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Groundwater Studies

Geochemistry

Phase I / II

Regional Flow Studies

Contaminant Investigations

OMB Hearings

Water Quality Sampling

Monitoring

Groundwater Protection Studies

Groundwater Modelling

Groundwater Mapping

Our File: 9506

January 14, 2014

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo
Hydrogeologist

Dear Mr. Hopkins:

Re: Response to Burnside Review of Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site
Burnside File No.: 300032475.0000

We are pleased to respond to the November 12, 2013 comments provided by R.J. Burnside and Associates Limited (attached Appendix A). It appears that we are able to find agreement on many issues. Burnside has requested additional information or clarification on other issues as reported herein. It is our intention to provide sufficient technical analysis in this letter to satisfy the outstanding concerns raised by Burnside and Associates. A separate letter from Harden responds to Burnside and Associates comments on the Hydrogeological Summary report.

2.2 Bedrock

We are in agreement that the Eramosa confining layer is not present at the site.

We are in agreement that the extraction will occur in the Niagara Falls Member and the Gasport Formation.

2.3 Description of Core Breaks

We are in agreement that bedrock extraction will occur from 10 to 40 metres below ground surface and the portions of the upper 10 m of rock that has fewer fractures, will respond slower to both dewatering and filling conditions of the quarry.

3.0 Pumping Tests

We are in agreement that the bulk hydraulic conductivity is approximately 2 x 10^{-5} m/s.

We agree that there is a system of interconnected fractures at depth as indicated by the response observed in M2 from the pumping in M15.

We agree, based on the observations, that it is possible that there is an anisotropic response with preferential flow from the northwest direction. Additional deep monitoring locations may prove otherwise. The rapid response observed suggests that the fracture(s) is/are under confined conditions. The persistence of this fracture network is unknown, however, the conventional wisdom by local practitioners (AquaResources, Golder Associates and Gartner Lee) suggests that the use of an equivalent porous media (EPM) model is a reasonable approach to evaluating groundwater flow and response to withdrawals from the aquifer. Recent discussions with Dr. Beth Parker at the University of Guelph suggest that the EPM method is reasonable over a macro scale.

We agree that the lack of response to the pumping of M15 as measured in shallow bedrock wells can be attributed to limited pumping duration and/or poor local fracture network connecting deep and shallow fractures.

We have added notation to Figure 5 (attached) indicating which portions of the drawdown correlate to pumping, flow profiling and video logging.

3.1 Flow Test

We agree that between the depths of 19 and 26 metres below ground surface there is a zone of lower permeability as indicated by a relatively stable flow velocity in that zone.

We agree that there will be dewatering of fractures in the upper portion of the bedrock aquifer along the northern boundary of the quarry; however, the maximum allowable "dewatering" of the bedrock is 2.54 metres. It has been agreed by James Dick Construction Ltd. that this will be visually monitored daily in the extraction area and recorded automatically every hour in nearby monitoring wells.

6.0 Water Quality Results

Nitrate

We agree that nitrate levels across thickness of the quarry profile will change due to the averaging of existing nitrate levels and the nitrogen inputs from quarry activities. The recent water sample from monitoring well M15 and the Rental House well (W1) at the Hidden Quarry site found nitrate concentrations in the bedrock were 2.0 and 0.13 mg/L respectively. The nitrate concentration in shallow bedrock groundwater entering the site averages 4.38 mg/L. The Ontario Drinking Water Quality Standard for nitrate is 10.0 mg/L. With quarrying activity, nitrate levels in the quarry ponds are estimated to be approximately 3.56 mg/L. Examination of other similar quarries, including locally the Guelph Dolime Quarry, indicate that quarry nitrate levels are not a significant concern. The following sections contain a detailed discussion of expected nitrate concentrations at the Hidden Quarry.

Existing examples within the Township of Guelph Eramosa, Milton, Ontario and Florida, U.S.A., suggest that nitrogen concentrations in the quarry water will be lower than that predicted.

Township of Guelph Eramosa

The Guelph Limestone Quarry (formerly Dolime Quarry) is being mined with both subaqueous and dry-bench methods. The discharge water from the quarry was measured in October 2013 and November 2013 with total nitrogen concentrations of 0.24 mg/L and 0.65 mg/L respectively. This data confirms that nitrogen concentrations are not a concern in the quarry. The highest total nitrogen concentration obtained at the Guelph Limestone Quarry was 1.9 mg/L from a sample obtained within four hours of explosives detonation.

Holcim Quarries – Milton Ontario

The total nitrogen concentration in discharge water from the Milton Quarry (Conestoga Rovers and Associates, 2012) ranged from 0.67 mg/L to 0.99 mg/L depending on which discharge location was sampled. This is an active quarry with a 2012 tonnage of 3.9 million tonnes which equates to approximately 760,000 kg of explosives being used.

Florida, United States of America

Subaqueous mining is used extensively in southwest Florida. There are several limestone quarries that are extracting limestone from below the water table in Lee County Florida. We were able to find two sites where there was nitrogen data available, the Cemex Alico Road site and the Verandah site.

The Alico Road site has ammonia levels less than 0.63 mg/L in groundwater and 0.35 mg/L measured in the surface water at the site. TKN values at this site do not exceed 1.2 mg/L in groundwater and 1.1 mg/L in surface water. We contacted Devan Coppock at Cemex who said that they blast a couple of times a month at this site, they have been blasting since 1972. Devan confirmed that they only use emulsion explosives.

At the Verandah site the maximum ammonia level is 0.55 mg/L in surface water. This is based on two sampling events, one in October where the high levels were measured and one in June of the same year (2007). The TKN values were measured up to 1.3 mg/L in the surface water.

We also contacted Lee Werst, the State Hydrogeologist for Lee County. He indicated that they do not commonly sample for nitrogen species because with the amount of dilution that is available, nitrogen is generally not a contaminant of concern.

A fact sheet (Appendix B) prepared by the Florida Department of Environmental Protection shows that there are no sources of groundwater contamination around the Cemex Brooksville Quarry well. This is a drinking water well drawing water from the same aquifer being mined and is within 152 m of the quarry pond. Similar results were found for the Florida Crushed Stone Camp Mine Quarry (2008) and the Rinker Fec Quarry Employees (2004).

Our conclusion is that nitrogen will not occur in significant concentrations at the Hidden Quarry site. A detailed nitrate balance for the Hidden Quarry site is discussed elsewhere in this letter.

Iron

Samples confirm that local groundwater contains reduced iron. The presence of a quarry pond with elevated concentrations of dissolved oxygen relative to the groundwater, will result in a reduction of iron concentrations in the surface water and groundwater downgradient of the quarry. Dissolved iron was not detected in monitoring well M15 and in the Rental House well (W1) a concentration of 0.13 mg/L was found. It is our opinion that dissolved iron will not increase downgradient of the quarry as a result of quarry activities.

Reduced iron will also assist in the denitrification of the surface water. Reduced iron is an efficient electron donor and facilitates conversion of nitrate to nitrogen gas and water in the following way;

$$2\ NO_3^- + 10\ e^- + 12\ H^+ \rightarrow N_2 + 6\ H_2O$$

This further limits the likelihood that iron will remain in the groundwater downgradient of the pond and helps reduce nitrogen compounds in the water system.

Nitrogen Mass Balance

There are two sources of nitrogen at the proposed quarry. The first source is nitrogen imported to the site within the explosives used to liberate the rock. The second is nitrogen flowing onto the site in groundwater. The origin of this nitrogen is upgradient farms which apply fertilizers (both commercial and natural) or generate manure. This balance has not included dry deposition of nitrogen as a source as this will be very small in comparison to the other sources.

Nitrogen will leave the site via the atmosphere following detonation of the explosives and also through the groundwater flow system. Neither denitrification processes in the groundwater regime nor nitrogen sequestering in organic sediments has been considered in this nitrogen balance.

1) Nitrogen From Explosives

The proposed explosive emulsion is known by its commercial name Hydromite 4400. This product contains between 70 and 82% ammonium nitrate. At the Guelph Limestone Quarry (formerly Dolime Quarry) 5.122 tonnes of rock is liberated per kilogram of explosives. Assuming that the maximum annual tonnage of rock of 700,000 tonnes is extracted at the Hidden Quarry, there will be a total mass of 136,665 kg of explosives required.

The basic chemical equation for explosions involving ammonium nitrate is as follows;

$3NH_4NO_3 + CH_2 \rightarrow CO_2 + 7\ H_2O + 3N_2$

The end products of the explosion are two gases and water. Explosions are not 100% efficient and some residue may remain to dissolve in the water in the quarry. In order to estimate the efficiency of the blasting process we have used detailed data available from the James Dick Construction quarry in Gamebridge Ontario (Table 1 following figures). The quarry is a dry quarry and all dissolved residue leaves the quarry via the dewatering system. The mass of explosives used annually from 2009 to 2013 ranged from 60,875 to 103,480 kg. A total of eighty five water samples were obtained in that period and the total concentration of nitrogen in the water is determined by summing the concentrations of nitrate, nitrite and total kjeldahl nitrogen. Multiplying the volume of water by the concentration of total nitrogen in the water provides an estimate of total nitrogen discharged from the quarry. The mass of nitrogen in the discharge water between 2009 and 2013 is summarized in Table 1. The loss of nitrogen to the water at the quarry is 2.28% on average between 2009 and 2013. Therefore, the efficiency of the blasting process is shown to average 97.72% over the past five years.

Assuming that the Hydromite 4400 contains 82% ammonium nitrate, the maximum mass of ammonium nitrate required at Hidden Quarry will be 112,066 kg. Based on atomic weights, ammonium nitrate is 35% nitrogen. Therefore, the maximum total annual mass of nitrogen required at the site will be approximately 39,223 kg. Assuming that the average blast efficiency is 97.72%, the total mass of nitrogen residue available for dissolving in the water is 894 kg/year.

2) Nitrogen from Groundwater Inflow

The average hydraulic gradient upgradient of the site is estimated to be 2 m over 175 m or 0.011 m/m. The width of the flow field is 700 m and the transmissivity is estimated to be 75 m^2/day. Using

$$Q = T * i * W$$

Where
Q – groundwater flow through (m^3/day)
T – transmissivity (m^2/day)
i – gradient (m/m)
W – width of flow field (m)

the estimated groundwater flow through the site under a natural gradient is 578 m^3/day or 210,970 m^3/year.

The drawdown within the excavation will result in additional water moving onto the site. Our experience with subaqueous aggregate mining in this area is that annual equilibrium occurs within the groundwater system and a year-over-year deficit does not occur. Therefore, the removal of 270,000 m^3 of rock will result in the inflow of 256,500 m^3 of water (after accounting for 5% rock porosity).

The total volume of groundwater moving onto the site from upgradient is therefore 467,470 m^3.

Nitrogen Mass From Upgradient Groundwater

The farming activity upgradient of the site results in the introduction of nitrogen compounds to the groundwater. Samples obtained in 1998 and in 2013 confirm that nitrate, ammonia and total kjeldhal nitrogen is found in the groundwater. Table 2 summarizes the nitrogen compounds found in surface and groundwater samples. The observed concentrations of nitrogen compounds in the groundwater entering the northern boundary of the site average 4.38 mg/L in 2013. The nitrogen compounds present in the lower portions of the aquifer are estimated to be 0.2 mg/L.

The water samples obtained from monitoring well M15 and the Rental House well (W1) represent vertically mixed groundwater quality and groundwater where natural attenuation has removed nitrate from the groundwater flow system. The values obtained from M15 and the Rental House were 2.0 mg/L and 0.13 mg/L respectively.

The average value of nitrogen compounds entering the site is 4.38 mg/L. Assuming that this represents the total nitrogen concentration in groundwater flowing through the upper third of the aquifer, the mass of nitrogen compounds entering the site under natural flow conditions is 4.38 mg/L x 70,323[1] m^3 or 308 kg per year. Nitrogen compounds flowing through the lower zones is estimated to be 28 kg/year.

In addition, 256,500 m^3 of water will be drawn into the site from the subaqueous mining processes on an annual basis. Assuming that a third of this water (85,500 m^3) is obtained

[1] 210,970 m^3/3

from the upper aquifer and two thirds from middle and lower zones, the additional mass of nitrogen compounds entering the site from up gradient is 408 kg.

Table 3: Nitrogen Balance

Zone	**Nitrogen Concentration (mg/L)**	**Groundwater Flow Volume (m^3)**	**Mass of Nitrogen (kg)**	**Total Nitrogen (kg)**
Upper	4.38	70,323	308	
Middle	0.2	70,323	14	
Lower	0.2	70,323	14	336
Induced Flow				
Upper	4.38	85,500	374	
Middle	0.2	85,500	17	
Lower	0.2	85,500	17	408
Total from Groundwater			774	
Total from Explosives			894	1,668
Total Dilution		467,469		
Final Nitrogen Concentration	3.56			

The total mass of nitrogen input to the Hidden Quarry site on an annual basis is therefore estimated to be 1,668 kg/year. The amount of dilution for this nitrogen is 467,469 m^3/year (Table 3).

The resulting concentration of nitrogen compounds in groundwater is therefore estimated to be 3.56 mg/L.

It is our opinion that this nitrogen balance represents a worst case scenario as natural processes within the pond and the groundwater system will further reduce nitrogen movement in the groundwater system.

Surface Water Pathogens

We concur that surface water pathogens may be present in the quarry pond. However, the quarry will not be the most likely source of surface water pathogens in the area.

According to the Ontario Ministry of Agriculture and Food (http://www.omafra.gov.on.ca/english/engineer/facts/04-015.htm), the list of most likely sources includes:

- sewage treatment plant discharge
- municipal storm sewer discharge
- overland runoff from manure storages and feedlots
- illegal connections of domestic septic systems to subsurface drains emptying into surface water
- wildlife
- runoff from fields receiving livestock manure
- runoff from fields receiving sewage sludge
- livestock manure entering streams as a result of defecation in or near streams
- other sewage sources (e.g. interception of septic plumes by surface water or marine discharge)

The quarry does not represent the most likely source of surface water pathogens. Considering the elevated nitrate observed in water samples from Tributary B indicating contamination from upgradient farming, the more likely source of surface pathogens is water infiltrating into the bedrock from Tributary B. Also, the elevated nitrate concentrations in groundwater indicate that the overburden does not provide effective protection from anthropogenic activity.

The bedrock aquifer is already susceptible to contaminants from the ground surface as recognized in several reports including Halton Rural Drinking Water Study, Phase 1 and City of Guelph Final Groundwater and Surface Water Vulnerability Report (Aqua Resources, March 2010). The water quality survey by Halton Region found that the water from 31% of drilled wells in their survey was unsafe for drinking. The Beak International (1999) study states that in the Blue Springs Creek watershed, the rapid movement of surface water into the bedrock leads to high susceptibility of contamination. Therefore, the quarry is being developed in an area already susceptible to contamination from the ground surface.

The mining is phased such that quarrying will commence in the northern portion of the site. This is the most distant part of the site from downgradient private water wells. The monitoring program is designed to determine if groundwater quality is being impacted by the quarry.

Two ponds will remain upon maturity of this site. These ponds are upgradient from five private wells as shown on Figure 2 as determined by reverse particle tracking from the private wells. At least one of the private wells (W19) is already utilizing an Ultra Violet Light to treat for a chronic bacteriological issue in the well water.

James Dick Construction Ltd. has agreed to a pre-bedrock extraction water well survey that includes a water quality assessment. James Dick Construction Ltd. has agreed to ameliorate water quality issues in private wells relating to the quarry. This can include one or more of the following remedies;

1) Lining of the well to restrict water intake to deep fractures,
2) Deepening of the well,
3) Installation of water treatment.

7.0 Recommended Multi-Level Installation Details

We agree with the proposed Burnside multi-level installation details in M15. In-situ hydraulic conductivity testing and water quality testing will be undertaken upon completion.

8.0 Discussion

We agree that the drawdown observed in M2 during the pumping of M15 is consistent with the groundwater flow direction and a fracture alignment in approximately a northwest to southeast orientation.

9.0 Response to Burnside Comments

72) The subaqueous blasting process is such that the full quarry depth is drilled and blasted in one event. Traditional mining allows for a series of working benches and mine lifts between 10 and 15 metres thick. In the Hidden Quarry case, the entire 30 metre lift will be drilled and blasted in one event. With the top of rock at approximately 350 m AMSL, the approach will be to drill and blast the rock to an elevation of 320 m AMSL. The full depth of the aquifer to an elevation of 320 m AMSL will thus be exposed and able to contribute water during the extraction process.

It is our conservative estimate that based on an annual extraction rate of 700,000 tonnes per year, the daily extraction rate will be the equivalent of 1145 m^3 of rock. If the initial sinking cut has the dimensions of 25 m x 50 m, the anticipated daily drawdown will be

0.91 metres. The hydraulic modelling shows that where there is a drawdown of 2.54 metres, the drawdown in the nearest well is approximately 1.6 metres. Given the relatively high transmissivity of the aquifer and availability of water from a wide range of depths within the aquifer, this predicted change in water level will not affect the functioning of the well.

James Dick Construction Ltd. has agreed to limit the maximum drawdown in the excavation to 2.54 metres below the historic low water level. Based on the depth of upgradient wells and the availability of water from multiple depths in the aquifer, it is our opinion that no domestic well will be impacted by the proposed rock extraction activities. Based on our water well survey, there are no shallow dug wells being used for domestic or any other water supply reasons in the area upgradient of the quarry.

60) It is our opinion that the inclusion of a low flow zone at depth in close proximity to the quarry, will not have a significant effect on the model outcome or the model's ability to predict maximum water level changes in nearby wells. The model calculations were conducted using hydraulic conductivity as a variable rather than using a constant transmissivity. Therefore, where the thickness of the model layer increases, the transmissivity increases. Creating a lower hydraulic conductivity layer beneath the proposed quarry would decrease the overall transmissivity within the model proximal to the quarry.

An analytical approach to estimating potential impacts from the quarry is presented in the accompanying letter. In the scenario where transmissivity is decreased, the potential impacts to nearby homes decreased. We do not feel that a change to the model is warranted considering that (a) the analytical approach does not suggest a greater impact, (b) Rockwood Well No. 3 has a large fracture set between the elevation of 313.2 and 316 m AMSL indicating that significant permeability occurs at depth, (c) the 'water found at' distribution is scattered suggesting fractures are found throughout the rock body thickness and (d) the field experience indicated by Burnside is that two wells drilled in close proximity can have different fracture patterns. Therefore expanding the conditions observed in M15 to the whole quarry is not reasonable.

54) We agree.

56) We agree with this statement and also conclude that the till layer is not an effective aquitard over this site as M12, M11 and M7 are consistently dry indicating no saturated overburden above the bedrock at those locations.

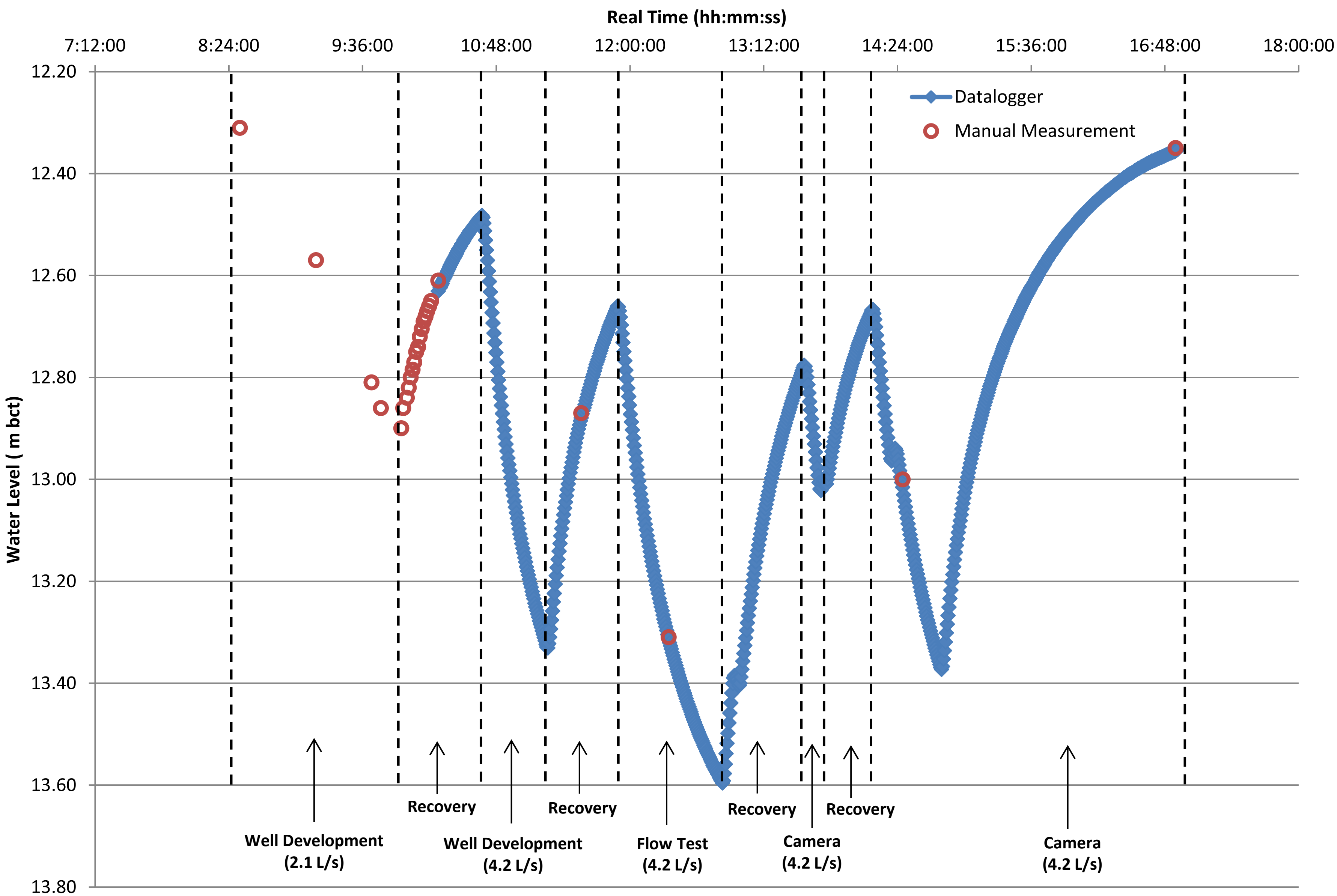
Respectully submitted,
Harden Environmental Services Ltd.

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

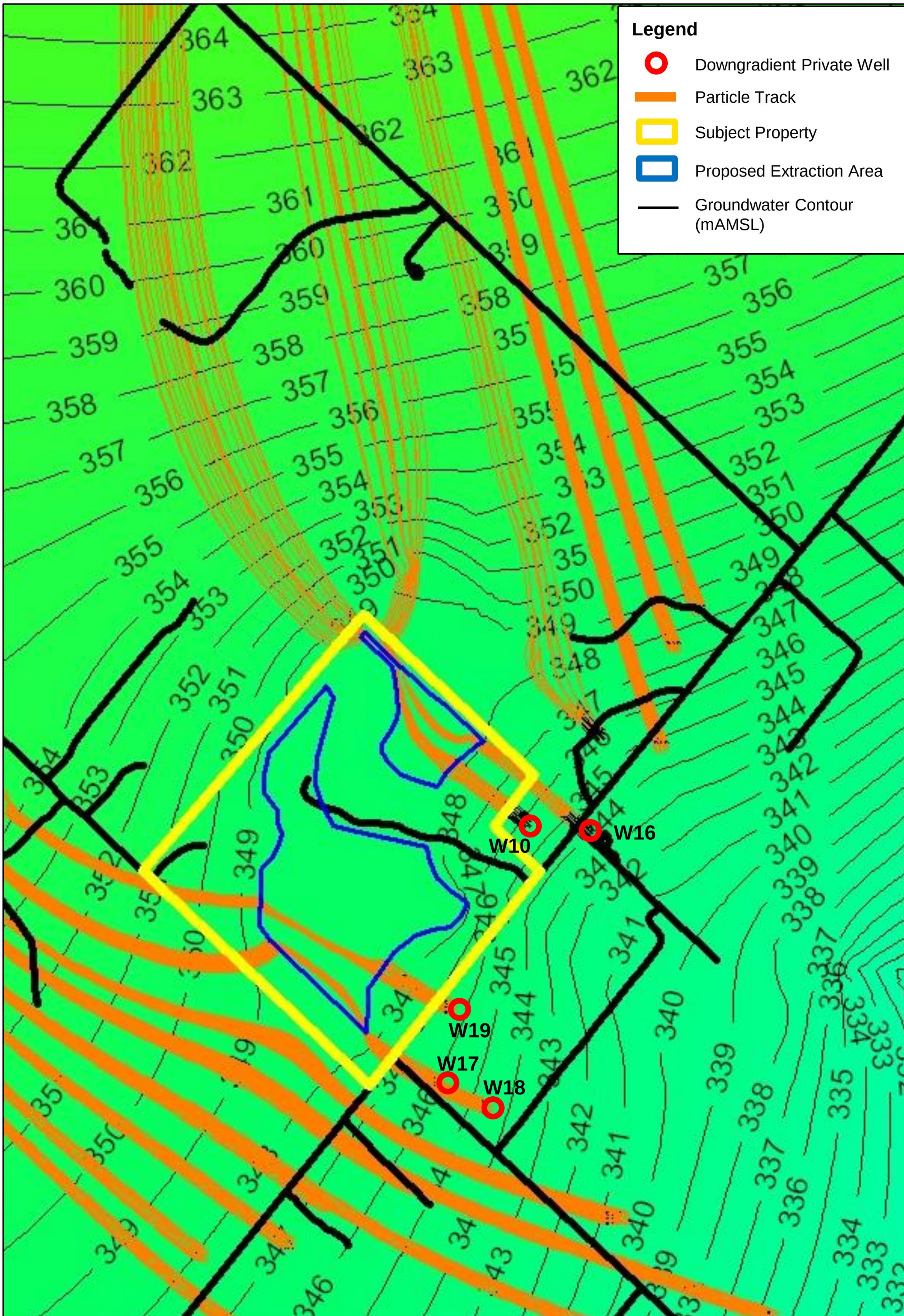
LICENSED PROFESSIONAL ENGINEER
S. E. DENHOED
PROVINCE OF ONTARIO

cc: Greg Sweetnam, James Dick Construction Limited

Figure 5: M2 Response During M15 Testing



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 5: M2 Response During M15 Testing**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	Figure 2:
	Date: Dec 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	Downgradient Private Wells
	Drawn By: SD		

Table 1: Loss of Total Nitrogen from Explosives at Gamebridge Quarry

Year	Total Pumping Volume (L)	Average N in Discharge (mg/L)	Average N Background (mg/L)	Total N Discharged From Quarry (kg)	Total Explosives (kg)	Total Ammonium Nitrate (kg)	Total N (kg)	% N Loss to Water
2009	182,333,606	6.50	1.4	930	71,192	66,920	23,422	3.97
2010	180,089,922	6.72	1.4	958	103,480	97,271	34,045	2.82
2011	201,966,454	4.17	1.4	559	86,030	80,868	28,304	1.97
2012	169,069,434	3.11	1.4	288	60,875	57,223	20,028	1.44
2013	144,973,994	3.81	1.4	350	88,090	82,805	28,982	1.21

Average % N Loss to Water	**2.28**

% Ammonium Nitrate in Explosives	94
% Nitrogen in Ammonium Nitrate	35

Note: Average background calculated from average ammonia in groundwater multiplied by 0.35 as groundwater component of quarry water. No background Nitrogen species accounted for in surface water entering the quarry.

Table 2: Nitrogen Compounds of Hidden Quarry Groundwater and Surface Water Samples

November 21, 1996

Location	Nitrate (mg/L)
Tributary A	8.2
M3	5.3
SW3	9.0
M2	6.8
M4	2.8
M1	0.7
TP1	0.9
M5	1.6
SW1	<0.05
Blue Springs Creek	1.8

May 18, 2012

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)
Rental House (W1)	0.13	<0.050

May 24, 2013

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)	TKN (mg/L)
M15	2.0	0.060	0.20

November 20, 2013

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)	TKN (mg/L)
M2	5.2	<0.050	0.77
M3	4.6	<0.050	1.3
M13D	0.9	<0.050	0.38

November 25, 2013

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)	TKN (mg/L)
Tributary B	6.7	<0.050	0.35

Appendix A

Burnside & Associates Comments

November 12, 2013

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 Canada
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BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

November 12, 2013

Via: Email/Mail

Mr. Stan Denhoed, M.Sc., P.Eng.
Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road,
R.R. 1
Moffat, ON L0P 1J0

Dear Mr. Denhoed:

Re: Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site
File No.: 300032475.0000

Thank you for providing R.J. Burnside & Associates Limited (Burnside) with a copy of the June 7, 2013 Harden Environmental Services Ltd. (Harden) letter which documents the drilling and testing of new well M15 at the Hidden Quarry site. The Burnside comments are provided under the same section headings as used in the Harden letter.

2.2 Bedrock

Harden indicates that the uppermost bedrock encountered was the Niagara Falls Member of the Goat Island Formation and is not representative of the Eramosa Formation.

Burnside Comment

This is consistent with OGS Map P955 which indicates the Eramosa Formation extends just to the west of Rockwood and is not present beneath the Hidden Quarry Site.

Gasport Formation

The Gasport Formation is found between 10.03 and 48.50 mbgs (350.00 mamsl to 311.53 mamsl).

Burnside Comment

The extraction will occur in the Niagara Falls Member and the Gasport Formation with the proposed base of the quarry at 320 masl.

2.3 Descriptions of Core Breaks

Harden looked at each core break in the field and at their office and recorded only naturally occurring core breaks as either open or closed fractures. The highest concentrations of open fractures occur between a depth of 20 and 40 mbgs.

Burnside Comment

The bedrock extraction will occur from 10 to 40 mbgs. The upper 10 m of rock is not as fractured and may not fill with water as quickly as the rock from 20 to 40 mbgs resulting in temporary localized dewatering of the shallow fracture system.

3.0 Pumping Tests

Brief pumping tests were completed on M15 at rates of 2.1 L/s (for 60 minutes) and 4.2 L/s (30 minutes) with 1.21 m and 2.67 m of drawdown respectively. Wells M1D, M3 and M13D had no response to pumping. Water levels in M2 declined about 1.23 m. The pumping test data has been used to estimate the Transmissivity and hydraulic conductivity (K) of the bedrock aquifer.

Burnside Comment

A review of Figure 3.17 (Bedrock Groundwater Contours) in the Hydrogeological Investigation Report indicates that M2 is upgradient of M15 and M3 is crossgradient.

Water levels prior to the start of testing were as follows:

	Start
M15	350.69
M1D	352.34
M3	349.40
M13D	354.70
M2	not reported

The borehole log of M15 indicates bedrock was encountered at 9.55 mbgs and flow profiling indicates no flow below 41 m. As a result, the effective aquifer thickness is only 31.45 m which is less than indicated.

Using an average T of 60 m^2/day (from M15) and an aquifer thickness (b) of 31.45 m results in a K of 2.2 x 10^{-5} m/s which is very similar to that calculated by Harden.

The rapid response to pumping at M2 suggests there is a system of interconnected fractures aligned in a northwest direction. The lack of responses in MD, M3 or M13D could be simply due to the limited duration of the test or may indicate that the fracture system present at M2 and M15 is not present at the other locations.

Notation should be added to Figure 5 (Well M2 response)to indicate which portions of the graph represent the pumping test, flow profiling and pumping video.

3.1 Flow Test

The flow testing completed indicates approximately one-third of the M15 yield is derived from fractures between 10 and 36 mbgl, one-third from a single set of fractures at 36 m and a third is obtained from a fracture at 42 mbgs.

Burnside Comment

The flow testing indicates that the flow in the upper portion of the rock is decreased between 19 and 26 m. Similarly, the bedrock between 36 and 42 mbgs produces minimal flow could result in some temporary dewatering of the fractures above these zones while this portion of the rock fills with water during the extraction process.

6.0 Water Quality Results

A water sample collected from M15 had a nitrate concentration of 2.0 mg/L and a chloride concentration of 16.0 mg/L. Iron was not detected.

Burnside Comment

Samples from M2 collected in 1996 had a nitrate concentration of 6.8 mg/L, a chloride concentration of 12 mg/L and iron of 0.68 mg/L. A sample from the Dolime pit following a subaqueous blast had a nitrate concentration of 1.2 mg/L. This indicates that blasting may increase nitrate concentrations in the bedrock aquifer.

Once the quarry pond is created, there will be water mixing from all directions and depths. Harden should provide additional detail on how the exposure of the groundwater to air will impact iron (the concentrations at M2 are already above the Ontario Drinking Water Quality Standards (ODWQS)). Although iron is an aesthetic parameter, Harden should comment on the potential for iron to increase in downgradient wells; possibly causing problems with fixture staining and odours. Similarly, a mass balance calculation should be performed to estimate the nitrate concentration at the downgradient end of the quarry. Once the pond is created during extraction, it is anticipated that surface water pathogens such as Cryptosporidium and Giardia possibly will be present. These have the potential to move rapidly through bedrock fractures, impacting nearby domestic wells.

7.0 Recommended Multi-level Installation Details

Harden proposes that M15 be converted into a multi-level well with the following zones for monitoring:

Monitoring Level	Interval (mbgs)		Interval (mamsl)	
	From	To	From	To
Shallow	10	28	350.03	332.03
intermediate	33	38	327.03	322.03
Deep	40	55	320.03	3,05.03

Burnside Comment

Flow profiling and the pumping video do not indicate any flow below 45 m so there is no need to monitor this interval. Also, the proposed separation between the intermediate and deep monitors is only 2 m which is less than ideal to provide a good separation between the fractures. Burnside recommends the following be considered.

Monitoring Level (including 0.30 m of sand pack above screen)	Interval (mbgs)	
	From	To
Shallow	10	28
Seal	28	34
Intermediate	34	37
Seal	37	40
Deep	40	43

Burnside suggests that the screened interval be 0.3 m less than the monitored interval to allow for the placement of 0.3 m of sand between the top of the screen and the bentonite seal.

Once the multi-level well has been constructed and developed, in situ hydraulic conductivity and water quality testing should be completed.

8.0 Discussion

Based on the installation of M15, Harden offers the following comments regarding the hydrogeological conditions at the site:

1. There are no significant karst features identified in the geological profile. This is in keeping with the observations at M1, M2, M3, M4, M13D and M14D. The core obtained from M15 contains fractures, however, none suggest karstification of the dolostone aquifer.
2. Water bearing zones occur throughout the geological profile. The Gasport Formation is well known for its water bearing ability and this characteristic was confirmed at M15. Water bearing zones occur from the top of bedrock at an elevation of 350 mamsl to an elevation of 318 mamsl. There was no indication of preferential flow through the upper three metres of the geological profile.
3. Lateral hydraulic connectivity within the aquifer occurs at depth. There was a hydraulic response noted in monitor M2 to the pumping of M15. M2 and M15 fully penetrate the dolostone aquifer and the response in M2 verifies that water transmission will occur through the aquifer. This proves that M2 will be a useful monitor during the quarry operation to observe changes in the aquifer during extraction.
4. Hydraulic responses were not observed within the shallow bedrock at M1D, M13D or M3 whose completion elevations are all above 346 mamsl. These wells are completed in the upper 3 m of the bedrock. The lack of immediate hydraulic response is due to a relatively poor hydraulic connectivity between the shallow bedrock and deeper fractures; and poor lateral connectivity in the shallow zone. It is

anticipated that the shallow bedrock zone will ultimately experience a hydraulic response after a prolonged water level change. Although pumping periods were short, the response in the pumping well and in M2 were used to estimate transmissivity of the aquifer. The near-well transmissivity is estimated to range from 50 m^2/day to 80 m^2/day. This correlates well to the bulk hydraulic conductivity used in the model for the dolostone aquifer. These values also correlate well to the hydraulic testing conducted on the adjacent Mudge property where transmissivity of the aquifer was found to range from 20 to 150 m^2/day.

Burnside Comment

Burnside concurs with the Harden discussion.

Under item 4, the lack of water level response in M1D, M3 and M13D while M15 was pumping appears to indicate a lack of hydraulic conductivity between the shallow bedrock and deeper fractures. However, the drawdown at M2 is consistent with the groundwater flow direction and may also indicate preferential alignment of water bearing fractures in a northwest direction.

9.0 Response to Burnside Comments

Harden provided updated responses to previous Burnside Comments 72, 60, 54 and 56.

Burnside Comments

72. Figure 7 provides a graphical presentation of the flow velocity. It indicates that 66% (2.78 L/s) of the flow is derived from fractures at 36 m and 41 mbgs with 30% (1.3 L/s) of flow found in the upper 36 m. There are several zones in the upper 36 m where there is no significant flow (i.e., from 19 to 26 m). As a result, as excavation proceeds between 19 and 26 m, water to make up the volume of rock removed will need to come from the bedrock between 10 and 19 mbgs. Burnside understands that this effect will decrease as each sinking cut is completed, however, the amount of drawdown during the initial cut should be quantified so that the impacts on nearby domestic wells can be realiably predicted.

60. The short term tests of M15 provide confirmation that the bulk hydraulic conductivity value used in the groundwater model is reasonable. Once the well is converted to a multi-level monitoring well, additional ‘K’ testing should be completed. Since the original groundwater model used a localized zone of higher ‘K’ to simulate conditions on the east side of the site, is there a benefit to including the low flow zone from 36 to 40 mbgs as a separate layer in the near site grid of the model. The Assessment of water quality impacts should consider the potential for nitrate, turbidity and surface water pathogens to move rapidly through fractures such as those seen at 36 and 41 mbgs in M15.

54. M15 was installed to address a concern with lack on onsite information on the bedrock formations. Once the multi-level monitor well is constructed and K tested and set up for long term monitor this comment will be satisfied.

56. Figure R8 indicates that there is a basal silt/till unit that is present throughout the site yet water from Tributary B is hypothesized to enter the bedrock at some point upstream of SW3. Since Harden indicates the water table is not present in the overburden throughout the entire site, there must be areas in the southern portion of the site where the silt unit is thin or absent. This was observed at M15 where granular sediments extended from the surface to the top of the bedrock.

Should you have any questions, please contact the undersigned.

Yours truly,

R.J. Burnside & Associates Limited

Dave Hopkins, P.Geo.
Hydrogeologist
DH:sd

cc: Ms. J. Sheppard, Township of Guleph/Eramosa (Hand Delivery)
Mr. D. McNalty, R.J. Burnside & Associates Limited (Email)
Cuesta Planning Consultants Inc. (Mail)
Mr. Greg Sweetnam, James Dick Construction Ltd. (Mail)

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Appendix B

Florida Department of Environmental Protection

Source Water Assessment & Protection Program

Factsheets

Florida Department of Environmental Protection

Cemex Brooksville Quarry 2010

Source: http://www.dep.state.fl.us/swapp/DisplayPWS.asp?pws_id=6277026&odate=01-OCT-10

Source Water Assessment & Protection Program

Results for: 2010

CEMEX BROOKSVILLE QUARRY
11430 CAMP MINE ROAD
BROOKSVILLE, FL 34601

Public Water System ID: 6277026

Previously Known As:
FL CRUSHED STONE CAMP MINE QUARRY
FL CRUSHED STONE GREGG MINE

County: HERNANDO
DEP Regulatory Office: DEP Southwest District
13051 N Telecom Parkway
Temple Terrace, FL 33637
813-632-7600
Public Water System Type : NONTRANSIENT NONCOMMUNITY
Public Water System Source : GROUND
Primary Use: INDUSTRY/MINING
Population Served: 125
Size of Assessment Area:
GROUND: For this system, a 500-foot radius circle around each well was used to define the assessment area.

Number of Wells: 1

Well ID	Owner ID	Status	Well Depth(ft)	Aquifer
12864	WELL #1	ACTIVE	250	

Results:

GROUND WATER:
A search of the data sources indicated no potential sources of contamination.

Last updated: November 20, 2013

Florida Department of Environmental Protection

FL Crushed Stone Camp Mine Quarry 2008

Source: http://www.dep.state.fl.us/swapp/DisplayPWS.asp?pws_id=6277026&odate=01-OCT-08

Source Water Assessment & Protection Program

Results for: 2008

FL CRUSHED STONE CAMP MINE QUARRY
CAMP MINE ROAD
BROOKSVILLE, FL 34601

Public Water System ID: 6277026

Previously Known As:
FL CRUSHED STONE GREGG MINE
CEMEX BROOKSVILLE QUARRY

County: HERNANDO
DEP Regulatory Office: DEP Southwest District
13051 N Telecom Parkway
Temple Terrace, FL 33637
813-632-7600
Public Water System Type : NONTRANSIENT NONCOMMUNITY
Public Water System Source : GROUND
Primary Use: INDUSTRY/MINING
Population Served: 125
Size of Assessment Area:
GROUND: For this system, a 500-foot radius circle around each well was used to define the assessment area.

Number of Wells: 1

Well ID	Owner ID	Status	Well Depth(ft)	Aquifer
12864	WELL #1	ACTIVE	250	FLORIDAN

Results:

GROUND WATER:
A search of the data sources indicated no potential sources of contamination.

Last updated: November 20, 2013

Florida Department of Environmental Protection

Rinker Fec Quarry Employees 2004

Source: http://www.dep.state.fl.us/swapp/DisplayPWS.asp?pws_id=4134527&odate=01-OCT-04

Source Water Assessment & Protection Program

Results for: 2004

RINKER FEC QUARRY EMPLOYEES
12150 NW 136 ST
MIAMI, FL 33178

Public Water System ID: 4134527

Previously Known As:
RINKER EMPLOYEES
CEMEX EMPLOYEES

County: MIAMI-DADE
DEP Regulatory Office: Dade County Health Dept.
1725 NW 167th St. Suite 119
Opa-Locka, FL 33056
305-623-3551
Public Water System Type : NONCOMMUNITY
Public Water System Source : GROUND
Primary Use: INDUSTRY/MINING
Population Served: 150
Size of Assessment Area:
GROUND: For this system, a 500-foot radius circle around each well was used to define the assessment area.

Number of Wells: 1

Well ID	Owner ID	Status	Well Depth(ft)	Aquifer
21034		ACTIVE	Not Available	BISCAYNE

Results:

GROUND WATER:
A search of the data sources indicated no potential sources of contamination.

Last updated: November 20, 2013