as to whether the documents adequately characterize the hydrogeology, hydrology and natural environment in the area of the proposed Braeside Quarry extension, in terms of assessing the potential for adverse effects of the quarry operation on groundwater, surface water and biological/ecological resources. The review was based on the information provided in the referenced documents. Golder Associates did not conduct any independent field investigations, analysis, or testing. Any use of which a third party makes of this report, any reliance on the report, or decisions based on the report, are the responsibility of those third parties unless authorized by Golder Associates in writing. Golder Associates accepts no responsibility for damages suffered by any unauthorized third parties as a result of decisions made or actions taken based on this report.

Closure

We trust that this submission meets with your approval. Please contact the undersigned if you have any questions.

Yours truly,

GOLDER ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
B. T. BYERLEY
May 10/11
PROVINCE OF ONTARIO

Brian T. Byerley, M.Sc., P.Eng.
Senior Hydrogeologist/Associate

Kris. A Marentette, M.Sc., P.Geo.
Senior Hydrogeologist/Principal

KMM/JK/KT/BTB/KAM/am
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cc: Jennifer B. Gorrell, M.Sc.,P.Eng.,P.Geo, BGC Engineering Inc.
Tom Jones, Property Manager, Miller Paving Limited
Gary Bell, Skelton, Brumwell and Associates Inc.

Skelton Brumwell
& ASSOCIATES INC.

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CONSULTING
ENGINEERS
AND
PLANNERS

REC'D by SBA JUL 0 4 2011

To		Initial	To		Initial
GKB	✓		BAL		
SWB			JAM		
BWB			BWM		
MJB			TPP		
JAC	✓		CAP		
SLC			CNR		
PPD			TAR		
BDD			TCW		
JKF	✓		IPW		
CJG			DJW		
ATG	✓				
cc:					

FILE: 2033

July 4, 2011

Miller Paving Limited
505 Miller Ave
Markham, Ontario L3R 9R8

Attention: Tom Jones
Property Manager

Dear Tom:

Re: Miller Braeside Quarry
Combined Response to Peer Review by Golder Associates May 10, 2011
Natural Environment, Hydrology and Hydrogeology
Our File: P/N 2033

The peer review letter by Golder Associates of May 10, 2011 (dated May 10, 2010) provided comments on four documents related to Natural Environment, Hydrology and Hydrogeology. This combined response has been prepared by Skelton Brumwell and Associates Inc., Brunton Consulting and BGC Engineering Inc. We addressed the outstanding issues, provided clarification of the identified information and resolved the request for additional monitoring.

We have organized this response to follow the order of the May 10, 2011 Golder per review letter in three sections; 1. Natural Environment, 2. Hydrology, and 3. Hydrogeology. The relevant Golder comment is quoted.

1. Natural Environment

1.1 Potential Impacts on Wetland to Southeast

> The concerns that we raised about the wetland to the southeast of the proposed expansion was not based upon any particular knowledge of its features, qualities or ecological functions, but was based upon its "environmental area" designations in both the County of Renfrew Official Plan (2009) and the McNab/Braeside Official Plan (2008). The policies of both the County and Township OP require that it be demonstrated that there will be no negative impacts to such designated features from development(s) on adjacent lands. The Braeside Quarry project team has provided some clarification on the features and qualities of this area. However, the effect of the quarry expansion on the water balance of the wetland is still in question (as detailed in the following Hydrology Section). The magnitude and importance of the surface water and groundwater contribution to this wetland remain unclear and Golder is still of the opinion that some monitoring of groundwater levels beyond the proposed extraction zone is prudent to assess the potential impact on the wetland as a result of groundwater level drawdown associated with quarry development.

These issues are addressed in Hydrology Section 2.

1.2 The Significant Wildlife Protection Area

> The Significant Wildlife Protection Area (SWPA) was asserted to include a full representation of the most important natural heritage features of the Miller property, as well as the largest proportion of the populations of rare plants that were identified on the site. However, that assertion was not evident from the information provided in the Natural Environment Report Level 1 & 2 (NEL; Skelton, Brumwell & Associates 2007) and the letter of December 8, 2009 did not provide any supplemental data to support the assertion. Brunton (pers. comm. Feb 28, 2011) made it clear that the distribution mapping for ram“s-head lady-slipper (Cypripedium arietinum) and Coopers milkvetch (Astragalus neglectus) that appeared in the NEL was a considerable under-representation of the distribution of those two species across the site and, particularly, in the SWPA, where he believed some of the largest clusters were present. He also reported that the alvar community in the SWPA was the equal of or superior to any comparable habitat elsewhere on the site and that the SWPA would conserve the features, qualities and species populations that were present on the site.
>
> Golder has no reason to doubt this information. However, Golder is of the opinion that the features and condition of the SWPA should be re-assessed in the post-licensing period. Assuming that land clearing will only occur in those areas to be opened for extraction, Golder recommends that two natural feature re-assessments be conducted in the SWPA; one within five years of the first land clearing operation following licensing of the expansion lands; and a second within three years of the final land clearing operation. During the first re-assessment, Golder recommends that a semi-quantitative inventory of the ram“s-head lady-slipper and Coopers milkvetch populations be made to provide comparisons with the population numbers that appear in the NEL. Golder also recommends that if significant population losses are identified, i.e., declines of more than 33%, measures be identified and implemented to halt or reverse these declines, if possible. The second re-assessment should use similar semi-quantitative methods to evaluate the success of any remediation measures that were implemented after the first re-assessment.

Monitoring of the populations of the two Provincially Rare plant species found in the SWPA is recommended in the 10 May 2011 Golder letter. Such monitoring presents a useful tool for assessing not just the status of these two presently-designated Provincially rare species but the overall health of the natural environment of the SWPA.

Dan Brunton and Kyle Fleming propose to conduct population counts along fixed transects on a more frequent basis that suggested in the Golder letter, undertaking biannual population counts along fixed transects across the SWPA. Particular species population in this habitat can vary hugely from year by year, however, so interpreting a 33% decline in a given year (the figure suggested by Golder as indicating the need for population mitigation) can be problematic. More frequent monitoring, therefore, will provide better trend data.

In this proposed monitoring scheme, two consecutive declines exceeding 33% would be detected quicker (in four years, not the suggested five years). This would trigger contact with OMNR or its equivalent at the time in order to develop population mitigation measures. We further propose to continue this monitoring for a ten year period (5 biannual sessions). Should populations remain stable over that period, monitoring will cease. One final population monitoring will be conducted three years after the final land clearing operation.

2. Hydrology

2.1 Zone of Influence of Southeast Wetland

> . .We further note; however, that there is no planned discharge to the southeast wetland to provide it with the same level of protection. After reviewing the June 2010 GRI report, our level of confidence in the exact extent of the zone of influence of the proposed quarry is not sufficient for Golder to agree that no effects on this wetland are likely.

Figure 6 (Radius of Influence – Weathered Bedrock Zone) will be revised at the squared corner in the area of the southeast wetland to show the zone of influence as an actual 306 m radius from the southeast corner of the proposed extraction limits. This more accurately exhibits the area of influence adjacent to the Southeast Wetland. The AECOM supplemental assessment dated June 2010 suggests the radius of influence due to drainage from the weathered bedrock may only range from 90 m to 190 m. This provides further evidence to suggest that the southeast wetland will not be under-drained. The hydrologic and hydrogeologic impacts on the southeast wetland are predicted to be less than 1 percent, which is consistent with a reduction in the drainage area of about 1 percent.

2.2 Discharge Flow Rate

> On page 11 of the GRI report, last paragraph, the discharge of 248 m3/day is reported to be the average of the water surplus calculated for the existing quarry. How does this flow rate compare to recorded pumping from the existing quarry?

Runoff entering the quarry as a result of water surplus was calculated for each year from 2006 to 2010 inclusive for comparison with annually recorded pumping. The five year average runoff (112,491m^3/yr) was found to be 81 percent of the five year average recorded pumping (138,895 m^3/yr) for the period. The 19 percent differential should primarily be due to the variation in actual site precipitation verses published climate station precipitation used as an estimate for the site. Thus calculated runoff compares favourably with the recorded pumping.

The SBA hydrology report will recommend the installation of a Davis 6163 wireless Vantage Pro2 Plus (weather station) or equivalent which includes a rain collector, temperature, humidity and barometric sensors and anemometer and a 7720 Rain Collector Heater. Therefore allowing more accurate comparison of future recorded pumping and calculated runoff.

The SBA hydrology report will be updated providing annual runoff and discharge information and the BGC hydrogeology report will be updated with a reference to the hydrology report's calculated water surplus, runoff and discharge.

2.3 Velocity in Creek (Roadside Ditch)

> In the table at the bottom of page 17 and top of page 18 of the GRI report, the reported velocities seem to be too high; for example, the reported 15.5 m/s is approximately 56 km/h, which seems very fast for a 15 cm deep creek. Should the reported velocities have been in cm/s?

BGC confirmed the magnitude of the flow velocities in the current surface water monitoring program. The referenced measurements are taken at Station SW5. Photos 1 and 2 show the characteristics and setting at SW5. The station is located on a steep slope, with an approximate fall of 5 m over 100 m. The ditch in which the measurement is taken is armoured with 8- to 30-cm diameter stone on the sides and bottom. After significant precipitation events, erosion from the flow through the ditch and downstream towards Ryan Creek, was observed by BGC staff, indicating that flows in the velocity range measured in the monitoring program are reasonable and in many places the armoured stone has been eroded and transported downstream. Indeed, a series of gravel bars with clasts up to 25 cm in diameter formed near where the ditch merges with Ryan Creek after two observed significant precipitation events, in 2009 and 2010.

2.4 Southeast Wetland

Photo 1: SW 5, looking north-east along Carmichael Side Road. Campbell Road is at top of road (see Culvert), May 9, 2011

Photo 2: SW5, May 9, 2011

The southeast wetland is reported to be perched on competent bedrock, and affected by beaver activity; however, based on the information presented in the GRI report, we are not confident that it will not be affected by the proposed expansion. With reference to Figures 4 (Section A-A") and 5, we note the following:

- The southeast wetland is lower in elevation than both the upper and lower springs along the east side of the site. Under existing conditions, these springs likely represent a significant part of the wetland water balance;

The easterly upper springs are found at elevations between 137 to 140 m ASL and the easterly lower springs at an elevation of approximately 129 m ASL. The 1:10,000 OBM identifies the southeast wetland elevation at 135.0 m ASL. The contour information indicates that the lower springs are at an elevation some 6 m lower than the wetland and therefore do not contribute to the southeast wetland.

Figure 4 (Section A-A') will be revised to exhibit the above noted elevations for the upper and lower springs. Figure 5: Surface Water Features will be revised to show the southeast wetland drainage area boundary as per the Figure 4: Drainage Areas in the SBA Hydrology Report, for clarity and consistency.

2.5 Expanded Quarry Zone of Influence Southeast

- The proposed expanded quarry base elevation is lower in elevation than the upper and lower springs as well as the southeast wetland. As such, we feel it is likely that much if not all existing groundwater discharge to the southeast wetland will be diverted to the quarry. The anticipated zone of influence in the weathered bedrock zone, as shown on Figure 6, encroaches right up to the delineated edge of the wetland. In our opinion, the level of certainty associated with the analysis of this zone of influence is not high enough to be confident that the wetland will not be under-drained; and,

The proposed quarry expansion lower lift elevation is at 125 m ASL. This is below the lower spring elevation of 129 m ASL, the upper spring elevations found between 137 and 140 m ASL and the southeast wetland at 135 m ASL.

Figure 6 (Radius of Influence – Weathered Bedrock Zone) will be revised at the squared corner in the area of the Southeast Wetland to show the zone of influence as an actual 306 m radius from the southeast corner of the proposed extraction limits. This more accurately exhibits the area of influence adjacent to the Southeast Wetland. The AECOM supplemental assessment dated June 2010 suggests the radius of influence due to drainage from the weathered bedrock may only range from 90 m to 190 m. This provides further evidence to suggest that the Southeast Wetland will not be under-drained.

The upper springs mark the base of the weathered bedrock where it is exposed on the side of the plateau. Shallow groundwater flows away from the quarry through the weathered bedrock, then along the underlying competent shaley bedrock to exit as springs.

Negligible seepage from the weathered bedrock enters the quarry, exhibited by the existing vegetation which remains very close to the limits of extraction. No running seepage is visible, but damp patches exist on the quarry face below the interface between the weathered bedrock and the competent bedrock. Only minor shallow pools have formed from seepage at a few locations along the base of the quarry face.

The source of the upper (weathered bedrock) springs is surface water i.e. infiltration from precipitation. It is our interpretation that recharge to the upper aquifer is localized and that the shallow groundwater flow is topographically controlled. Thus it is compatible to the hydrological impacts as it is controlled by the drainage area.

The hydrologic and hydrogeologic impacts on the southeast wetland are predicted to be less than 1 percent, which is consistent with a reduction in the drainage area of about 1 percent.

2.6 Drainage Area Appears to be Overestimated

- Based on the (possibly new) topographical information presented on Figure 5, the drainage area contributing runoff to the southeast wetland appears to be overestimated, specifically to the west and southwest of the wetland. The drainage area shown in the original Hydrology Report appears to have been delineated from different topographical information. The reported minor change in the surface drainage area to this feature due to expansion of the quarry would be more significant if the existing drainage area was in fact overestimated. The drainage area contributing to the southeast wetland and the potential change in drainage area should be confirmed using the best currently available mapping.

Figure 5 (Surface Water Features) will be revised in the Hydrogeology Report to show the southeast wetland drainage area boundary as per the Figure 4 (Drainage Areas) in the SBA Hydrology Report, for clarity and consistency. The southeast wetland drainage area reduction is less than 1 %.

2.7 Five Additional Springs

In addition to the springs feeding the southeast wetland, there are five additional springs, shown on Figure 5 of the GRI Report along the east side of the plateau. For the same reasons listed above, it is likely that groundwater discharging at these springs will be diverted to the proposed quarry. We expect that this discharge to surface water features to the east would quickly become insignificant as one moves further east; however, the GRI report offers no assessment of the ecological value of the springs on a local scale. The GRI report states that no monitoring of the springs is required. Golder would only agree with this statement if it can be demonstrated that the springs have no significant local ecological function.

The limit of the lower springs along the east side of the plateau as shown in Figure 5 was superimposed on the radius of influence for competent bedrock in Figure 7. The lower springs limit varies from a distance of 300 m to 630 m east of the 1.0m drawdown radius; and either intersects or is about 75m west of the limit of no impact. Thus, we anticipate negligible impacts on groundwater discharging at these springs.

The Aggregate Resources Provincial standards for a Category 2 application (Quarry below the Water table) require natural environmental reports to identify features on and within 120 m of the site. The limit of the lower springs shown in Figure 5 varies from about 275 m to 450 m from the east property line. Thus no assessment was required or completed.

2.8 Northwest wetland and east side Springs monitoring program

GRI has not recommended a surface water monitoring plan. Golder recommends water level monitoring within the northwest wetland. The frequency of the water level monitoring should be the same as the groundwater level monitoring. Correlation of groundwater levels and surface water levels would allow for evaluation of potential effects due to quarry dewatering. We also recommend that the east side springs be observed quarterly for presence or absence of flow and a photographic record of them be developed.

The area of the northwest wetland is designated in the McNab/Braeside Official Plan as a Mineral Aggregate Resource Area. It is not an area of Environmental Protection. Environmental impact assessment and protection is not required as this wetland is not a PSW or identified as a sensitive area of concern.

Beaver activity controls the water level at this wetland and on the backyards of the adjacent homes which front on Usborne Street. Residents are known to annually remove beaver dams to reduce flooding on their properties. This impacts the wetland water level. Any monitoring of potential quarry excavation would be impractical as the beaver and human activities determine the wetland water levels, not the quarry. Thus monitoring is not warranted and should not be required for this local wetland.

We anticipate negligible impacts on groundwater discharging at the lower springs limit along the east side of the plateau and about 275 m to 450 m from the east property line See also Section 2.7. Therefore monitoring is not warranted and should not be required for the eastside springs.

2.9 Southeast Wetland Reduction in Drainage Area

> With respect to the southeast wetland, if the 1% reduction in drainage area contributing to it can be confirmed, the potential effects of the proposed quarry on the wetland should be monitored by monitoring groundwater levels close to, and upgradient of, the wetland (i.e., on the Miller property). If the reduction in drainage area is found to be significantly larger than 1%, monitoring in the wetland may also be warranted.

Figure 5: Surface Water Features will be revised in the Hydrogeology Report to show the southeast wetland drainage area boundary as per the Figure 4: Drainage Areas in the SBA Hydrology Report, for clarity and consistency. Thus confirming the southeast wetland drainage area reduction is less than 1 %.

The Ministry of the Environment accepts permits to take water (PTTW) with an instantaneous rate of water taking less than 5 % of drought flow. The predicted impact on this wetland is less that 1% and well below accepted practice. Annual precipitation variance will be greater than the 1 % reduction in contributing area. The ultimate quarry impact on the southeast wetland is immeasurable. Thus monitoring is not warranted and should not be required for this local wetland.

2.10 Request for Monitoring and Mitigation and Contingency Plan

> With respect to the northwest wetland, GRI states that discharge from the quarry sump, "contributes to the maintenance of the wetland", and further states, "Continuation of the practice through the quarry operation will provide the necessary mitigation of potential impacts to the weathered bedrock zone from the proposed excavation." However, concerning the post-operational stage when the quarry will be filling with water, GRI states that, "this area is already within the radius of influence of the existing quarry with no natural heritage impacts evident. Monitoring and mitigation will not be required for this stage." Based on the information presented by GRI, it is our opinion that GRI has not demonstrated that impacts to the wetland will not occur if discharge from the quarry sump is halted. Therefore, Golder recommends that GRI develop a mitigation and contingency plan for the northwest wetland during the period when the lake is filling to its final elevation. Continuation of pumping (at a reduced rate) into the wetland, during the closure period when the quarry will be filling with water could be considered in order to maintain current conditions. With respect to the southeast wetland and east side springs, Miller should develop a contingency plan to mitigate effects on these features if it becomes necessary based on the results of the monitoring program.

The northwest wetland is designated in the McNab/Braeside Official Plan as Mineral Aggregate Resource Area. It is not designated as an area of Environmental Protection. An Impact Assessment and protection is not required as this wetland is not a PSW or identified as a sensitive area of concern. If this wetland was located in the proposed quarry extraction area to the east, it would be proposed to be removed for excavation of the limestone resource below the wetland. Therefore a monitoring, mitigation and contingency plan is not warranted and should not be required for this local wetland.

Southeast Wetland is an ephemeral water body, the volume of water largely controlled by beaver damming activity. It is shallow and typically is largely or entirely dry by late summer. The ecological significance of this water body is minor, being typical of innumerable (hundreds?) of such small, predominantly ephemeral ponds on the limestone bedrock areas of Renfrew County and adjacent Ottawa.

Figure 5: Surface Water Features will be revised in the Hydrogeology Report to show the south east wetland drainage area boundary as per the Figure 4: Drainage Areas in the SBA Hydrology Report, for clarity and consistency. This was discussed with Golder Hydrologist Kevin MacKenzie in a phone conversation May 19, 2011 with Jay Clark. The wetland drainage area reduction is less than 1 %. This is acceptable based on the revision to Figure 5 of the Hydrogeology Report.

The Ministry of the Environment accepts permits to take water (PTTW) with an instantaneous rate of water taking less than 5 % of drought flow. The predicted impacts on this wetland, of less that 1%, are well below accepted practice. Annual precipitation variance will be greater than the 1 % reduction in contributing area. Ultimate quarry impact on the south east wetland is immeasurable. Monitoring is not warranted and should not be required for this local wetland.

The quarry impact on the east side springs is negligible (Section 2.7). Therefore a monitoring and mitigation and contingency plan is not warranted and should not be required for these features. Adequate surface water monitoring is currently undertaken to fulfil requirements of the C of A for the Industrial Sewage Works Number 6988-6VZJFB for the existing quarry and prescribed in Site Plan notes as necessary for the quarry expansion.

3. Hydrogeology

3.1 Lateral and vertical extent of weathered bedrock

> Regarding the first Golder statement and BGC reply: Golder perceives the statements regarding the lateral and vertical extent of weathered bedrock to be contradictory. The label on Figure 4 indicates that the degree of dissolution increases with depth. If this statement is accurate, BGC should also indicate the depth at which dissolution features are not present.

The wording in Figure 4 will be corrected to read the "Degree of dissolution decreases laterally with depth".

3.2 Groundwater flow direction

> Regarding the fifth Golder statement and BGC reply: BGC is correct – groundwater flow direction is indicated on our copy of Figure 2.

No further response required.

3.3 Upper Springs wording

> Regarding the seventh Golder statement and BGC reply: The words "Upper Springs" do not appear on our copies of Figures 1 and 6.

This is a printing error that will be corrected on Figures 1 and 6.

3.4 Grey Area defining weathered bedrock

> Regarding the eighth Golder statement and BGC reply: Our copy of Figure 1 does not include a grey area, marking the edge of the weathered bedrock zone; the grey area is included on Figure 6.

Figure 1 will be revised to include a grey area marking the edge of the weathered bedrock zone, as shown on Figure 6.

3.5 Specific Remaining Comments in accordance with the BGC report

There are a few remaining responses which require attention to Golder comments. The numbers follow the Golder/ BGC referred comments.

3.5.3 Clay thickness

> 3) BGC has indicated that the reported thickness of the clay beneath the northwest wetland will be revised to indicate a maximum thickness of 5.8 metres. Because the well record for TW3-1 indicates 0 metres of clay at that location, Golder suggests that the description of clay thickness beneath the northwest wetland should indicate a range of clay thickness between approximately 5.8 and 0 metres.

We agree that the clay thickness ranges from approximately 0 m to a least 5.8 m beneath the northwest wetland.

3.5.4 TW13-1 weathered bedrock

> 4) Golder notes that TW13-1 is reportedly not completed in the weathered bedrock.

BGC has reviewed the GRI report dated November 2009. In that report, TW13-1 was indicated as being in the weathered bedrock zone and as already shown in Figures 1 and 6 (Summary Report, June 2010). This is further supported by the highly weathered zone observed from 1.98 to 2.74 m within the Bobcaygeon formation as shown in the borehole log for TW13 (Appendix B, GRI Nov 2009), suggesting the weathered zone can extend about 3 m into the bedrock at the location of TW13. There are references to this in the description in Sections 7.4.5.1 and 8.5, and also Table 6. Based on the available information, the piezometer is most probably at the edge of the zone vertically and horizontally.

3.5.5 Hydrology

> 5) See discussion in Hydrology Section.

Refer to Hydrology Section 2.

3.5.6 Well Depth and Available Drawdown Table

6) Golder requests that BGC tabulate well depth and available drawdown data for each well (individually) located within 800 metres of the proposed lower sump. The statistical information presented in Table 1 of the BGC letter is informative, but it is not adequate in terms of identifying possibly vulnerable water supply wells. The November 2009 GRI report includes some well information (well IDs 1 – 32), however, Figure 7 of the June 2010 GRI report shows many more than 32 wells (up to well ID 81, and several wells without IDs). BGC also incorrectly states that the maximum drawdown predicted by AECOM is 1.0 metre. The maximum predicted drawdown is actually 3.0 metres (at the lower lift sump).

BGC has examined the door-to-door survey information completed in 2006 and 2009. The survey provided information on the water supply wells within 800 m of the proposed lower sump. The information is presented in Table 1. Water well records were matched with specific site, or measurements that were made in the field. There is a moderate to high level of confidence in the accuracy of this information.

The attached Table 1 provides the available information on wells within the calculated (800 m) radius of influence. Additional wells referenced in the hydrogeology report are beyond the calculated zone of influence.

With respect to the maximum predicted drawdown, the wording in point 6 of the March 17 2011 letter should have correctly been, "The calculation by AECOM provided as Appendix A of the GRI Executive Summary Report dated August 2010 indicated a maximum predicted drawdown of 3.0 m at the lower lift sump with a drawdown of about 1.0 m at a radius distance of 800 m from the sump. The existing wells shown in Figure 7 are located at least 600 m from the sump suggesting that the predicted maximum drawdown in these wells attributed to the quarry expansion would be about 1.2 m."

3.5.10 TW9-1 and TW9-2 monitors

10) BGC believes that the groundwater levels at TW9-1 and TW9-2 are not influenced by the existing quarry, and therefore these monitors do not need to be replaced at this time. BGC also states that the existing and proposed quarry floor will remain above the potentiometric elevation of the significant water bearing zone (SWB). This is incorrect, as the quarry is reportedly licensed to extract to 125 masl. The existing quarry sump is reportedly at 125.5 masl and the proposed elevation for the lower sump is 123 masl, while the potentiometric elevation of the SWB is reportedly 127 masl.

    Based on the information presented by BGC, it is not clear whether or not TW9-1 and TW9-2 are influenced by the existing quarry. Therefore, Golder requests the following additional information:

i) Available data for water supply wells located within 800 metres of the proposed lower sump, including total depth and static water level elevations at the time of drilling, as requested above (see comment #6); and

ii) Chronology of the quarry development, indicating the depth and extent of the quarry and the depth of the quarry sump over time.

The existing first lift sump base is approximately 130 masl as surveyed by Miller. The 127.5 masl refers to the elevation of the current lowest point (second lift) in the quarry. There is no sump currently in the lowest lift.

The Skelton Brumwell Drawing No. 2033 – 2 of 5 dated Nov 2007 identifies the existing features and cross sections. Section A-A' shows the existing quarry floor sloping down from southwest corner at about 142 masl towards the northeast corner at approximately 135 masl. The existing southwest quarry floor is 9 m above the proposed first lift elevation at 133 masl and 8m below the two TW9 monitors at the top of the escarpment elevation of about 150 masl. The potentiometric elevation is lowest at the southeast corner at about 125 masl. As the quarry southeast corner has only been excavated to about half its proposed depth, it is affected to a lesser extent compared to other parts of the quarry.

The analysis of the available well records within 800 m of the proposed lower sump shows that for the examined wells, they are all greater than 600 m from the proposed lower sump. These locations fall between the lines that define the theoretical 1.5 m and 1.0 m drawdown, near the 1.0 m drawdown radius. The smallest calculated available drawdown based on available data indicated in Table 1 is 8 m. The theoretical drawdown of 1.0 to 1.5 m would comprise 12.5 to 18.8% of the available drawdown.

Regarding the data for wells within the 800 m radius of the quarry sump, see response in section 3.5.6 above

A Chronology of the quarry was developed from aerial photography and other sources. The Quarry development chronology is outlined with the source aerial photos and as much of the requested information as is known on Table 2 attached.

The approximate quarry excavation was interpolated from the available aerial photography. The extent of the excavation over the years is shown on Map 01- Quarry Development. The excavation is shown in approximate location for the specified years on the 2007 air photograph.

3.6 Quarry Development Chronology

> Based on our review of this additional information and the historical record of groundwater levels at TW9-1 and TW9-2, we will be better able to ascertain whether or not the groundwater levels at these monitors have been influenced by the existing quarry and if Golder would recommend additional monitors in this area of the site.

Based on the additional information and chronology, the expanded excavation does not require additional monitoring from that already in place or proposed.

Conclusion

The Miller Team members are available to discuss this response directly with their counter parts at Golder Associates.

On the basis of our consultations with Golder staff and this response we expect to receive written concurrence from Golder Associates on acceptance of peer review responses for these last three disciplines. We will then finalize and submit the revised reports to the Township, County and Golder Associates.

The results of the municipal peer review will be included in the updated Planning Report and implemented on the revised Site Plan. This should provide suitable information and justification for completion of the Municipal Official Plan Amendment and Zoning By- law Amendment application process and for completion of the quarry expansion Licensing process.

Yours truly,

SKELTON, BRUMWELL & ASSOCIATES INC.

Per: Gary Bell

Gary Bell, BES, RPP
Principal

attach Table 1. Well Depth and Available Drawdown
Table 2. Miller Braeside Quarry Development Chronology
Dwg 01 Quarry Development

GKB/JAC/JG/DM/DB/SLC

C-11-162

cc: BGC Engineering – Jennifer Gorrell
AECOM- Don McQuay
Brunton Consulting- Dan Brunton
Skelton Brumwell & Associates- Jay Clark, Kyle Fleming

Table 1. Well Depth and Available Drawdown in Surrounding Private Wells within Zone of Influence (800 m) of the Proposed Lower Sump (2006/ 2009 Door to Door Survey Data).

Well Site Reference	Well Depth (m) A	Date Water Level Measured	Water Level (m)	Available Drawdown B (m)
5818	24.4	June 2009	16.4	8.0
5729	25.9	June 2009	13.1	12.8
5900	35.1	June 2009	10.0	25.0
6621	27.1		n/a	n/a
7318	unknown	August 2006	13.0	n/a
7543	unknown	August 2006	13.8	n/a
6129	unknown	June 2009	7.0	n/a
7335	54.3	June 2009	20.4	33.9
6938	unknown	June 2009	13.1	n/a
6874	45.7		n/a	n/a
6723	38.1	June 2009	10.6	27.5
6632	73.2		n/a	n/a
6599	32.0	June 2009	4.2	27.8
6540	30.5	June 2009	9.5	21.0
Well Head Lower than Quarry Base by Elevation				
5764	72.5	June 2009	16.5	56.1

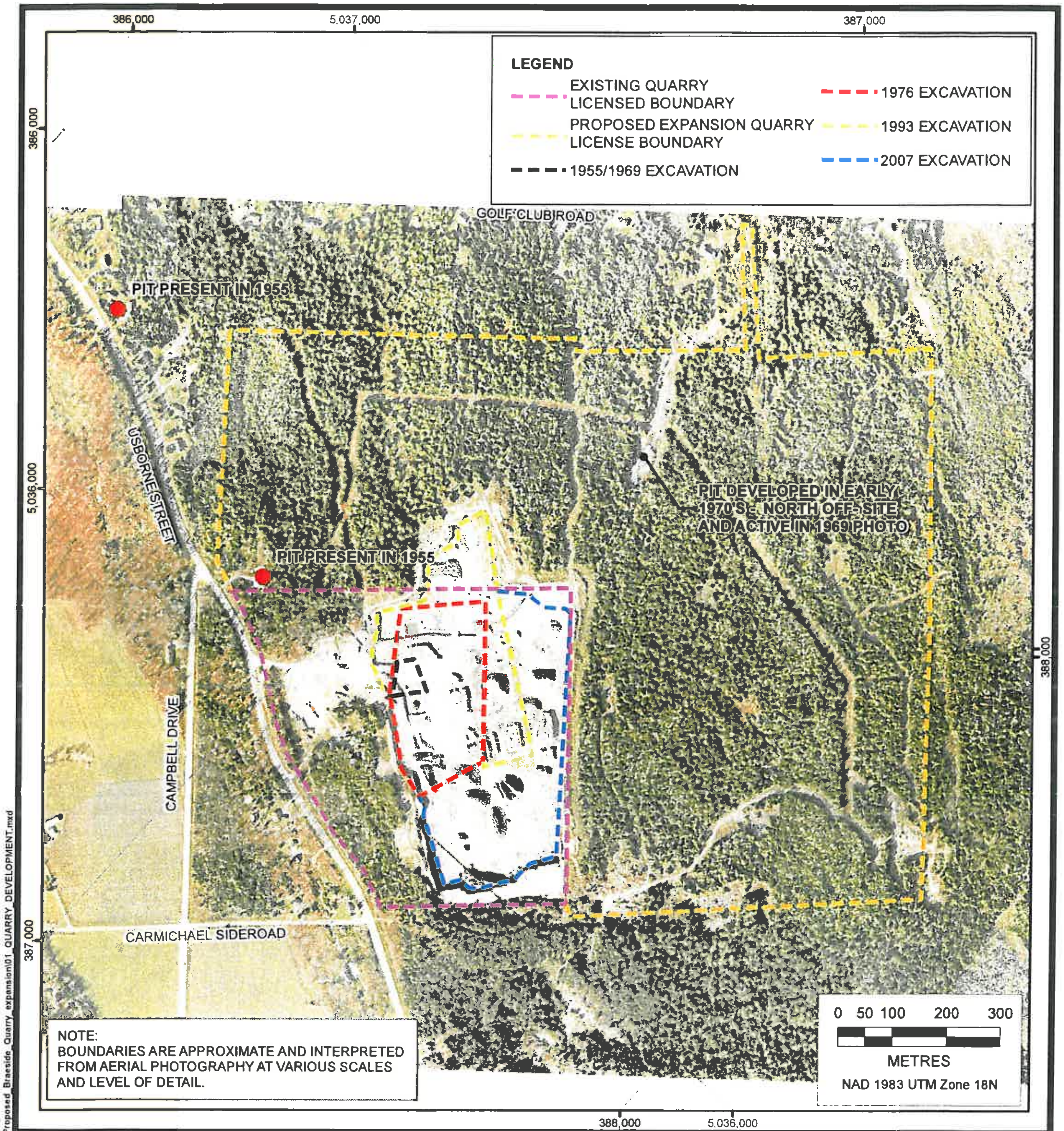
Notes:

A. Source- water well records

B. Calculated from well level depth (column 4) – static well depth (column 2)

Table 2 Miller Braeside Quarry Development Chronology

Year	Aerial Photography Source	Quarry Development	Quarry Depth (masl)	Quarry Extent of extraction (ha)	Sump Depth (m asl)
1955	NRCAN A 19955. Photos 7,8	A small quarry was present in the north-central portion of the existing licensed quarry.	Not determined	See Quarry Development Map	Unknown
1969	NRCAN A 18638 Photos 78,79	The excavation boundaries were similar in 1955 and 1969 suggesting little activity during this period.	Not determined	See Quarry Development Map. Less than 1 ha	Unknown
1976	NRCAN A 24324 Photos 9, 10	The quarry had expanded south-east, east and north-east, and the excavation was approximately one-quarter to one-third of the present size.	Not determined	See Quarry Development Map. Approx. 7 - 8 ha	Unknown
1993	McElhanney Mapping (Site Plan Photo Base) Oct/Nov 1993 . Scale 1:30,000, Roll. No. 352-353 Line 1, Photos 113, 114	The 1993 photograph was used for the current Site Plan. This showed an excavation enlarged east to north-east, and north into a portion of the property north of the license boundary.	To approx. 134 – 135 masl	10.1 ha	Unknown
2007	First Base Solutions photos November 2007	The 2007 aerial photos were used for the quarry expansion application. Since 1993 the excavation proceeded outward toward the limits of extraction in the east and south side.	To approx. 134 – 135 masl	17.1 ha	Approx. 130 masl



NOTE:
BOUNDARIES ARE APPROXIMATE AND INTERPRETED FROM AERIAL PHOTOGRAPHY AT VARIOUS SCALES AND LEVEL OF DETAIL.

SCALE:	1:10,000	DESIGNED:	JBG
DATE:	JULY 2011	CHECKED:	GAG
DRAWN:	LL	APPROVED:	JBG

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

PROJECT:
PROPOSED BRAESIDE QUARRY EXPANSION,
REPLY TO MAY 10, 2010 PEER REVIEW COMMENTS

TITLE:
QUARRY DEVELOPMENT

CLIENT:
MILLER GROUP INC.

PROJECT No.:	DWG No.:	REV.:
0910-006	01	

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DWG TO BE READ WITH BGC LETTER TITLED "REPLY TO MOE COMMENTS ON SUPPORTING DOCUMENTATION TO PTTW RENEWAL AND AMENDMENT"
DATED JULY, 2010

August 16, 2011

Project No. 08-1122-0216

Bruce Howarth, MCIP, RPP, Senior Planner
County of Renfrew
9 International Drive
Pembroke, Ontario
K8A 6W5

NATURAL ENVIRONMENT, HYDROLOGY AND HYDROGEOLOGY REVIEW COMMENTS
PROPOSED BRAESIDE QUARRY EXPANSION
MUNICIPALITY OF MCNAB/BRAESIDE, ONTARIO

Dear Mr. Howarth:

The County of Renfrew has retained Golder Associated Ltd. (Golder) to conduct a technical review of various reports related to a proposed quarry expansion in the municipality of McNab/Braeside. These reports were prepared in support of an application for Zoning By-Law Amendment under the Township of McNab/Braeside Official Plan (Section 9.3(3)) as well as an application to the Ministry of Natural Resources ("MNR") for a quarry license with extraction below the water table. The owner and operator of the quarry is Miller Group Inc. (Miller).

Golder has previously completed technical reviews of documents dealing with three major areas of potential impacts arising from the proposed quarry expansion: (1) hydrogeology; (2) hydrology; and, (3) biology, including ecology, referred to as natural heritage features. This submission comprises Golder's review of the Skelton Brumwell Associates Inc. letter dated July 4, 2011 which was prepared in response to the Golder letter of May 10, 2011 (dated May 10, 2010).

Based on the review of the Skelton Brumwell Associates Inc. letter dated July 4, 2011, we are generally satisfied with the responses to our questions and comments. We note, however, that despite any proposed changes to the figures indicating the predicted radius of influence of the proposed quarry expansion, under-draining of the southeast wetland could potentially occur. Regardless, the proposed groundwater monitoring program should provide the data necessary to evaluate the potential for impacts to springs and the wetland located east and southeast of the quarry. Thus, we will not recommend that monitoring of the springs or wetlands be required, unless and until the results of the groundwater monitoring program indicate that impacts to either the springs and/or the wetland may occur. We also note that Table 1 attached to the July 4, 2011 letter includes "Well Site Reference" numbers that do not correspond to any mapping that we are aware of. This should be addressed in the final reports.

It is our understanding that revised reports will be prepared by the Miller team and submitted to the Township and the County, and that Golder will then be requested to review and comment on those reports.

We trust that this submission meets with your approval. Please contact the undersigned if you have any questions.

Yours truly,

GOLDER ASSOCIATES LTD.

for Brian T. Byerley, M.Sc., P.Eng.
Senior Hydrogeologist/Associate

Kris. A Marentette, M.Sc., P.Geo.
Senior Hydrogeologist/Principal

BTB/KAM/sg

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cc:
Jennifer B. Gorrell, M.Sc.,P.Eng.,P.Geo, BGC Engineering Inc.
Tom Jones, Property Manager, Miller Paving Limited
Gary Bell, Skelton, Brumwell and Associates Inc.