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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

June 10, 2014

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

Attention: Mr. David Hopkins, P.Geo.
Sr. Hydrogeologist

Dear Mr. Hopkins:

Re: Letter - Response to Burnside Review of Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site (Burnside Response April 8, 2014)
Harden Response to Burnside Review of Hydrogeological Summary Report (Burnside Response April 9, 2014)
Hidden Quarry Site for Township of Guelph/Eramosa
Burnside File No.: 300032475.0000

Thank you for your comments on our two January 14, 2014 submissions. We have combined the outstanding concerns from both Burnside and Associates letters into this response. Copies of these letters are provided in Appendix A. It is our intention to provide sufficient technical analysis in this letter to satisfy the outstanding concerns raised by Burnside and Associates. Burnside and Associates states that they are primarily concerned with the following;

1) Water levels in the upgradient domestic wells

2) Water quality in the downgradient domestic wells

3) Rockwood Well No. 4

In summary, with respect to the three main items of concern we restate the following.

The largest magnitude of water level change in the nearest domestic well is approximately 1.6 metres. It is our professional opinion, based on our knowledge that the dolostone aquifer has a relatively high transmissivity, that a water level change of 1.6 metres will not adversely affect the availability of water to any domestic well. A rigorous on-site monitoring program will be instituted to confirm this opinion. James Dick Construction Ltd. (JDCL) has also agreed to conduct a voluntary private well survey commencing well in advance of any below-water-table extraction. The combination of these two programs will allow the early detection of possible changes in the potentiometric elevation on the site and in neighbouring wells.

The water quality in downgradient domestic wells will be discussed at length in this submission. There are five domestic wells downgradient of the quarry that obtain water from the dolostone aquifer and that also may pass through the quarry. Based on monitoring at existing proxy quarry sites it is our opinion that this quarry will not impact on any chemical parameter that will affect the potability of water in the area. A monitoring program will be implemented that will ensure this is the case. Modifications have been made to the quarry design such that there will remain a substantial thickness of undisturbed rock beneath the quarry. Wells downgradient from the quarry will have access to water resources that flow in the undisturbed fracture sets beneath the quarry. Pro-active modifications or retrofitting of these down gradient wells such that they are only taking water from the deeper fracture sets will be undertaken at the request of the landowner. Out of an abundance of caution we have also recommended that at-source domestic UV treatment systems be installed at the downgradient wells. UV systems should be in place in this fractured bedrock environment area in any event even without a quarry. All modifications will be done at no cost to the landowners. With these measures in place it is our opinion that there will remain access to abundant high quality domestic water supplies at all receptors.

We are in agreement with Burnside that the quarry will not affect the GUDI status of Well No. 4 and JDCL has agreed to make the multi-level monitoring well M15 available for monitoring during the pumping test of Well No. 4.

In regards to the remaining comments, we have categorized the concerns into eight areas of interest. These are;

1) Karst
2) Groundwater Parameter – Hydraulic Connectivity – M15 Intervals
3) Nitrate Balance
4) Deeper Water Sources and Water Quality
5) Local Well Survey

6) Quarry Depth Limitation
7) Brydson Spring and Blue Springs Creek
8) Sinking Cut – Monitoring and Historical Low Water Level

1.0 Karst

Water losses in Tributary B are consistent with a "losing stream", a stream that loses water to either unsaturated sediments underlying the stream or the local groundwater regime due to the difference in hydraulic potential between the stream water level and underlying groundwater levels and are not consistent with characteristics of a stream that loses water to karstic bedrock.

The following observations are made from data collected on-site;

a) Tributary B is a losing stream across the length of the Hidden Quarry site,

b) Tributary B is not in direct contact with the underlying bedrock anywhere on the site,

c) Tributary B is physically separated from the underlying bedrock by several metres of permeable unconsolidated sediments. Jim Baxter of Burnside and Associates was present for the drilling of M15 (within 30 metres of Tributary B) where there are approximately ten metres of unconsolidated sediments comprising mainly coarse aggregate.

d) The water table is found to be several metres below the Tributary B stream bed.

Given these facts, the loss of streamflow is entirely due to the hydraulic potential of water in Tributary B being greater than that of the underlying unsaturated glacial outwash sediments. The loss of streamflow is in no way related to the underlying bedrock geology or structure.

Streamflow measurements have been obtained regularly since 2005. As shown on Figure 1, Tributary B only loses all of its water (no flow at SW3) when the incoming flow at SW4 is less than approximately 20 L/s. With flows of greater than 20 L/s, flow is found in all on-site reaches of Tributary B. Table 1 summarizes observations of flow conditions where streamflow has been observed to cease within different reaches of Tributary B. The surface water station locations are shown on Figure 2. Our observations are that the stream will cease to flow in various reaches within the proposed quarry boundaries depending on the incoming flow at SW4. This gradual loss of water supports the geological and hydrogeological observations of the creek being underlain by unsaturated unconsolidated sediments.

Table 1: Qualitative Observations of Flow in Tributary B

Monitoring Station	28-Jun-05	13-Jul-05	18-Jul-07	18-Aug-08	08-Sep-08	30-Oct-08	26-Jul-11	05-Oct-11
Streamflow at SW4 (L/s)	4.40	1.70	1.82	14.27	18.35	2.85	8.92	1.04
SW4	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow
SW5	Flow	Dry	Dry	Flow	Flow	Dry	Flow	Flow
SW7	Dry	Dry	Dry	Flow	Flow	Dry	Flow	Dry
SW3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Our conclusion is that it is unnecessary to instrument Tributary B with more continuous water level devices than already agreed upon. It has already been agreed upon to instrument two locations of the stream with continuous water level recording devices at SW4 and SW8.

Examination of the groundwater contours at the site, do not reveal large areas of the property with equal hydraulic potential. To the contrary, there is a gradual sloping water table across the property indicating hydraulic resistance to water movement. Therefore there is no indication of large contiguous karst features underlying the site. Furthermore, given the fact that this site will not be dewatered, karst geology is not an operational, water supply or safety issue at this site.

Further to this we find that a detailed study of the Blue Springs Creek watershed by Coward and Barouch[1] stated that *"…the karst in Blue Springs Creek is not well developed and that the flow in the dolomite must be taking place through joints and bedding planes. The groundwater flow pattern, therefore, has not been significantly affected by karst development."*

2.0 Groundwater Parameter – Hydraulic Connectivity

M15 was reconstructed as a multi-level monitoring station on May 1st and 2nd, 2014. There are four monitoring intervals as summarized in Table 2. 25 mm screen and riser

[1] J.M.H. Coward and M Barouch, 1978, Hydrogeology and Groundwater Model of the Blue Springs Creek IHD Representative Drainage Basin

was used for the installation. No bridging of sand or bentonite seal was detected during the installation.

Table 2: M15 Monitoring Intervals

Monitoring Interval	Material	Depth From (mbct)	Depth To (mbct)
	Seal	9.03	10.00
M15-IV	Sand Pack	10.00	20.57
	Seal	20.57	24.33
M15-III	Sand Pack	24.33	30.51
	Seal	30.51	34.02
M15-II	Sand Pack	34.02	38.51
	Seal	38.51	40.82
M15-I	Sand Pack	40.82	44.72
	Seal	44.72	47.57
	Sand Pack	47.57	55.00

As shown on Figure 3, the test intervals were designed to isolate major fractures and water producing sections of the aquifer identified in the video log and flow test.

2.1 Groundwater Elevations Multi-Level M15

The water levels obtained from the monitoring intervals are summarized in Table 3.

Table 3: Water Levels Multi-Level M15

Monitoring Interval	May 1, 2014 1613h (mbct)	May 2, 2014 1245h (mbct)	May 5, 2014 1000h (mbct)	May 6, 2014 1100 h (mbct)
M15-IV		8.77	8.66	8.71
M15-III	8.81	8.78	8.68	8.70
M15-II	9.00	9.08	8.98	9.00
M15-I	8.94	8.94	8.89	8.90

The water levels are found within a narrow range (30 centimeters). The lowest water level is observed in M15-II which has an interval across a known fracture. The highest water levels occur in the upper two intervals. This suggests a downward gradient between intervals M15-II and M15-III and an upward gradient between M15-I and M15-II. The water movement in the well is therefore both upward and downward towards the fracture set located at approximately thirty-six metres below ground surface.

This vertical profile gives no suggestion of a significant connection to lower hydraulic potential areas such as Brydson Spring or higher potential areas upgradient of the site.

This data shows that significant water level changes will not occur as a result of making vertical hydraulic connections within the quarry.

2.2 Hydraulic Testing in Multi-Level M15

The hydraulic testing of M15 was conducted on May 6, 2014. The testing was conducted both by adding a slug of water to the test interval (falling head test) and recording the response and by removing a physical slug from the test interval (rising head test) and recording the response. Graphs showing the response to this testing are found in Appendix B.

The analysis of the data was conducted in several ways. The methods used in the analysis are;

Method (1) Traditional Hvorslev (1951) analysis as presented in Freeze and Cherry (1979)

Method (2) High K Hvorslev (1951) as presented by Butler (2000)

Method (3) High K Bouwer and Rice (1976) as presented by Butler (2000)

Method (4) Hvorslev with Shape Factor Applicable to Test Intervals (Muldoon and Bradbury, 2005)

The intent of using multiple methods is not to evaluate each method but to show that using various methods results in similar estimates of hydraulic conductivity.

The hydraulic conductivity obtained from each of these methods represents the hydraulic conductivity of the test section and not individual fractures. These methods likely underestimate the hydraulic conductivity of individual fractures. However, the fractures are part of a larger fracture network that can be considered a continuum allowing a bulk hydraulic conductivity to be used in impact analysis.

The results of hydraulic testing are summarized in Table 4.

Table 4: Results of Hydraulic Conductivity Testing

Test Interval	Method 1	Method 2	Method 3	Method 4	Geometric Mean
M15-IV	2.2×10^{-5}	7.1×10^{-5}	5.3×10^{-5}	2.0×10^{-5}	3.6×10^{-5}
M15-III	3.4×10^{-5}			3.1×10^{-5}	3.3×10^{-5}
M15-II	1.0×10^{-4}	8.9×10^{-5}	8.1×10^{-5}	9.3×10^{-5}	9.1×10^{-5}
M15-I	6.7×10^{-5}	1.1×10^{-4}	9.9×10^{-5}	6.2×10^{-5}	8.2×10^{-5}

All results in m/s

The greater value hydraulic conductivity intervals M15-I and M15-II correspond with the greater flow velocities as observed in the flow test as shown on Figure 3. Approximately 75% of the flow to the well comes from the aquifer represented by test intervals M15-I and M15-II, both of which are below the proposed level of the quarry. This means that a significant proportion of the flow in the aquifer will not interact directly with the quarry water. In the unlikely event that the lake water from the quarry affects shallow aquifer water quality, there is a significant portion of the aquifer that can be accessed by downgradient wells. Burnside and Associates has made the recommendation that the quarry be limited to elevations above 327 m AMSL for this reason.

It is our opinion that these findings do not significantly affect the results of the groundwater-model-predicted-impacts to nearby upgradient wells. To test this opinion, we used the law of superposition and the modified Theis equilibrium equation to estimate the drawdown at nearby upgradient wells using a wide range of aquifer transmissivity. The northern edge of the quarry can be represented by a series of pumping wells. We have used a set of 20 wells, distributed as shown on Figure 4. Each well is designed to have a drawdown of 2.54 metres, thus representing the maximum drawdown allowed along the northern edge of the quarry. The drawdown occurring in the nearest private well W3 is then a summation of the drawdown attributed to each individual pumping well. We calculated the drawdown at private well W3 from transmissivity values ranging from 75 to 302,000 m^2/day. The drawdown at W3 is shown on Figure 5 to range from 1.8 metres to 2.2 metres[2]. Therefore, even at extremely high transmissivity, the impact to the nearest well is not great and in our opinion, will not affect the functioning of any private well. The curvature of the graph line in Figure 5 also shows that there is a maximum potential impact at extremely high transmissivity, being somewhat less than the maximum expected drawdown of 2.54 metres.

2.3 Combined Impact of Future Rockwood Well No. 4 and Hidden Quarry

Hydrogeologic work presented by both Gartner Lee and AquaResources in their modelling of the capture zones of future Well No. 4 show that the primary source area for this new well will be north and east of the well. This is north of the Hidden Quarry and thus the source area for Well No. 4 does not include Hidden Quarry. The most significant changes in aquifer water levels due to pumping from Well No. 4 will thus occur northeast of the well. This hydrogeologic interpretation is consistent with studies conducted at the Hidden quarry site.

The quarry will also become a large reservoir of water and therefore become a positive boundary condition for the expanding cone of influence of the well and for local wells.

[2] This method is highly conservative as it does not account for recharge of the aquifer and therefore values presented in this report are greater than those of the groundwater model. This method is also conservative in that the estimated drawdown of 2.54 metres will only occur in a small central portion of the site and less drawdown occurring elsewhere.

This will result in a lessening of the impact of the Well No. 4 on aquifer water levels local to the quarry. According to our conversation with Mr. Jaroszewski, the mushroom farmer who takes water from well W3, there are some tens of metres of drawdown in his production well used to cool his farm building. This drawdown level is below the water level in the Hidden Quarry pond and therefore, the proposed Hidden Quarry pond becomes a significant potential source of water for well W3, thereby lessening the impact of well W3 on neighbouring wells.

2.4 Water Quality Testing in Multi-Level M15

Water quality samples were obtained from each of the test intervals. A minimum of six well volumes was removed from each of the test intervals prior to water quality samples being obtained. No external water was used in the construction of the well. The samples were analyzed by Maxxam Analytical Laboratories in Mississauga.

The test results are found in Appendix C. Graphs of TKN, DOC, nitrate, strontium and sulphate are shown on Figures 6 and 7. The strontium concentration increases with depth, a confirmation that sufficient water was removed from the test sections for water samples to be representative of the aquifer water at the interval depths sampled. Typical of the lower Gasport Formation, the strontium value is elevated in the lower elevations.

The highest TKN, DOC and nitrate concentrations occur in test interval M15-III. This indicates that this intermediate depth fracture set interacts with shallow fracture sets resulting in the movement of chemicals lower within the aquifer. The lower fracture sets represented by intervals M15-II and M15-I have lower nitrate, DOC and TKN concentrations than the M15-III interval. The sharp contrast in chemical concentrations with the lower fracture sets indicates some degree of isolation between the fracture sets, whereas the mere presence of these chemicals in the lower aquifer suggests interconnectivity between the lower and upper fracture sets.

The likely source of TKN and nitrate is anthropogenic activity. Water samples in groundwater obtained from the northern edge of the quarry contained nitrate in the range of 0.9 to 5.6 mg/L (November 2013) and in Tributary B was 4.64 mg/L upstream and 4.53 mg/L downstream. Thus the nitrate originating from upgradient sources is found to penetrate to all water producing levels of the aquifer.

The availability of DOC throughout the aquifer also provides opportunity for denitrification as the organic carbon is a food source for denitrifying bacteria.

In response to the Burnside comment that oxygenated water entering the aquifer may result in changes to existing downgradient water quality, we agree. However, the effect is benign since groundwater is oxygenated to a greater degree at every household tap prior to domestic use. As well, the oxygenated effect from the quarry is not likely to exist a significant distance from the quarry given the presence of iron (II) as found in pyrite in the aquifer. As described by C.A.J. Appelo and C. Postma (1993), the oxidation of pyrite occurs as follows;

$$FeS_2 + 15/4O_2 + 7/2H_2O \rightarrow Fe(OH)_3 + 2SO_4^{2-} + 4H^+$$

In this way, three and three quarters moles of oxygen are consumed for every mole of FeS_2 in the reaction.

3.0 Nitrate Balance M15 Results and Re-Testing of Guelph Limestone Quarry

3.1 Guelph Limestone Quarry Water Quality Sampling

Four additional water samples were obtained from the Guelph Limestone quarry (formerly Dolime Quarry) in order to evaluate the water quality impact of explosive use at the site. We observed the filling of the blast holes, each with 79.5 kg of Hydromite 4400 explosives. There were 102 holes resulting in a total loading of 8109 kg of explosives. A water sample was obtained from immediately below the blast location prior to the blast. The blast took place at 1722 h on Monday April 28th and samples were obtained 12 minutes, 78 minutes and fifteen hours after the blast. The samples were analyzed for nitrate, nitrite, total kjeldahl nitrogen (TKN) and ammonia. The samples following the blast were turbid and were not filtered prior to analysis. The results are shown in Table 5 and Appendix C.

Table 5: Summary of Nitrogen Testing at Guelph Limestone Quarry

Sampling Date		2014/04/28 11:50	2014/04/28 17:34	2014/04/28 18:40	2014/04/29 08:25
	Units	**S1: Before Blast**	**S2: +12 min**	**S3: +78 min**	**S4: + 903 min**
Inorganics					
Total Ammonia-N	mg/L	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.31	0.43	0.43	0.29
Nitrite (N)	mg/L	ND	ND	ND	ND
Nitrate (N)	mg/L	0.47	0.46	0.44	0.47

ND Not detected

There is no ammonia in the water before or after the blast. There is no nitrite in the water before or after the blast. The nitrate concentration before the blast was 0.47 mg/L and was 0.46 mg/L, 0.44 mg/L and 0.47 mg/L in the subsequent samples.

The TKN concentration was 0.31 mg/L before the blast and was 0.43 mg/L, 0.43 mg/L and 0.29 mg/L in the subsequent samples. TKN is a measure of organic nitrogen + ammonia. Ammonia was not detected in the water samples, therefore the increase in TKN is a result of increased organic nitrogen, not nitrogen products generated by the blasting materials. The water was very turbid after the blast and the increased organic nitrogen from stirred up organic material in the pond. Once settled, the organic nitrogen content of the water decreased as observed after fifteen hours of the blast. The data therefore shows that the use of explosives in a sub aqueous mining operation does not affect the nitrogen levels in the water of the quarry pond. As sampled on a previous occasion in 2012 and already reported to Burnside and Associates Ltd., the quarry water following a blast event at Guelph Limestone met all chemical Ontario Drinking Water Quality standards for a comprehensive parameter list including volatile organic compounds, petroleum hydrocarbons and polyaromatic hydrocarbons.

The Dolime Quarry water has less nitrogen content than either groundwater entering the Hidden Quarry site or surface water in Tributary A and Tributary B.

3.2 Nitrogen Compounds in Groundwater and Surface Water

We have obtained sixteen groundwater and surface water samples since February 2012 and analyzed the water for nitrate, nitrite, TKN and ammonia. The results are summarized in Table 6 (following Figures).

The results show that the Guelph Limestone quarry pond water quality is generally better than either groundwater flowing into the Hidden Quarry site or surface water flowing into the Hidden Quarry site. In all circumstances, the Ontario Drinking Water Quality Standards for nitrate or nitrite are not exceeded. The Operational Guideline for Organic Nitrogen is exceeded in every water type.

3.3 Revised Nitrate Prediction

The recent testing of the Guelph Limestone Quarry and the water quality testing of multiple levels in M15 indicate that the nitrate balance presented by Harden in January 14th, 2014 should be revised by;

a) distributing the nitrogen concentration evenly throughout the aquifer,

b) allowing mixing in only the upper and middle portions of the aquifer due to change in minimum quarry elevation change to 327 m AMSL,

c) reducing the introduction of nitrogen to the quarry pond by blasting activities as indicated by the recent Guelph Limestone Quarry sampling and

d) including dilution from infiltrating precipitation as suggested by Burnside and Associates Ltd.

The revised nitrate balance of the quarry is presented in Table 7.

Table 7: Revised 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	4.38	70,323	308	
Induced Flow				
Upper	4.38	85,500	374	
Middle	4.38	85,500	374	
Total from Groundwater			1,360	
Total from Explosives			0	1,360
Dilution from Groundwater		311,646		
Dilution from Infiltration		59,100		
Final Nitrogen Concentration	3.67			

The observed reduction in nitrate across the site is already more significant than presented in Table 7, suggesting that denitrification is already occurring in the aquifer. Biological activity in the future quarry ponds will also utilize nitrogen. Therefore, nitrogen concentrations downgradient of the quarry property will continue to be less than entering the quarry property.

4.0 Deeper Water Sources and Water Quality

James Dick Construction Ltd. has agreed to limit the depth of the quarry to an elevation of 327 m AMSL. The drilling of M15 has confirmed that significant water bearing fractures occur beneath the depth of the proposed quarry and the Rockwood Well No. 3 obtains water from fractures below this elevation.

4.1 Current State of Local Water Supplies and Vulnerability of the Aquifer

Water quality sampling on April 8th, 2014 of Tributaries B and C found that the surface water contained 40 and 10 Colony Forming Units (CFU) per 100 mL of surface water respectfully with respect to escherichia coli (*E. coli).* Tributary B had a flow exceeding 100 L/s and we estimate that 24 L of this water infiltrated within the Hidden Quarry property every second. This results in an estimated loading of 829,440,000 CFU per day of *E. coli* infiltrating beneath Tributary B. Therefore, a significant contaminant loading is already being introduced to the groundwater system. The drinking water standard for Ontario is 0 *E. coli*.

Water quality testing was also conducted on April 16th, 2014 of Tributary B and Tributary A. The samples were all analyzed for *E. coli* and for the presence of *E. coli* 0157:H7. The results of this testing are summarized in Table 8. It is found that none of the surface waters tested positive for *E. coli* 0157:H7. Tributary B and Tributary A contained 10 CFU/100 ml and 4 CFU/100ml respectively of *E. coli*. Certificates of Analysis are provided in Appendix C.

Table 8: Summary of Bacteriological Testing

Date	April 8 2014		April 16, 2014			
Location	Total Coliform (CFU/100 ml)	*E. coli* (CFU/100 ml)	Total Coliform (CFU/100 ml)	*E. coli* (CFU/100 ml)	Giardia	Crypto-Sporidium
Tributary A			1000	4		
Tributary B Upstream (SW4)	70	40	300	10		
Tributary B Downgradient (SW8)	120	20				
Tributary C	210	10				
Guelph Limestone Quarry			60	0	Negative	Negative

The bacteriological testing confirms that local streams are carrying bacteria including *E. coli*. These streams are contributing water to the local aquifer upgradient, cross-gradient and downgradient of the proposed Hidden Quarry. The samples obtained from the Guelph Limestone Quarry did not contain *E. coli*, giardia or cryptosporidium.

The source of the *E. coli* in local streams is likely farming activities such as cattle yards and manure spreading. The off-site watersheds of Tributary B (511,366 m^2) and Tributary C (1,924,590 m^2) are shown on Figure 8. These watersheds include surface water and groundwater contaminating activities such as cattle yards, cash crops, horse training facilities, manure storage and septic systems. Sampling at the Hidden Quarry site has already proven that shallow groundwater is impacted by nitrate from upgradient farming practices. Although the Hidden Quarry will be closer to the five downgradient wells than the farm fields, cattle yard and horse facilities, Tributaries A, B and C deliver contaminants to the lands just north of Hwy 7 where these contaminants infiltrate and enter the bedrock aquifer underlying the sand and gravel.

Quarrying is not considered a "threat" under source water protection. The potential for degradation of groundwater from quarry activities or the rehabilitated quarry is limited to biological factors emanating from the natural environment associated with the quarry, ie waste products from waterfowl or decomposing vegetation. Water quality monitoring from proxy sites demonstrates that the water quality in quarries is generally far better than that found in the tributaries A, B and C at the Hidden Quarry site. Thus, the potential for contamination of groundwater from quarry activities or the rehabilitated quarry is less than the potential for contamination from livestock farming or the application of manure to farm fields. In terms of stored volume of water, the dilution potential of the west quarry pond containing approximately some 2,400,000 m^3 of water is at least 20 times greater than the dilution potential of the existing bedrock aquifer.

It remains our opinion as stated in the January submission, that the Hidden Quarry will not be a major source of potential bacteriological contamination in this area.

4.2 Recent Research and Susceptibility of Local Wells to Contamination

Research conducted by A. Best at the University of Guelph in 2012 shows the vulnerability of the dolostone aquifer in nearby Arkell where one application of manure results in significant bacteriological contamination of the underlying bedrock aquifer. The bedrock aquifer at the Arkell research site is overlain by more than 12 metres of glacial sediments. This suggests that the aquifer downgradient of Tributary A, B, or C where glacial sediments are known to be less than ten metres thick are already susceptible to contamination originating from surface water infiltration.

Other recent research is telling us that bedrock wells are already vulnerable with 92% of wells tested by Amy Allen (M.Sc. Thesis, 2013) in Southern Wellington County having some indication of sewage derived contamination. Her conclusion as repeated below is astounding;

"all well types completed in the fractured bedrock aquifers of southern Wellington County are susceptible to contamination with at least one type of organic wastewater contaminant regardless of the well's construction, depth, surrounding land use, or overburden thickness. The wide array of wells sampled in this investigation revealed that areas served by sewers and septic systems are both vulnerable to human waste streams. As 95% of the wells exhibited wastewater contaminants, fractured bedrock seems to be more vulnerable to these contaminants than previous American (Barnes et al., 2008) and pan-European (Loos et al., 2010) studies would suggest."

Groundwater contamination from human activities is already occurring in this area. Measured existing nitrate levels in groundwater from agricultural activities in the area are already elevated. While not considered in the analysis for purposes of conservatism, it is likely that sunlight, biological activity within the quarry pond and the dilution potential of the quarry will result in improved water quality in the aquifer.

4.3 Waterfowl Use of Hidden Quarry Pond

The use of the East and West Pond by waterfowl will be limited by characteristics of the pond such as deep water, rocky shoreline and dense shoreline vegetation as discussed by GWS Ecological and Forestry Services (Appendix D).

Waterfowl were observed in the Guelph Limestone Pond at the time of the water quality sampling for *E. Coli*, cryptosporidium an giardia. None of these bacteria were detected in the water.

It is our conclusion that the natural introduction of nutrients and bacteria by waterfowl and wild mammals will not occur on a significant level.

4.4 Water Quality Early Warning and Mitigation

Quarry activities will commence in the northernmost extent of the site and west of Tributary B. As shown on Figure 9, groundwater monitor M3 and M16 will initially be downgradient of the sinking cut and ultimately M15 and M4 will be downgradient of the quarry pond. It will take approximately four years at maximum extraction levels to extend the quarry from the sinking cut near M3 to the western extent near M1. The proposed semi-annual water quality monitoring at M3, M16 and M15 will be able to detect water quality changes well in advance of water moving off-site. As shown on Figure 9, even after the end of four years (Phase 1 of the quarry), the only private wells downgradient of the quarry will be W10 and W16. Ultimately M4 will also be downgradient of the quarry pond(s). Through this monitoring effort, water quality changes in the aquifer will be observed and mitigative measures taken if necessary.

The drilling and testing of M16 will not occur until the quarry license has been approved. There will be several years of activity on the west side of Tributary B before the quarry on the east side of Tributary B is commenced. This will give ample time for baseline conditions (quality and quantity) to be established. Even after Phase 2 has been completed, the only potential downgradient wells of the open quarry ponds are W10 and W16.

Water well surveys of the five wells immediately downgradient of the site have been undertaken at various times since 1995. Table 9 summarizes the water well survey efforts made by Harden Environmental since 1995. The surveys confirm that none of the wells immediately downgradient meet current Ontario Regulation 903 standards. Two of the wells are buried (i.e. covered with soil), two are located in deep well pits and one has been damaged by landscaping equipment. In addition, at least one of the wells is located downgradient of their own septic system. These wells do not need to be accessed for water quality assessment (water will be taken from plumbing fixtures), therefore, upgrades to downgradient wells are not necessary (water levels are expected to rise, therefore regular water level monitoring is not necessary).

Baseline water quality and quantity assessments of these wells (W10, W16, W17, W18 and W19) will be undertaken as part of the overall private well survey. Pro-active modifications or retrofitting of these down gradient wells such that they are only taking water from the deeper fracture sets will be undertaken at the request of the landowner. Out of an abundance of caution we have also recommended that at-source domestic UV treatment systems be installed at the downgradient wells. UV systems should be in place in this fractured bedrock environment area in any event even without a quarry. All modifications will be done at no cost to the landowners. With these measures in place it is our opinion that there will remain access to abundant high quality domestic water supplies at all receptors.

Section 3.2 of the Monitoring Program addresses water quality monitoring and contingency measures for private wells.

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5.0 Local Well Survey

James Dick Construction Ltd. has agreed to undertake a voluntary detailed well inventory and water quality assessment of wells within 500 m of the quarry. This will be conducted to establish baseline water quality and quantity conditions. Harden Environmental has already undertaken three such studies as summarized in Table 9 and Figure 10. Since

1995 we have surveyed forty local residents and have on at least one occasion, visited every residence within 500 metres of the quarry.

James Dick Construction Ltd. has agreed to upgrade wells, those in pits or buried, to facilitate water level monitoring of upgradient wells, if agreed to by the home owner. Based on previous surveys, this will include wells W5, W8 and possibly W7. Downgradient wells and those distant from the quarry are not expected to experience any significant water level change, or have a higher water level, and thus regular water level monitoring is not needed and water quality can be obtained from the existing plumbing system.

Residents at locations W25 to W30 and W36 to W40 will be asked if they are willing to participate in the voluntary baseline monitoring program. These wells are beyond the 500 metre distance and unlikely to be impacted by the quarry. However, a one-time baseline survey will be conducted.

There will be a minimum period of two years after the quarry is given approval before below-water-table extraction can conmmence. This provides ample opportunity to obtain seasonal water quality data as recommended by Burnside and Associates.

6.0 Quarry Depth Limitation

James Dick Construction Ltd. has agreed to limit the depth of the quarry to a minimum elevation of 327 m AMSL.

7.0 Brydson Spring and Blue Springs Creek

We disagree that the quarry will decrease the flow in Brydson Spring. The hydraulic potential at the southern edge of the quarry will increase, thereby increasing the hydraulic gradient between the quarry and the spring. In addition, the volume of water stored in the quarry will moderate seasonal water level change, thereby providing a more stable source of water during drier conditions. It is likely that the infiltrating waters of Tributary B and C contribute significantly to the Brydson Spring discharge. Since flow in Tributary B and C will not be affected by the quarry operation, no change in the outflow from Brydson Spring will occur.

James Dick construction has agreed, providing that permission is given by the owner, to conduct flow and water quality testing of the spring to establish baseline conditions.

8.0 Rock Extraction Water Level Change Monitoring

JDCL has agreed to limit the depth of the quarry and thus the sinking cut will now extend from the top of the bedrock to a minimum elevation of 327 m AMSL. The elevation of the water table in the sinking cut is approximately 350 m AMSL, thus there will be approximately twenty-three metres of standing water in the sinking cut. James Dick Construction Ltd. is agreeing to a maximum drawdown of 2.54 metres in the sinking cut and will modify the extraction rate to ensure that this water level drawdown is not exceeded.

The nearest groundwater monitor to the sinking cut is M3. The hydrograph of M3 is found attached as Figure 11. The low water level in M3 is 349.37 m AMSL. We propose to use this as the reference elevation resulting in a minimum allowable water elevation in the sinking cut of 349.37 – 2.54 = 346.83 m AMSL. JDCL proposes to hang a buoy from a tether with the buoy floating in the water until the water level falls below an elevation of 346.83 m AMSL. The buoy will be a visual indicator of the minimum allowable water level to the operator. Once the extraction face has been established, a level logger will be used to verify that water levels in the sinking cut do not fall below 346.83 m AMSL.

There will only be two sinking cuts necessary for this quarry, one each on the east and west sides of Tributary B. James Dick Construction Ltd. is agreeing to a maximum water level change of 2.54 m in each sinking cut.

As suggested by Burnside and Associates, the frequency of automatic water level measurements during the first three months of bedrock extraction will be increased to five minute intervals. A revised monitoring program with this change is attached as Appendix E.

As suggested by Burnside and Associates, a dedicated monitoring well completed as an open hole to 327 m AMSL will be installed within the quarry limits. This well will be installed as M17 at the location shown on Figure 2. M17 will be installed upon approval of the quarry. This monitor has been added to the monitoring program.

8.1 Historic Low Water Level

There is a seasonal water level variability observed in groundwater monitors at the Hidden Quarry site. A similar magnitude of natural variability is expected to occur in private wells. It is expected that there will be a maximum water level change at the quarry edge of 2.45 metres and 1.6 metres at the nearest private well. This quarry induced change is in addition to the natural variation in water levels. Therefore, we are stating that when water levels are at their natural low (as obtained from historic water level data), an additional 1.6 metres of water level change is anticipated at the nearest well. James Dick Construction Ltd. has agreed to conduct a voluntary detailed private well survey to determine if any wells could be impacted by the predicted change in water level and either modify the well or decrease allowable drawdown in the quarry as necessary. It is anticipated that there may be small water level changes in wells W3, W4, W5, W7, W8 and W9, however, these small changes will not have any impact on the ability of these wells to supply the farm and domestic uses currently in place. With the permission of the land owner, James Dick has agreed to monitor these wells to establish baseline conditions prior to quarrying as outlined in Section 5 of this letter.

The details of how drawdown monitoring in the monitoring network is presented along with trigger levels in the proposed monitoring program (Appendix E). These trigger values are based on the lowest historical water level plus the anticipated water level change.

8.2 Monitoring Plan Revisions

The following revisions have been made to the monitoring plan. The revised monitoring plan is found in Appendix E.

1) At the request of the GRCA we have increased flow measurements at SW4, SW8 and SW3 to monthly.

2) At the request of the GRCA we have increased the automated frequency of water level measurements at SW4, SW8 and SW6 to four hours.

3) At the request of the GRCA we have included the Northwest Wetland in regular surface water quality monitoring.

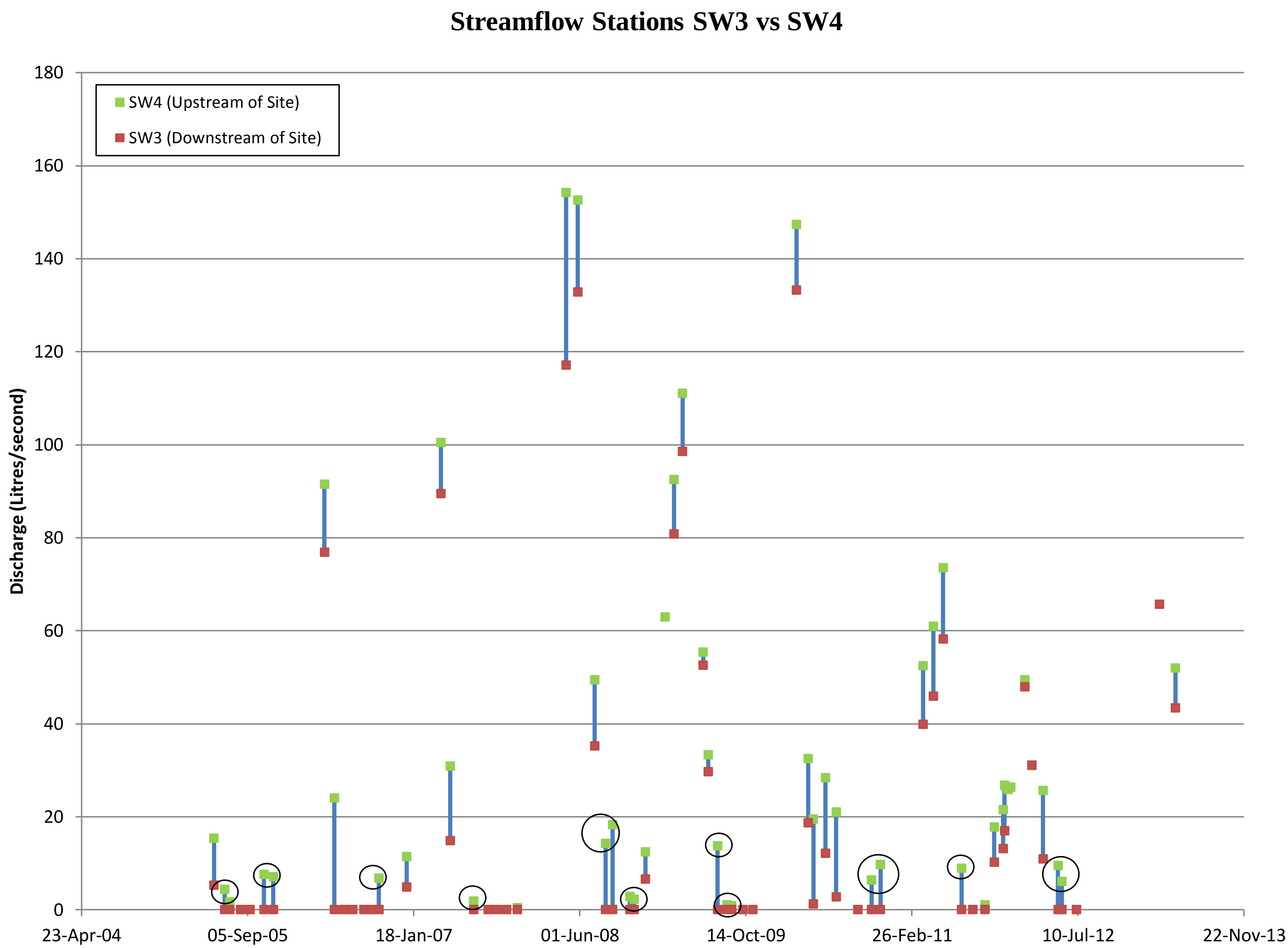
4) The proposed sinking cut water level monitoring locations have been added to Figure C1.

5) The location of M17 has been added to Figure C1 and M17 has been added to the groundwater level monitoring program with a continuous water level recording device.

Respectfully submitted,
Harden Environmental Services Ltd.

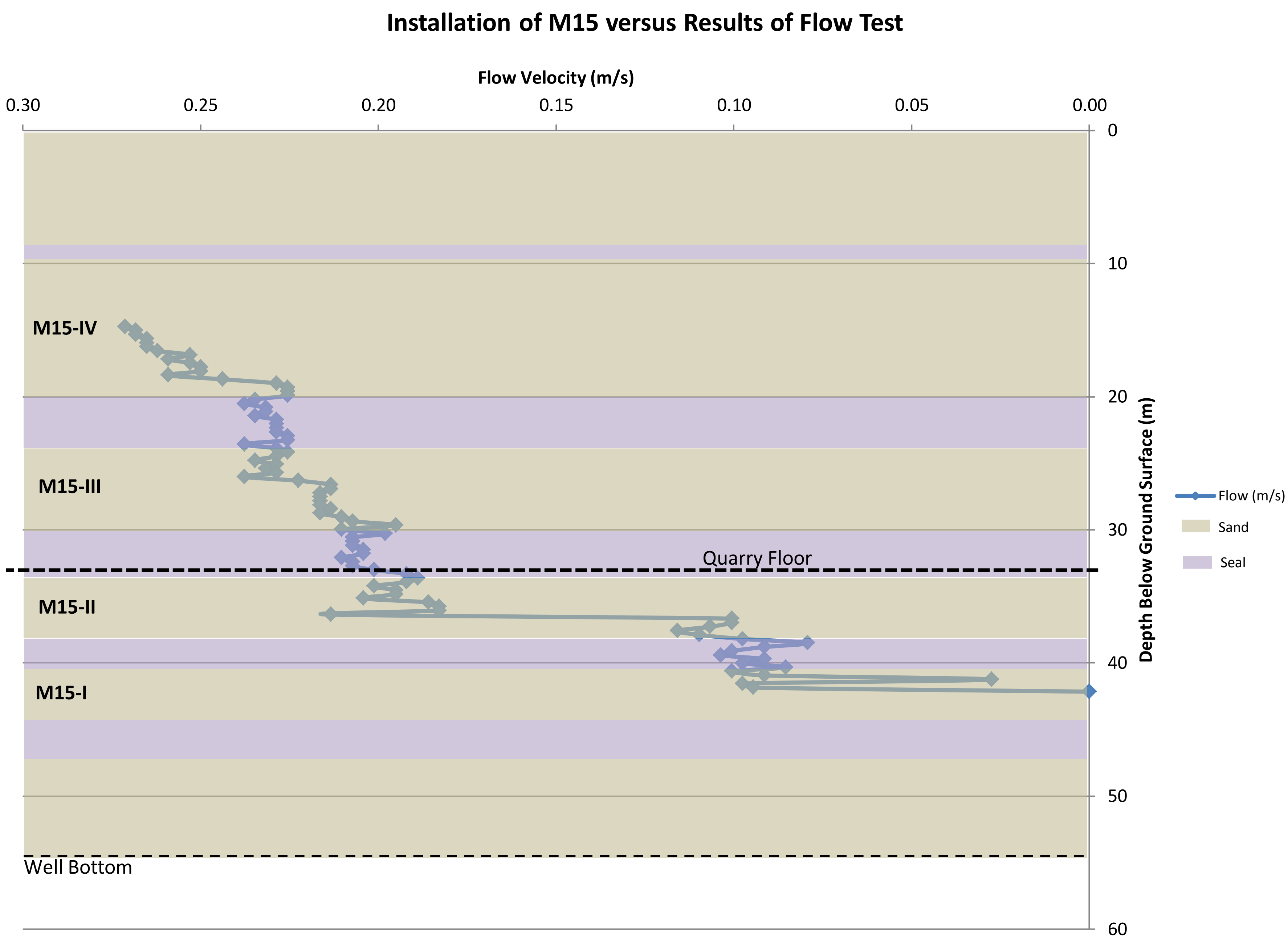
Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

cc: Greg Sweetnam, James Dick Construction Limited



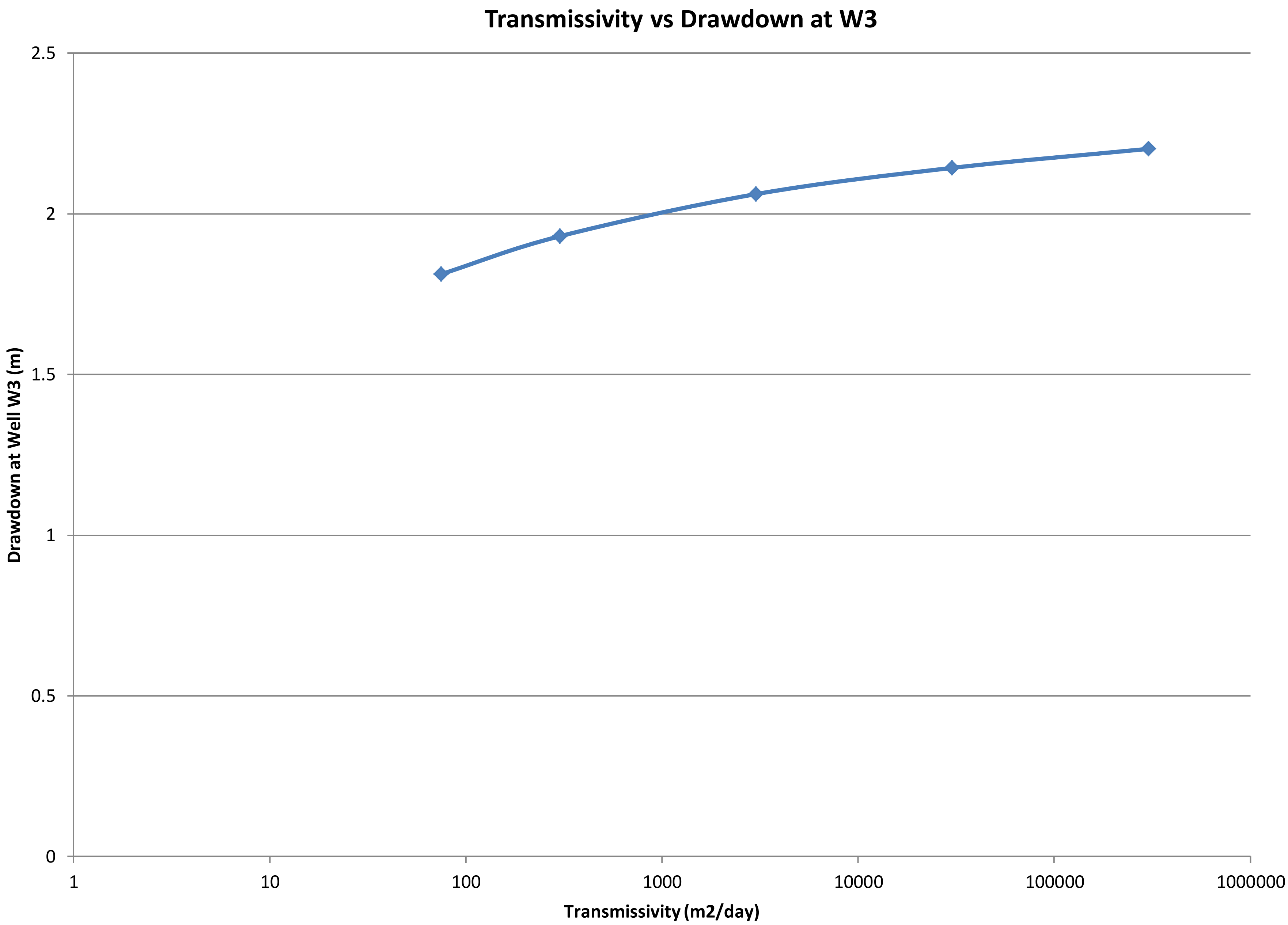
Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Apr 2014 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure 1: Streamflow Stations SW3 vs SW4**

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 2:**
	Date: Apr 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Monitoring Locations**
	Drawn By: AR		



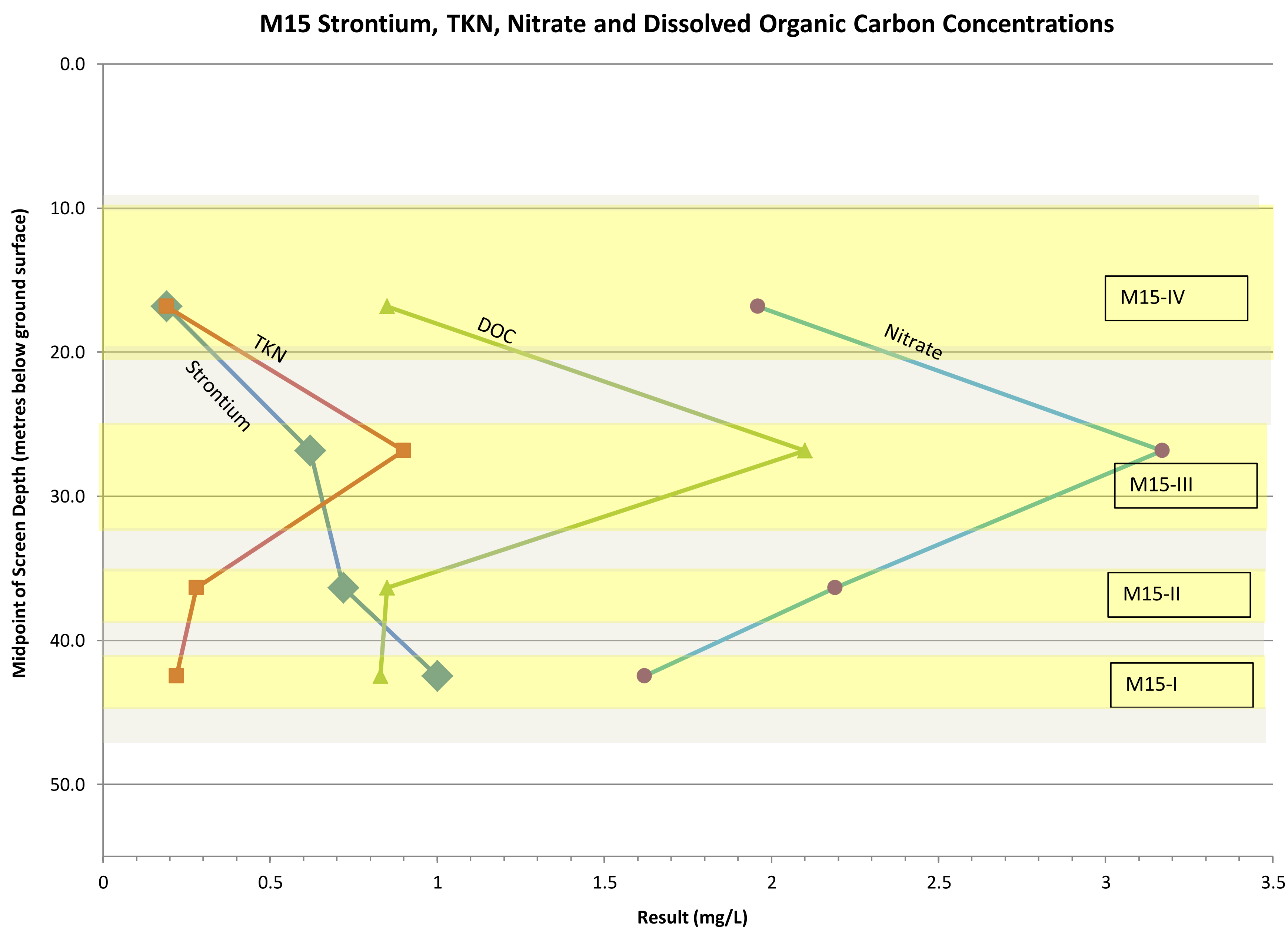
Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 3: Installation of M15 versus Results of Flow Test**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 4: Dewatering Wells**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

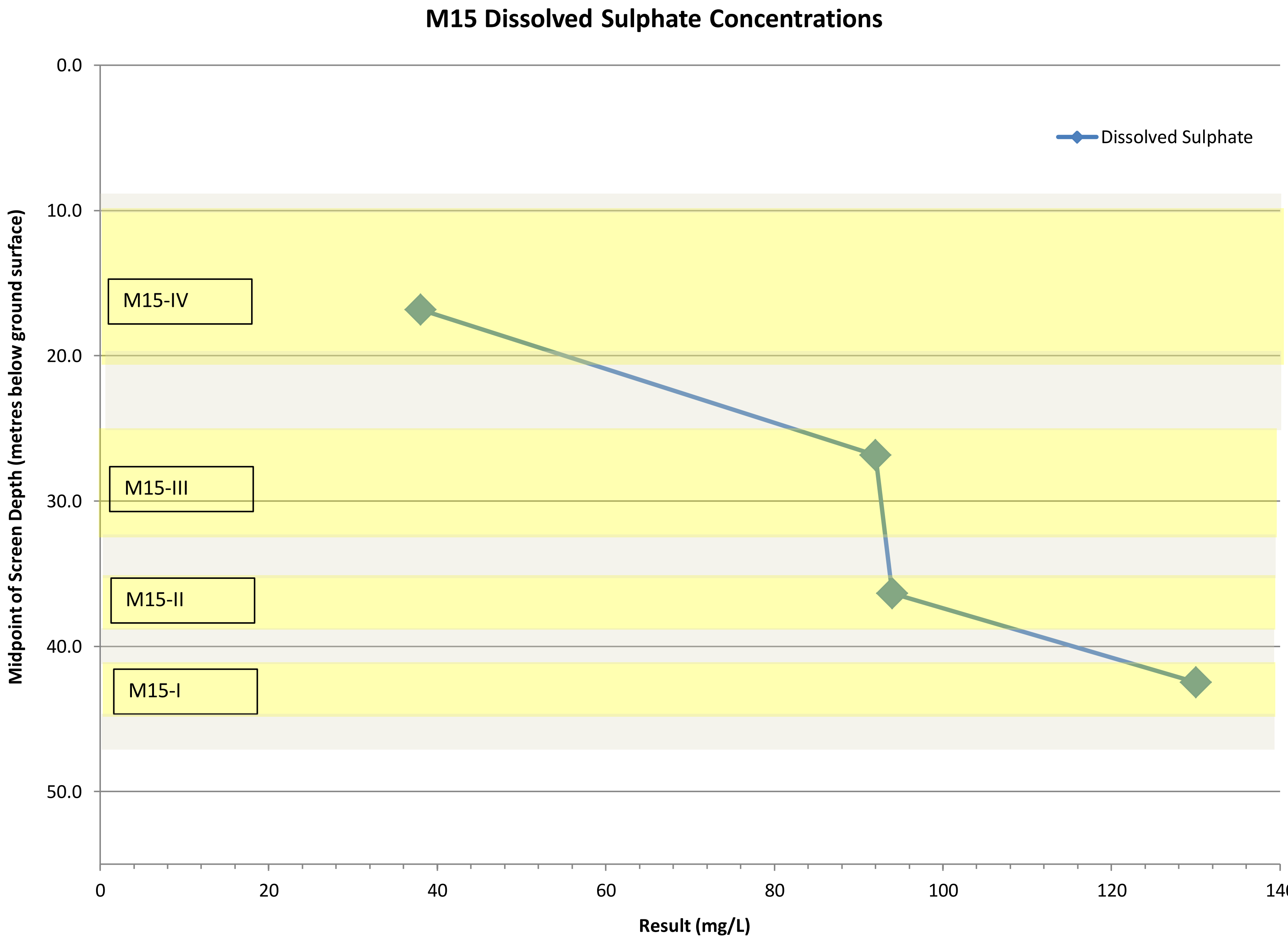


Harden Environmental Services Ltd.

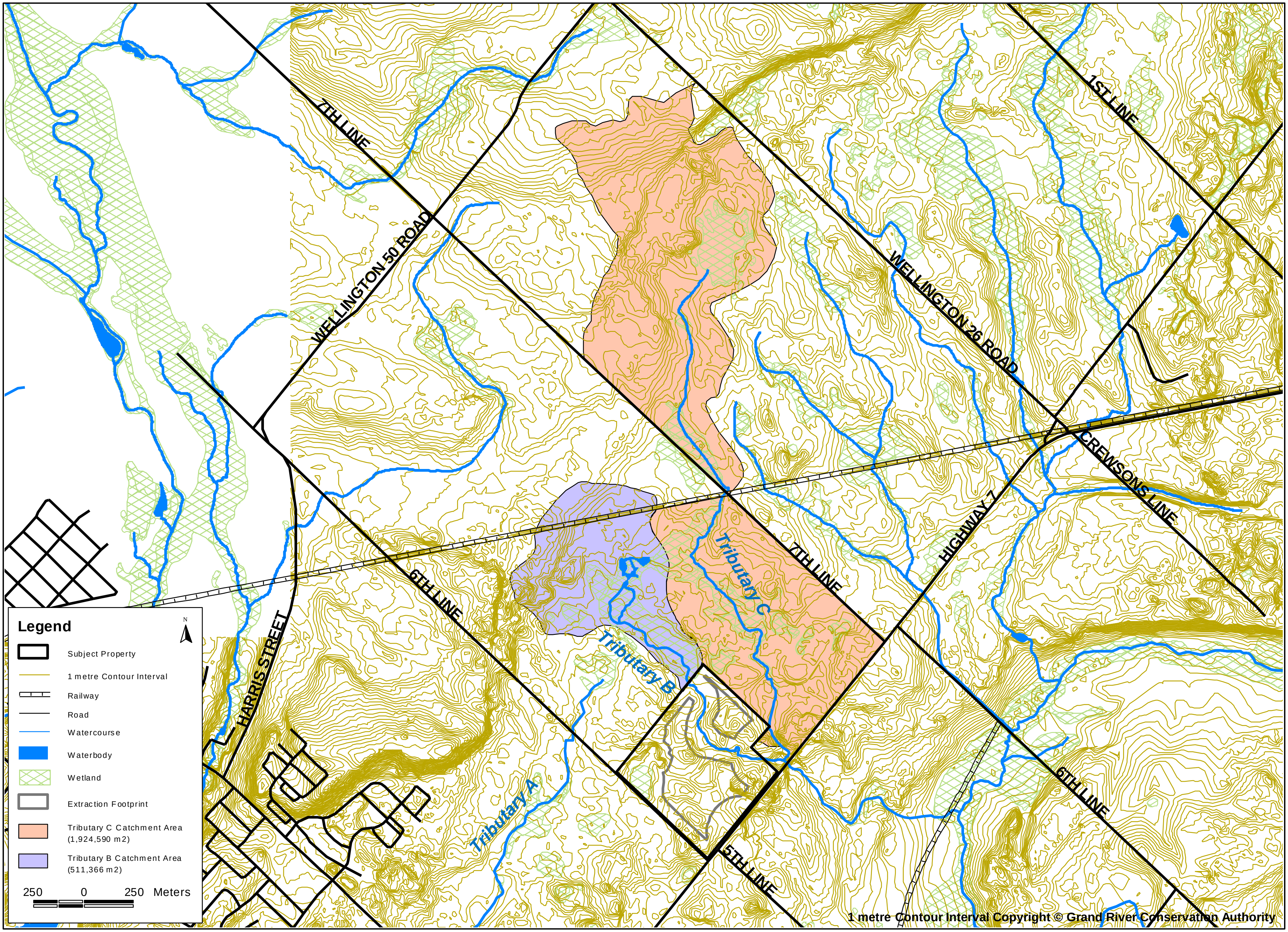
Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 5: Transmissivity versus Drawdown at W3**
Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 6: M15 Water Quality Results**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



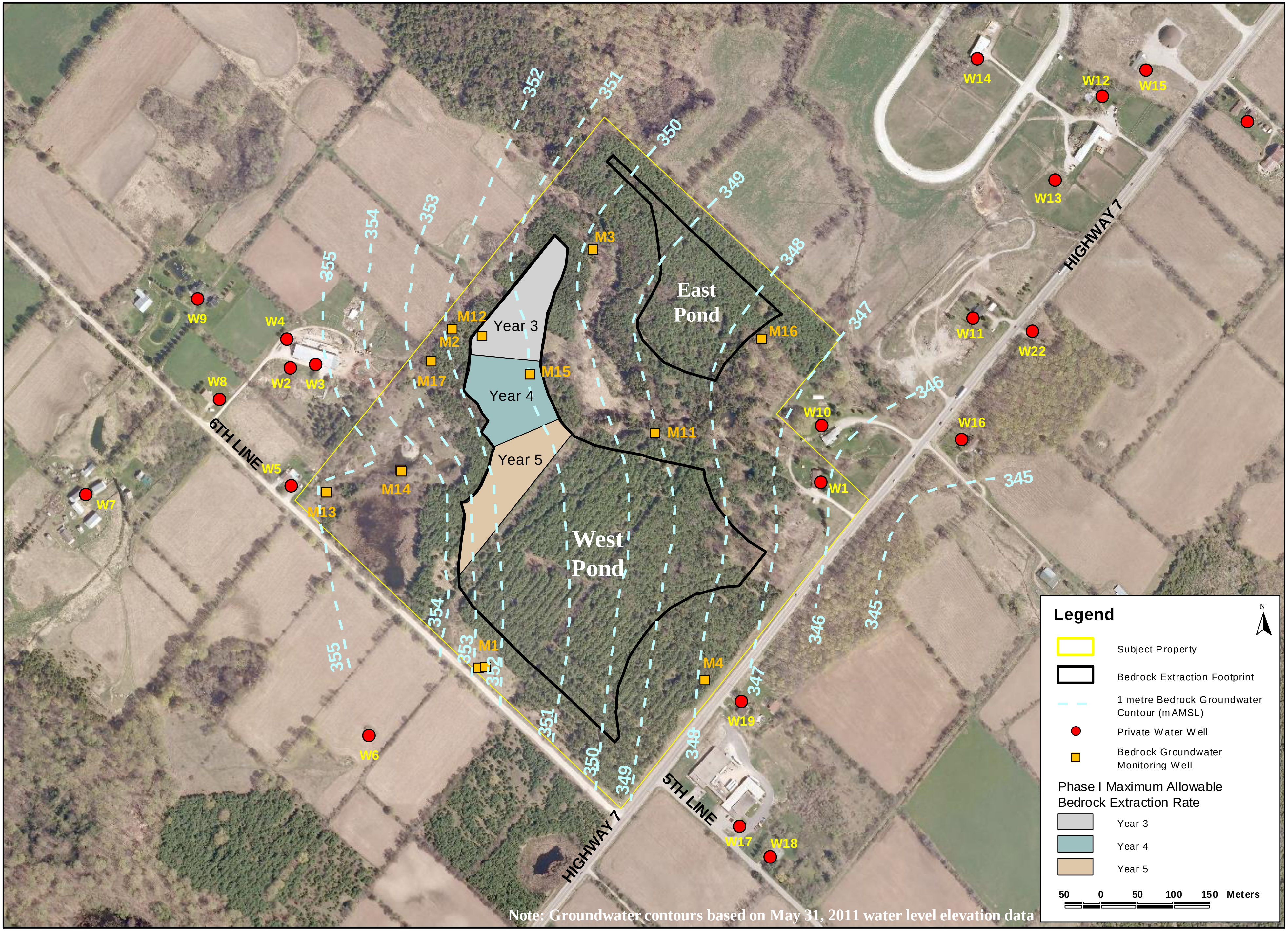
Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** May 2014 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure 7: M15 Water Quality Results**



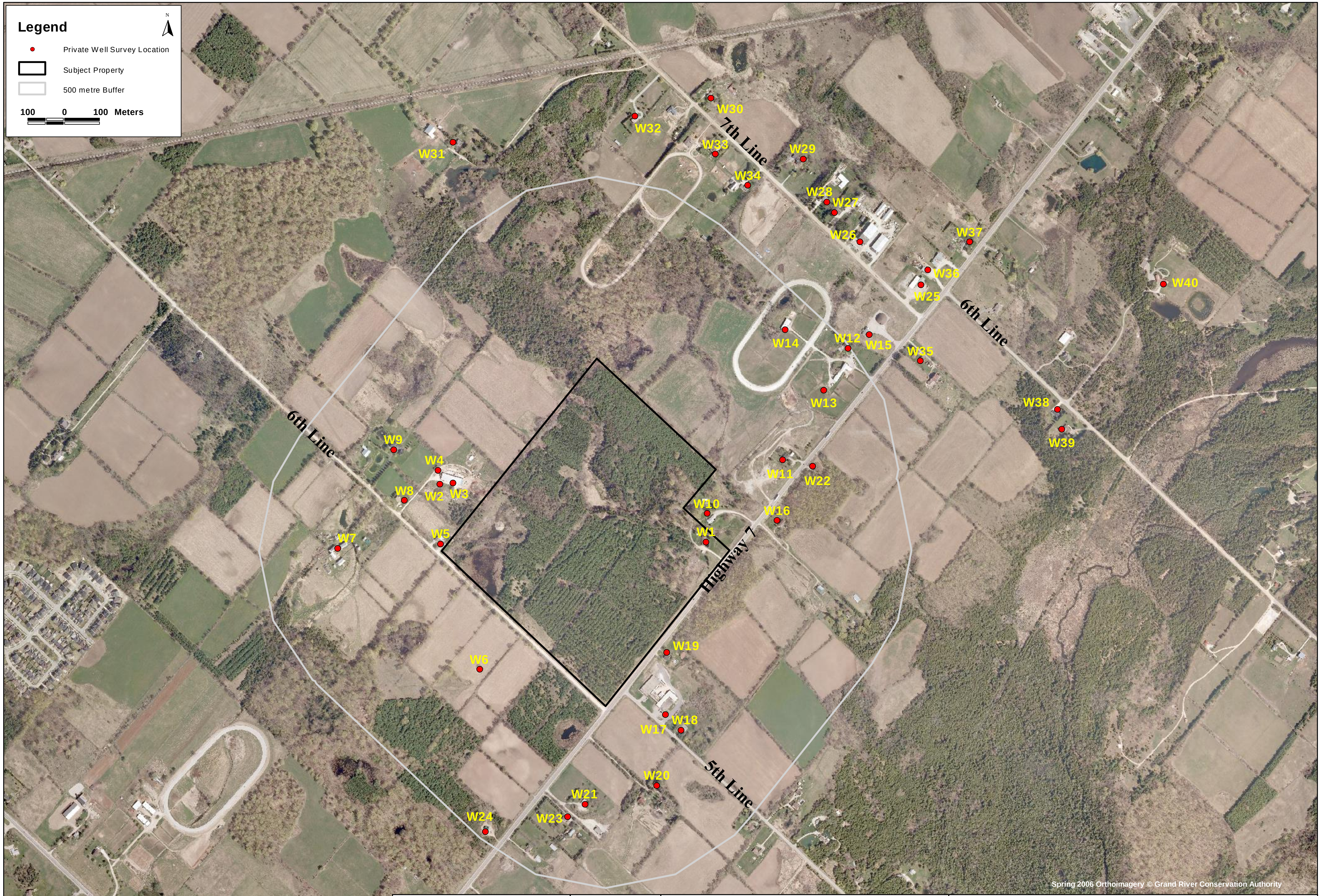
Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	
Date: Apr 2014		
Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	

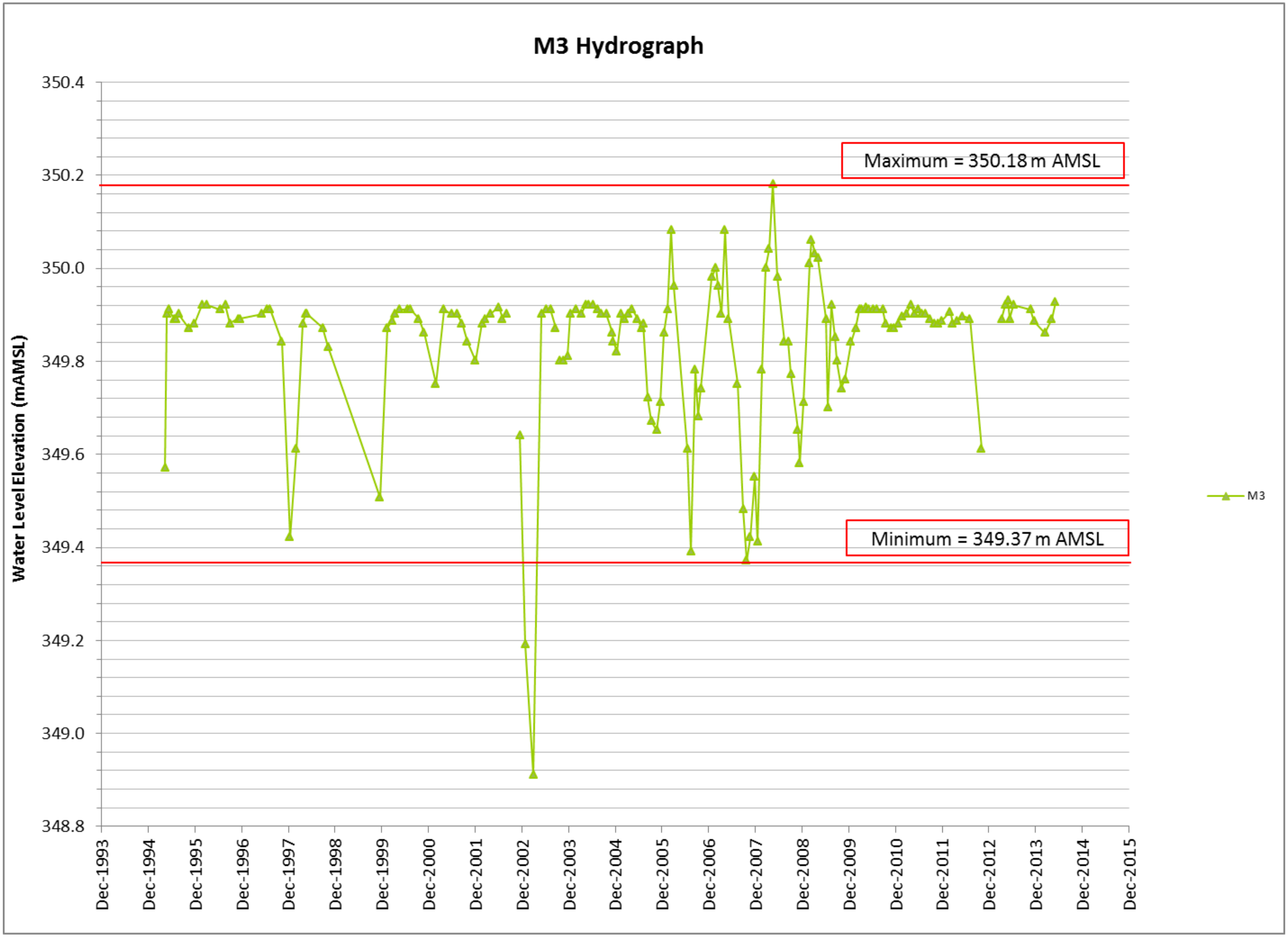
Figure 8: Watersheds of Tributaries B and C



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 9: Maximum Rate of Bedrock Extraction**
	Date: May 2014		
	Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	



Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Apr 2014 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	Figure 10: **Private Water Well Locations**



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 11: M3 Hydrograph**
	Date: Jun 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Table 6: Nitrogen Compounds in Groundwater and Surface Water

Station	Type	Date	NH3-N (mg/L)	NO2-N (mg/L)	NO3-N (mg/L)	TKN (mg/L)	Calculated Organic Nitrogen (mg/L)	Total Nitrogen (mg/L)
M3	Groundwater	20-Nov-13	ND	ND	5.2	0.77	0.77	5.97
M2	Groundwater	20-Nov-13	ND	ND	4.6	1.3	1.3	5.9
SW4	Surface Water: Tributary B	08-Apr-14	ND	ND	4.64	0.54	0.54	5.18
SW8	Surface Water: Tributary B	08-Apr-14	ND	ND	4.53	0.43	0.43	4.96
M15-3	Groundwater	05-May-14	ND	ND	3.17	0.9	0.9	4.07
M15-2	Groundwater	05-May-14	ND	ND	2.19	0.28	0.28	2.47
Guelph Limestone 2012	Guelph Limestone Quarry Pond	15-Feb-12	0.39	0.05	1.2	0.7	0.31	2.34
M15-4	Groundwater	05-May-14	ND	ND	1.96	0.19	0.19	2.15
M15-I	Groundwater	05-May-14	ND	ND	1.62	0.22	0.22	1.84
SW11	Surface Water: Tributary C	08-Apr-14	ND	ND	0.9	0.62	0.62	1.52
M13D	Groundwater	20-Nov-13	ND	ND	0.9	0.38	0.38	1.28
Guelph Limestone S2	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.46	0.43	0.43	0.89
Guelph Limestone S3	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.44	0.43	0.43	0.87
Guelph Limestone S1	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.47	0.31	0.31	0.78
Guelph Limestone S4	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.47	0.29	0.29	0.76

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Table 9: Private Well Surveys

Well Identifier	Address	Date Surveyed 1995	1998	2011	2012
W1	8532 Hwy 7		✓	✓	✓
W2	4949 6th Line		✓	✓	
W3	4949 6th Line			✓	
W4	4949 6th Line			✓	
W5	4943 6th Line		✓	✓	
W6	4958 6th Line		✓	✓	
W7	4958 6th Line		✓	✓	
W8	4953 6th Line		✓	✓	
W9	4963 6th Line		✓	✓	
W10	8540 Hwy 7		✓	✓	
W11	8554 Hwy 7		✓	✓	
W12	8572 Hwy 7		✓	✓	
W13	8572 Hwy 7			✓	
W14	8572 Hwy 7			✓	
W15	MTO Hwy 7 & 7th Line	✓	✓		
W16	5134 Hwy 7		✓	✓	
W17	14321 5th Line		✓	✓	✓
W18	14297 5th Line		✓	✓	
W19	5036 Hwy 7		✓	✓	✓
W20	4300 Hwy 7		✓	✓	
W21	4264 Hwy 7		✓	✓	
W22	5198 Hwy 7	✓		✓	
W23	4248 Hwy 7		✓	✓	
W24	8470 Hwy 7			✓	
W25	Northeast corner Hwy 7 & 7th Line	✓			
W26	Northeast corner Hwy 7 & 7th Line	✓			
W27	Northeast corner Hwy 7 & 7th Line	✓			
W28	4925 7th Line	✓			
W29	4935 7th Line	✓			
W30	4961 7th Line	✓			
W31	4970 7th Line	✓		✓	✓
W32	4964 7th Line	✓			
W33	4952 7th Line	✓		✓	
W34	4944 7th Line	✓		✓	
W35	Hwy 7 South Side first house west of 7th Line	✓			
W36	Hwy 7 North side East of Well ID 25	✓			
W37	Hwy 7 North side East of Well ID 36	✓			
W38	RR1 Acton	✓			
W39	RR1 Acton	✓			
W40	RR1 Acton	✓			

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Appendix A

Burnside & Associates Comments

April 8, 2014
April 9, 2014

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 Canada
telephone (519) 823-4995 **fax** (519) 836-5477 **web** www.rjburnside.com

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April 8, 2014

Via: Email and Mail (sdenhoed@hardenv.com)

Mr. Stan Denhoed, M.Sc., P.Eng.
Sr. Hydrogeologist
Harden Environmental Services Limited
4622 Nassagaweya-Puslinch Townline Road
RR 1
Moffat ON L0P 1J0

Dear Mr. Denhoed:

Re: Harden Environmental Services Limited January 14, 2014 Letter – Response to Burnside Review of Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site
File No.: 300032475.0000

Thank you for your letter of January 14, 2014 which provides your responses to the November 12, 2013 Burnside review of the Summary of Drilling and Testing of New Well M15 at the Hidden Quarry Site.

The level of on-site data has been improved. Additional assessment and background data collection is required to reduce the number of variables. Burnside recommends that the monitor well construction/testing/sampling and domestic well survey be completed as soon as possible to improve our understanding of the bedrock aquifer.

The Burnside responses below are ordered in the same number as your comments in the January 24, 2014 letter.

2.2 Bedrock

Burnside concurs with Harden that the Eramosa confining layer is not present at the site and that the extraction will occur in the Niagara Falls Member and Gas Port Formation.

2.3 Description of Core Breaks

Agreed.

3.0 Pumping Test

Burnside is satisfied with the Harden response. It is anticipated that the pre extraction monitoring program that will be conducted at the Site will assist in identifying which fractures are inter connected and as a result which of the bedrock fractures may be impacted during the extraction of rock from the Quarry.

3.1 Flow Test

Burnside is satisfied by the Harden response. The pre-extraction monitoring program will assist in confirming that the maximum allowable dewatering of the bedrock of 2.5 m as developed by Harden is an appropriate value. It is anticipated that Harden/James Dick will provide additional detail on how the daily maximum drawdown will be monitored. It is expected that monitoring of water levels during the initial stages of the site works will be intensive (less than hourly). Once conditions are understood then monitoring events can reduce to the frequency indicated. For example, setting automatic water level recorders to 5 minute sampling intervals for the first month of quarrying activities will provide an excellent indication of the water level response at no additional cost.

6.0 Water Quality Results

The Burnside comment expressed concerns that the quarrying activities could impact current concentrations of nitrate, iron and also introduce surface water pathogens into the nearby groundwater system. The Harden response is broken down by nitrate, iron and surface water pathogens. Our response is provided below:

Nitrate

Harden provides examples from the Guelph Limestone (formerly Dolime Quarry), the Holcim Quarry in Milton Ontario and from two much larger quarries located in Florida. The examples provided by Harden indicate that the amount of nitrogen added from the explosives is generally less than 2 mg/L. Burnside trusts that the information provided by Harden is accurate and that the amount of nitrogen added from the explosives used in the quarrying process will have a small impact the down gradient well's water quality. Water samples obtained from the standing water in the Dolime quarry would be useful in this assessment as the nitrogen concentration in the discharge from a dewatering pump appears to be reduced by Dilution as the nitrogen in the discharge (0.24 to 0.65 mg/L) was much less than that measured in a sample collected within 4 hours of explosives detonation (1.9 mg/L).

Iron

Harden indicates that although samples of local groundwater contain reduced iron, the presence of a quarry with elevated concentrations of dissolved oxygen will result in the reduction of iron concentration in surface water and the groundwater down gradient of the quarry. In addition, the reduced iron will assist in the denitrification of the surface water. Burnside concurs with Harden that concentrations of iron in the groundwater will not be increased significantly down gradient of the quarry. However, there is the potential that oxygenated water entering the downgradient bedrock aquifer may result in changes to the existing downgradient water quality.

Nitrogen Mass Balance

Harden indicates that 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 up-gradient farms which apply fertilizers (both commercial and natural) or generate manure. Harden provides a number of calculations to show the mass of nitrogen provided from the explosives, from groundwater inflow and the mass of nitrogen from up-gradient groundwater.

Burnside points out that the following factors could significantly affect the predictions made by Harden:

- The nitrate concentrations entering the quarry from the up-gradient direction may increase or decrease significantly seasonally.
- The nitrate concentration in the deep well M15 was 2 mg/L on May 24, 2013. This well is open across the entire bedrock sequence and as a result this nitrate value likely represents a mixing of water from all zones.
- The water produced from the individual fractures is based on the distribution of flows from M15; a more accurate understanding of the individual fracture characteristics including water quality, static water level and hydraulic conductivity will be obtained once the monitor well is constructed.

Burnside recommends that once M15 has been reconstructed as a multi-level monitor that water quality, water levels and hydraulic parameters be assessed in order to provide a more defensible prediction. We also note that there may be additional dilution that occurs due to precipitation which falls on the site.

Surface Water Pathogens

In their response Harden provides a list of sources of pathogens and indicates that the quarry does not represent the most likely source of surface water pathogens. Harden indicates that "*considering the elevated nitrate observed in water samples from Tributary B indicating contamination from up-gradient farming, 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.*" Harden should provide some commentary as to the impact of water fowl on the surface water in the quarry and how this may impact down-gradient wells.

In addition, Harden indicates that 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 down-gradient water wells. The monitoring program is designed to determine if groundwater quality is being impacted by the quarry. Harden should provide additional detail on how the existing monitoring well network will provide sufficient early warning so that treatment systems can be installed in down-gradient domestic wells before unacceptable impacts to drinking water have occurred. In addition, once the door to door well survey has been completed, Harden should provide details on which of the three listed remedial options is the most appropriate for each individual well in the event that water quality is impacted. It is likely that given the small diameter of the existing wells in the area that the use of a liner will be impractical. As a result, Harden will need to qualify if any existing wells can be deepened or whether the installation of water treatment equipment will be the preferred option.

7.0 Recommended Multi-level Installation Details

Agreed.

8.0 Discussion

No additional comment required. However, local residents continue to raise concerns with regards to the potential for karst features to be present on the site. This issue is discussed in the response to the January 14, 2014 Harden letter responding to the Burnside comments regarding the Hydrogeological Summary Report.

Section 9.0 Response to Burnside Comments

Comment 72

Harden has indicated that James Dick Construction Limited has agreed to limit the maximum drawdown in the excavation to 2.54 m below the historic low water level.

Burnside provides the following comments:

- The location of the drawdown measurement needs to be clearly defined and should actually be a monitoring well that is representative of water levels within the quarry limits and is completed as an open hole to 320 masl. In addition to monitoring pre extraction water levels for several years within the quarry limits, James Dick will need to monitor levels in nearby domestic wells to see how levels correlate with "quarry" water levels.
- The "historic low water level" requires additional clarification. As indicated above, the location of the water level measuring point needs to be defined as does the period of monitoring used to define the historic low water level. Harden predicts that a drawdown of 2.54 m in the quarry will result in 1.60 m of drawdown in the closest domestic well. Assuming that the historic low water level in the quarry corresponds to the historic low water level in the monitored domestic well, confirmation that an additional 1.6 m of drawdown in the domestic well will not impact it's use needs to be confirmed and the allowable drawdown in the quarry decreased as necessary.
- Harden should provide additional details on how the drawdown will be monitored and which wells will be used to decide what the water level is prior to extraction of the rock. Domestic wells to be monitored should also be identified. We understand from personal communication that the water level will be measured with a float connected to the excavation itself, but this approach needs to be documented.

Comment 60

Burnside agrees that the fracture distribution with depth can vary significantly in bedrock and two wells in close proximity can have different fracture patterns. However, we note that the reliability of the water found depths in MOE well records is subject to the experience of the well contractor whereas the fracture depths in M15 were identified by both visual and flow measurements. Once M15 has been completed as a multi-level well it should be tested so that the results of the flow profiling can be verified and the nitrate values with depth confirmed. Similarly, well M16 should be completed as soon as possible. Hydraulic and water quality data from the multi-level wells should be assessed and the model revised if necessary.

Collection of both water level and water quality data should continue so that predictions regarding water quality and water level response can be confirmed/revised.

Comment 54

No Comment.

Comment 56

The Burnside letter suggested that there must be areas in the southern portion of the site where the silt unit is thin or absent which results in Tributary B entering the bedrock at some point upstream of SW3. Harden agreed with the Burnside comment. Burnside notes that concerned residents have suggested that the disappearance of Tributary B suggests that there are karst features beneath the site. It is not clear to Burnside whether Tributary B always disappears at the same point on a consistent basis or if the tributary dries up in the summer and as a result there is no flow in the tributary at the southern end of the site. It may be that the stream disappears because of the lack of a till layer over lying the bedrock combined with low flow allowing infiltration to become dominant over lateral flow. However, this should be confirmed in order to alleviate residents' concerns. Collection of water level data in the tributary at several locations with automatic recorders will provide an improved understanding of the tributary and will provide better baseline data for the assessment of impacts in the future.

Should you have any questions regarding the above, please contact the undersigned.

Yours truly,

R.J. Burnside & Associates Limited

Dave Hopkins
Sr. Hydrogeologist
DH:sd

cc Kim Wingrove, Township of Guelph Eramosa (Via: Email) (kwingrove@get.on.ca)
Saidur Rahman, Township of Guelph Eramosa (Via: Email) (srahman@get.on.ca)
Leigh Mugford, James Dick Construction Ltd. (Via: Email) (lmugford@jamesdick.com)

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April 9, 2014

Via: Email and Mail (sdenhoed@hardenv.com)

Mr. Stan Denhoed, M.Sc., P.Eng.
Sr. Hydrogeologist
Harden Environmental Services Limited
Nassagaweya-Puslinch Townline
RR 1
Moffat ON L0P 1J0

Dear Mr. Denhoed:

**Re: Harden Response to Burnside Review of Hydrogeological Summary Report
Hidden Quarry Site for Township of Guelph Eramosa
Letter Dated January 14, 2014
File No.: 300032475.0000**

Thank you for your letter of January 14 2014 that provides your response to several issues and concerns addressed by R.J. Burnside & Associates Limited (Burnside) in our letter of November 12, 2013.

Burnside is primarily concerned with the impact of the proposed quarry on:

- Water levels in the upgradient domestic wells,
- The water quality in the down gradient domestic wells and,
- Rockwood Well 4

Although additional information has been provided in the latest letter, the predictions regarding the response of the fracture systems in the bedrock aquifer need to be confirmed through on going data collection and a thorough investigation of nearby domestic wells.

For consistency, our comments are presented using the same numbering as those contained in the Harden letter.

1.0 Karst

Burnside concurs with Harden that there is no evidence of cavernous karst features within the site. There have been a number of boreholes advanced into the underlying bedrock and as Harden indicates there is no evidence of cavernous karst features. However, the Rockwood area is identified by the Ontario Geological Survey as a Karst area and the water producing intervals in the bedrock are described as micro karst by some fractured bedrock specialists. It is Burnside's understanding that local residents have expressed concern that Karst features may exist beneath the Site, primarily because of the disappearance of Tributary B. Harden has indicated that there can be flow in Tributary B entering the north end of the Site and under dry conditions there is no flow in the tributary as it exits the southern portion of the site. It is not clear to Burnside if the flow always terminates at the same point in Tributary B or whether there is some variation depending on weather conditions. Clarification of this would assist in understanding whether this is a "disappearing stream" or simply an intermittent stream that dries up during the summer months.

2.0 Water Quality

Harden had originally calculated a nitrate (nitrogen) mass balance in their response letter to Burnside comments on the M15 well drilling. Harden has now recalculated the nitrogen mass balance assuming that the lower 33% of the fractured bedrock does not contribute to dilution of nitrogen. As a result the anticipated nitrogen value has increased from 4.38 to 4.54 mg/L at the down gradient property line.

Burnside recommends that detailed water level and water quality data be obtained from M15 (and also M16) following completion as a multi-level monitor so that the assumptions used in the mass balance calculation can be verified. In particular, water quality data should be collected from the various screened intervals along with the other wells on site and applied to Table1.

Deeper Water Sources

The Burnside comments had suggested that the quarry would allow the shallow groundwater to mix with water from deeper zones in the bedrock. These deeper zones at 36 and 41 m are currently secure sources of groundwater that are recharged over time by water moving into those formations. Burnside indicates that the excavation of the quarry into these factures will cause the water in the deeper fracture system to be under the influence of surface water and associated bacteria and viruses such as cryptosporidium and giardia. The existing secure water supply in the deep bedrock aquifer will therefore be changed to a surface water source for an unknown distance from the quarry. Burnside indicated that once the quarry is finished, there will be a large surface water body directly in contact with the bedrock fracture system which may allow rapid movement of water pathogens towards bedrock wells down-gradient at the site.

Harden concurred that the quarry activities will result in the mixing of groundwater from various depths and indicates that test results from monitoring well M15 indicates that confining conditions occur at depth. This suggests that the water sources at depth are somewhat isolated from shallower groundwater sources unless exposed to anthropogenic contamination. Harden goes on to indicate that the majority of wells obtain water from the upper and middle portions of the aquifer exposing those wells to contamination from anthropogenic activities and possibly surface water already. Harden concludes that the quarry is being developed in an area already susceptible to contamination from the ground surface. Harden concurs that the mixing of water in the quarry will occur, however they note that this mixing already occurs in each bedrock well drilled in the area including the deep well servicing the mushroom farm. The aquifer is also exposed to surface contaminants from the Eramosa River Valley and the Blue Springs Creek Valley.

Burnside agrees that each individual well allows an opportunity for connection between the shallow and intermediate depths in the bedrock and as a result water quality in these wells will be impacted by anthropogenic sources. This is only true for the deep bedrock wells; the shallow bedrock wells in the area do not allow mixing. The quarry will connect a much larger number of fractures and will also allow the opportunity for pathogens and bacteria from waterfowl, other wildlife and near quarry runoff to directly enter the surface water body and ultimately the down-gradient water system. Although pathogens and bacteria can be dealt with by currently available home treatment technology it is Burnsides opinion that most residents would prefer to have a "clean" source of water that does not require treatment. As a result this was the intent of Burnside suggesting that the quarry stop at a somewhat shallower depth in order to allow the opportunity for impacted down gradient wells to obtain water from the deeper fracture systems.

GUDI Condition in Proposed Rockwood Well 4

Burnside has suggested that the quarry may result in the classification of future Well Number 4 as groundwater under the direct influence of surface water (GUDI). Harden provides a detailed assessment from excerpts from Ontario Regulation 178-03 and the conditions anticipated at the future Well Number 4. Harden concludes that proposed Well Number 4 will be flagged as potentially GUDI even in the absence of the proposed quarry, and that there are other potential sources of surface water contamination closer than the proposed quarry. Harden suggests that it is unlikely that fractures are isolated to the extent that interconnections to the bedrock surface will not occur between proposed Well Number 4 and the proposed quarry. Based on the information currently available, Burnside concurs with the Harden assessment of the GUDI status of future well 4. Once Well Number 4 has been constructed, testing will be undertaken to see whether there is any connection between pumping at the new well and water level responses at the quarry.

Pathogen Movement

Harden Figure 4 provides information showing the wells that are down-gradient from the quarry. Harden indicates that these are the only wells that have any risk of water quality impacts. It is Harden's opinion that the detailed monitoring program will identify chemical and bacteriological movement from the quarry and contingency measures are in place in the event that a local well is impacted. Harden indicates that recent testing of the Guelph Limestone Quarry found that the water met all the drinking water quality standards for a comprehensive suite of parameters.

It is Burnside's opinion that Harden should undertake a detailed well inventory and water quality assessment of the wells that surround the quarry. The assessment should include a sampling of wells in the spring and fall of 2014 in order to establish baseline conditions. Sampling should continue on a semi-annual basis until a sufficient baseline of data is established prior to quarry operations. Once sufficient baseline data has been collected an individual approach to addressing the potential for impact should be devised for each well. Burnside is of the opinion that wells within 500 m of the site that are located in pits or have buried well heads should be proactively upgraded so that the wells meet Ontario Regulation 903 and are easily monitored. Data collected from the domestic well survey and re-construction and testing of M15 should be used to update the groundwater model and refine the predicted impacts.

Quarry Depth Limitation

The flow profiling at M15 indicates that there are significant fractures at elevations of 318 masl and 324 masl (42 and 36 m below ground surface respectively). The proposed quarry will extend to an elevation of 320 masl. Harden indicates that they do not think that limiting the depth of the quarry to an elevation greater than 324 masl will guarantee protection of the lower fracture set. They suggest that rather than limiting the depth of the quarry that mitigation of water quality issues be undertaken at the few down-gradient wells as they occur since there are proven effective measures designed specifically to address such water quality problems.

It is Burnsides opinion that most residents would prefer to have a safe secure source of water that does not require treatment rather than treating water that has been impacted by quarry activities. As a result, Burnside recommends that the current water quality be established for all of the wells within 500 m of the site and individual plans be devised to protect the water quality for each well.

3.0 Private Wells with Shallow Fracture Sources of Water

It is Burnside's contention that shallow wells have the greatest potential to be impacted by quarry activities. As a result, Harden identified the shallow wells on Figure 5 and indicates that none of the shallow wells are located up-gradient of the quarry. The shallow wells are located down-gradient of the quarry where water levels will rise. Harden indicates that with respect to wells that are up-gradient of the quarry it is their opinion that the magnitude of change will not affect the functioning of the domestic wells. Harden indicates that this opinion will be verified upon the completion of a detailed pre-bedrock extraction water well survey. If an up-gradient well is found, during a flow test, to have a drawdown near to the location of the pump then the pump will be set to a deeper depth.

Harden disagrees with Burnsides recommendation to proactively modify all existing well as a necessary step. In the case of wells that may currently be impacted by surface runoff such as those in well pits, the improvements to the well head may result in improved quality which would reduce the likelihood that the quarry operators will have to provide water quality treatment in the future.

The plan for protection of existing wells should be devised once the domestic well survey is completed.

4.0 Groundwater Model Parameter - Hydraulic Connectivity

In this section Harden uses data obtained from well M15 and the laws of super positioning in order to assess the potential impacts of drawdown in the quarry on neighbouring domestic wells. In order to estimate the magnitude of impact at the nearest private wells shown on Figure 6, Harden calculated the cumulative drawdown from each of six dewatering wells at each private well. The drawdown was estimated using the modified equilibrium equation (Cooper and Jacob, 1946). Harden also includes a list of nine conditions that need to be met in order for the Cooper and Jacob method to be valid. Although many of the conditions are not met, it is Burnside's opinion that this method does provide additional support for the groundwater model used by Harden in the December 2012 report. Harden indicates that the analytical analysis confirms that:

- The results obtained from the model are reasonable;
- If a lower fracture set does not contribute water to the quarry the water will fill more slowly but the impact on local wells is similar to the full depth scenario; and
- The maximum drawdown in the nearest wells is always less than will occur in the quarry.

Burnside recommends that following reconstruction of M15 as a multi-level well, hydraulic and water quality data be collected from each of the screened intervals and used to improve the current interpretation of the hydrogeologic environment. Harden also indicates that their exercise supports the assertion that a shallower quarry will not result in significantly less impact. It was Burnside's suggestion that the quarry be terminated at a shallower depth in order to reduce the potential for the lower fractures to be impacted; thereby providing an opportunity for potentially impacted domestic wells to be drilled deeper.

5.0 Brydson Spring and Blue Springs Creek

Burnside's agrees with Harden's assertion that the 2.5 m water level change in the quarry will not change the water level along the Southern boundary. However, a lowered water level at the northern end of the site will result in a reduced hydraulic gradient and therefore discharge from the bedrock to the Brydson Spring may be reduced.

A spring flows because the water level in the ground is above grade. The degree that the water level is above grade could range from 0.1 to 10 m. A change in water levels less than 1 m can result in a reduction in flow. The conditions at this spring including flow volume and water quality should be characterized to establish a baseline condition and the spring should be included in the monitoring program.

6.0 Rock Extraction Water Level Change

Harden uses four pumping wells to simulate potential impacts to local wells during the initial rock excavation from the sinking cut. The simulation results in a maximum predicted drawdown of 0.87 m at the nearest well.

Burnside agrees that based on a maximum drawdown of 2.5 m in the sinking cut is not likely to result in significant impacts to nearby wells. However, it is unclear why the maximum drawdown cannot be the same as the depth of the sinking cut. This conservative value seems appropriate until the impacts predicted by the model can be confirmed.

Regardless of the maximum drawdown agreed to, it is Burnside's opinion that this value is the maximum total drawdown allowed, not the amount that is allowed with each sinking cut. Details need to be provided regarding the location for monitoring the drawdown and also the method for establishing the pre extraction reference water level needs to be agreed upon.

Combined Impact from Rockwood Well No. 4 and Hidden Quarry

It is Burnside's opinion that the combined effect of the quarry and proposed Rockwood Well 4 cannot be predicted until M15 and the well are constructed and tested. The quarry will introduce bacteria into portions of the previously confined aquifer. Without detailed investigations there is no way to reliably predict the connection of fractures in the quarry with fractures found in domestic wells. The domestic well survey and water level/water quality monitoring program needs to be designed to identify the wells most likely to be impacted so they can be proactively protected.

7.0 Aquitard

Agreed

9.0 Monitoring Plan, Trigger Levels and Contingency Plan

The monitoring program should reference the pre extraction well survey that will include water quality/quantity testing and indicate the wells will be potentially involved in the monitoring program. Trigger levels for water quality and water levels should be established once baseline conditions are established. Investigation of the proposed pre-quarry well survey locations in Figure C-2 should be mandatory. Residents at wells W25 to W30 and W36 to W40 should be asked if they are willing to participate in the monitoring program.

1.0 On Site Monitoring Program

All of Burnside's suggestions have been incorporated into the monitoring program.

2.0 Trigger Levels

2.1 Trigger Levels for the Bedrock Aquifer

Agreed.

2.2 Trigger Level for Northwest Wetland

No comments.

3.0 Contingency Measures

3.1 Groundwater Levels and Northwest Wetland

Agreed.

3.2 Groundwater Quality

JDCL has agreed to Burnside's additions to the program.

4.0 Pre-Bedrock Extraction Water Well Survey

See comment under 3.0 Private Wells with Shallow Fracture Sources of Water.

10.0 Well Complaint

No comments.

11.0 Next Stages

Burnside agrees to the list of next steps but continues to request a reduction in the depth of the quarry and proactive improvements in surrounding existing wells based on the results of the well survey future documentation on this site should include detailed information on the domestic wells, construction and testing of M15/M16 and information on the Brydson Spring.

Yours truly,

R.J. Burnside & Associates Limited

David Hopkins
Sr. Hydrogeologist
DH:sd

cc Kim Wingrove, Township of Guelph Eramosa (Via: Email) (kwingrove@get.on.ca)
Saidur Rahman, Township of Guelph Eramosa (Via: Email) (srahman@get.on.ca)
Leigh Mugford, James Dick Construction Ltd. (Via: Email) (lmugford@jamesdick.com)

Appendix B

Hydraulic Testing in Multi-Level M15

Well			M15-I
Test Method			Hvorslev (rising head test)
Hydraulic Conductivity			6.67E-05 m/sec
Slug of water removed			1 Litre
Screened Formation			Bedrock Dolostone
Top of Intake Elevation			319.72
Bottom of Intake Elevation			315.82
Well Depth (mbtoc)			44.72
TOC Elevation			360.54
Test Date			06-May-14
Datum			metres above datalogger sensor
H	9.970	metres	[static water level]
Ho	8.666	metres	[water level at t=0]
To	1.2	sec	[t when H-h/H-Ho = 0.37]
To	0.020	min	[t when H-h/H-Ho = 0.37]
L	3.90	metres	[length of piezometer intake]
R	0.0762	metres	[intake radius]
r	0.0127	metres	[piezometer radius]

K-Hvorslev	**6.67E-05**	**m/sec**
K-Hvorslev	**6.67E-03**	**cm/sec**
K-Hvorslev	**4.00E-03**	**m/min**
K-Hvorslev-Muldoon	**6.19E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	8.6659	1.304	1.000
1	0.017	9.2378	0.732	0.561
1.5	0.025	9.6647	0.305	0.234
2	0.033	9.8516	0.118	0.091

Hvorslev Analysis

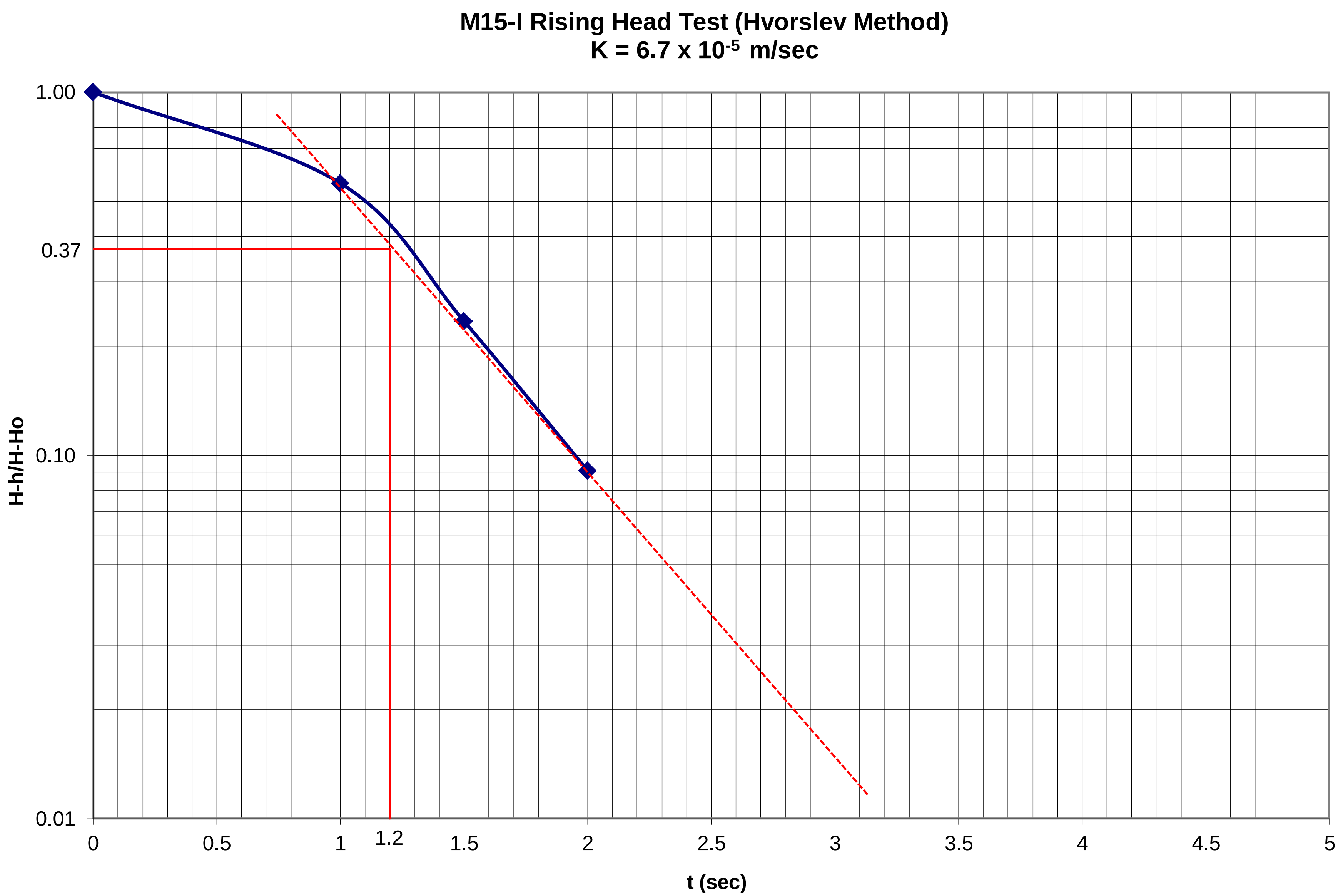
$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	M15-I Rising Head Test
Date: May 2014	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	**M15-I Rising Head Test**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Well		M15-II	
Test Method		Hvorslev (rising head test)	
Hydraulic Conductivity		1.00E-04	m/sec
Slug of water removed		1 Litre	
Screened Formation		Bedrock Dolostone	
Top of Intake Elevation		326.52	
Bottom of Intake Elevation		322.03	
Well Depth (mbtoc)		38.51	
TOC Elevation		360.54	
Test Date		06-May-14	
Datum		metres above datalogger sensor	

H	9.887	metres	[static water level]
Ho	6.890	metres	[water level at t=0]
To	0.7	sec	[t when H-h/H-Ho = 0.37]
To	0.01	min	[t when H-h/H-Ho = 0.37]
L	4.49	metres	[length of piezometer intake]
R	0.0762	metres	[intake radius]
r	0.0127	metres	[piezometer radius]

K-Hvorslev	**1.00E-04**	**m/sec**
K-Hvorslev	**1.00E-02**	**cm/sec**
K-Hvorslev	**6.02E-03**	**m/min**
K-Hvorslev-Muldoon	**9.28E-05**	**m/sec**

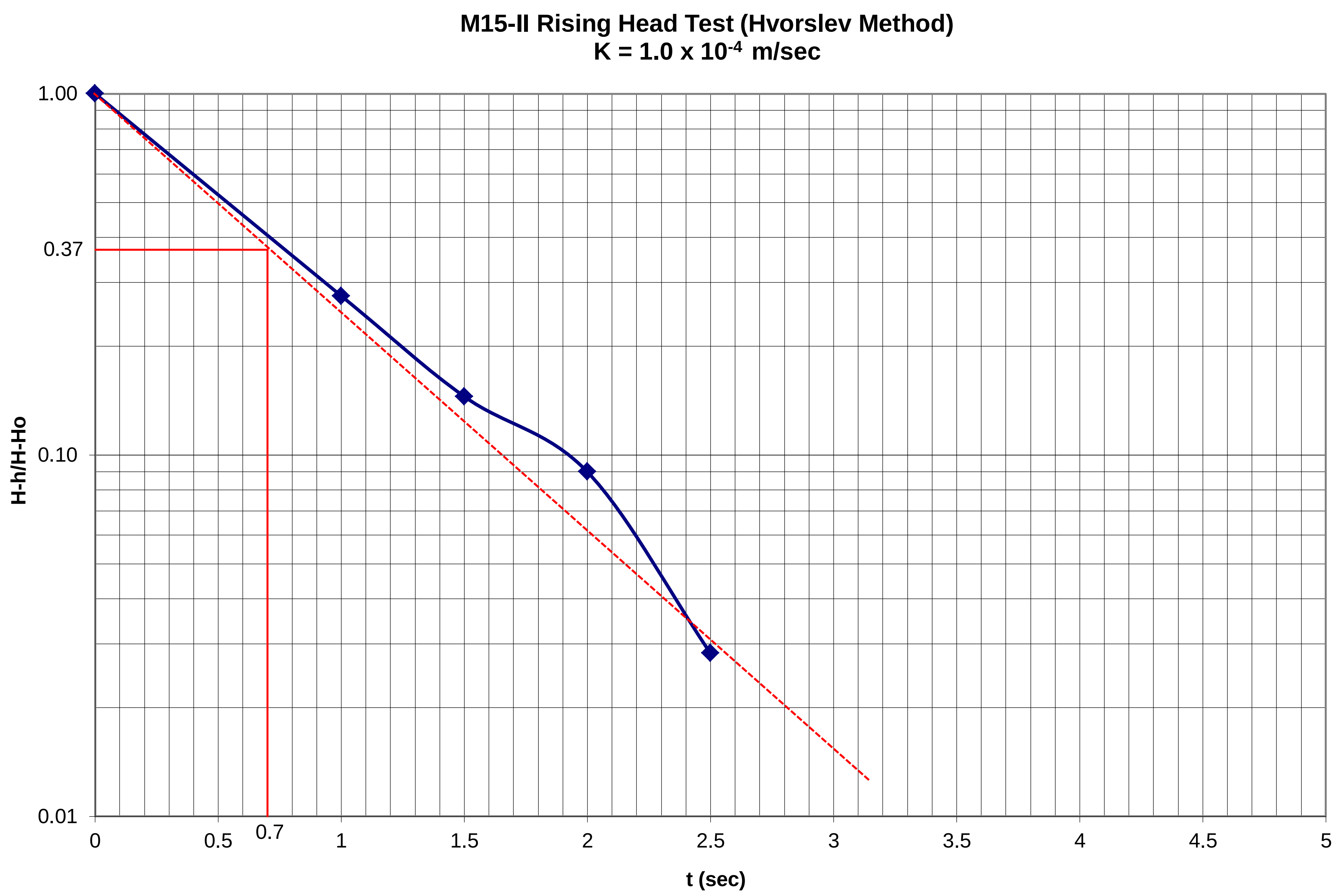
Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	6.8897	2.998	1.000
1	0.017	9.0612	0.826	0.276
1.5	0.025	9.4523	0.435	0.145
2	0.033	9.6183	0.269	0.090
2.5	0.042	9.8027	0.085	0.028

Hvorslev Analysis

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-II Rising Head Test**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Well			M15-III	
Test Method			Hvorslev (rising head test)	
Hydraulic Conductivity			3.37E-05	m/sec
Slug of water removed			1 Litre	
Screened Formation			Bedrock Dolostone	
Top of Intake Elevation			336.21	
Bottom of Intake Elevation			330.03	
Well Depth (mbtoc)			30.51	
TOC Elevation			360.54	
Test Date			06-May-14	
Datum			metres above datalogger sensor	
H	10.146	metres	[static water level]	
Ho	8.302	metres	[water level at t=0]	
To	1.7	sec	[t when H-h/H-Ho = 0.37]	
To	0.03	min	[t when H-h/H-Ho = 0.37]	
L	6.18	metres	[length of piezometer intake]	
R	0.0762	metres	[intake radius]	
r	0.0127	metres	[piezometer radius]	

K-Hvorslev	**3.37E-05**	**m/sec**
K-Hvorslev	**3.37E-03**	**cm/sec**
K-Hvorslev	**2.02E-03**	**m/min**
K-Hvorslev-Muldoon	**3.10E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	8.3022	1.844	1.000
0.5	0.008	8.5448	1.602	0.868
1	0.017	9.1061	1.040	0.564
1.5	0.025	9.276	0.870	0.472
2	0.033	9.5274	0.619	0.336
2.5	0.042	9.6607	0.486	0.263
3	0.050	9.8524	0.294	0.159
3.5	0.058	9.9576	0.189	0.102
4	0.067	10.0439	0.102	0.056
4.5	0.075	10.0911	0.055	0.030

Hvorslev Analysis

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

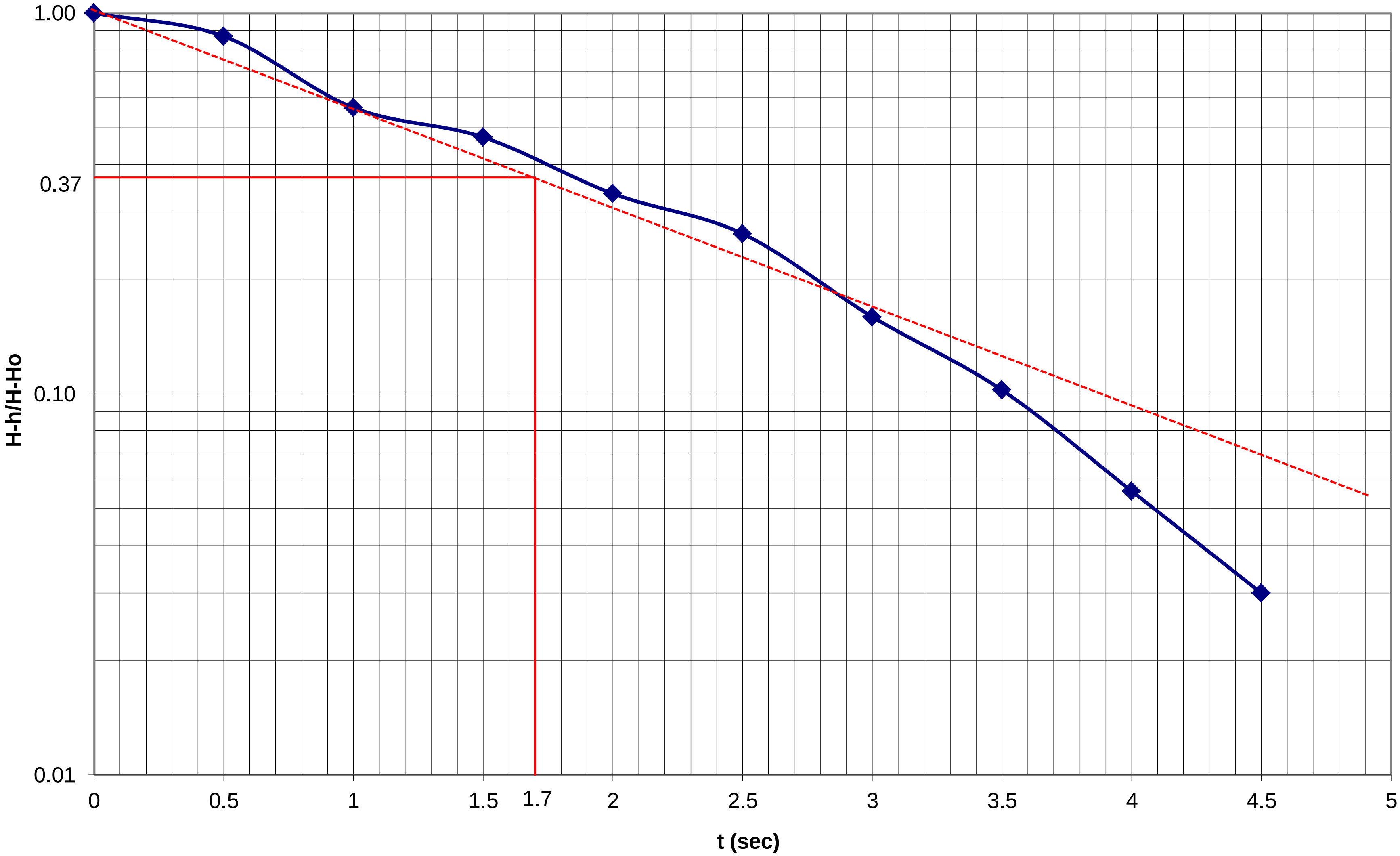
Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-III Rising Head Test**
Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		

M15-III Rising Head Test (Hvorslev Method)
K = 3.4 x 10^{-5} m/sec



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-III Rising Head Test**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Well		M15-IV	
Test Method		Hvorslev (rising head test)	
Hydraulic Conductivity		2.21E-05	m/sec
Slug of water removed		1 Litre	
Screened Formation		Bedrock Dolostone	
Top of Intake Elevation		350.54	
Bottom of Intake Elevation		339.97	
Well Depth (mbtoc)		20.57	
TOC Elevation		360.54	
Test Date		06-May-14	
Datum		metres above datalogger sensor	

H	10.1981	metres	[static water level]
Ho	9.761	metres	[water level at t=0]
To	1.7	sec	[t when H-h/H-Ho = 0.37]
To	0.03	min	[t when H-h/H-Ho = 0.37]
L	10.57	metres	[length of piezometer intake]
R	0.0762	metres	[intake radius]
r	0.0127	metres	[piezometer radius]

K-Hvorslev	**2.21E-05**	**m/sec**
K-Hvorslev	**2.21E-03**	**cm/sec**
K-Hvorslev	**1.33E-03**	**m/min**
K-Hvorslev-Muldoon	**2.02E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	9.7612	0.437	1.000
0.5	0.008	9.8511	0.347	0.794
1	0.017	9.93	0.268	0.614
1.5	0.025	10.0036	0.195	0.445
2	0.033	10.071	0.127	0.291
2.5	0.042	10.136	0.062	0.142
3	0.050	10.178	0.020	0.046
3.5	0.058	10.193	0.005	0.012

Hvorslev Analysis

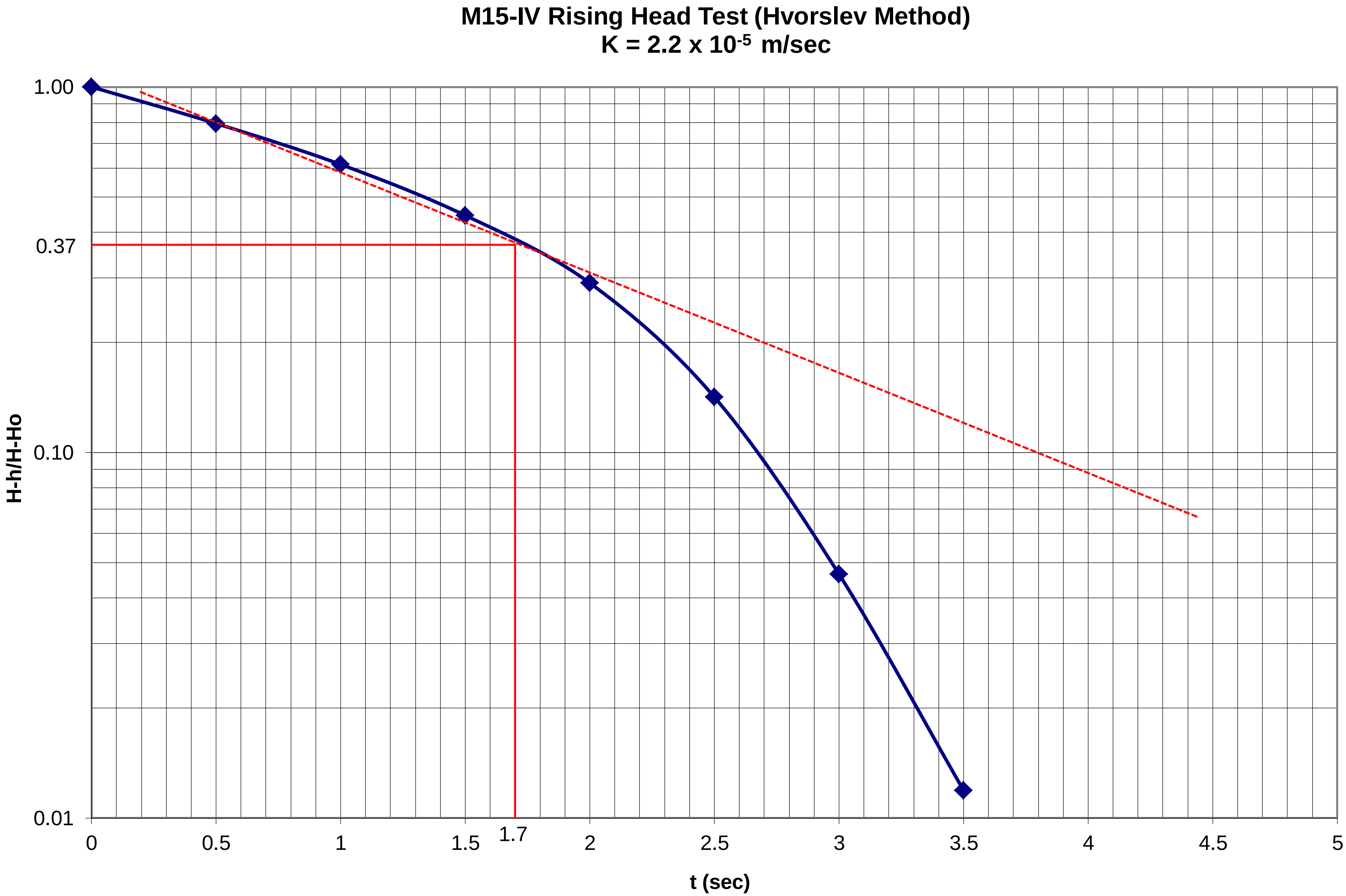
$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-IV Rising Head Test**
Date: May 2014	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	**M15-IV Rising Head Test**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

High K Estimator Spreadsheet
Metric Units

General Test Data

Site Location:	Hidden	
Date:	06/05/2014	
Time:		
Test Designation:	M15-I	
Static Level:	9.97	m
Initial Water Level Change (H_0):	1.304	m
Start Time for Test:	42805	sec

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	40.82	m
Screen Length (b):	3.050	m
Depth to Static Water Level (from toc):	8.89	m
Top of Screen to Water Table (d):	35.82	m
Radius of Well Screen (r_w):	0.013	m
Nominal Radius of Well Casing (r_{nc}):	0.013	m
Radius of Transducer Cable (r_{tc}):	0.003	m
Effective Casing Radius (r_c =(r_{nc}^2-r_{tc}^2)^0.5):	0.013	m
Modified Screen Radius (r_w*):	0.017	m
Aspect Ratio (b/r_w*):	182.963	
Formation Thickness (B):	45	m

Time Correlation Ratio t_d*/t*		Best Fit Type Curve C_D	
0.588		0.75	
computed from ratio	Le =	28.351	m
nominal	Le =	30.478	m
% difference		7%	
Modulation Factor =		1.7	

Unconfined - High-K Bouwer and Rice Model

K_r = t_d* r_c^2 ln[R_e/r_w*] / (t* 2bC_D)

ln(R_e/r_w*)=	4.795	***A*** =	5.776	
		B =	1.088	
first term	1.1/(ln((d+b)/r_w*)			
	0.142			
second term	(***A*** +***B****(ln[(B-(d+b))/r_w*]))/(b/r_w*)			
		0.067		
ln[(B-(d+b))/r_w*]		5.907		5.907
		Cannot exceed 6.		
		See Butler (1997) - p.108.		

K_r =	**9.90E-05 m/sec**	
	8.55E+00 m/day	**2.81E+01 ft/day**
	9.90E-03 cm/sec	

A = 1.4720+3.537E-2(b/r_w*)-8.148E-5(b/r_w*)^2+1.028E-7(b/r_w*)^3-6.484E-11(b/r_w*)^4+1.573E-14(b/r_w*)^5

B = 0.2372+5.151E-3(b/r_w*)-2.682E-6(b/r_w*)^2-3.491E-10(b/r_w*)^3+4.738E-13(b/r_w*)^4

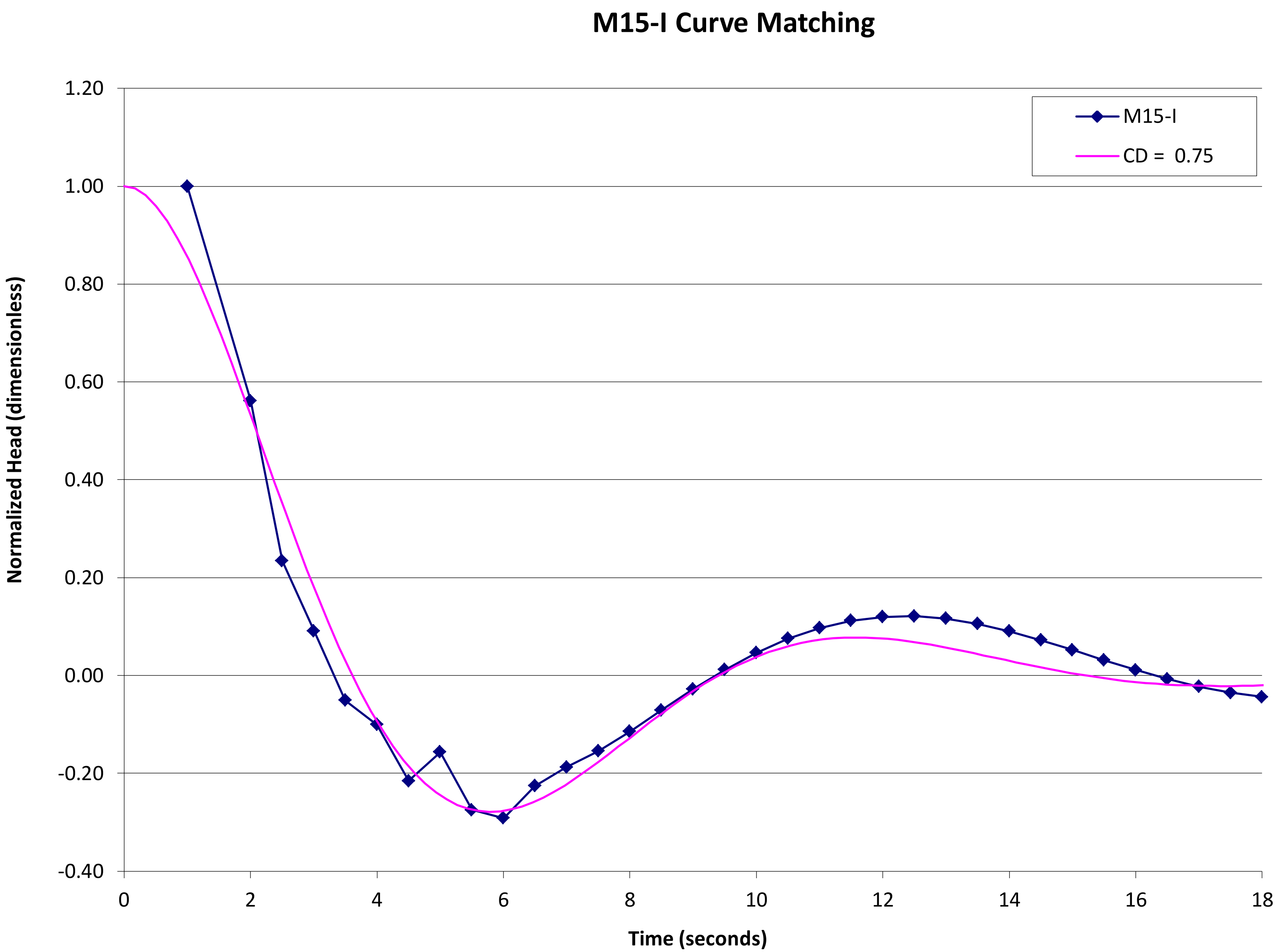
Confined - High-K Hvorslev Model

K_r = t_d* r_c^2 ln[b/(2r_w*)+(1+(b/(2r_w*))^2)^0.5] / (t* 2bC_D)

Bracketted quantity 182.969

K_r =	**1.08E-04 m/sec**	
	9.29E+00 m/day	**3.05E+01 ft/day**
	1.08E-02 cm/sec	

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-I Underdamped Slug Test Analysis**
	Date: May 2014	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	**M15-I Underdamped Slug Test Analysis**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

High K Estimator Spreadsheet
Metric Units

General Test Data

Site Location:	Hidden	
Date:	06/05/2014	
Time:		
Test Designation:	M15-II	
Static Level:	9.88	m
Initial Water Level Change (H_0):	2.990	m
Start Time for Test:	43232	sec

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	34.02	m
Screen Length (b):	3.050	m
Depth to Static Water Level (from toc):	8.89	m
Top of Screen to Water Table (d):	29.6	m
Radius of Well Screen (r_w):	0.013	m
Nominal Radius of Well Casing (r_{nc}):	0.013	m
Radius of Transducer Cable (r_{tc}):	0.003	m
Effective Casing Radius (r_c =(r_{nc}^2-r_{tc}^2)^0.5):	0.013	m
Modified Screen Radius (r_w*):	0.017	m
Aspect Ratio (b/r_w*):	182.963	
Formation Thickness (B):	45	m

Time Correlation Ratio		**Best Fit Type Curve C_D**	
t_d*/t*		1.1	
0.714			
computed from ratio	Le =	19.228	m
nominal	Le =	23.678	m
% difference		19%	
Modulation Factor =		1.4	

Unconfined - High-K Bouwer and Rice Model

$K_r = \dfrac{t_d^* \, r_c^2 \ln[R_e/r_w^*]}{t^* \quad 2bC_D}$

ln(R_e/r_w*)=	4.709		***A*** =	5.776		
			B =	1.088		
	first term	1.1/(ln((d+b)/r_w*)				
		0.145				
	second term		(***A*** +***B****(ln[(B-(d+b))/r_w*]))/(b/r_w*)			
			0.067			
	ln[(B-(d+b))/r_w*]		6.000			6.608
			Cannot exceed 6.			
			See Butler (1997) - p.108.			

K_r = 8.05E-05 m/sec
6.95E+00 m/day   2.28E+01 ft/day
8.05E-03 cm/sec

Confined - High-K Hvorslev Model

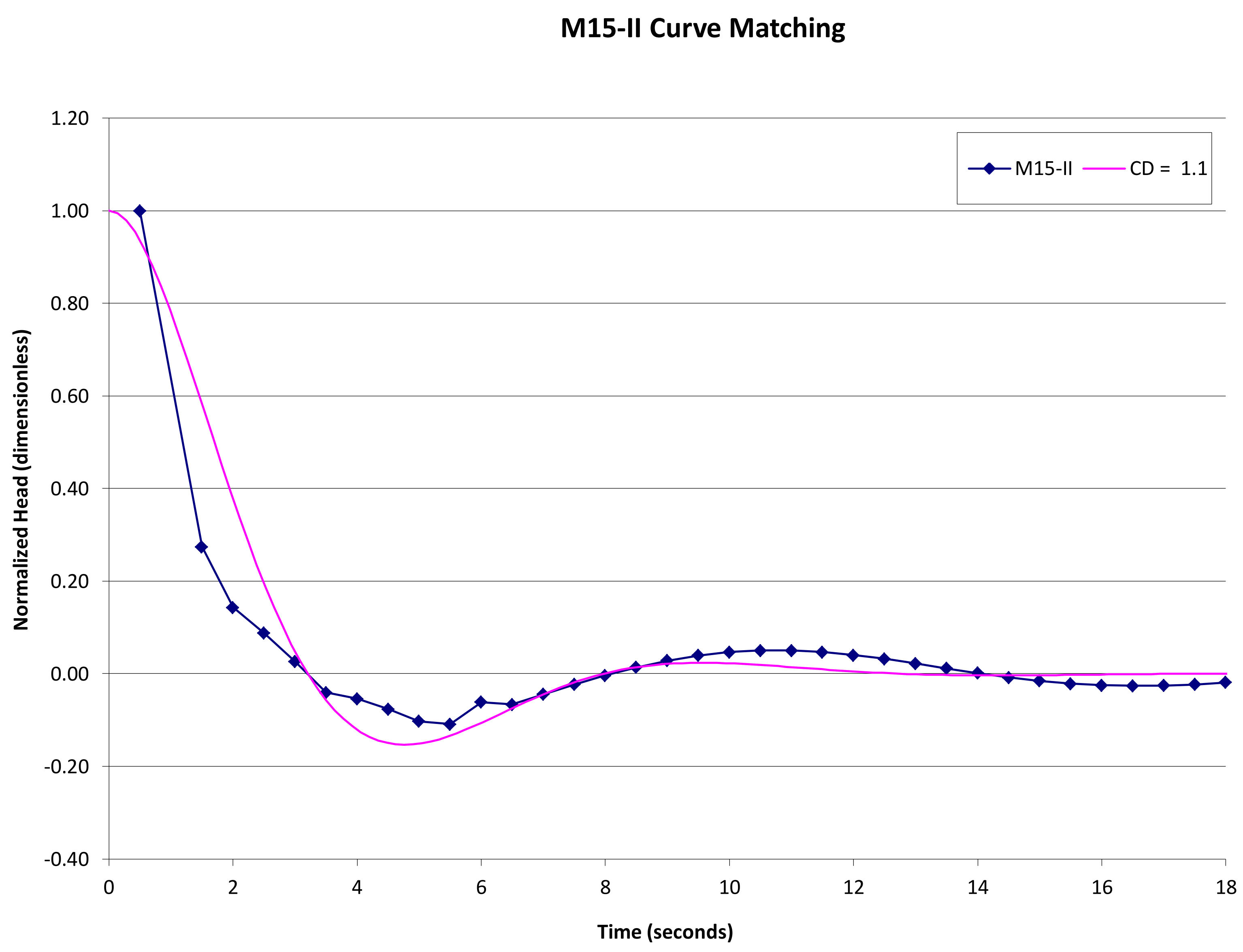
$K_r = \dfrac{t_d^* \, r_c^2 \ln[b/(2r_w^*)+(1+(b/(2r_w^*))^2)^{0.5}]}{t^* \quad 2bC_D}$

Bracketted quantity	182.969

K_r = 8.91E-05 m/sec
7.69E+00 m/day   2.52E+01 ft/day
8.91E-03 cm/sec

A =	1.4720+3.537E-2(b/r_w*)-8.148E-5(b/r_w*)^2+1.028E-7(b/r_w*)^3-6.484E-11(b/r_w*)^4+1.573E-14(b/r_w*)^5
B =	0.2372+5.151E-3(b/r_w*)-2.682E-6(b/r_w*)^2-3.491E-10(b/r_w*)^3+4.738E-13(b/r_w*)^4

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-II Underdamped Slug Test Analysis**
	Date: May 2014	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	**M15-II Underdamped Slug Test Analysis**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

High K Estimator Spreadsheet
Metric Units

General Test Data

Site Location:	Hidden	
Date:	06/05/2014	
Time:		
Test Designation:	M15-IV	
Static Level:	10.17	m
Initial Water Level Change (H_0):	0.409	m
Start Time for Test:	44141.5	sec

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	20.57	m
Screen Length (b):	6.090	m
Depth to Static Water Level (from toc):	8.89	m
Top of Screen to Water Table (d):	2	m
Radius of Well Screen (r_w):	0.013	m
Nominal Radius of Well Casing (r_{nc}):	0.013	m
Radius of Transducer Cable (r_{tc}):	0.003	m
Effective Casing Radius (r_c =(r_{nc}^2-r_{tc}^2)^0.5):	0.013	m
Modified Screen Radius (r_w*):	0.017	m
Aspect Ratio (b/r_w*):	365.327	
Formation Thickness (B):	45	m

Time Correlation Ratio t_d*/t*		Best Fit Type Curve C_D	
0.909		1	
computed from ratio	Le =	11.870	m
nominal	Le =	8.781	m
% difference		35%	
Modulation Factor =		1.1	

Unconfined - High-K Bouwer and Rice Model

K_r = t_d* r_c^2 ln[R_e/r_w*] / (t* 2bC_D)

ln(R_e/r_w*)=	4.403	***A*** =	7.479	
		B =	1.752	
first term	1.1/(ln((d+b)/r_w*)			
	0.178			
second term	(***A*** +***B****(ln[(B-(d+b))/r_w*]))/(b/r_w*)			
		0.049		
ln[(B-(d+b))/r_w*]		6.000		7.703
		Cannot exceed 6.		
		See Butler (1997) - p.108.		

K_r = 5.28E-05 m/sec
4.56E+00 m/day 1.50E+01 ft/day
5.28E-03 cm/sec

Confined - High-K Hvorslev Model

K_r = t_d* r_c^2 ln[b/(2r_w*)+(1+(b/(2r_w*))^2)^0.5] / (t* 2bC_D)

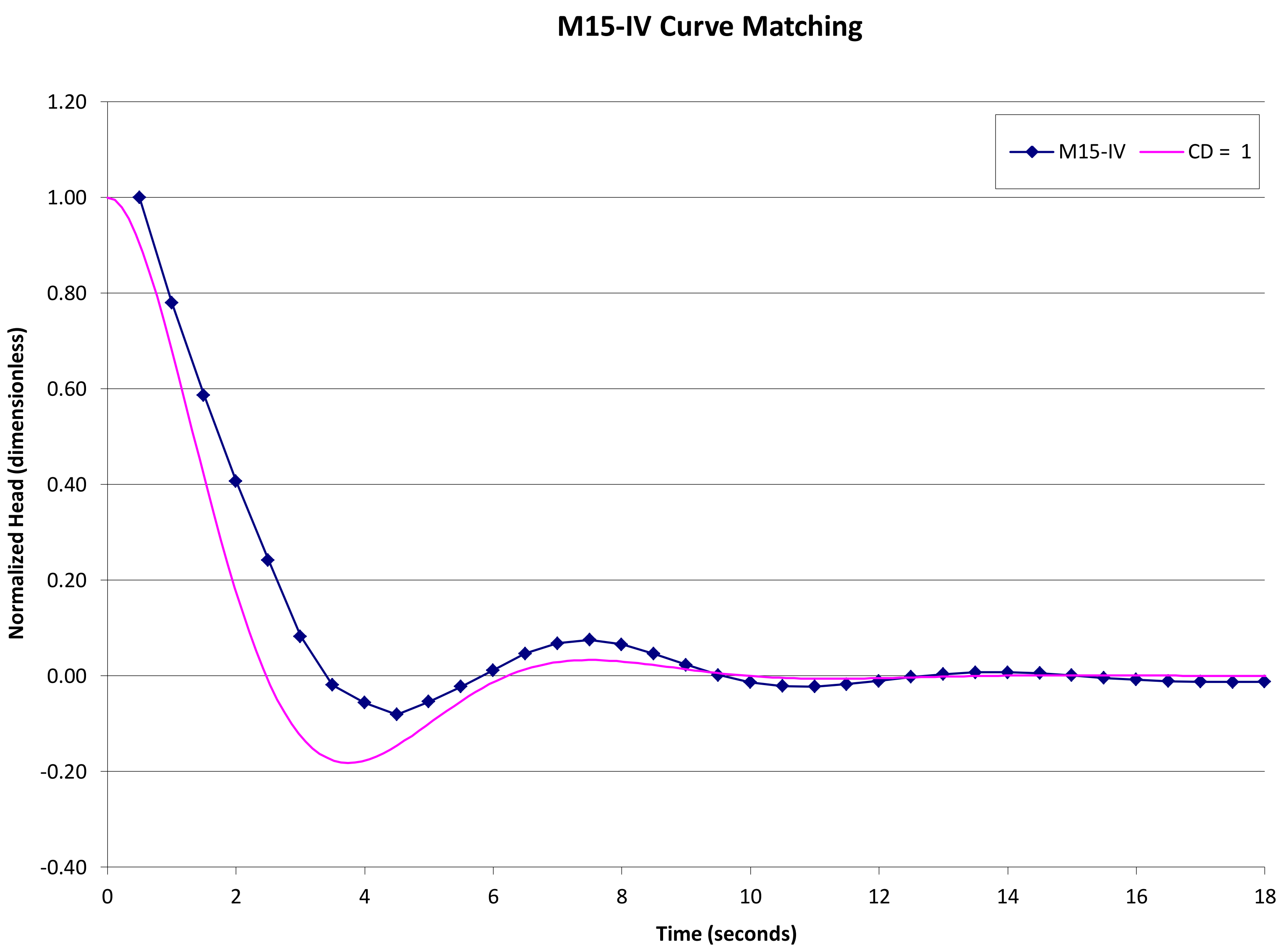
Bracketted quantity 365.330

K_r = 7.07E-05 m/sec
6.11E+00 m/day 2.00E+01 ft/day
7.07E-03 cm/sec

A = 1.4720+3.537E-2(b/r_w*)-8.148E-5(b/r_w*)^2+1.028E-7(b/r_w*)^3-6.484E-11(b/r_w*)^4+1.573E-14(b/r_w*)^5

B = 0.2372+5.151E-3(b/r_w*)-2.682E-6(b/r_w*)^2-3.491E-10(b/r_w*)^3+4.738E-13(b/r_w*)^4

Harden Environmental Services Ltd.	Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	M15-IV Underdamped Slug Test Analysis
	Date: May 2014	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	**M15-IV Underdamped Slug Test Analysis**
Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		

Appendix C

Water Quality Results

i. Hidden Quarry M15-I, M15-II, M15-III, M15-IV

ii. Guelph Limestone Quarry S1, S2, S3, S4

iii. Hidden Quarry Tributary B Upstream (SW4), Tributary B Downstream (SW8), Tributary C (SW11)

iv. Hidden Quarry Tributary B (Sample ID SW1), Hidden Quarry Tributary A (Sample ID SW2), Guelph Limestone Quarry (Sample ID SW3)

Your Project #: 9506
Site Location: ROCKWOOD
Your C.O.C. #: 34279

Attention:Stan Denhoed

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/05/08
Report #: R3023763
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B472934
Received: 2014/05/05, 14:39

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	4	N/A	2014/05/06	CAM SOP-00448	SM 2320B
Carbonate, Bicarbonate and Hydroxide	4	N/A	2014/05/07	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	4	N/A	2014/05/07	CAM SOP-00463	EPA 325.2
Conductivity	4	N/A	2014/05/06	CAM SOP-00414	SM 2510
Dissolved Organic Carbon (DOC) (1)	4	N/A	2014/05/07	CAM SOP-00446	SM 5310 B
Hardness (calculated as CaCO3)	4	N/A	2014/05/08	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	4	N/A	2014/05/08	CAM SOP-00447	EPA 6020
Ion Balance (% Difference)	4	N/A	2014/05/08		
Anion and Cation Sum	4	N/A	2014/05/08		
Total Ammonia-N	4	N/A	2014/05/07	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (2)	4	N/A	2014/05/06	CAM SOP-00440	SM 4500 NO3I/NO2B
pH	4	N/A	2014/05/06	CAM SOP-00413	SM 4500H+ B
Orthophosphate	4	N/A	2014/05/07	CAM SOP-00461	EPA 365.1
Sat. pH and Langelier Index (@ 20C)	4	N/A	2014/05/08		
Sat. pH and Langelier Index (@ 4C)	4	N/A	2014/05/08		
Sulphate by Automated Colourimetry	4	N/A	2014/05/07	CAM SOP-00464	EPA 375.4
Total Dissolved Solids (TDS calc)	4	N/A	2014/05/08		
Total Kjeldahl Nitrogen in Water	4	2014/05/06	2014/05/07	CAM SOP-00454	EPA 351.2 Rev 2

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Success Through Science®

Your Project #: 9506
Site Location: ROCKWOOD
Your C.O.C. #: 34279

Attention:Stan Denhoed

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/05/08
Report #: R3023763
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B472934
Received: 2014/05/05, 14:39

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Andrew Turner, Project Manager
Email: ATurner@maxxam.ca
Phone# (800)268-7396 Ext:233
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B472934
Report Date: 2014/05/08

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

RESULTS OF ANALYSES OF WATER

Maxxam ID				VU0497	VU0498		VU0499		VU0500		
Sampling Date				2014/05/05 10:40	2014/05/05 11:00		2014/05/05 11:30		2014/05/05 11:45		
COC Number				34279	34279		34279		34279		
	Units	**Criteria A**	**A/O**	**M15-1**	**M15-2**	**RDL**	**M15-3**	**RDL**	**M15-4**	**RDL**	**QC Batch**
Calculated Parameters											
Anion Sum	me/L	-	-	8.48	7.96	N/A	8.17	N/A	7.03	N/A	3594544
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	-	260	260	1.0	270	1.0	290	1.0	3594475
Calculated TDS	mg/L	-	500	470	440	1.0	450	1.0	370	1.0	3594547
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	-	1.9	2.0	1.0	2.0	1.0	2.3	1.0	3594475
Cation Sum	me/L	-	-	8.30	7.92	N/A	7.96	N/A	7.03	N/A	3594544
Hardness (CaCO3)	mg/L	-	80:100	390	370	1.0	340	1.0	340	1.0	3593957
Ion Balance (% Difference)	%	-	-	1.07	0.230	N/A	1.33	N/A	0.0100	N/A	3594543
Langelier Index (@ 20C)	N/A	-	-	0.883	0.879		0.866		0.911		3594545
Langelier Index (@ 4C)	N/A	-	-	0.635	0.631		0.618		0.662		3594546
Saturation pH (@ 20C)	N/A	-	-	7.01	7.02		7.04		7.03		3594545
Saturation pH (@ 4C)	N/A	-	-	7.26	7.27		7.29		7.28		3594546
Inorganics											
Total Ammonia-N	mg/L	-	-	ND	ND	0.050	ND	0.050	ND	0.050	3596106
Conductivity	umho/cm	-	-	760	730	1.0	750	1.0	640	1.0	3595001
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	0.22	0.28	0.10	0.90	0.50	0.19	0.10	3595316
Dissolved Organic Carbon	mg/L	-	5	0.83	0.85	0.20	2.1	0.20	0.85	0.20	3595143
Orthophosphate (P)	mg/L	-	-	ND	ND	0.010	ND	0.010	ND	0.010	3595530
pH	pH	-	6.5:8.5	7.89	7.90	N/A	7.90	N/A	7.94	N/A	3595002
Dissolved Sulphate (SO4)	mg/L	-	500	130	94	1	92	1	38	1	3595531
Alkalinity (Total as CaCO3)	mg/L	-	30:500	260	270	1.0	270	1.0	290	1.0	3594997
Dissolved Chloride (Cl)	mg/L	-	250	18	19	1	20	1	12	1	3595528
Nitrite (N)	mg/L	**1**	-	ND	ND	0.010	ND	0.010	ND	0.010	3595183
Nitrate (N)	mg/L	**10**	-	1.62	2.19	0.10	3.17	0.10	1.96	0.10	3595183
Nitrate + Nitrite	mg/L	**10**	-	1.62	2.19	0.10	3.17	0.10	1.96	0.10	3595183

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria A,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

N/A = Not Applicable

ND = Not detected

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Maxxam

Success Through Science®

Maxxam Job #: B472934
Report Date: 2014/05/08

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					VU0497	VU0498	VU0499	VU0500		
Sampling Date					2014/05/05 10:40	2014/05/05 11:00	2014/05/05 11:30	2014/05/05 11:45		
COC Number					34279	34279	34279	34279		
	Units	**Criteria A**	**IMC**	**A/O**	**M15-1**	**M15-2**	**M15-3**	**M15-4**	**RDL**	**QC Batch**
Metals										
Dissolved Aluminum (Al)	mg/L	-	-	0.1	0.0069	0.0065	0.014	0.0061	0.0050	3594697
Dissolved Antimony (Sb)	mg/L	-	0.006	-	0.0033	0.0027	0.0011	ND	0.00050	3594697
Dissolved Arsenic (As)	mg/L	-	0.025	-	ND	ND	ND	ND	0.0010	3594697
Dissolved Barium (Ba)	mg/L	**1**	-	-	0.12	0.096	0.094	0.070	0.0020	3594697
Dissolved Beryllium (Be)	mg/L	-	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Bismuth (Bi)	mg/L	-	-	-	ND	ND	ND	ND	0.0010	3594697
Dissolved Boron (B)	mg/L	-	5	-	0.016	0.013	0.016	0.017	0.010	3594697
Dissolved Cadmium (Cd)	mg/L	**0.005**	-	-	ND	ND	ND	ND	0.00010	3594697
Dissolved Calcium (Ca)	mg/L	-	-	-	110	100	96	89	0.20	3594697
Dissolved Chromium (Cr)	mg/L	**0.05**	-	-	ND	ND	ND	ND	0.0050	3594697
Dissolved Cobalt (Co)	mg/L	-	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Copper (Cu)	mg/L	-	-	1	ND	ND	ND	ND	0.0010	3594697
Dissolved Iron (Fe)	mg/L	-	-	0.3	ND	ND	ND	ND	0.10	3594697
Dissolved Lead (Pb)	mg/L	**0.01**	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Magnesium (Mg)	mg/L	-	-	-	29	28	24	28	0.050	3594697
Dissolved Manganese (Mn)	mg/L	-	-	0.05	ND	0.0024	0.0080	ND	0.0020	3594697
Dissolved Molybdenum (Mo)	mg/L	-	-	-	0.0020	0.0029	0.0026	0.0013	0.00050	3594697
Dissolved Nickel (Ni)	mg/L	-	-	-	0.0031	0.0048	0.0024	ND	0.0010	3594697
Dissolved Phosphorus (P)	mg/L	-	-	-	ND	ND	ND	ND	0.10	3594697
Dissolved Potassium (K)	mg/L	-	-	-	4.5	5.1	7.1	2.0	0.20	3594697
Dissolved Selenium (Se)	mg/L	**0.01**	-	-	ND	ND	ND	ND	0.0020	3594697
Dissolved Silicon (Si)	mg/L	-	-	-	4.1	4.1	4.2	4.1	0.050	3594697
Dissolved Silver (Ag)	mg/L	-	-	-	ND	ND	ND	ND	0.00010	3594697
Dissolved Sodium (Na)	mg/L	**20**	-	200	8.0	8.3	**23**	5.4	0.10	3594697
Dissolved Strontium (Sr)	mg/L	-	-	-	1.0	0.72	0.62	0.19	0.0010	3594697
Dissolved Thallium (Tl)	mg/L	-	-	-	0.00011	0.000098	0.000067	0.000052	0.000050	3594697
Dissolved Titanium (Ti)	mg/L	-	-	-	ND	ND	ND	ND	0.0050	3594697
Dissolved Uranium (U)	mg/L	**0.02**	-	-	0.0010	0.00096	0.0015	0.00031	0.00010	3594697
Dissolved Vanadium (V)	mg/L	-	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Zinc (Zn)	mg/L	-	-	5	0.028	0.040	0.017	0.034	0.0050	3594697

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria A,IMC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ND = Not detected

TEST SUMMARY

Maxxam ID: VU0497
Sample ID: M15-1
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

Maxxam ID: VU0498
Sample ID: M15-2
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

Maxxam Job #: B472934
Report Date: 2014/05/08

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

TEST SUMMARY

Maxxam ID: VU0499
Sample ID: M15-3
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

Maxxam ID: VU0500
Sample ID: M15-4
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

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TEST SUMMARY

Maxxam ID: VU0500 Dup
Sample ID: M15-4
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman

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GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3594697	JBW	Matrix Spike [VU0500-04]	Dissolved Aluminum (Al)	2014/05/08		108	%	80 - 120
			Dissolved Antimony (Sb)	2014/05/08		111	%	80 - 120
			Dissolved Arsenic (As)	2014/05/08		105	%	80 - 120
			Dissolved Barium (Ba)	2014/05/08		106	%	80 - 120
			Dissolved Beryllium (Be)	2014/05/08		105	%	80 - 120
			Dissolved Bismuth (Bi)	2014/05/08		106	%	80 - 120
			Dissolved Boron (B)	2014/05/08		107	%	80 - 120
			Dissolved Cadmium (Cd)	2014/05/08		109	%	80 - 120
			Dissolved Calcium (Ca)	2014/05/08		NC	%	80 - 120
			Dissolved Chromium (Cr)	2014/05/08		101	%	80 - 120
			Dissolved Cobalt (Co)	2014/05/08		107	%	80 - 120
			Dissolved Copper (Cu)	2014/05/08		103	%	80 - 120
			Dissolved Iron (Fe)	2014/05/08		104	%	80 - 120
			Dissolved Lead (Pb)	2014/05/08		101	%	80 - 120
			Dissolved Magnesium (Mg)	2014/05/08		NC	%	80 - 120
			Dissolved Manganese (Mn)	2014/05/08		106	%	80 - 120
			Dissolved Molybdenum (Mo)	2014/05/08		103	%	80 - 120
			Dissolved Nickel (Ni)	2014/05/08		103	%	80 - 120
			Dissolved Phosphorus (P)	2014/05/08		112	%	80 - 120
			Dissolved Potassium (K)	2014/05/08		107	%	80 - 120
			Dissolved Selenium (Se)	2014/05/08		107	%	80 - 120
			Dissolved Silicon (Si)	2014/05/08		102	%	80 - 120
			Dissolved Silver (Ag)	2014/05/08		97	%	80 - 120
			Dissolved Sodium (Na)	2014/05/08		103	%	80 - 120
			Dissolved Strontium (Sr)	2014/05/08		106	%	80 - 120
			Dissolved Thallium (Tl)	2014/05/08		97	%	80 - 120
			Dissolved Titanium (Ti)	2014/05/08		107	%	80 - 120
			Dissolved Uranium (U)	2014/05/08		107	%	80 - 120
			Dissolved Vanadium (V)	2014/05/08		100	%	80 - 120
			Dissolved Zinc (Zn)	2014/05/08		103	%	80 - 120
3594697	JBW	Spiked Blank	Dissolved Aluminum (Al)	2014/05/08		103	%	80 - 120
			Dissolved Antimony (Sb)	2014/05/08		104	%	80 - 120
			Dissolved Arsenic (As)	2014/05/08		99	%	80 - 120
			Dissolved Barium (Ba)	2014/05/08		103	%	80 - 120
			Dissolved Beryllium (Be)	2014/05/08		100	%	80 - 120
			Dissolved Bismuth (Bi)	2014/05/08		104	%	80 - 120
			Dissolved Boron (B)	2014/05/08		101	%	80 - 120
			Dissolved Cadmium (Cd)	2014/05/08		104	%	80 - 120
			Dissolved Calcium (Ca)	2014/05/08		100	%	80 - 120
			Dissolved Chromium (Cr)	2014/05/08		97	%	80 - 120
			Dissolved Cobalt (Co)	2014/05/08		102	%	80 - 120
			Dissolved Copper (Cu)	2014/05/08		98	%	80 - 120
			Dissolved Iron (Fe)	2014/05/08		98	%	80 - 120
			Dissolved Lead (Pb)	2014/05/08		98	%	80 - 120
			Dissolved Magnesium (Mg)	2014/05/08		99	%	80 - 120
			Dissolved Manganese (Mn)	2014/05/08		101	%	80 - 120
			Dissolved Molybdenum (Mo)	2014/05/08		96	%	80 - 120
			Dissolved Nickel (Ni)	2014/05/08		99	%	80 - 120
			Dissolved Phosphorus (P)	2014/05/08		107	%	80 - 120
			Dissolved Potassium (K)	2014/05/08		102	%	80 - 120
			Dissolved Selenium (Se)	2014/05/08		103	%	80 - 120
			Dissolved Silicon (Si)	2014/05/08		100	%	80 - 120
			Dissolved Silver (Ag)	2014/05/08		88	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Sodium (Na)	2014/05/08		98	%	80 - 120
			Dissolved Strontium (Sr)	2014/05/08		101	%	80 - 120
			Dissolved Thallium (Tl)	2014/05/08		93	%	80 - 120
			Dissolved Titanium (Ti)	2014/05/08		101	%	80 - 120
			Dissolved Uranium (U)	2014/05/08		102	%	80 - 120
			Dissolved Vanadium (V)	2014/05/08		95	%	80 - 120
			Dissolved Zinc (Zn)	2014/05/08		101	%	80 - 120
3594697	JBW	Method Blank	Dissolved Aluminum (Al)	2014/05/08	ND , RDL=0.0050		mg/L	
			Dissolved Antimony (Sb)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Arsenic (As)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Barium (Ba)	2014/05/08	ND , RDL=0.0020		mg/L	
			Dissolved Beryllium (Be)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Bismuth (Bi)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Boron (B)	2014/05/08	ND , RDL=0.010		mg/L	
			Dissolved Cadmium (Cd)	2014/05/08	ND , RDL=0.00010		mg/L	
			Dissolved Calcium (Ca)	2014/05/08	ND , RDL=0.20		mg/L	
			Dissolved Chromium (Cr)	2014/05/08	ND , RDL=0.0050		mg/L	
			Dissolved Cobalt (Co)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Copper (Cu)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Iron (Fe)	2014/05/08	ND , RDL=0.10		mg/L	
			Dissolved Lead (Pb)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Magnesium (Mg)	2014/05/08	ND , RDL=0.050		mg/L	
			Dissolved Manganese (Mn)	2014/05/08	ND , RDL=0.0020		mg/L	
			Dissolved Molybdenum (Mo)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Nickel (Ni)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Phosphorus (P)	2014/05/08	ND , RDL=0.10		mg/L	
			Dissolved Potassium (K)	2014/05/08	ND , RDL=0.20		mg/L	
			Dissolved Selenium (Se)	2014/05/08	ND , RDL=0.0020		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Silicon (Si)	2014/05/08	ND , RDL=0.050		mg/L	
			Dissolved Silver (Ag)	2014/05/08	ND , RDL=0.00010		mg/L	
			Dissolved Sodium (Na)	2014/05/08	ND , RDL=0.10		mg/L	
			Dissolved Strontium (Sr)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Thallium (Tl)	2014/05/08	ND , RDL=0.000050		mg/L	
			Dissolved Titanium (Ti)	2014/05/08	ND , RDL=0.0050		mg/L	
			Dissolved Uranium (U)	2014/05/08	ND , RDL=0.00010		mg/L	
			Dissolved Vanadium (V)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Zinc (Zn)	2014/05/08	ND , RDL=0.0050		mg/L	
3594697	JBW	RPD [VU0500-04]	Dissolved Aluminum (Al)	2014/05/08	NC		%	20
			Dissolved Antimony (Sb)	2014/05/08	NC		%	20
			Dissolved Arsenic (As)	2014/05/08	NC		%	20
			Dissolved Barium (Ba)	2014/05/08	0.5		%	20
			Dissolved Beryllium (Be)	2014/05/08	NC		%	20
			Dissolved Bismuth (Bi)	2014/05/08	NC		%	20
			Dissolved Boron (B)	2014/05/08	NC		%	20
			Dissolved Cadmium (Cd)	2014/05/08	NC		%	20
			Dissolved Calcium (Ca)	2014/05/08	0.3		%	20
			Dissolved Chromium (Cr)	2014/05/08	NC		%	20
			Dissolved Cobalt (Co)	2014/05/08	NC		%	20
			Dissolved Copper (Cu)	2014/05/08	NC		%	20
			Dissolved Iron (Fe)	2014/05/08	NC		%	20
			Dissolved Lead (Pb)	2014/05/08	NC		%	20
			Dissolved Magnesium (Mg)	2014/05/08	1.0		%	20
			Dissolved Manganese (Mn)	2014/05/08	NC		%	20
			Dissolved Molybdenum (Mo)	2014/05/08	NC		%	20
			Dissolved Nickel (Ni)	2014/05/08	NC		%	20
			Dissolved Phosphorus (P)	2014/05/08	NC		%	20
			Dissolved Potassium (K)	2014/05/08	0.8		%	20
			Dissolved Selenium (Se)	2014/05/08	NC		%	20
			Dissolved Silicon (Si)	2014/05/08	1.6		%	20
			Dissolved Silver (Ag)	2014/05/08	NC		%	20
			Dissolved Sodium (Na)	2014/05/08	0.2		%	20
			Dissolved Strontium (Sr)	2014/05/08	0.5		%	20
			Dissolved Thallium (Tl)	2014/05/08	NC		%	20
			Dissolved Titanium (Ti)	2014/05/08	NC		%	20
			Dissolved Uranium (U)	2014/05/08	NC		%	20
			Dissolved Vanadium (V)	2014/05/08	NC		%	20
			Dissolved Zinc (Zn)	2014/05/08	2.5		%	20
3594997	YPA	Spiked Blank	Alkalinity (Total as CaCO3)	2014/05/06		97	%	85 - 115
3594997	YPA	Method Blank	Alkalinity (Total as CaCO3)	2014/05/06	ND , RDL=1.0		mg/L	
3594997	YPA	RPD	Alkalinity (Total as CaCO3)	2014/05/06	0.7		%	25

Maxxam Job #: B472934
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Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3595001	YPA	Spiked Blank	Conductivity	2014/05/06		100	%	85 - 115
3595001	YPA	Method Blank	Conductivity	2014/05/06	ND , RDL=1.0		umho/cm	
3595001	YPA	RPD	Conductivity	2014/05/06	0		%	25
3595143	AHA	Matrix Spike	Dissolved Organic Carbon	2014/05/07		NC	%	80 - 120
3595143	AHA	Spiked Blank	Dissolved Organic Carbon	2014/05/07		104	%	80 - 120
3595143	AHA	Method Blank	Dissolved Organic Carbon	2014/05/07	ND , RDL=0.20		mg/L	
3595143	AHA	RPD	Dissolved Organic Carbon	2014/05/07	0.2		%	20
3595183	C_N	Matrix Spike	Nitrite (N)	2014/05/06		102	%	80 - 120
			Nitrate (N)	2014/05/06		NC	%	80 - 120
3595183	C_N	Spiked Blank	Nitrite (N)	2014/05/06		99	%	80 - 120
			Nitrate (N)	2014/05/06		104	%	80 - 120
3595183	C_N	Method Blank	Nitrite (N)	2014/05/06	ND , RDL=0.010		mg/L	
			Nitrate (N)	2014/05/06	ND , RDL=0.10		mg/L	
3595183	C_N	RPD	Nitrite (N)	2014/05/06	NC		%	25
			Nitrate (N)	2014/05/06	0.2		%	25
3595316	AHA	Matrix Spike	Total Kjeldahl Nitrogen (TKN)	2014/05/07		87	%	80 - 120
3595316	AHA	QC Standard	Total Kjeldahl Nitrogen (TKN)	2014/05/07		103	%	80 - 120
3595316	AHA	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2014/05/07		97	%	80 - 120
3595316	AHA	Method Blank	Total Kjeldahl Nitrogen (TKN)	2014/05/07	ND , RDL=0.10		mg/L	
3595316	AHA	RPD	Total Kjeldahl Nitrogen (TKN)	2014/05/07	NC		%	20
3595528	DRM	Matrix Spike	Dissolved Chloride (Cl)	2014/05/07		NC	%	80 - 120
3595528	DRM	Spiked Blank	Dissolved Chloride (Cl)	2014/05/07		104	%	80 - 120
3595528	DRM	Method Blank	Dissolved Chloride (Cl)	2014/05/07	ND , RDL=1		mg/L	
3595528	DRM	RPD	Dissolved Chloride (Cl)	2014/05/07	0.3		%	20
3595530	ADB	Matrix Spike	Orthophosphate (P)	2014/05/07		102	%	75 - 125
3595530	ADB	Spiked Blank	Orthophosphate (P)	2014/05/07		100	%	80 - 120
3595530	ADB	Method Blank	Orthophosphate (P)	2014/05/07	ND , RDL=0.010		mg/L	
3595530	ADB	RPD	Orthophosphate (P)	2014/05/07	NC		%	25
3595531	ADB	Matrix Spike	Dissolved Sulphate (SO4)	2014/05/07		NC	%	75 - 125
3595531	ADB	Spiked Blank	Dissolved Sulphate (SO4)	2014/05/07		99	%	80 - 120
3595531	ADB	Method Blank	Dissolved Sulphate (SO4)	2014/05/07	ND , RDL=1		mg/L	
3595531	ADB	RPD	Dissolved Sulphate (SO4)	2014/05/07	1.0		%	20
3596106	COP	Matrix Spike	Total Ammonia-N	2014/05/07		96	%	80 - 120
3596106	COP	Spiked Blank	Total Ammonia-N	2014/05/07		99	%	85 - 115
3596106	COP	Method Blank	Total Ammonia-N	2014/05/07	ND , RDL=0.050		mg/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3596106	COP	RPD	Total Ammonia-N	2014/05/07	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

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Maxxam Job #: B472934
Report Date: 2014/05/08

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eva Pranjic CHARTERED CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Your Project #: 0508
Site Location: JAMES DICK
Your C.O.C. #: 24525

Attention:Stan Denhoed

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/05/01
Report #: R3017140
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B468586
Received: 2014/04/29, 10:30

Sample Matrix: Water
\# Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Total Ammonia-N	4	N/A	2014/05/01	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (1)	4	N/A	2014/04/30	CAM SOP-00440	SM 4500 NO3I/NO2B
Total Kjeldahl Nitrogen in Water	4	2014/04/29	2014/04/30	CAM SOP-00454	EPA 351.2 Rev 2

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Andrew Turner, Project Manager
Email: ATurner@maxxam.ca
Phone# (800)268-7396 Ext:233
==
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Maxxam Job #: B468586
Report Date: 2014/05/01

Harden Environmental
Client Project #: 0508
Site Location: JAMES DICK

RESULTS OF ANALYSES OF WATER

Maxxam ID			VR9820	VR9821	VR9822	VR9823		
Sampling Date			2014/04/28 11:50	2014/04/28 17:34	2014/04/28 18:40	2014/04/28 08:25		
COC Number			24525	24525	24525	24525		
	Units	**MAC**	**S1**	**S2**	**S3**	**S4**	**RDL**	**QC Batch**
Inorganics								
Total Ammonia-N	mg/L	-	ND	ND	ND	ND	0.050	3588966
Total Kjeldahl Nitrogen (TKN)	mg/L	-	0.31	0.43	0.43	0.29	0.10	3588404
Nitrite (N)	mg/L	**1**	ND	ND	ND	ND	0.010	3588115
Nitrate (N)	mg/L	**10**	0.47	0.46	0.44	0.47	0.10	3588115

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

MAC: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ND = Not detected

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TEST SUMMARY

Maxxam ID: VR9820
Sample ID: S1
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

Maxxam ID: VR9820 Dup
Sample ID: S1
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal

Maxxam ID: VR9821
Sample ID: S2
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

Maxxam ID: VR9822
Sample ID: S3
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

Maxxam ID: VR9823
Sample ID: S4
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

GENERAL COMMENTS

Results relate only to the items tested.

Maxxam Job #: B468586
Report Date: 2014/05/01

Harden Environmental
Client Project #: 0508
Site Location: JAMES DICK

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3588115	C_N	Matrix Spike [VR9820-01]	Nitrite (N)	2014/04/30		102	%	80 - 120
			Nitrate (N)	2014/04/30		98	%	80 - 120
3588115	C_N	Spiked Blank	Nitrite (N)	2014/04/30		98	%	80 - 120
			Nitrate (N)	2014/04/30		98	%	80 - 120
3588115	C_N	Method Blank	Nitrite (N)	2014/04/30	ND , RDL=0.010		mg/L	
			Nitrate (N)	2014/04/30	ND , RDL=0.10		mg/L	
3588115	C_N	RPD [VR9820-01]	Nitrate (N)	2014/04/30	NC		%	25
3588404	AHA	Matrix Spike	Total Kjeldahl Nitrogen (TKN)	2014/04/30		61 (1)	%	80 - 120
3588404	AHA	QC Standard	Total Kjeldahl Nitrogen (TKN)	2014/04/30		104	%	80 - 120
3588404	AHA	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/30		91	%	80 - 120
3588404	AHA	Method Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/30	ND , RDL=0.10		mg/L	
3588404	AHA	RPD	Total Kjeldahl Nitrogen (TKN)	2014/04/30	1.3		%	20
3588966	COP	Matrix Spike	Total Ammonia-N	2014/05/01		103	%	80 - 120
3588966	COP	Spiked Blank	Total Ammonia-N	2014/05/01		100	%	85 - 115
3588966	COP	Method Blank	Total Ammonia-N	2014/05/01	ND , RDL=0.050		mg/L	
3588966	COP	RPD	Total Ammonia-N	2014/05/01	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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Maxxam Job #: B468586
Report Date: 2014/05/01

Harden Environmental
Client Project #: 0508
Site Location: JAMES DICK

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Services

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Your Project #: 9506 Rockwood
Your C.O.C. #: 46314602, 463146-02-01

Attention:Allan Rodie

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/04/15
Report #: R3001006
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455991
Received: 2014/04/08, 15:14

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	3	N/A	2014/04/10	CAM SOP-00448	SM 2320B
Carbonate, Bicarbonate and Hydroxide	3	N/A	2014/04/11	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	3	N/A	2014/04/10	CAM SOP-00463	EPA 325.2
Conductivity	3	N/A	2014/04/10	CAM SOP-00414	SM 2510
Dissolved Organic Carbon (DOC) (1)	3	N/A	2014/04/09	CAM SOP-00446	SM 5310 B
Hardness (calculated as CaCO3)	3	N/A	2014/04/10	CAM SOP 00102/00408/00447	SM 2340 B
Lab Filtered Metals Analysis by ICP	3	2014/04/10	2014/04/10	CAM SOP-00408	SW-846 6010C
Total Metals Analysis by ICPMS	3	N/A	2014/04/14	CAM SOP-00447	EPA 6020
Ion Balance (% Difference)	3	N/A	2014/04/11		
Anion and Cation Sum	3	N/A	2014/04/11		
Coliform, (CFU/100mL)	3	N/A	2014/04/08	CAM SOP-00552	MOE LSB E3371
E.coli, (CFU/100mL)	3	N/A	2014/04/08	CAM SOP-00552	MOE LSB E3371
Total Ammonia-N	3	N/A	2014/04/14	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (2)	3	N/A	2014/04/09	CAM SOP-00440	SM 4500 NO3I/NO2B
Organic Nitrogen	3	N/A	2014/04/14	APHA Standard Methods	SM4500
pH	3	N/A	2014/04/10	CAM SOP-00413	SM 4500H+ B
Orthophosphate	3	N/A	2014/04/10	CAM SOP-00461	EPA 365.1
Sat. pH and Langelier Index (@ 20C)	3	N/A	2014/04/11		
Sat. pH and Langelier Index (@ 4C)	3	N/A	2014/04/11		
Sulphate by Automated Colourimetry	3	N/A	2014/04/10	CAM SOP-00464	EPA 375.4
Total Kjeldahl Nitrogen in Water	3	2014/04/11	2014/04/11	CAM SOP-00454	EPA 351.2 Rev 2
Total Organic Carbon (TOC) (3)	3	N/A	2014/04/12	CAM SOP-00446	SM 5310B
Total Phosphorus (Colourimetric)	3	2014/04/14	2014/04/15	CAM SOP-00407	APHA 4500 P,B,F
Turbidity	3	N/A	2014/04/09	CAM SOP-00417	APHA 2130B

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting

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Your Project #: 9506 Rockwood
Your C.O.C. #: 46314602, 463146-02-01

Attention:Allan Rodie

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/04/15
Report #: R3001006
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455991
Received: 2014/04/08, 15:14

results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

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* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.
(3) Total Organic Carbon (TOC) present in the sample should be considered as non-purgeable TOC.

Encryption Key

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Andrew Turner, Project Manager
Email: ATurner@maxxam.ca
Phone# (800)268-7396 Ext:233
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Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

RESULTS OF ANALYSES OF WATER

Maxxam ID			VL9687	VL9688		VL9689		
Sampling Date			2014/04/08 10:30	2014/04/08 11:00		2014/04/08 12:00		
COC Number			463146-02-01	463146-02-01		463146-02-01		
	Units	**Criteria**	**SW 8**	**SW 4**	**QC Batch**	**SW 11**	**RDL**	**QC Batch**
Calculated Parameters								
Anion Sum	me/L	-	5.99	6.05	3566801	4.21	N/A	3566801
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	240	240	3566798	180	1.0	3566798
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	3.0	2.7	3566798	2.0	1.0	3566798
Cation Sum	me/L	-	6.50	6.89	3566801	4.60	N/A	3566801
Hardness (CaCO3)	mg/L	-	300	320	3566098	210	1.0	3566098
Ion Balance (% Difference)	%	-	4.09	6.49	3566800	4.43	N/A	3566800
Langelier Index (@ 20C)	N/A	-	1.02	0.984	3566803	0.710		3566803
Langelier Index (@ 4C)	N/A	-	0.770	0.736	3566804	0.461		3566804
Total Organic Nitrogen	mg/L	-	0.4	0.5	3566120	0.5	0.1	3566120
Saturation pH (@ 20C)	N/A	-	7.12	7.09	3566803	7.36		3566803
Saturation pH (@ 4C)	N/A	-	7.36	7.34	3566804	7.61		3566804
Inorganics								
Total Ammonia-N	mg/L	-	ND	ND	3571016	0.076	0.050	3571016
Conductivity	umho/cm	-	560	570	3568643	390	1.0	3568643
Total Kjeldahl Nitrogen (TKN)	mg/L	-	0.43	0.54	3570432	0.62	0.10	3570432
Dissolved Organic Carbon	mg/L	-	2.4	2.3	3567546	5.2	0.20	3568077
Total Organic Carbon (TOC)	mg/L	-	2.6	2.7	3571047	5.5	0.20	3571047
Orthophosphate (P)	mg/L	-	ND	ND	3568684	0.030	0.010	3568684
pH	pH	**6.5:8.5**	8.13	8.07	3568644	8.07	N/A	3568644
Total Phosphorus	mg/L	**0.01**	0.002	0.002	3572645	**0.047**	0.002	3572645
Dissolved Sulphate (SO4)	mg/L	-	14	14	3568685	7	1	3568685
Turbidity	NTU	-	0.4	0.3	3568272	1.4	0.2	3568272
Alkalinity (Total as CaCO3)	mg/L	-	240	240	3568642	180	1.0	3568642
Dissolved Chloride (Cl)	mg/L	-	20	21	3568680	14	1	3568680
Nitrite (N)	mg/L	-	ND	ND	3567578	ND	0.010	3567578
Nitrate (N)	mg/L	-	4.53	4.64	3567578	0.90	0.10	3567578

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999
N/A = Not Applicable
ND = Not detected

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Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID			VL9687	VL9688	VL9689		
Sampling Date			2014/04/08 10:30	2014/04/08 11:00	2014/04/08 12:00		
COC Number			463146-02-01	463146-02-01	463146-02-01		
	Units	**Criteria**	**SW 8**	**SW 4**	**SW 11**	**RDL**	**QC Batch**
Metals							
Dissolved Calcium (Ca)	mg/L	-	85.1	90.4	60.7	0.05	3568899
Dissolved Magnesium (Mg)	mg/L	-	21.9	23.1	15.3	0.05	3568899
Dissolved Potassium (K)	mg/L	-	3	3	3	1	3568899
Dissolved Sodium (Na)	mg/L	-	9.1	9.6	5.3	0.5	3568899
Total Aluminum (Al)	mg/L	-	0.012	0.011	0.064	0.0050	3572799
Total Antimony (Sb)	mg/L	**0.02**	ND	ND	ND	0.00050	3572799
Total Arsenic (As)	mg/L	**0.1**	ND	ND	ND	0.0010	3572799
Total Barium (Ba)	mg/L	-	0.023	0.024	0.020	0.0020	3572799
Total Beryllium (Be)	mg/L	**0.011**	ND	ND	ND	0.00050	3572799
Total Boron (B)	mg/L	**0.2**	0.011	0.011	ND	0.010	3572799
Total Cadmium (Cd)	mg/L	**0.0002**	ND	ND	ND	0.00010	3572799
Total Calcium (Ca)	mg/L	-	78	79	56	0.20	3572799
Total Chromium (Cr)	mg/L	-	ND	ND	ND	0.0050	3572799
Total Cobalt (Co)	mg/L	**0.0009**	ND	ND	ND	0.00050	3572799
Total Copper (Cu)	mg/L	**0.005**	ND	ND	0.0015	0.0010	3572799
Total Iron (Fe)	mg/L	**0.3**	ND	ND	ND	0.10	3572799
Total Lead (Pb)	mg/L	**0.005**	ND	ND	ND	0.00050	3572799
Total Magnesium (Mg)	mg/L	-	20	21	14	0.050	3572799
Total Manganese (Mn)	mg/L	-	0.0031	0.0066	0.018	0.0020	3572799
Total Molybdenum (Mo)	mg/L	**0.04**	ND	ND	0.00053	0.00050	3572799
Total Nickel (Ni)	mg/L	**0.025**	ND	ND	ND	0.0010	3572799
Total Potassium (K)	mg/L	-	2.3	2.3	2.9	0.20	3572799
Total Silicon (Si)	mg/L	-	2.8	2.8	2.6	0.050	3572799
Total Selenium (Se)	mg/L	**0.1**	ND	ND	ND	0.0020	3572799
Total Silver (Ag)	mg/L	**0.0001**	ND	ND	ND	0.00010	3572799
Total Sodium (Na)	mg/L	-	8.3	8.5	4.7	0.10	3572799
Total Strontium (Sr)	mg/L	-	0.098	0.10	0.071	0.0010	3572799
Total Thallium (Tl)	mg/L	**0.0003**	ND	ND	ND	0.000050	3572799
Total Titanium (Ti)	mg/L	-	ND	ND	0.0054	0.0050	3572799
Total Uranium (U)	mg/L	**0.005**	0.00040	0.00039	0.00080	0.00010	3572799
Total Vanadium (V)	mg/L	**0.006**	ND	0.00051	0.00061	0.00050	3572799
Total Zinc (Zn)	mg/L	**0.03**	**0.032**	**0.032**	**0.076**	0.0050	3572799

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999
ND = Not detected

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Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

MICROBIOLOGY (WATER)

Maxxam ID		VL9687	VL9688	VL9689		
Sampling Date		2014/04/08 10:30	2014/04/08 11:00	2014/04/08 12:00		
COC Number		463146-02-01	463146-02-01	463146-02-01		
	Units	**SW 8**	**SW 4**	**SW 11**	**RDL**	**QC Batch**
Microbiological						
Background	CFU/100mL	1900	1500	5100	10	3566835
Total Coliforms	CFU/100mL	120	70	210	10	3566835
Escherichia coli	CFU/100mL	20	40	10	10	3566832

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

TEST SUMMARY

Maxxam ID: VL9687
Sample ID: SW 8
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	3566798	N/A	2014/04/11	Automated Statchk
Chloride by Automated Colourimetry	AC	3568680	N/A	2014/04/10	Alina Dobreanu
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3567546	N/A	2014/04/09	Anastasia Hamanov
Hardness (calculated as CaCO3)		3566098	N/A	2014/04/10	Automated Statchk
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Ion Balance (% Difference)	CALC	3566800	N/A	2014/04/11	Automated Statchk
Anion and Cation Sum	CALC	3566801	N/A	2014/04/11	Automated Statchk
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/08	
E.coli, (CFU/100mL)	PL	3566832	N/A	2014/04/08	Maxima Hermanez
Total Ammonia-N	LACH/NH4	3571016	N/A	2014/04/14	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3567578	N/A	2014/04/09	Chandra Nandlal
Organic Nitrogen	CALC	3566120	N/A	2014/04/14	Automated Statchk
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Orthophosphate	AC	3568684	N/A	2014/04/10	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3566803	N/A	2014/04/11	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3566804	N/A	2014/04/11	Automated Statchk
Sulphate by Automated Colourimetry	AC	3568685	N/A	2014/04/10	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	AC	3570432	2014/04/11	2014/04/11	Anastasia Hamanov
Total Organic Carbon (TOC)	TOCV/NDIR	3571047	N/A	2014/04/12	Anastasia Hamanov
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9687 Dup
Sample ID: SW 8
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/09	
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9688
Sample ID: SW 4
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	3566798	N/A	2014/04/11	Automated Statchk
Chloride by Automated Colourimetry	AC	3568680	N/A	2014/04/10	Alina Dobreanu
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3567546	N/A	2014/04/09	Anastasia Hamanov
Hardness (calculated as CaCO3)		3566098	N/A	2014/04/10	Automated Statchk

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TEST SUMMARY

Maxxam ID: VL9688
Sample ID: SW 4
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Ion Balance (% Difference)	CALC	3566800	N/A	2014/04/11	Automated Statchk
Anion and Cation Sum	CALC	3566801	N/A	2014/04/11	Automated Statchk
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/08	
E.coli, (CFU/100mL)	PL	3566832	N/A	2014/04/08	Maxima Hermanez
Total Ammonia-N	LACH/NH4	3571016	N/A	2014/04/14	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3567578	N/A	2014/04/09	Chandra Nandlal
Organic Nitrogen	CALC	3566120	N/A	2014/04/14	Automated Statchk
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Orthophosphate	AC	3568684	N/A	2014/04/10	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3566803	N/A	2014/04/11	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3566804	N/A	2014/04/11	Automated Statchk
Sulphate by Automated Colourimetry	AC	3568685	N/A	2014/04/10	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	AC	3570432	2014/04/11	2014/04/11	Anastasia Hamanov
Total Organic Carbon (TOC)	TOCV/NDIR	3571047	N/A	2014/04/12	Anastasia Hamanov
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9688 Dup
Sample ID: SW 4
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru

Maxxam ID: VL9689
Sample ID: SW 11
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	3566798	N/A	2014/04/11	Automated Statchk
Chloride by Automated Colourimetry	AC	3568680	N/A	2014/04/10	Alina Dobreanu
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3568077	N/A	2014/04/09	Anastasia Hamanov
Hardness (calculated as CaCO3)		3566098	N/A	2014/04/10	Automated Statchk
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Ion Balance (% Difference)	CALC	3566800	N/A	2014/04/11	Automated Statchk
Anion and Cation Sum	CALC	3566801	N/A	2014/04/11	Automated Statchk

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Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

TEST SUMMARY

Maxxam ID: VL9689
Sample ID: SW 11
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/08	
E.coli, (CFU/100mL)	PL	3566832	N/A	2014/04/08	Maxima Hermanez
Total Ammonia-N	LACH/NH4	3571016	N/A	2014/04/14	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3567578	N/A	2014/04/09	Chandra Nandlal
Organic Nitrogen	CALC	3566120	N/A	2014/04/14	Automated Statchk
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Orthophosphate	AC	3568684	N/A	2014/04/10	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3566803	N/A	2014/04/11	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3566804	N/A	2014/04/11	Automated Statchk
Sulphate by Automated Colourimetry	AC	3568685	N/A	2014/04/10	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	AC	3570432	2014/04/11	2014/04/11	Anastasia Hamanov
Total Organic Carbon (TOC)	TOCV/NDIR	3571047	N/A	2014/04/12	Anastasia Hamanov
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9689 Dup
Sample ID: SW 11
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3568077	N/A	2014/04/09	Anastasia Hamanov

GENERAL COMMENTS

Results relate only to the items tested.

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Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3567546	AHA	Matrix Spike	Dissolved Organic Carbon	2014/04/09		96	%	80 - 120
3567546	AHA	Spiked Blank	Dissolved Organic Carbon	2014/04/09		97	%	80 - 120
3567546	AHA	Method Blank	Dissolved Organic Carbon	2014/04/09	ND , RDL=0.20		mg/L	
3567546	AHA	RPD	Dissolved Organic Carbon	2014/04/09	6.5		%	20
3567578	C_N	Matrix Spike	Nitrite (N)	2014/04/09		105	%	80 - 120
			Nitrate (N)	2014/04/09		NC	%	80 - 120
3567578	C_N	Spiked Blank	Nitrite (N)	2014/04/09		102	%	80 - 120
			Nitrate (N)	2014/04/09		100	%	80 - 120
3567578	C_N	Method Blank	Nitrite (N)	2014/04/09	ND , RDL=0.010		mg/L	
			Nitrate (N)	2014/04/09	ND , RDL=0.10		mg/L	
3567578	C_N	RPD	Nitrite (N)	2014/04/09	NC		%	25
			Nitrate (N)	2014/04/09	1		%	25
3568077	AHA	Matrix Spike [VL9689-01]	Dissolved Organic Carbon	2014/04/09		98	%	80 - 120
3568077	AHA	Spiked Blank	Dissolved Organic Carbon	2014/04/09		99	%	80 - 120
3568077	AHA	Method Blank	Dissolved Organic Carbon	2014/04/09	ND , RDL=0.20		mg/L	
3568077	AHA	RPD [VL9689-01]	Dissolved Organic Carbon	2014/04/09	0.5		%	20
3568272	L_A	QC Standard	Turbidity	2014/04/09		98	%	85 - 115
3568272	L_A	Method Blank	Turbidity	2014/04/09	ND , RDL=0.2		NTU	
3568272	L_A	RPD [VL9687-01]	Turbidity	2014/04/09	NC		%	20
3568642	SAU	Spiked Blank	Alkalinity (Total as CaCO3)	2014/04/10		93	%	85 - 115
3568642	SAU	Method Blank	Alkalinity (Total as CaCO3)	2014/04/10	ND , RDL=1.0		mg/L	
3568642	SAU	RPD [VL9688-01]	Alkalinity (Total as CaCO3)	2014/04/10	0.4		%	25
3568643	SAU	Spiked Blank	Conductivity	2014/04/10		98	%	85 - 115
3568643	SAU	Method Blank	Conductivity	2014/04/10	ND , RDL=1.0		umho/cm	
3568643	SAU	RPD [VL9688-01]	Conductivity	2014/04/10	0.2		%	25
3568680	ADB	Matrix Spike	Dissolved Chloride (Cl)	2014/04/10		NC	%	80 - 120
3568680	ADB	Spiked Blank	Dissolved Chloride (Cl)	2014/04/10		103	%	80 - 120
3568680	ADB	Method Blank	Dissolved Chloride (Cl)	2014/04/10	ND , RDL=1		mg/L	
3568680	ADB	RPD	Dissolved Chloride (Cl)	2014/04/10	1		%	20
3568684	ADB	Matrix Spike	Orthophosphate (P)	2014/04/10		102	%	75 - 125
3568684	ADB	Spiked Blank	Orthophosphate (P)	2014/04/10		100	%	80 - 120
3568684	ADB	Method Blank	Orthophosphate (P)	2014/04/10	ND , RDL=0.010		mg/L	
3568684	ADB	RPD	Orthophosphate (P)	2014/04/10	NC		%	25
3568685	ADB	Matrix Spike	Dissolved Sulphate (SO4)	2014/04/10		114	%	75 - 125
3568685	ADB	Spiked Blank	Dissolved Sulphate (SO4)	2014/04/10		105	%	80 - 120
3568685	ADB	Method Blank	Dissolved Sulphate (SO4)	2014/04/10	ND , RDL=1		mg/L	
3568685	ADB	RPD	Dissolved Sulphate (SO4)	2014/04/10	NC		%	20
3568899	JOH	Matrix Spike [VL9688-01]	Dissolved Calcium (Ca)	2014/04/10		NC	%	80 - 120
			Dissolved Magnesium (Mg)	2014/04/10		NC	%	80 - 120
			Dissolved Potassium (K)	2014/04/10		95	%	80 - 120
			Dissolved Sodium (Na)	2014/04/10		NC	%	80 - 120
3568899	JOH	Spiked Blank	Dissolved Calcium (Ca)	2014/04/10		103	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Magnesium (Mg)	2014/04/10		101	%	80 - 120
			Dissolved Potassium (K)	2014/04/10		101	%	80 - 120
			Dissolved Sodium (Na)	2014/04/10		104	%	80 - 120
3568899	JOH	Method Blank	Dissolved Calcium (Ca)	2014/04/10	ND , RDL=0.05		mg/L	
			Dissolved Magnesium (Mg)	2014/04/10	ND , RDL=0.05		mg/L	
			Dissolved Potassium (K)	2014/04/10	ND , RDL=1		mg/L	
			Dissolved Sodium (Na)	2014/04/10	ND , RDL=0.5		mg/L	
3568899	JOH	RPD [VL9688-01]	Dissolved Calcium (Ca)	2014/04/10	3.8		%	25
			Dissolved Magnesium (Mg)	2014/04/10	4.0		%	25
			Dissolved Potassium (K)	2014/04/10	NC		%	25
			Dissolved Sodium (Na)	2014/04/10	4.6		%	25
3570432	AHA	Matrix Spike	Total Kjeldahl Nitrogen (TKN)	2014/04/11		74 (1)	%	80 - 120
3570432	AHA	QC Standard	Total Kjeldahl Nitrogen (TKN)	2014/04/11		101	%	80 - 120
3570432	AHA	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/11		89	%	80 - 120
3570432	AHA	Method Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/11	ND , RDL=0.10		mg/L	
3570432	AHA	RPD	Total Kjeldahl Nitrogen (TKN)	2014/04/11	4.4		%	20
3571016	COP	Matrix Spike	Total Ammonia-N	2014/04/14		105	%	80 - 120
3571016	COP	Spiked Blank	Total Ammonia-N	2014/04/14		99	%	85 - 115
3571016	COP	Method Blank	Total Ammonia-N	2014/04/14	ND , RDL=0.050		mg/L	
3571016	COP	RPD	Total Ammonia-N	2014/04/14	NC		%	20
3571047	AHA	Matrix Spike	Total Organic Carbon (TOC)	2014/04/12		NC	%	80 - 120
3571047	AHA	Spiked Blank	Total Organic Carbon (TOC)	2014/04/12		95	%	80 - 120
3571047	AHA	Method Blank	Total Organic Carbon (TOC)	2014/04/12	ND , RDL=0.20		mg/L	
3571047	AHA	RPD	Total Organic Carbon (TOC)	2014/04/12	1.2		%	20
3572645	VRO	Matrix Spike [VL9688-02]	Total Phosphorus	2014/04/15		98	%	80 - 120
3572645	VRO	QC Standard	Total Phosphorus	2014/04/15		105	%	80 - 120
3572645	VRO	Spiked Blank	Total Phosphorus	2014/04/15		98	%	80 - 120
3572645	VRO	Method Blank	Total Phosphorus	2014/04/15	ND , RDL=0.002		mg/L	
3572645	VRO	RPD [VL9688-02]	Total Phosphorus	2014/04/15	NC		%	20
3572799	KCO	Matrix Spike [VL9687-03]	Total Aluminum (Al)	2014/04/14		97	%	80 - 120
			Total Antimony (Sb)	2014/04/14		108	%	80 - 120
			Total Arsenic (As)	2014/04/14		101	%	80 - 120
			Total Barium (Ba)	2014/04/14		100	%	80 - 120
			Total Beryllium (Be)	2014/04/14		105	%	80 - 120
			Total Boron (B)	2014/04/14		95	%	80 - 120
			Total Cadmium (Cd)	2014/04/14		104	%	80 - 120
			Total Calcium (Ca)	2014/04/14		NC	%	80 - 120
			Total Chromium (Cr)	2014/04/14		100	%	80 - 120
			Total Cobalt (Co)	2014/04/14		95	%	80 - 120
			Total Copper (Cu)	2014/04/14		98	%	80 - 120
			Total Iron (Fe)	2014/04/14		98	%	80 - 120
			Total Lead (Pb)	2014/04/14		101	%	80 - 120
			Total Magnesium (Mg)	2014/04/14		NC	%	80 - 120
			Total Manganese (Mn)	2014/04/14		96	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Molybdenum (Mo)	2014/04/14		104	%	80 - 120
			Total Nickel (Ni)	2014/04/14		98	%	80 - 120
			Total Potassium (K)	2014/04/14		95	%	80 - 120
			Total Silicon (Si)	2014/04/14		101	%	80 - 120
			Total Selenium (Se)	2014/04/14		99	%	80 - 120
			Total Silver (Ag)	2014/04/14		97	%	80 - 120
			Total Sodium (Na)	2014/04/14		98	%	80 - 120
			Total Strontium (Sr)	2014/04/14		103	%	80 - 120
			Total Thallium (Tl)	2014/04/14		107	%	80 - 120
			Total Titanium (Ti)	2014/04/14		99	%	80 - 120
			Total Uranium (U)	2014/04/14		107	%	80 - 120
			Total Vanadium (V)	2014/04/14		97	%	80 - 120
			Total Zinc (Zn)	2014/04/14		100	%	80 - 120
3572799	KCO	Spiked Blank	Total Aluminum (Al)	2014/04/14		100	%	80 - 120
			Total Antimony (Sb)	2014/04/14		107	%	80 - 120
			Total Arsenic (As)	2014/04/14		101	%	80 - 120
			Total Barium (Ba)	2014/04/14		100	%	80 - 120
			Total Beryllium (Be)	2014/04/14		105	%	80 - 120
			Total Boron (B)	2014/04/14		95	%	80 - 120
			Total Cadmium (Cd)	2014/04/14		104	%	80 - 120
			Total Calcium (Ca)	2014/04/14		98	%	80 - 120
			Total Chromium (Cr)	2014/04/14		100	%	80 - 120
			Total Cobalt (Co)	2014/04/14		96	%	80 - 120
			Total Copper (Cu)	2014/04/14		99	%	80 - 120
			Total Iron (Fe)	2014/04/14		96	%	80 - 120
			Total Lead (Pb)	2014/04/14		100	%	80 - 120
			Total Magnesium (Mg)	2014/04/14		101	%	80 - 120
			Total Manganese (Mn)	2014/04/14		95	%	80 - 120
			Total Molybdenum (Mo)	2014/04/14		102	%	80 - 120
			Total Nickel (Ni)	2014/04/14		100	%	80 - 120
			Total Potassium (K)	2014/04/14		94	%	80 - 120
			Total Silicon (Si)	2014/04/14		100	%	80 - 120
			Total Selenium (Se)	2014/04/14		101	%	80 - 120
			Total Silver (Ag)	2014/04/14		97	%	80 - 120
			Total Sodium (Na)	2014/04/14		99	%	80 - 120
			Total Strontium (Sr)	2014/04/14		102	%	80 - 120
			Total Thallium (Tl)	2014/04/14		105	%	80 - 120
			Total Titanium (Ti)	2014/04/14		102	%	80 - 120
			Total Uranium (U)	2014/04/14		105	%	80 - 120
			Total Vanadium (V)	2014/04/14		97	%	80 - 120
			Total Zinc (Zn)	2014/04/14		101	%	80 - 120
3572799	KCO	Method Blank	Total Aluminum (Al)	2014/04/14	ND , RDL=0.0050		mg/L	
			Total Antimony (Sb)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Arsenic (As)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Barium (Ba)	2014/04/14	ND , RDL=0.0020		mg/L	
			Total Beryllium (Be)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Boron (B)	2014/04/14	ND , RDL=0.010		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Cadmium (Cd)	2014/04/14	ND , RDL=0.00010		mg/L	
			Total Calcium (Ca)	2014/04/14	ND , RDL=0.20		mg/L	
			Total Chromium (Cr)	2014/04/14	ND , RDL=0.0050		mg/L	
			Total Cobalt (Co)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Copper (Cu)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Iron (Fe)	2014/04/14	ND , RDL=0.10		mg/L	
			Total Lead (Pb)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Magnesium (Mg)	2014/04/14	ND , RDL=0.050		mg/L	
			Total Manganese (Mn)	2014/04/14	ND , RDL=0.0020		mg/L	
			Total Molybdenum (Mo)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Nickel (Ni)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Potassium (K)	2014/04/14	ND , RDL=0.20		mg/L	
			Total Silicon (Si)	2014/04/14	ND , RDL=0.050		mg/L	
			Total Selenium (Se)	2014/04/14	ND , RDL=0.0020		mg/L	
			Total Silver (Ag)	2014/04/14	ND , RDL=0.00010		mg/L	
			Total Sodium (Na)	2014/04/14	ND , RDL=0.10		mg/L	
			Total Strontium (Sr)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Thallium (Tl)	2014/04/14	ND , RDL=0.000050		mg/L	
			Total Titanium (Ti)	2014/04/14	ND , RDL=0.0050		mg/L	
			Total Uranium (U)	2014/04/14	ND , RDL=0.00010		mg/L	
			Total Vanadium (V)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Zinc (Zn)	2014/04/14	ND , RDL=0.0050		mg/L	
3572799	KCO	RPD [VL9687-03]	Total Aluminum (Al)	2014/04/14	NC		%	20
			Total Antimony (Sb)	2014/04/14	NC		%	20
			Total Arsenic (As)	2014/04/14	NC		%	20
			Total Barium (Ba)	2014/04/14	0.6		%	20
			Total Beryllium (Be)	2014/04/14	NC		%	20
			Total Boron (B)	2014/04/14	NC		%	20
			Total Cadmium (Cd)	2014/04/14	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Calcium (Ca)	2014/04/14	1.2		%	20
			Total Chromium (Cr)	2014/04/14	NC		%	20
			Total Cobalt (Co)	2014/04/14	NC		%	20
			Total Copper (Cu)	2014/04/14	NC		%	20
			Total Iron (Fe)	2014/04/14	NC		%	20
			Total Lead (Pb)	2014/04/14	NC		%	20
			Total Magnesium (Mg)	2014/04/14	1.1		%	20
			Total Manganese (Mn)	2014/04/14	NC		%	20
			Total Molybdenum (Mo)	2014/04/14	NC		%	20
			Total Nickel (Ni)	2014/04/14	NC		%	20
			Total Potassium (K)	2014/04/14	1.0		%	20
			Total Silicon (Si)	2014/04/14	1.4		%	20
			Total Selenium (Se)	2014/04/14	NC		%	20
			Total Silver (Ag)	2014/04/14	NC		%	20
			Total Sodium (Na)	2014/04/14	1.9		%	20
			Total Strontium (Sr)	2014/04/14	1.4		%	20
			Total Thallium (Tl)	2014/04/14	NC		%	20
			Total Titanium (Ti)	2014/04/14	NC		%	20
			Total Uranium (U)	2014/04/14	NC		%	20
			Total Vanadium (V)	2014/04/14	NC		%	20
			Total Zinc (Zn)	2014/04/14	0.06		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere, Scientific Services

Vimukthi Gunawardhan

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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UNIVERSITY of GUELPH
LABORATORY SERVICES
Agriculture and Food Laboratory

FINAL Report
Submission# **14-028699**
Reported: 2014-Apr-25

Submitted By:

HARDEN ENVIRONMENTAL SER. INC.
STAN DENHOED
4622 NASSAGAWEYA-PUSLINCH TOWNLINE RD
R.R. 1
MOFFAT, ON L0P 1J0

Owner:
STAN DENHOED

Phone: 519 826-0099
Fax: 519 826-9099
Sampling Date: Not given Received Date: 2014-Apr-16

EC O157:H7 GDS detection

Date Authorized: 2014-Apr-18 10:53

Sample ID	Client Sample ID	Specimen type/ Sampling Date/Time	E. coli O157:H7 GDS detection
0001	**SW1**	Water	Negative
0002	**SW2**	Water	Negative
0003	**SW3**	Water	Negative

Wash/Irrigation- E Coli & Coli 100ml

Date Authorized: 2014-Apr-17 15:16

Sample ID	Client Sample ID	Specimen type/ Sampling Date/Time	Coliform - water	E. coli - water
0001	**SW1**	Water	3.00E+02 cfu/100mL	1.00E+01 cfu/100mL
0002	**SW2**	Water	1.00E+03 cfu/100mL	4.00E+00 cfu/100mL

Wash/Irrigation- E Coli & Coli 100ml ....Continued

Date Authorized: 2014-Apr-17 15:16

			Coliform - water	E. coli - water
0003	**SW3**	Water	6.00E+01 cfu/100mL	<1.00E+00 cfu/100mL

Test method(s): MID-216(MFLP-16) MID-160

Co-Supervisor: Susan Lee PhD 519 823-1268 ext 57211 suelee@uoguelph.ca
Co-Supervisor: Carlos Leon Velarde MSc 519 823-1268 ext 57301 cleonvel@uoguelph.ca

Cryptosporidium PCR

Date Authorized: 2014-Apr-25 16:29

Sample ID	**Client Sample ID**	**Specimen type/ Sampling Date/Time**	Cryptosporidium parvum - PCR
0004	**SW3**	Water	Negative

Giardia detectin by PCR

Date Authorized: 2014-Apr-25 16:29

Sample ID	**Client Sample ID**	**Specimen type/ Sampling Date/Time**	Giardia intestinalis - PCR
0004	**SW3**	Water	Negative

Test method(s): MOL-157 MOL-170

Supervisor: Shu Chen PhD 519 823 1268 ext. 57319 schen@uoguelph.ca

Appendix D

Potential Waterfowl Use of Hidden Quarry

GWS Ecological & Forestry Services Inc.

File: 3028
By: Email

June 9, 2014

James Dick Construction Limited
P.O. Box 470
Bolton, Ontario
L7E 5T4

Attention: Greg Sweetnam

Dear: Mr. Sweetnam

Re: Potential Waterfowl Use of Hidden Quarry

It is anticipated that waterfowl will utilize the rehabilitated quarry ponds but not in large numbers. Habitat conditions will generally be unfavourable to heavy waterfowl use of the area, particularly during spring and summer. Habitat features which will discourage waterfowl nesting and feeding include the following.

- There will be 316m of exposed unvegetated cliff face that is unsuitable for waterfowl nesting or feeding.
- After quarry sideslopes are topsoiled and seeded with an upland meadow mix they will be densely reforested. Waterfowl, particularly geese, do not like nesting in treed areas and hence as the trees grow the quality of nesting habitat will decline.
- The grassy reforested sideslopes will not be mowed or fertilized. Geese are attracted to grassy areas that are mowed and fertilized (e.g. golf courses) as these areas provide very nutritious goose pasture.
- Aquatic emergent vegetation will become densely established in shallow shoreline areas adjacent to graded sideslopes and this vegetation will retard the movement of ducklings and goslings from backshore areas to open water. This shoreline vegetation will make waterfowl, particularly young birds, vulnerable to predation.
- The ponds will be about 22m deep and aquatic emergent and submergent vegetation will therefore be limited to the relatively narrow littoral zone where water depths are less than 2m. As a result, there will not be an abundance of food available that is attractive to waterfowl. The wetlands that may develop in the shallow areas will be below the minimum size necessary to support waterfowl broods. Dabbling ducks typically feed in the top 20cm of the water column, so there will be limited areas that are suitable for foraging for them. Most diving ducks can dive to depths of only about 5m, far less than the 22m depth of the quarry ponds, so they will not be able to access food on the ponds' substrate.

GWS Ecological & Forestry Services Inc.
4670 Townline Road, Cambridge, ON. N3C 2V1
Tel.: (519) 651-2224 Fax: (519) 651-2002
Email: gwsefs@sympatico.ca

Given the above considerations waterfowl nesting and brood rearing in the quarry during the spring and summer months should be minimal. The greatest waterfowl use of the area will likely occur during the fall migration although the number of birds should still be relatively low.

Yours truly,

GWS Ecological & Forestry Services Inc.

Greg W. Scheifele, M. A., R.P.F.
Principal Ecologist/Forester

Appendix E

Monitoring Program and Contingency Measures

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES (JUNE 2014)

Colour Coding Scheme for Requested Agency Modifications to Monitoring Plan

Green – Ministry of the Environment

Orange – Grand River Conservation Authority

Magenta – Township of Guelph - Eramosa

1.0 ON-SITE MONITORING PROGRAM

Monitoring has taken place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	Monitoring Locations	Frequency
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4, M15, M16	Manually Monthly Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following bedrock extraction with re-evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16, M17	5 minute interval during first 3 months of extraction
Surface Water Level	Sinking Cut	Daily
Surface Water Level	SW14, SW5, SW7	Manually Monthly Coincident with groundwater monitoring
Surface Water Levels	SW6, SW4, SW8	Automated Water Level Readings (4 hour interval)
Surface Water Flow	SW4, SW8, SW3	Manually Monthly *coincident with groundwater monitoring
Groundwater Quality	W1, M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond, Northwest Wetland, Tributary B (SW4, SW3)	Semi –Annually (Spring and Fall)
Climate	On-Site Weather Station at Scale House to include precipitation and temperature	Daily

Monitoring locations are shown on Figure C1.

2.0 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

2.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	347.81
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98
M15	TBD			
M16	TBD			

TBD – to be determined

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.2 Trigger Level for Northwest Wetland and Allen Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

Trigger levels and warning levels have been determined for three periods as follows:

Winter Trigger Level - lowest water level observed between December 1 and March 1

Spring Trigger Level - lowest water level observed between March 2 and June 15

Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

A warning level is established 0.15 metres higher than the trigger level. The warning and trigger levels relative to historical water levels are shown on Figure C6.

Table 2: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

2.3 Trigger Level for Sinking Cut

James Dick Construction Ltd. has agreed to a maximum water level change of 2.54 metres in the sinking cut. The nearest groundwater monitor to the sinking cut is M3. The hydrograph of M3 is found attached as Figure C7. The low water level in M3 is 349.37 m AMSL. We propose to use this as the reference elevation resulting in a minimum water elevation in the sinking cut of 349.37 – 2.54 = 346.83 m AMSL. JDCL proposes to hang a buoy from a tether with the buoy floating in the water until the water level falls below an elevation of 346.83 m AMSL. The buoy will be a visual indicator of the minimum allowable water level to the operator.

Extraction will cease if the water level falls below 346.83 m AMSL and can only recommence with a water level above 346.83 m AMSL in the sinking cut.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours. Increase monitoring to weekly until source of the trigger level exceedence is identified.

2) Within seven days conduct an evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- decreased rate (or stopping) subaqueous extraction
- increase the length and/or width of barrier
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

3.2 Water Quality

The water quality program will commence at least one year prior to bedrock extraction.

Groundwater Monitors and the East and West Pond

The parameters that will be included in the semi-annual monitoring will be general chemistry, cryptosporidium, giardia, E. coli, TKN, ammonia, DOC, pH, temperature, anions and metals.

In the event that there is an increasing trend in the concentration of one or more elements or compounds, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing (commencing immediately) of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home, drilling a new well or isolating the water supply to the deeper aquifer

Northwest Wetland

The northwest wetland water will be analyzed for nitrate, dissolved oxygen, temperature, conductivity and pH for a period of three years or upon completion of construction activities in the surface water catchment area of the northwest wetland whichever is longer.

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C8. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

If there are domestic wells suitable for water level monitoring identified in the survey, they will be included in the water level monitoring program and monitored on a semi-annual basis.

If the survey indicates that modification(s) to the well are necessary either for continued monitoring or to minimize the potential for impact, the modifications will be made to the well at the expense of James Dick Construction Ltd.

5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

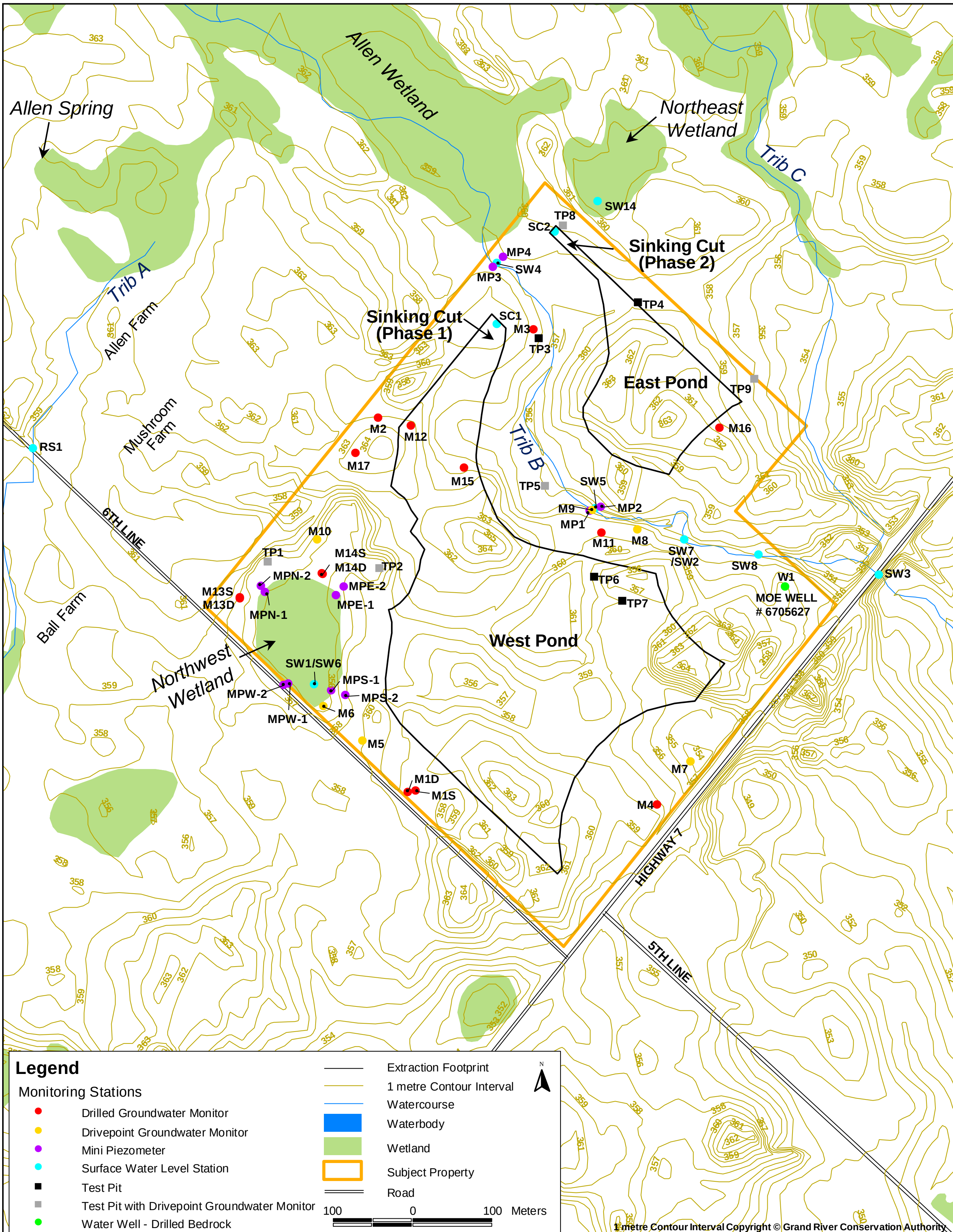
An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year.

The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

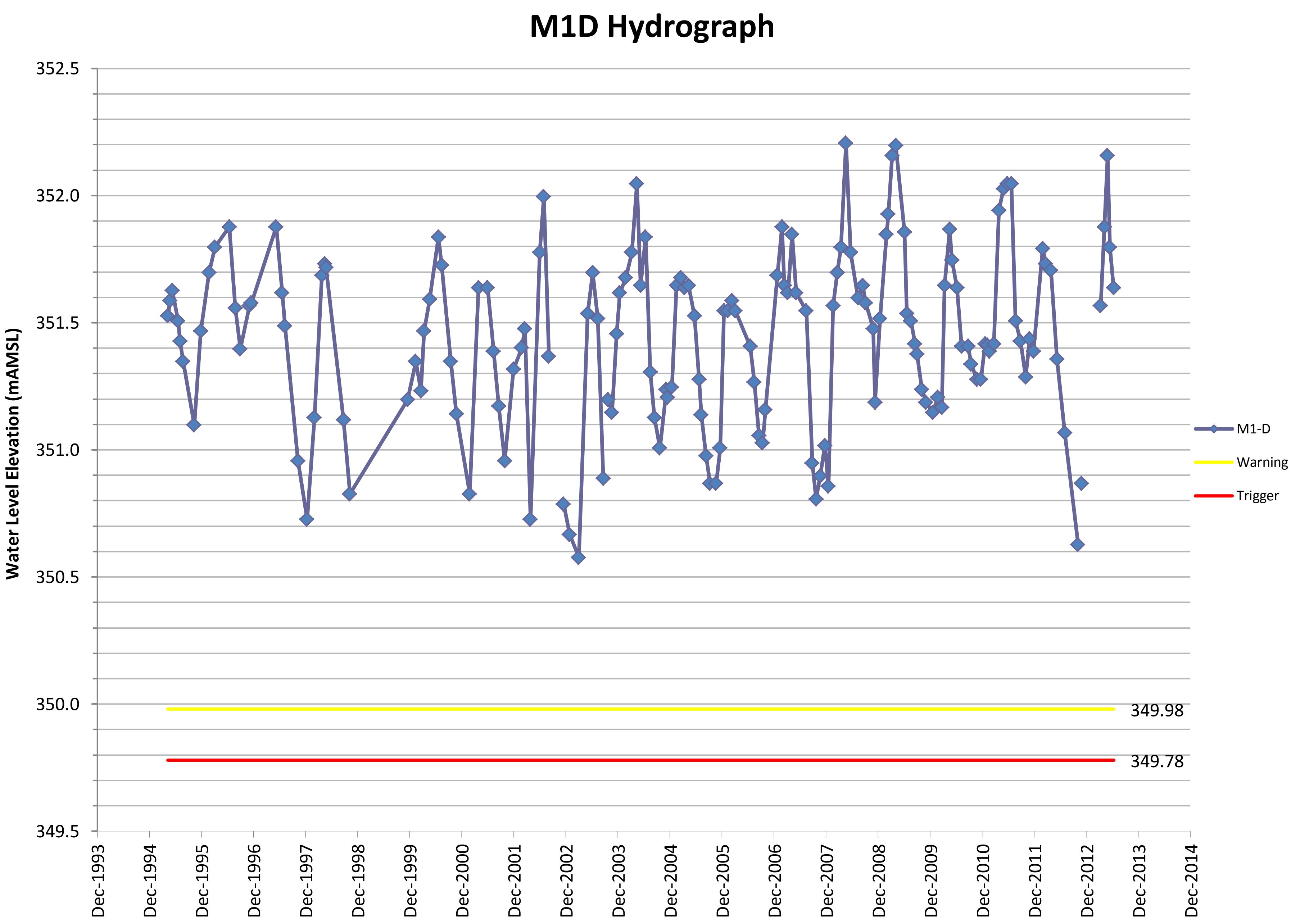
The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and streamflow loss from Tributary B.

6.0 Water Well Complaints

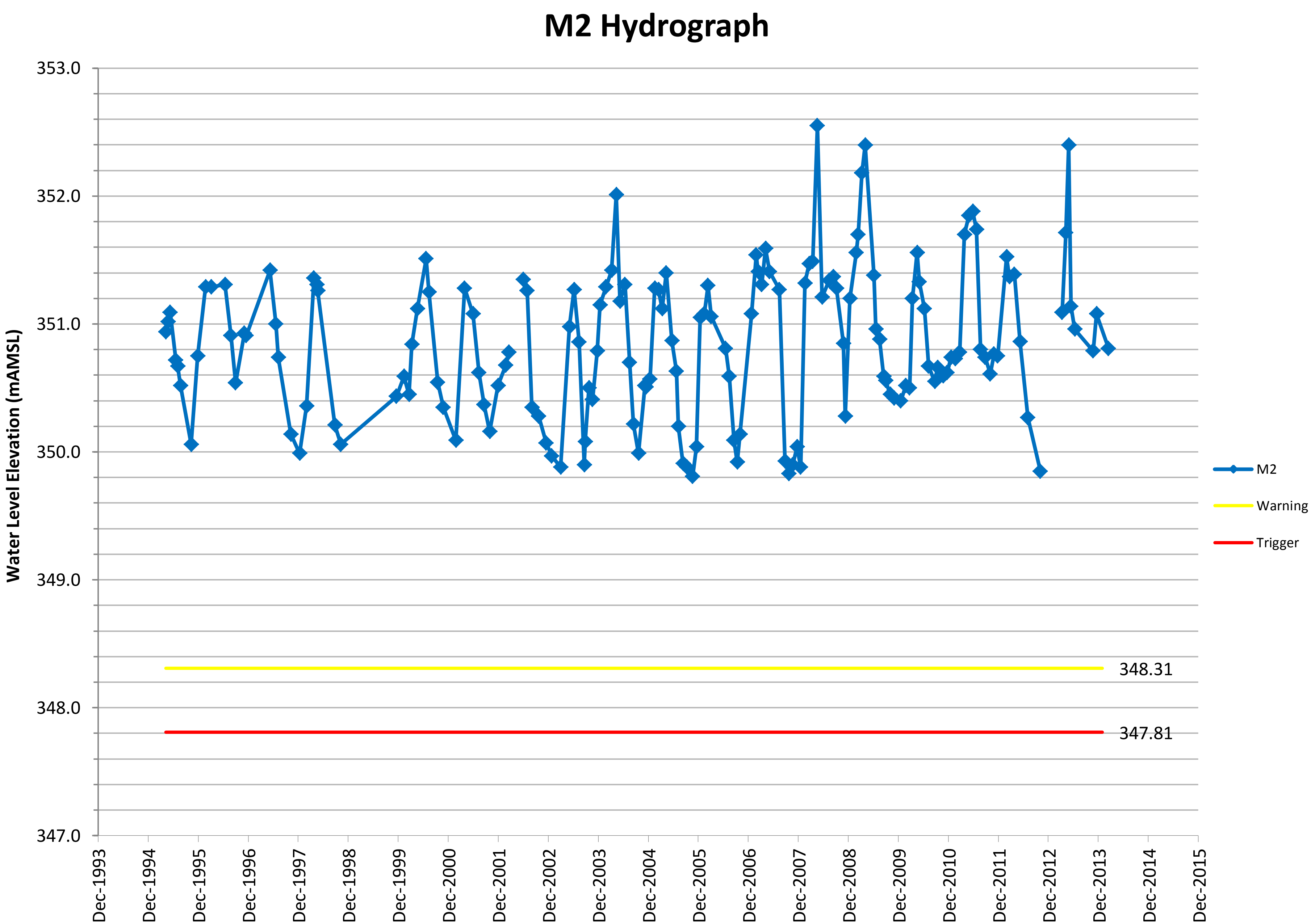
James Dick Construction Ltd. agrees to inform the Township of Guelph Eramosa and the Ministry of the Environment upon the receipt of a water well complaint and the results of any related investigation.



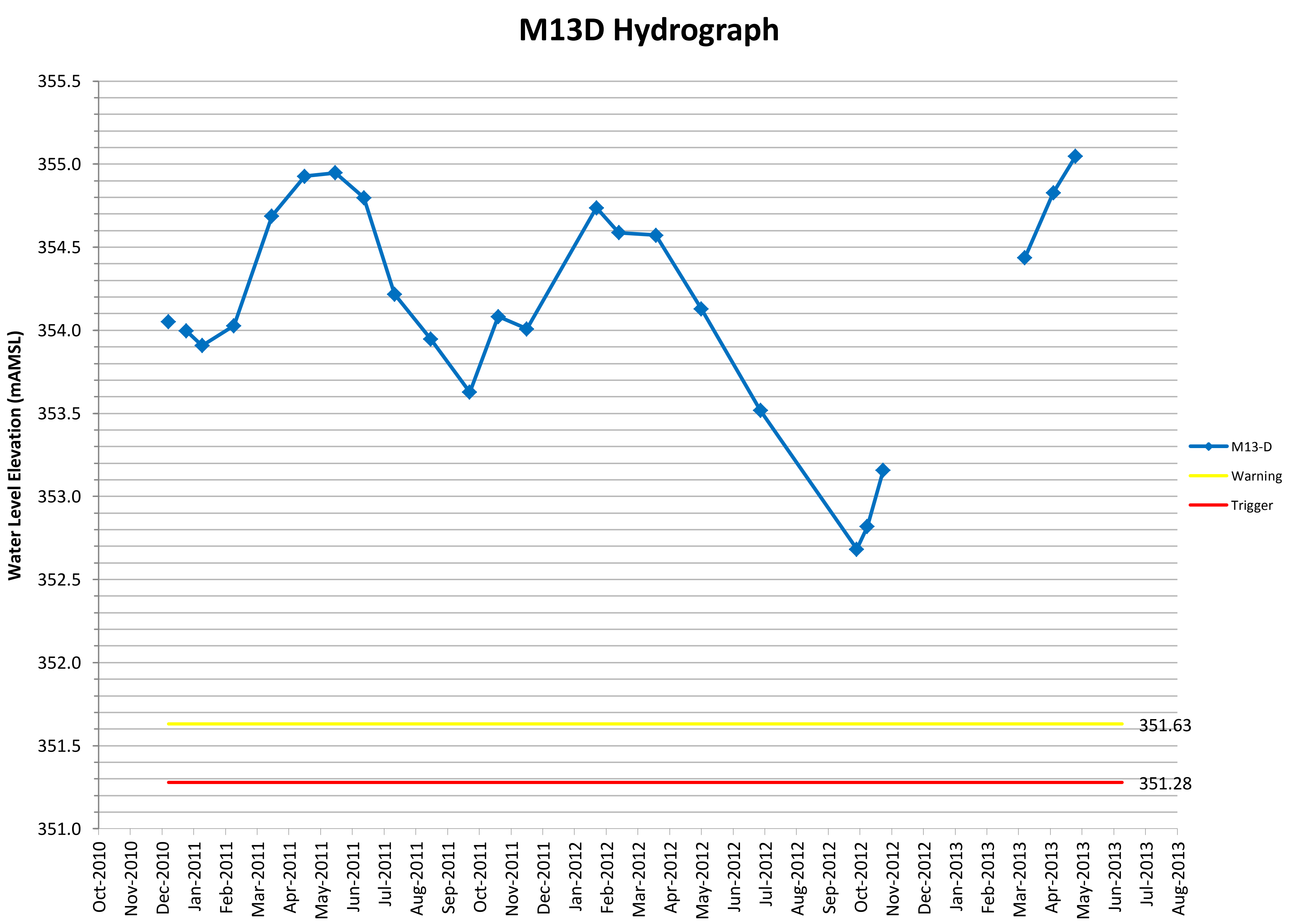
Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C1:**
	Date: Apr 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Monitoring Locations**
	Drawn By: AR		



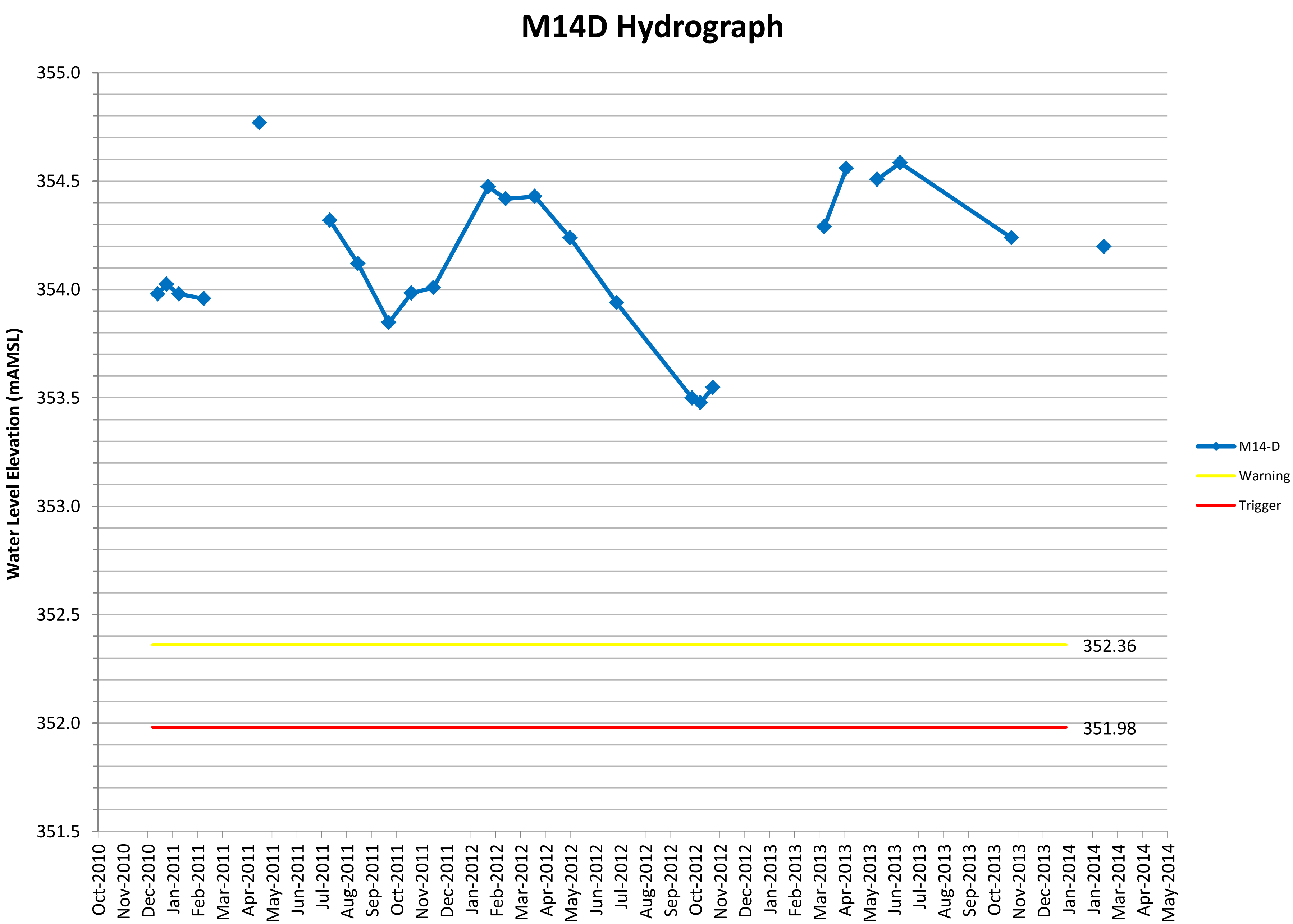
Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C2: M1D Trigger Level**
	Date: Jul 2013		
	Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C3: M2 Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

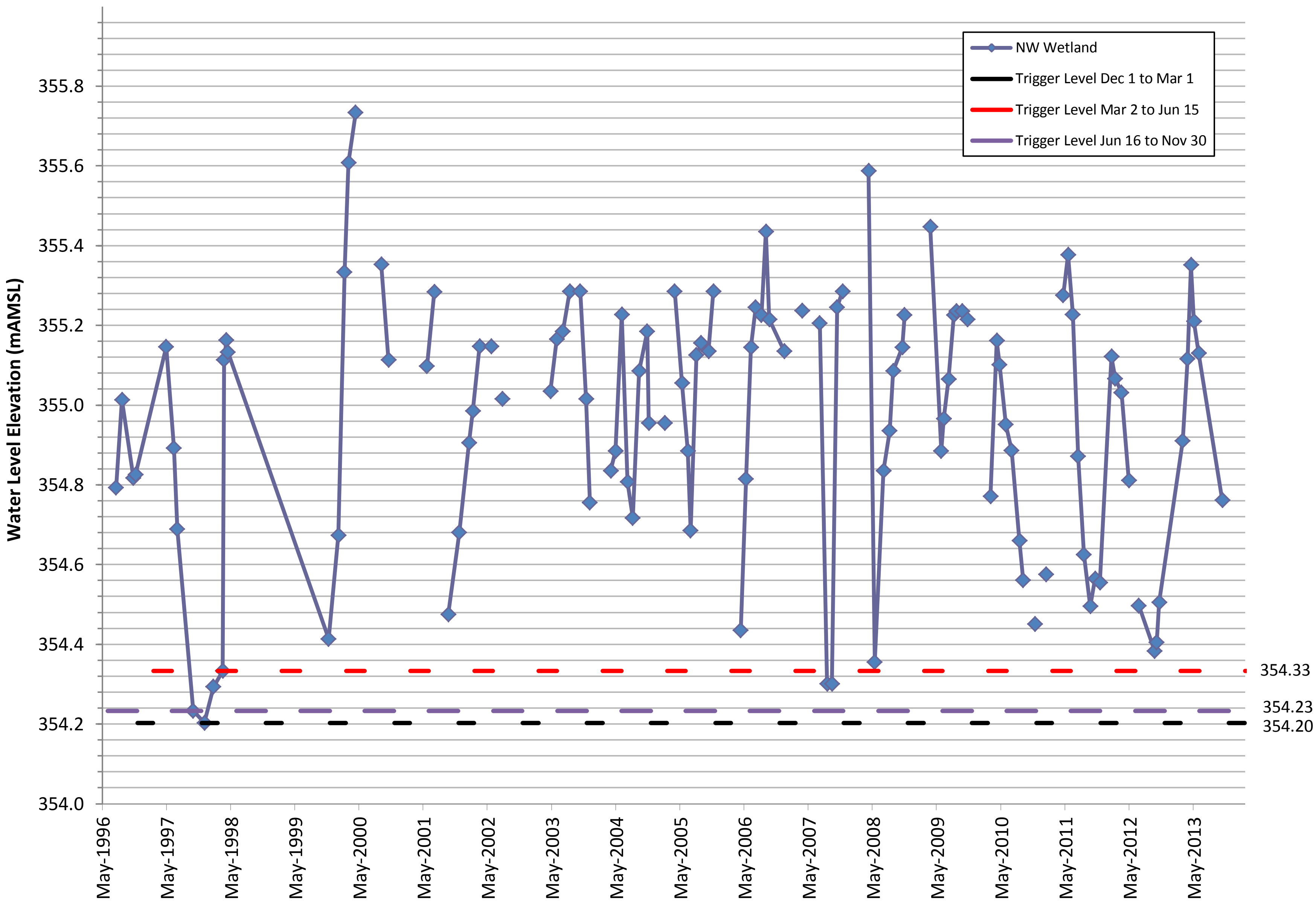


Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C4: M13D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

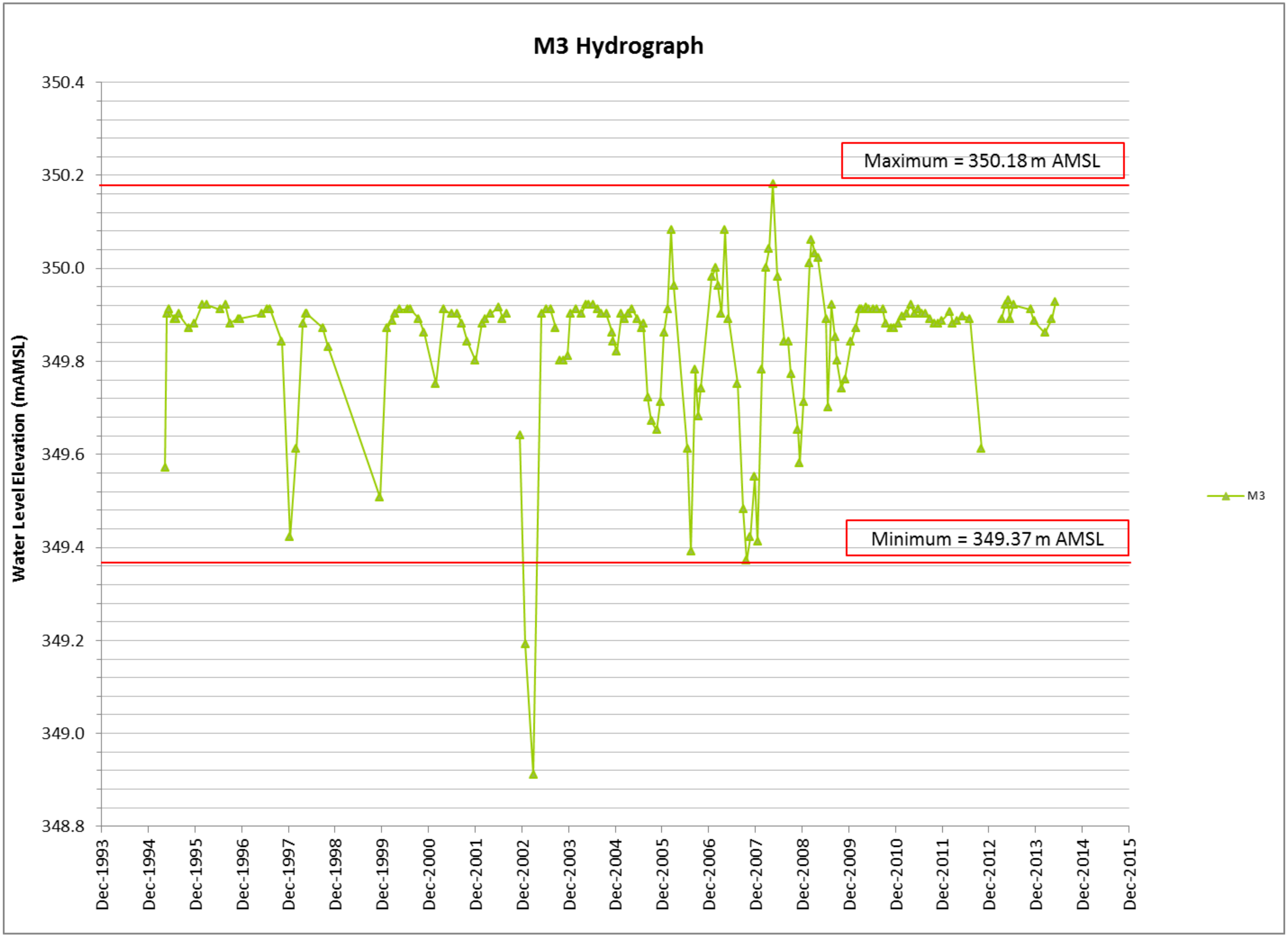


Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C5: M14D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

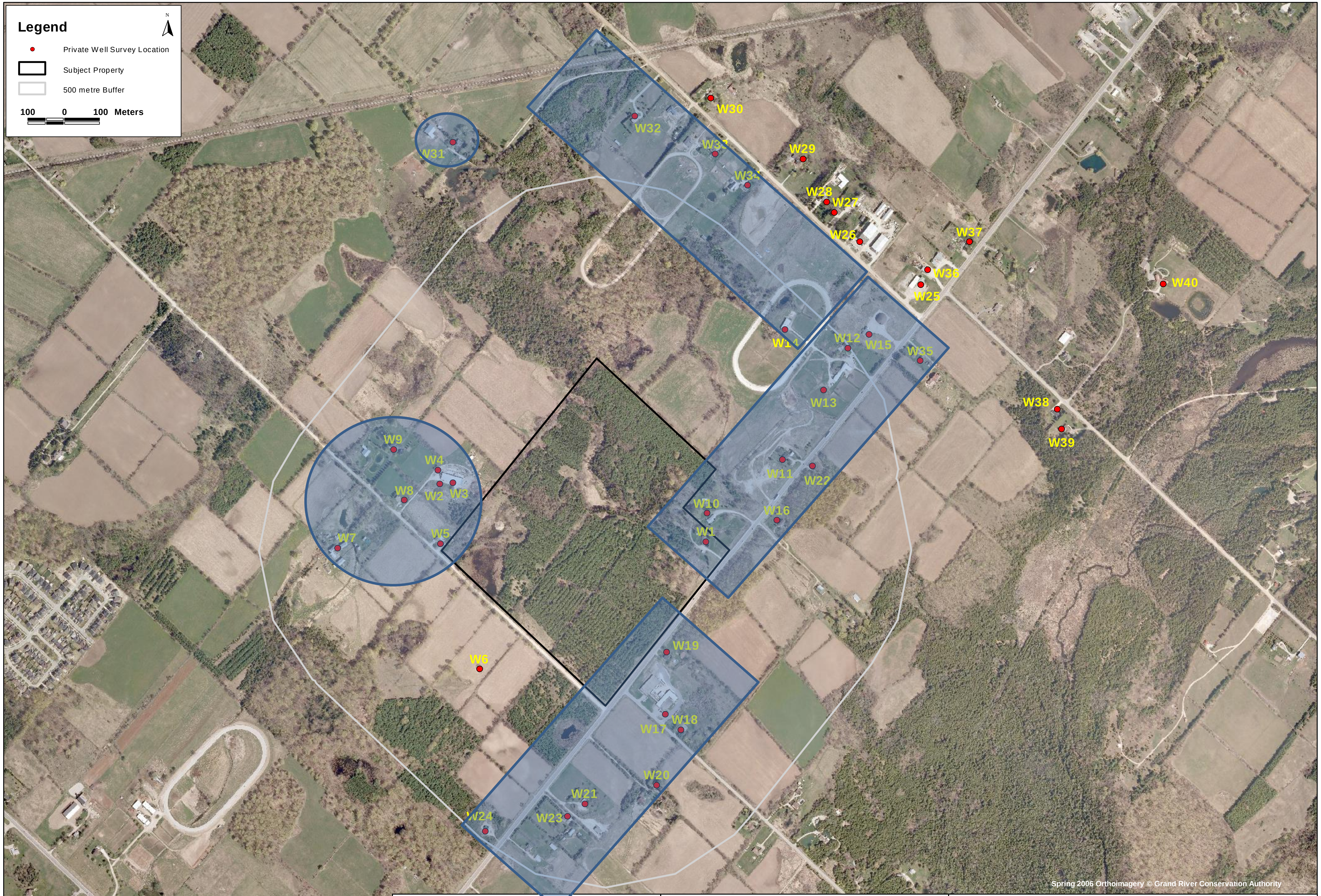
Northwest Wetland Hydrograph



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C6: Northwest Wetland Trigger Levels**
	Date: Jul 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 C7: M3 Hydrograph**
	Date: Jun 2014	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 C8:
	Date: Apr 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Proposed Pre Quarry Well Survey Locations**
	Drawn By: SD		