HARDEN

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

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

July 15, 2013

James Dick Construction Ltd.
Box 470, Bolton
Ontario, L7E 5T4

Attention: Mr. Greg Sweetnam,
Property Manager

Dear Mr. Sweetnam:

Re: MOE Comments Hidden Quarry

We are pleased to respond to the comments provided by the Ministry of the Environment. We have attached the original MOE comments in Appendix A and have not duplicated the comments in the text of this report.

The MOE comments were separated into surface water comments provided by Craig Fowler and groundwater comments provided by Rosa Stewart and we respond by first addressing surface water comments followed by groundwater comments.

All groundwater and surface water monitoring stations referenced in this report are shown on Figure 1.

Surface Water Comments (SWC)

SWC1) Hydraulic Gradient Analysis related to Streamflow Loss in Tributary B

We have considered two ways that the streamflow loss from a losing stream could be influenced by development activities. First, if an excavation physically encounters the 'mound' of infiltrating water beneath the losing stream and thus increases the hydraulic gradient; and secondly if the water table beneath the losing stream is lowered thereby taking longer to generate a mound resulting in greater loss of water from the losing stream.

Physical Interference Analysis

Figure 2 shows a hydraulic gradient analysis between Tributary B monitoring station SW5 and groundwater monitor M9. For the purpose of this analysis we assume that the creek flow is channelized and the distance from the edge of water to groundwater monitor M9 does not change. The hydraulic gradient ranges from 0.016 m/m to 0.259 m/m. The highest gradients are observed in October/November when the sediments beneath the creek are unsaturated. The lowest gradients occur in the spring after the underlying sediments have been saturated for several months.

The data displayed in Figure 2 shows us that where unsaturated conditions occur, the slope of the infiltrating water from Tributary B is approximately 1V:4H. This is a steep slope and considering that the bedrock aquifer is approximately five metres beneath the creek at SW5, the zone of infiltration will not extend beyond a distance of 20 metres from the creek edge. This condition is confirmed at M11 which is located 23 metres from Tributary B. Although hydraulic gradients decrease in magnitude seasonally, standing water has never occurred in M11 indicating that all infiltrating water intersects the water table in the bedrock aquifer within 23 metres of the creek. No layers of significant permeability contrast are revealed in the drilling log of M11 and no isolated layers of saturated soil were encountered in the drilling of M11.

Figure 3 is a cross-section of the area at SW5. Near SW5 there is a setback distance of 30 metres from Tributary B to the edge of extraction. In addition, a 2:1 horizontal: vertical slope will be maintained in the overburden resulting in a distance of approximately 50 metres between the creek and where the extraction will encounter the water table in the bedrock. Where there is a 20 metre setback, there will be a minimum distance of 40 metres between Tributary B and active below-water-table extraction. This provides ample separation distance between extractive activities and the water infiltrating beneath and adjacent to Tributary B. Based on this analysis, there will be no disturbance of infiltrating waters and no increase in loss from Tributary B arising from physical interference with the infiltrating waters.

Additional confirmation of near tributary infiltration beneath Tributary B is provided in data obtained from groundwater monitors MP3 and MP4. The monitors are four metres deep and are located six and eight metres from Tributary B respectively. The water levels obtained from MP3 and MP4 have always been at least 1.5 metres lower in elevation than Tributary B. The lowest measured hydraulic gradient between Tributary B and groundwater monitors MP3 and MP4 is 0.26 m/m and the highest gradient is 0.37

m/m. This data confirms that a) there is no groundwater discharge to Tributary B and b) infiltration follows a very steep pathway adjacent to Tributary B and that the extraction face at a distance of no less than 20 metres will not intersect infiltrating water and thus increase loss from Tributary B.

Change in Position of Water Table Analysis

The creation of a pond on either side of Tributary B will result in a change in the position of the water table. The position of the water table will rise in the southern half of the quarry site and fall in the northern half. The relative magnitude of the change is the same for the northern and southern portions of the quarry. Thus although a greater amount of infiltrating water from Tributary B is required to create a groundwater mound in the northern half of the quarry, less infiltrating water is required to create a groundwater mound in the southern half of the quarry. It is thus anticipated that there will be no net change in surface water loss from Tributary B. In addition, a silt till is identified in the northern 100 metres of the site (above the 'waterfalls') and thus further limiting the potential for a change in streamflow loss in the northern half of the site.

Monitoring of Streamflow Loss from Tributary B

In order to evaluate the loss of streamflow from Tributary B, the flow measured at SW3 will be subtracted from the flow measured at SW4 and compared to historical rates of loss. The rate of streamflow loss is highly variable and decreases to zero during the summer months. Figure 4 is a summary of monthly streamflow loss from Tributary B across the site. Included in the annual report will be an analysis of the streamflow loss and a continuation of this graph (between stations SW3 and SW4). If anomalous streamflow loss occurs, the cause will be evaluated and contingency measures invoked. Groundwater levels are more accurate than streamflow measurements and monitors MP1, MP2, MP3 and MP4 have been added to the groundwater monitoring program. An interpretation of results will be presented in the annual monitoring program and the results will be evaluated for anomalous or trending data. Should a change in streamflow loss or water level (in MP1-MP4) be noted, contingency measures as presented in Appendix C will be initiated.

SWC2) Allen Wetland and Northeast Wetland

We concur that Northeast Wetland and Allen Wetland are not connected to the bedrock water table and thus will not be affected by the proposed quarry.

SWC3) Recommended changes to the Surface Water Monitoring Program

The monitoring program will be amended as follows;

a) Surface water stations SW4 and SW8 have added to the monitoring program.

b) The frequency of flow measurements have been increased to semi-monthly between April and November (inclusive) and coincide with groundwater measurements. With this frequency of monitoring required, it may be beneficial to install a weir and establish a stage-discharge rating curve.

c) MP1, MP2, MP3 and MP4 have been added to the monitoring program and measurements will be obtained at the same time as groundwater measurements.

The revised monitoring program is found in Appendix C.

SWC4) Detailed analysis of Streamflow in Tributary B and water levels in Northwest Wetland

Tributary B

Figures R2 and R3 were submitted to Burnside and Associates in response to a similar question of the relationship between precipitation and flow in Tributary B. Figure R2 compares monthly precipitation from the Shand Dam in Fergus to streamflow at SW4. The monthly precipitation data does not have an annual pattern whereas flow in Tributary B has a pattern of no flow in the late summer months, increasing flow in the fall, winter, early spring and declining flow in the late spring/early summer months. The magnitude of flow in Tributary B is not responding to monthly precipitation.

Figure R3 compares both annual precipitation rates and November to March cumulative precipitation rates to streamflow measured at SW4. There is no apparent correlation between annual precipitation rates and flow in Tributary B. There is no apparent correlation between November to March cumulative precipitation rate and flow measured at SW4. Thus, although precipitation is the ultimate source of water in Tributary B, there is no readily identifiable correlation between monthly flow and monthly precipitation.

A comparison of streamflow in the Eramosa River measured at Watson Road and streamflow in Tributary B is shown on Figure R4. The graph shows that Tributary B has a similar flow profile as the Eramosa River. The Eramosa River responds to runoff events and thus peaks in the spring and has low flows late summer/early fall. This is also the pattern in Tributary B except that flow ceases in the summer. This confirms that flow in Tributary B relies on runoff from its catchment area and does not rely on local groundwater input.

We discussed streamflow in general with Dwight Boyd at the Grand River Conservation Authority. Dwight suggested that spring flow depends on several factors including amount of snow pack, winter thaw events, precipitation and daily temperature range. The variability in these factors alone result in a wide range of possible flow volumes making flow prediction extremely difficult. The history of streamflow at SW4 does provide a basis for comparison with post-development streamflow and there will be several years of data collection prior to aggregate extraction from below the water table.

The historical data provides a range of spring flows between 50 and 150 L/s and informs us that in some years the stream is dry for several months and other years there is continuous flow. The data shows that the magnitude of flow in the spring is not consistent, but provides a range of expected spring flow that can be used for comparison during and post development of the quarry.

Streamflow measurements are included in the monitoring program at upgradient and downgradient stations. Streamflow will be compared to historical values and additional study will be initiated if anomalous readings are found.

Northwest Wetland

Figure 5 compares surface water levels in the northwest wetland to precipitation. The water level has historically ranged from 354.2 to 355.68 m AMSL. Other than seasonal fluctuations (spring highs - fall lows) there is no season over season trend to the data. These seventeen years of historical data will be used to compare water levels during and post quarry development.

We are recommending an annual trigger value of 354.20 m AMSL. The warning level is established at fifteen centimeters above the trigger level or 354.35 m AMSL. The water level in the wetland falls about fifteen centimeters per month during summer months. This would provide approximately four weeks of enhanced monitoring to determine if there are quarry related impacts. Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

The following wording has been added to the monitoring program.

Monthly surface water levels obtained from station SW6 in the northwest wetland will be compared to historical data. An elevation of 354.20 m AMSL will be used as a level to trigger the following contingencies.

1) Confirmation of water level within 24 hours.

2) 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.

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

Groundwater Comments (GC)

GC1) Impact to Private Wells

We concur that private wells will not be impacted by the proposed quarry. The pre bedrock extraction survey will be conducted and will be detailed enough to evaluate any water quality or quantity concerns that arise during the bedrock extraction phase.

GC2) Water Quality Impact

We concur with the MOE’s finding that there is a low potential for water quality impacts. Two newly installed dedicated groundwater monitors (M15 and M16) along with M2 and M4 will be used to monitor groundwater quality. The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, bacteria, 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 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 or drilling a new well and isolating the water supply to the deeper aquifer.

GC3) Thermal effect on Brydson Spring and Blue Springs creek

The spring on the Brydson Farm (Figure 2.4 of Level I/II report) emerges approximately 400 metres southeast of the site property boundary and 600 metres southeast of the bedrock extraction. Blue Springs Creek occurs some 1200 metres from the extraction area. Our experience with thermal impact from pit ponds includes thermal data collected for Mill Creek Aggregates in Puslinch Township (Genevar, 2013) and Roszell Pit in Puslinch Township (Pentney, 2013). Each of these sites have data showing that the during the summer, the temperature of the surface of the pit ponds approaches 25 C and in the winter the temperature of the unfrozen water is 4 C. Each of these pit ponds recharges the downgradient groundwater system and a cyclical thermal impact has been recorded within downgradient groundwater monitors. Mill Creek is located 100 m from the Mill Creek Aggregates pond and springs emerge within 120 metres of the Roszell Pit Pond. In the data presented to-date, a thermal impact occurs within 30 m of each of the pit ponds. However, at both the Mill Creek Aggregates pit and the Roszell Pit, a thermal impact in a second groundwater monitor located less than 100 metres from the pit pond is not found. Therefore, the thermal impact is attenuated within 100 metres of the pit pond. Scientific work conducted by Rob Shincarol and Jeff Markle (2007) suggests that the thermal plume will be attenuated within 250 metres of a site.

Although the thermal plume at the Hidden Quarry will occur within a fractured bedrock setting, the groundwater remains subject to the huge thermal mass of bedrock formations and will exhibit similar temperature profiles to observation made in gravel pit environments. The observations of thermal attenuation at gravel pits suggests that the six hundred metre travel distance to the Brydson Spring will be more than sufficient to attenuate thermal changes in the groundwater. Blue Springs Creek is an additional 600 metres, for a total of 1200 metres, from the edge of bedrock extraction and therefore will not be affected by thermal changes at the site.

GC4) Presence of karst

There are six groundwater monitors and one water well at the site that have been drilled into the bedrock. Detailed borehole records are available for boreholes drilled for M1D, M2, M3, M4, M13D, M14D and M15. There is also a water well record for the well servicing the rental house at the site (MOE Well # 6705627). None of the geological observations suggest significant solution enhanced karst features. The presence of vugs and fossiliferous zones (reefal zones) within the bedrock are not necessarily indicative of karst conditions. Open fissures on the scale of millimeters are well documented in the video log of M15, however, large cavities indicative of karst were not found.

We have attached a recent report summarizing the drilling, flow testing and video logging of monitor M15 (Appendix B). There are no observations that suggest significant physical karst features at that location.

Groundwater flow in the bedrock is controlled by fractures and the recent pumping of M15 with a response in M2 confirms that fractures at depth in the dolostone aquifer are persistent. The maximum drawdown in the quarry will be no greater than 2.45 metres and the greatest impact to the nearest private well will be approximately 1.6 metres. We concur with the MOE that this magnitude of water level change will not significantly affect the yield of the private well.

The net result of the quarrying activity will be the creation of a large reservoir of water. This reservoir will be a positive boundary condition for nearby water takers and thus limit the drawdown in nearby wells. Therefore, the presence of fissures in the bedrock does not result in there being any greater potential impact to wells than already predicted.

GC5) Changes to Proposed Groundwater Monitoring Program

GC5a) In our response to water quality concerns raised by the GRCA, we confirmed that James Dick Construction Ltd. was willing to install groundwater monitors M15 and M16. These locations are shown on Figure 1.

GC5b) In response to the MOE recommendation that daily water levels be obtained prior to below-water-table extraction, we suggest installing continuous water level measuring devices in groundwater monitors M1D, M2, M3, M13D, M4, M15 and M16.

GC5c) 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. The trigger level is set at the historic low less 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.

Monitor	**Historical Low m AMSL**	**Predicted Change (m)**	**Warning Level m AMSL**	**Trigger Level m AMSL**
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98

GC5d) We recommend that an annual report be prepared and submitted by March 31 of the following year. The report will include all historical data and an interpretation of trends and anomalous observations.

GC5e) Continuous groundwater monitoring devices will be installed in M1D, M2, M3, M13D, M4, M15 and M16. The devices will provide both water level and water temperature information. This information will be evaluated and interpreted in the annual monitoring report.

GC5f) We have increased groundwater quality monitoring frequency to semi-annually.

The revised groundwater monitoring program is found in Appendix C and reflects all recommendations made by the Ministry of the Environment.

We trust that this additional analysis will satisfy the MOE comments made on the Hidden Quarry. If there are any questions regarding this submission, please do not hesitate to contact Stan Denhoed at (519) 826-0099.

References

Genevar Inc., 2013, 2012 Monitoring Report, Mill Creek Aggregates, Hydrogeology

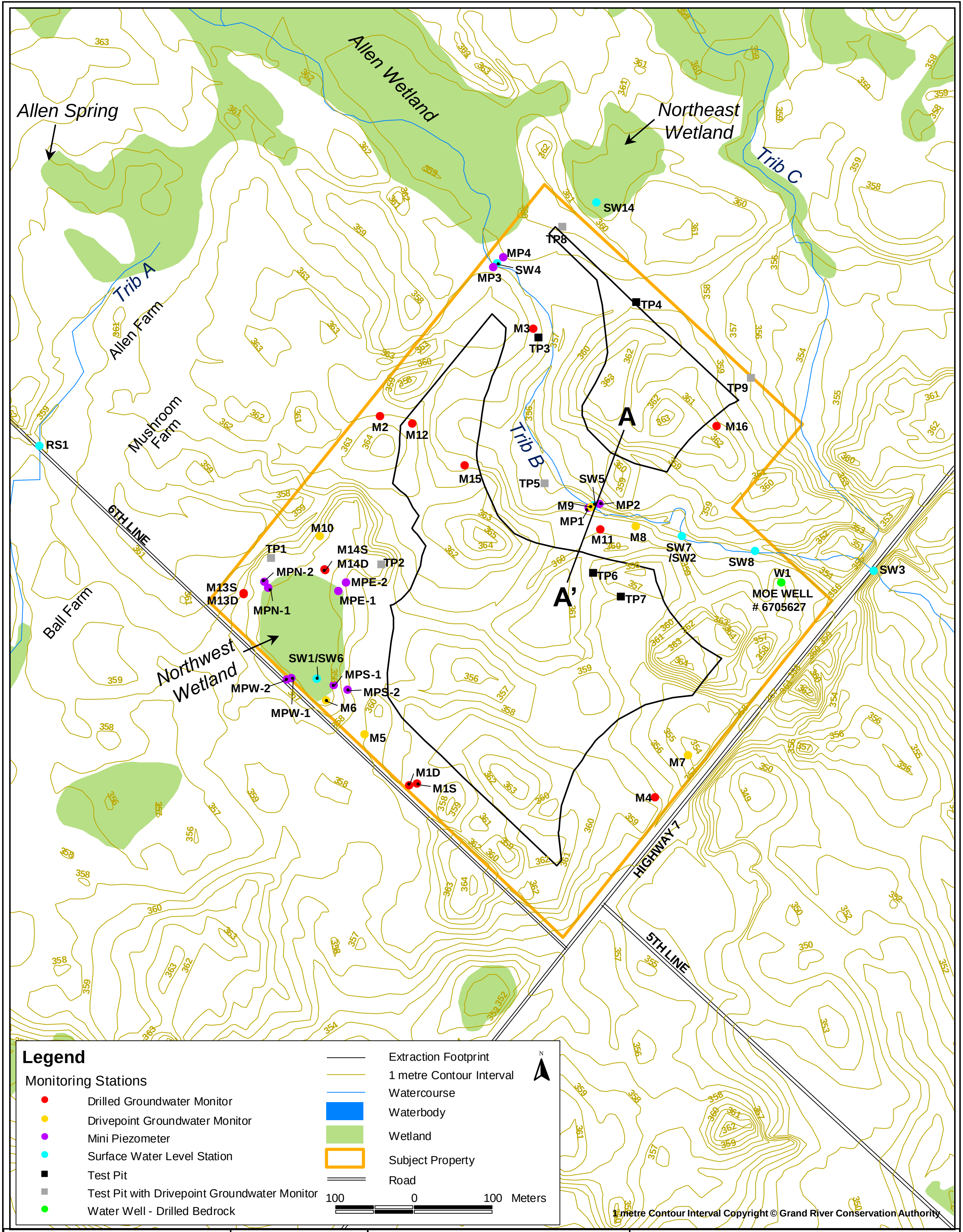
Pentney, A, 2013, Roszell Road Pit, License No. 625189, 2012 Groundwater Monitoring Report

Shincarol and Markle, 2007, Thermal Plume Transport from Sand and Gravel Pits, Potential Thermal Impacts to Cool Water Streams, Journal of Hydrology, (338) p 174-195

Sincerely,
Harden Environmental Services Ltd.

Stan Denhoed

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



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

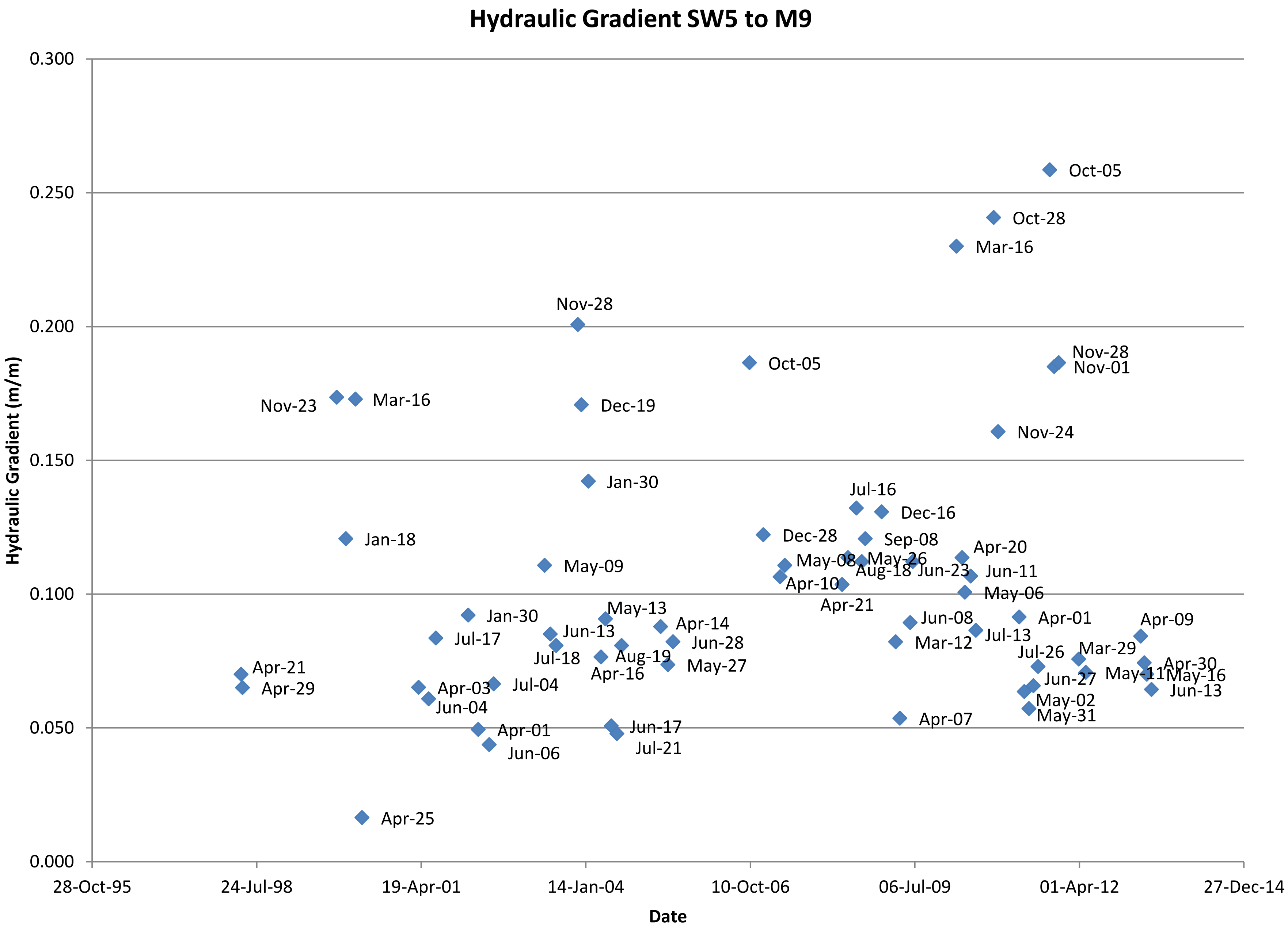
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1:

Monitoring Locations



Harden Environmental Services Ltd.

Project No: 9506

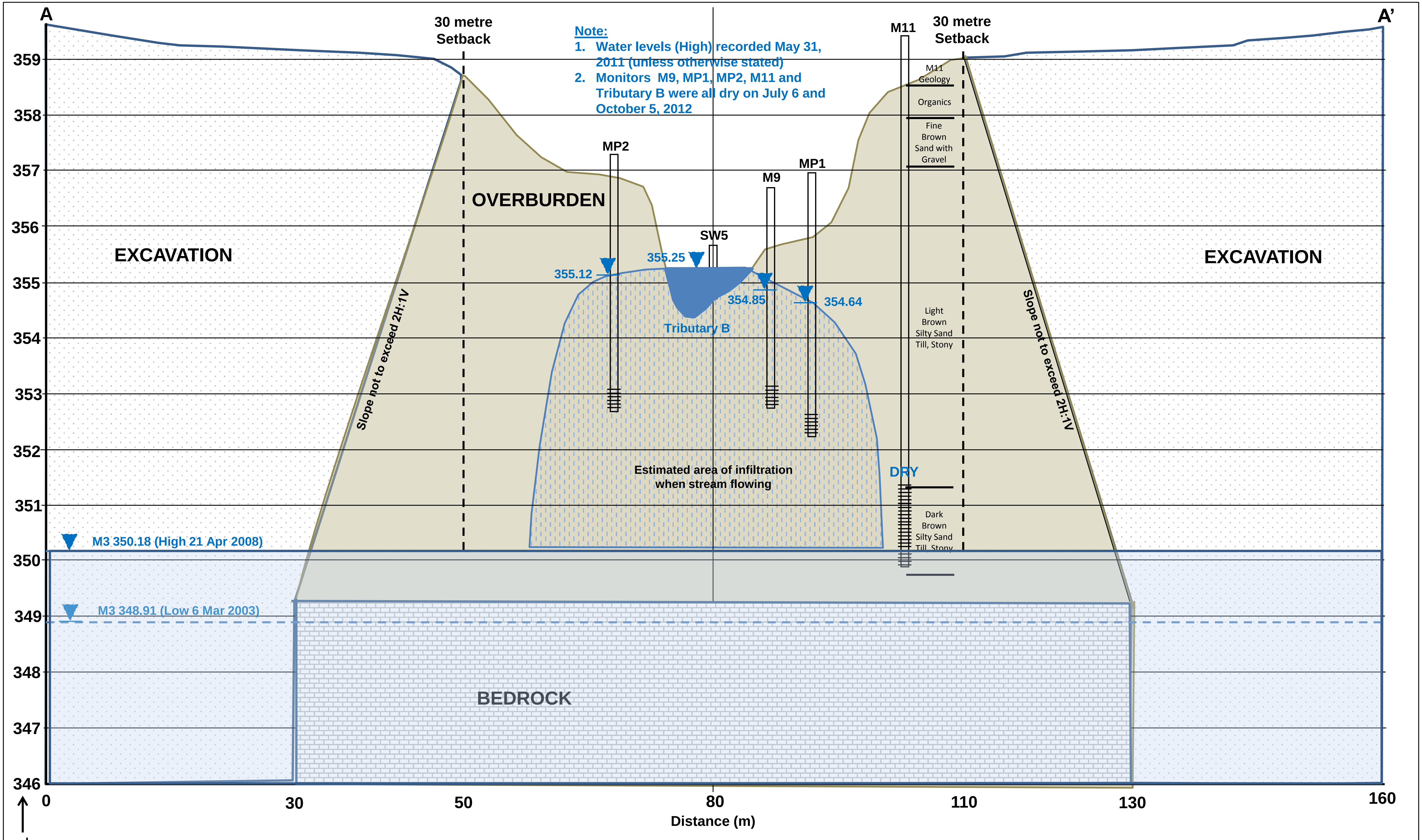
Date: Jul 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2: Hydraulic Gradient Analysis

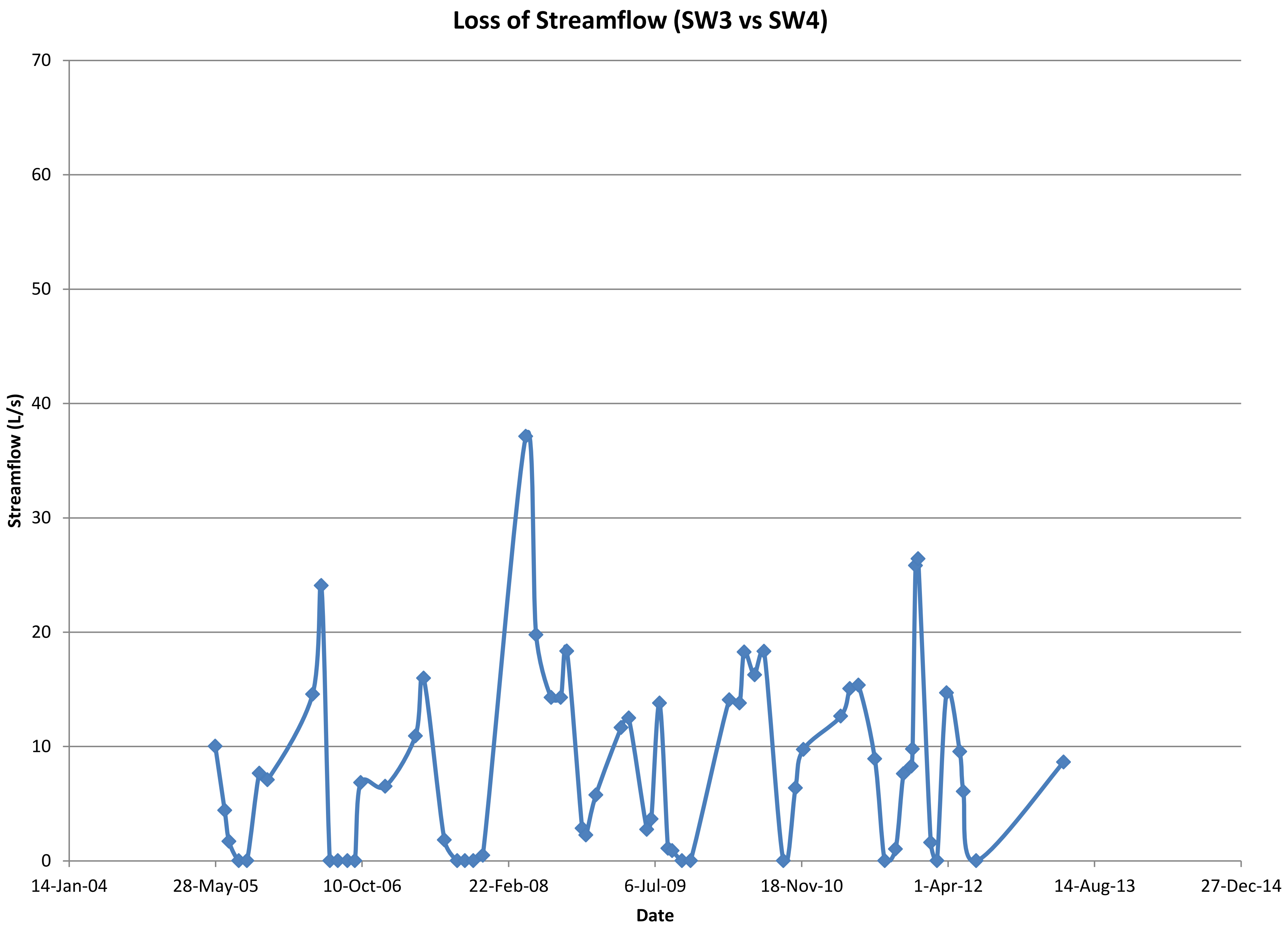


Note:

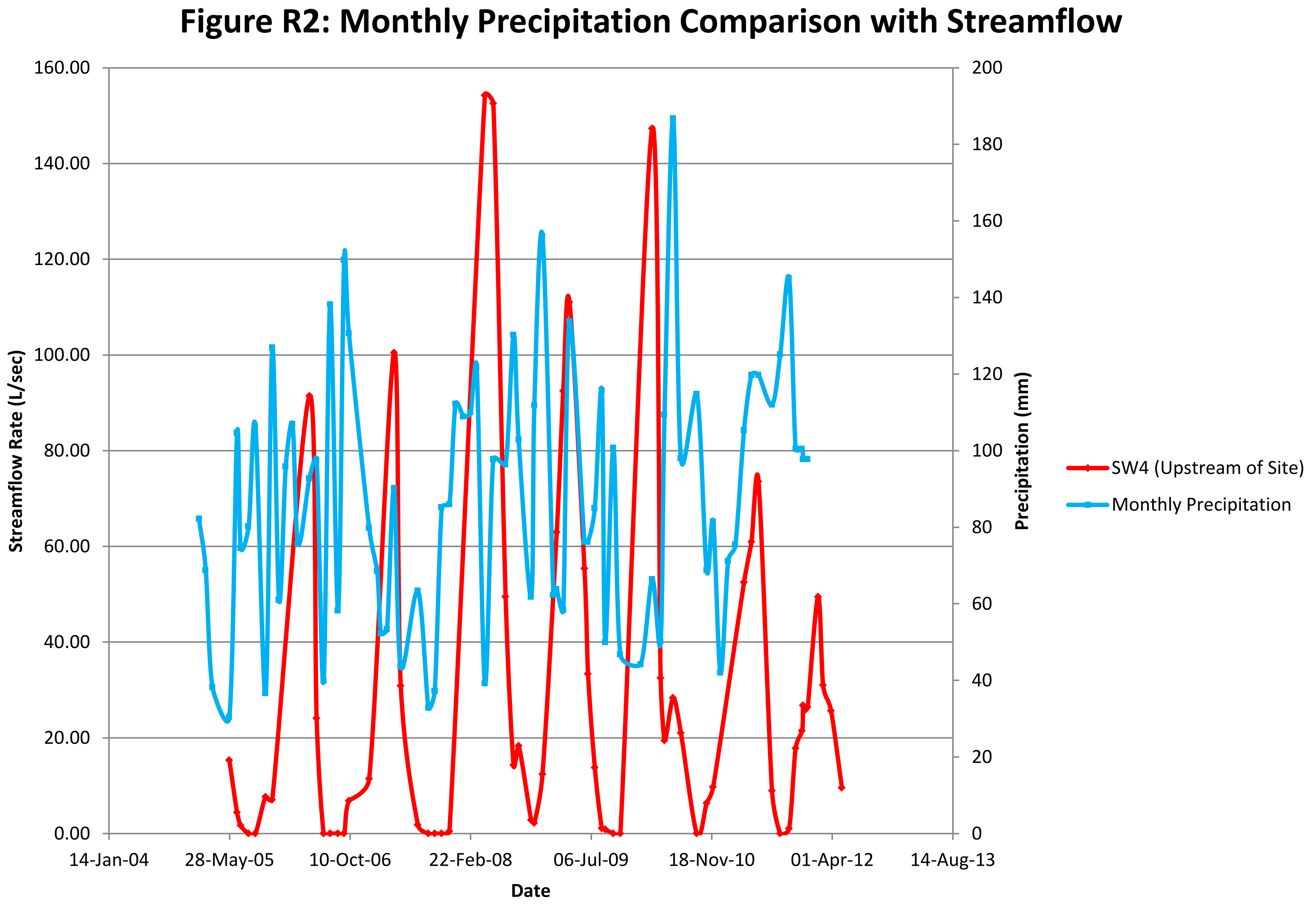
1. Water levels (High) recorded May 31, 2011 (unless otherwise stated)
2. Monitors M9, MP1, MP2, M11 and Tributary B were all dry on July 6 and October 5, 2012

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	Figure 3:
Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Tributary B Cross Section**
Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 4: Loss of Streamflow Tributary B**
	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

Date: Jan 2013

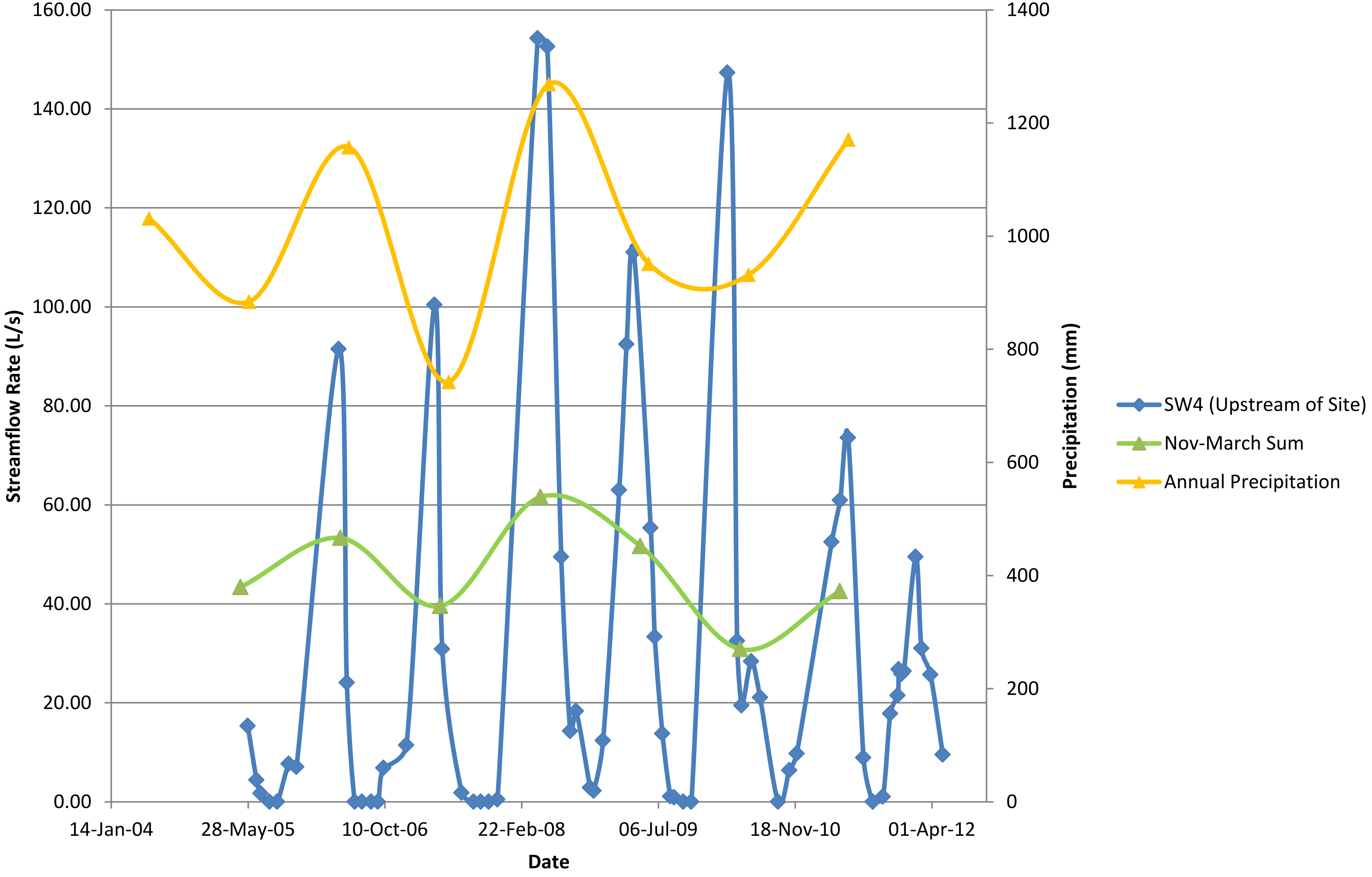
Drawn By: JD

Hidden Quarry

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

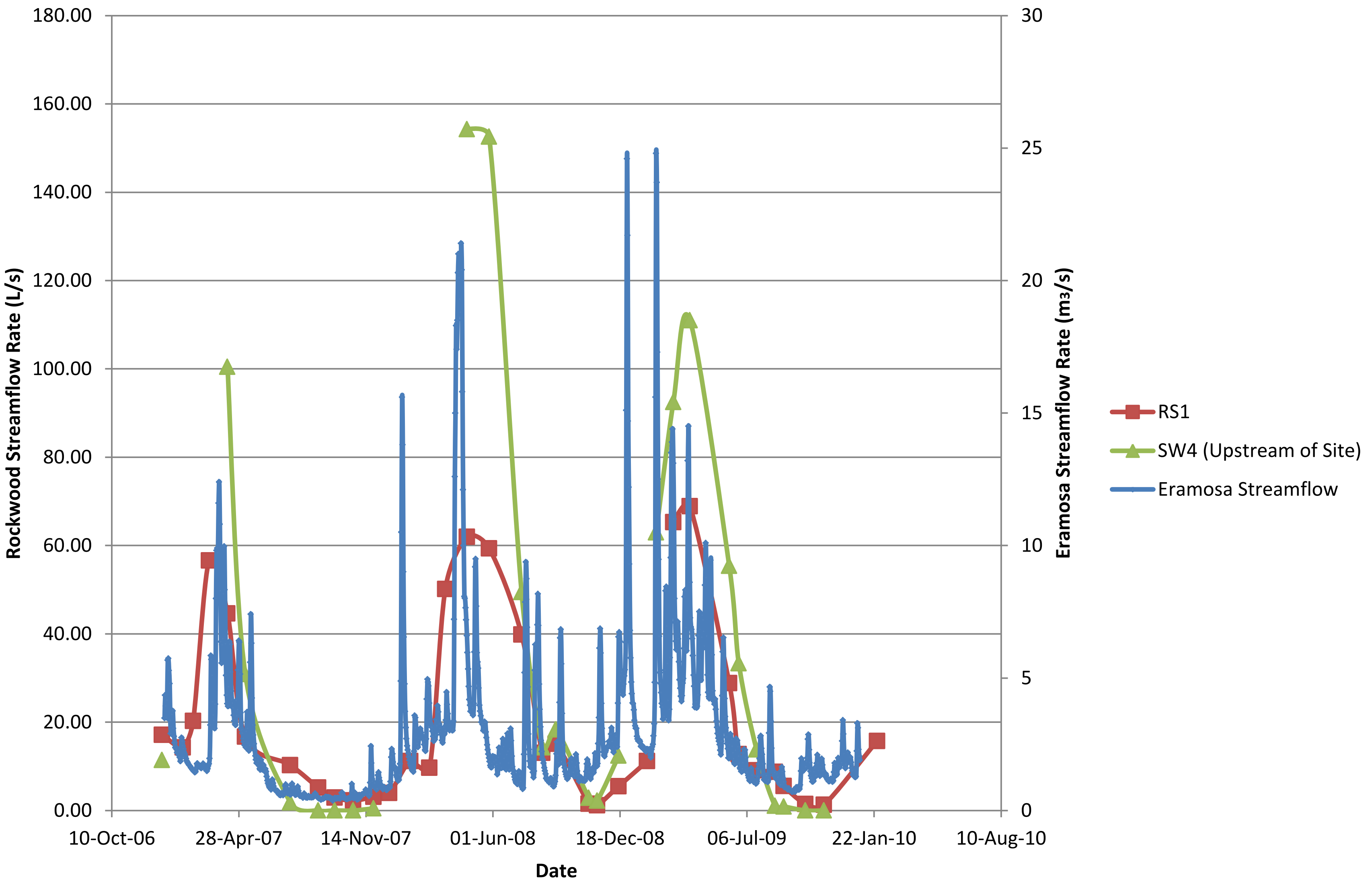
Figure R2:
Monthly Precipitation Comparison with Stream Flow

Figure R3: Precipitation Totals Comparison with Streamflows



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry	**Figure R3:** **Precipitation Totals Comparison with Streamflows**
	Date: Jan 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

Figure R4: Eramosa and Rockwood Site Streamflows



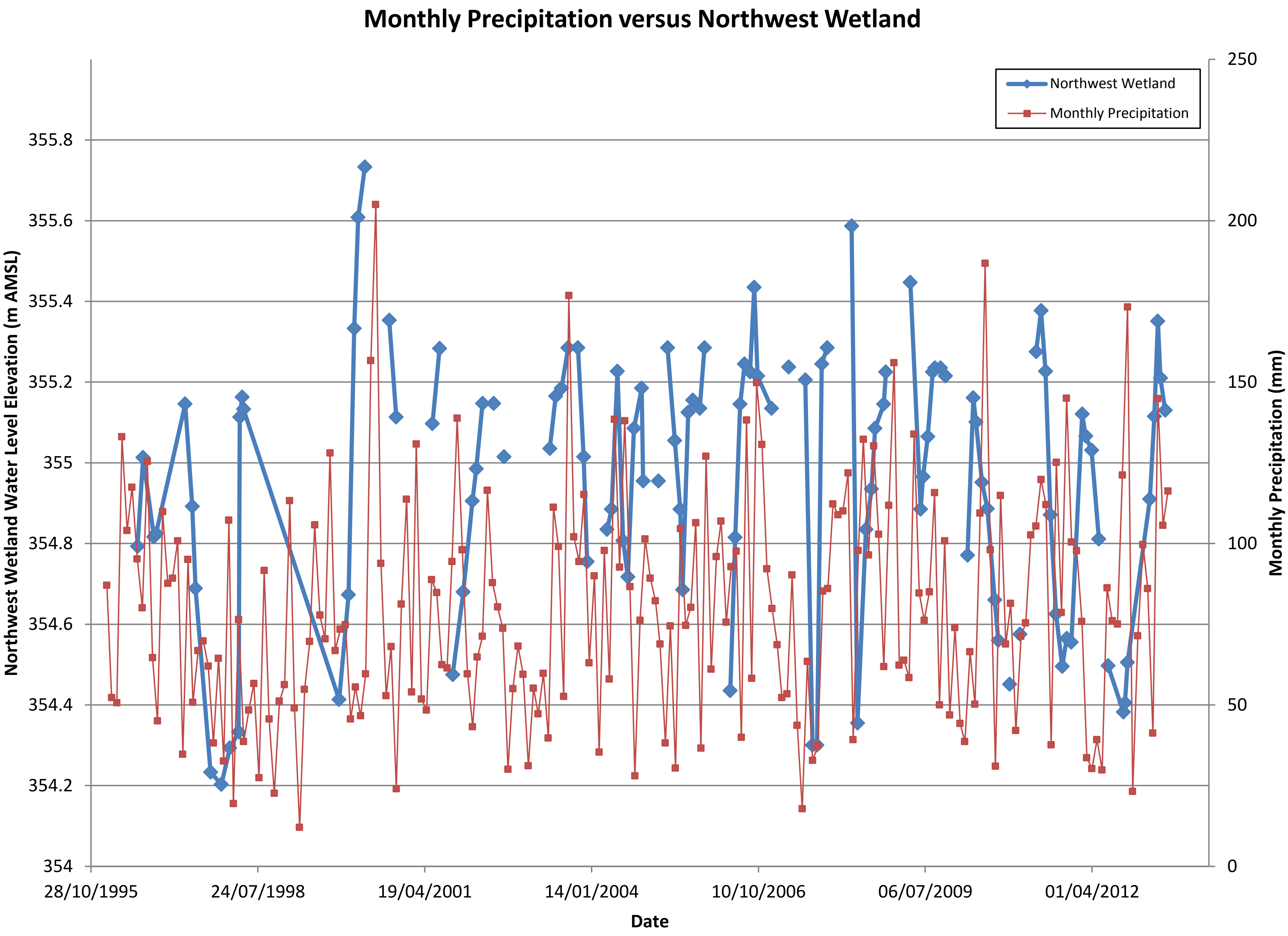
Harden Environmental Services Ltd.

Project No: 9506
Date: Jan 2013
Drawn By: JD

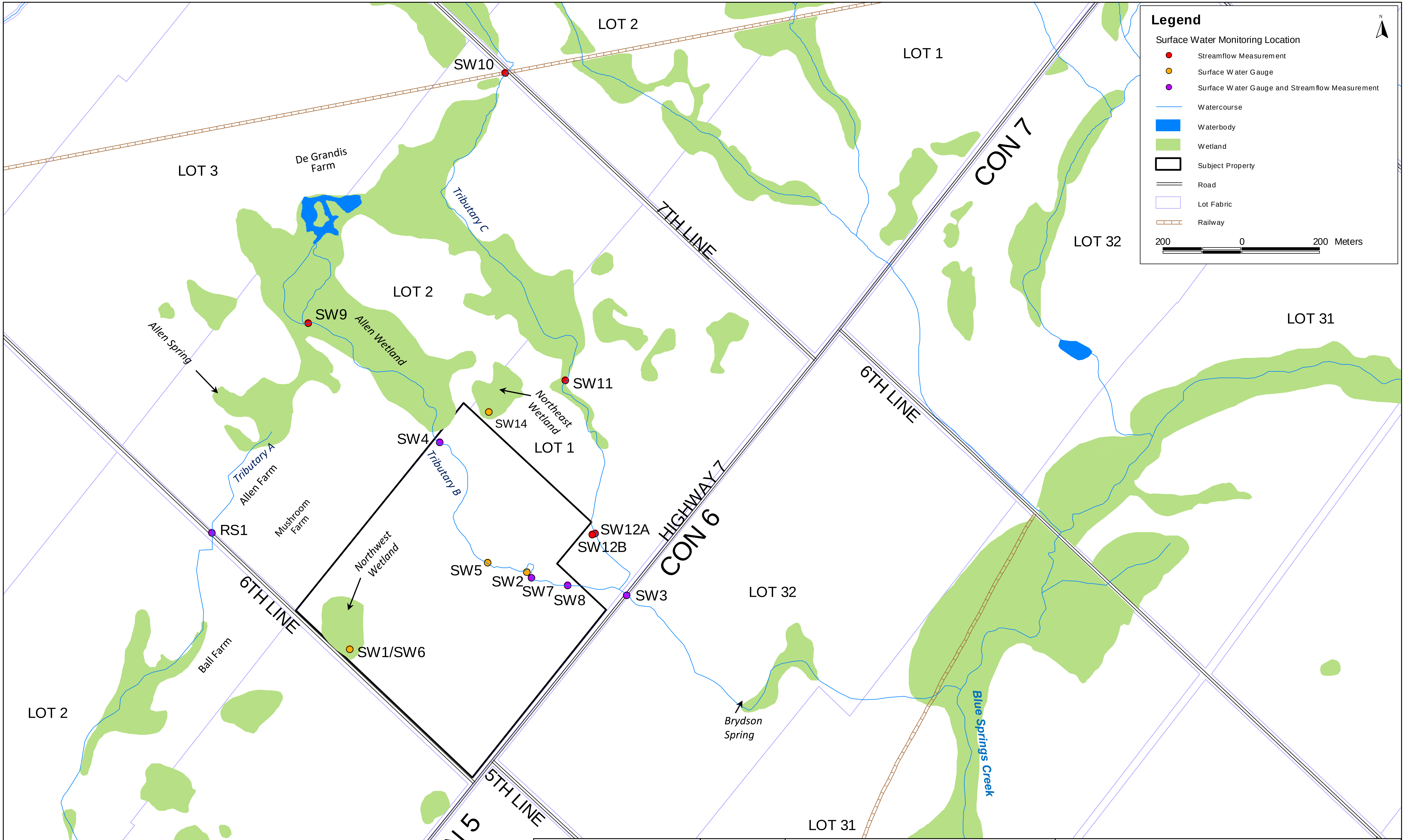
Hidden Quarry

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure R4: Eramosa and Rockwood Site Streamflows



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 5: Precipitation Versus Northwest Wetland**
	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

Date: Mar 2012

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2.4:

Surface Water Monitoring Locations

APPENDIX A

MOE Comments Dated July 3, 2013

Ministry of the Environment
West Central Region

119 King Street West
12th Floor
Hamilton, Ontario L8P 4Y7
Tel.: 905 521-7640
Fax: 905 521-7820

Ministère de l'Environnement
Direction regionale du Centre-Quest

119 rue King ouest
12e étage
Hamilton (Ontario) L8P 4Y7
Tél. : 905 521-7640
Téléc. : 905 521-7820

Ontario

July 3, 2013

Mr. G. Sweetnam
Vice President, Resources
James Dick Construction Limited
Box 470
Bolton, Ontario.
L7E 5T4

Dear Mr. Sweetnam:

Re: Application for an Aggregate Resources Act Class A, Category 2 below water table Licence
Part lot 1, Concession 6, Guelph/Eramosa, County of Wellington
James Dick Construction Limited, Hidden Quarry

This is to follow up to my letter dated April 15, 2013 to Mr. S. May, Aggregate Resources Officer, Ministry of Natural Resources regarding the above referenced application. That letter indicated that Ministry of the Environment staff would undertake a more detailed review of the supporting documentation to the application to provide specific comment or concerns in the context of the Aggregate Resources Act approval process. I apologize for the delay in this response.

Ministry of the Environment staff have reviewed the following documents:

- Report titled: "*Level I and II Hydrogeological Investigation, Hidden Quarry, Rockwood, Ontario*", dated September 2012, prepared by Harden Environmental Services Ltd. (Harden)
- Site Plans plotted September 21, 2012, prepared by Stovel and Associates Inc. for James Dick Construction Ltd.

Background

James Dick Construction Ltd. (JDCL) is proposing to extract sand, gravel, and dolostone that will extend below the water table. The site is located on Lot 1, Concession 6, County of Wellington and is approximately 38 hectares. The site is in an agricultural setting and is bound by 6th Line on the southwest side of the property and Highway 7 on the southeast side of the property.

The site is located within the Blue Springs Creek watershed. In terms of local hydrological features, Tributary A is located to the west of the property and flows towards the southwest. Tributary B enters the property from the north and flows in a southerly direction and exits the property on the east side. Tributary C is located to the east of the site and flows in a southerly direction where it converges with Tributary B downstream of the site. The Northwest Wetland is fully contained within the subject property and is approximately 1 hectare during non-drought conditions. Tributary B flows through a provincially significant wetland (Allen Wetland) which is located to the north and is adjacent to the site. There is also the Northeast Wetland which is located to the north outside of the property boundary. Groundwater flow direction is stated to be towards the southeast.

It is proposed that material will be removed to a depth of 30 metres below the water table. The rock will be removed using subaqueous methods without the need for dewatering.

Surface Water Review and Comments:

1. Surface water monitoring including water quantity and water quality has been conducted at different sampling locations within the tributaries and wetlands on and adjacent to the property. Based on the proposed extraction areas, material will be extracted on either side of Tributary B and a buffer of 20-30 metres will be maintained. Two ponds (West and East) will be created on either side of Tributary B. Given that Tributary B and the Northwest Wetland are the closest receptors to the proposed extraction areas, these features have the highest likelihood to be impacted if an impact were to occur.

   The period between when local groundwater levels will be influenced from extraction activities and the stabilization of local hydraulic conditions will represent the time when changes to hydraulic gradients would be the most pronounced. Based on the data presented Tributary B is a "losing" stream which indicates groundwater is not discharging to the part of the reach that flows through the subject property. Subsequently, decreasing the water table has the potential to increase the magnitude of the downward vertical hydraulic gradient. The report has not provided an analysis of hydraulic gradients for the data that has been collected to date or the anticipated changes during extraction activities and the potential change in the flux of water leaving the stream. More specifically, it is unclear if the rate and quantity of water lost to the underlying sediments will significantly increase as a result of lowering the water table which could cause the tributary to experience extended periods of little to no flow.

   The consultant has recommended that a hydraulic barrier be constructed along the southern and eastern perimeter of the Northwest Wetland to mitigate potential changes in hydraulic gradient that would result in loss of water from the wetland into the open space created by the excavation. The proposed approach seems reasonable to address potential impacts and will be evaluated by the proposed monitoring plan.

2. The Northeast Wetland is considered to be a perched hydrologic feature and is not an area of groundwater discharge. As such, the risk for impact associated with the wetland is low. Potential impacts to the Allen Wetland and pond that supplies flow to Tributary B are not anticipated given it is cross-gradient from the site.

3. The proposed monitoring program is presented in Section 6.1 of the subject report. Staff recommend the monitoring program be revised to reflect the following changes:

    a. Collect surface water level measurements at SW4 and SW8 in addition to SW6. This data has been collected historically and should continue to be monitored to assess potential impacts in Tributary B.

    b. Frequency of surface water level and flow measurements increase from monthly to semi-monthly between April and November (inclusive) and coincide with groundwater sampling events.

    c. Add MP1, MP2, MP3, and MP4 to the monitoring program to measure water levels and calculate vertical hydraulic gradients to address issues raised in Point#1. These monitors are useful for evaluating surface/groundwater interactions. The monitoring frequency should coincide with the groundwater monitoring program.

4. There needs to be further synthesis of the monitoring data that has been collected to date to describe pre-extraction conditions. Although the hydrogeological investigation provided the tables of surface water level and flow data, limited information was provided in terms of trends, the natural variation between years and within years (i.e. seasonal differences), and surface/groundwater interactions particularly in the Northwest Wetland and Tributary B. This information can be used to have a clearer understanding of baseline conditions prior to extraction, which is similar to what is being proposed in Section 6.2 to summarize baseline groundwater conditions. Also, it will allow to better define conditions that are outside of the natural variation measured prior to extraction and to establish when potential impacts may be occurring. More specifically, it is not clear how the monitoring program will identify potential impacts or what environmental condition will trigger contingency measures identified in Section 6.3.

<u>Groundwater Review and Comments:</u>

1. One of the potential impacts of the proposed quarry to the bedrock aquifer is the change of groundwater levels resulting from the groundwater flow into the quarry to replace the volume of rock removed. The proposed rate of extraction is 700,000 tonnes per year which is equivalent to 270,000 m^3 of rock per year.

    Based on the field work data and published data for the area, a computer modeling was used to predict the water level changes in the bedrock aquifer. The results indicate that the maximum decline of 1.8 m is predicted at the northern Site boundary; and a rise of 1.5 m at the southern Site boundary.

    The predicted water level changes in the groundwater should not significantly affect the private water wells in the area since the expected water level change is less than the measured seasonal water level variation (0.8 to 2.5 m in the bedrock and 1.0 to 2.4 in the overburden) and small compared to the available drawdown in the surveyed area wells (generally greater than 5 m with an average of approx 19 m). The pre-bedrock extraction water survey proposed in Section 6.2 of the report should provide an updated baseline conditions for the local water wells in the area.

2. The report asserts that the bedrock aquifer and wells completed in the aquifer are already subject to direct influence from surface water. This is based on the observation that the local streams recharge the aquifer in the dolostone at times, transporting agricultural nutrients and biological elements to the aquifer below. In addition, the susceptibility of the bedrock aquifer to contaminants from the ground surface has been recognized in several reports of studies done for the area. Harden collected samples from on-Site groundwater monitoring wells and an on-Site private well for water quality analyses. The results indicate that there are elevated nitrates (above 5mg/L) in two wells – one screened in the bedrock and the other in the contact zone between the overburden and the bedrock. Staff agree with Harden that the potential sources of nitrate are septic systems and farming practices existing in the area. In addition, the quarry pond to be created by the aggregate extraction activities will be susceptible to biological contamination introduced by wildlife.

   The proposed mining process – extraction below the groundwater without dewatering – also has the potential to have a detrimental effect on the groundwater quality since chemical explosives, in a water proof emulsion form, are brought in the sub-aqueous environment to break the rock. This type of mining is presently conducted at the Dolime Quarry in Guelph. Harden collected a water sample from the Dolime Quarry pond above the broken rock pile four hours after detonation; the sample was analyzed for metals, inorganic compounds, polycyclic aromatic hydrocarbons (PAH), volatile organic compounds (VOC) and hydrocarbons . The results indicate absence of PAH and VOC (except for benzene found at a concentration of 0.11 ug/L); absence of hydrocarbons; and concentration of inorganics and metals below the Ontario Drinking Water Standards (ODWS). This data indicate a low potential for negative water quality impacts.

3. Another potential impact of the quarry on groundwater is the thermal effects of the creation of the quarry ponds on the temperature of groundwater in the surrounding areas; particularly on the Brydson Spring south of the Site. This potential effect has not been addressed.

4. Based on the bedrock descriptions in the record of boreholes for M2 and M4, the presence of vuggy and reefy porosity, open fissures and large cavities suggest the presence of karst in the bedrock. This issue needs to be addressed.

5. The proposed monitoring and contingency plans are presented in Section 6 of the report. These should be revised to consider the following comments and recommendations:

   a. There is a lack of bedrock monitoring points in the area to the east of the stream crossing the Site; thus, at least a monitoring well should be drilled on the area; water levels should be monitored before bedrock extraction begins, and the well should be added to the monitoring plan.

b. The water level data presented was collected at an approximate monthly frequency; so, the data show the natural seasonal variation of the groundwater water levels in the area. However, during the active rock extraction, specially at the outset, the water levels are expected to fluctuate much more quickly; consequently, it is recommended that, before the commencement of bedrock extraction, bedrock water level data be collected at a frequency of at least once a day for at least one year to generate a baseline dataset. Future water levels fluctuation during the bedrock extraction phases can be compared to the baseline dataset. These future water levels fluctuations should also be measured at a daily frequency as a minimum for a minimum of year, at that point in time the data collected should be assess to establish the frequency of measurements for the life of the quarry.

c. Using the baseline dataset noted in Point b. above, the data from the pre-bedrock extraction water survey proposed in Section 6.2, and the existing data, establish preliminary triggers for the Contingencies Measures presented in Section 6.3 of the report. The preliminary triggers should be re-assessed at the same time of the assessment recommended in Point b. above.

d. Propose a method for reporting and interpretation of the collected data.

e. Consider the outcome of addressing the issues raised above in Points 3. and 4. to modify or enhance the monitoring plan.

f. Increase the groundwater quality frequency to semi-annually.

Ministry staff would be pleased to meet or discuss these comments. The groundwater reviewer is Ms. Rosa Stewart who can be contacted at (905)521-7592 or at Rosa.Stewart@Ontario.ca. The surface water reviewer is Mr. Craig Fowler who can be contacted at (905)521-7823 or at Craig.Fowler@Ontario.ca.

Yours truly,

Carl Slater

Carl Slater
Technical Support Manager
West Central Region

C: Mr. S. May, Ministry of Natural Resources
Ms. J. Glassco, District Manager, Guelph District Office, MOE
Ms. L. Armour, Environmental Officer, Guelph District Office, MOE

APPENDIX B

Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site

HARDEN

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

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

Date: June 7, 2013

James Dick Construction Ltd.
Box 470
Bolton, Ontario
L7E 5T4

Attn: Mr. Greg Sweetnam

Dear Mr. Sweetnam:

Re: Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site

1.0 Introduction

We are pleased to provide additional information in regards to geological and hydrogeological characterization of the bedrock underlying the proposed Hidden Quarry. The purpose of this exercise is twofold. Firstly the drilling and testing was conducted in order to satisfy comments made by R.J. Burnside and Associates Ltd. on the Level I and II Hydrogeology Report for the Hidden Quarry and secondly to facilitate monitoring of the site during a proposed pumping test by the Township of Guelph Eramosa in their Well No. 2.

This report details the following field efforts conducted at the site;

1) Drilling of a 140 mm (5.5”) cored borehole by Keith Lang Water Well Drilling,

2) Retrieval and storage of 44.35 metres of core, noted the presence of fractures and breaks in the core,

3) Photographing of the core in both metric and imperial depths below ground surface,

4) Pumping of the well at approximately 2.1 and 4.2 L/s for one hour,

5) Flow profiling of the well and

6) Video logging of the well.

2.0 Drilling Summary

On May 13th and 14th, Keith Lang Water Well Drilling drilled Monitor 15 (M15) at co-ordinates 4829516 N, 571926 E and shown on Figure 1. Keith Lang used a Speedstar 30K drill rig and used mud rotary in the overburden and air rotary in the bedrock. Bedrock was encountered at a depth of 9.55 metres below ground surface (m bgs). The final depth of the borehole was 54.33 m bgs. The diameter of the borehole in the bedrock is 140 mm (5.5”). 150 mm (6”) casing was installed to a depth of 10.46 m bgs. There is a stick-up of fifty-one centimetres above ground surface. Bentonite grout was used in the mud circulation to seal the annulus between the overburden and the steel casing. The ground elevation of the borehole is 360.03 metres above mean sea level (m AMSL) and the top of steel casing has an elevation of 360.54 m AMSL.

2.1 Overburden

Wash samples of the overburden were obtained at 1.5 metre intervals. The wash samples only allow for general descriptions of the overburden and in general overburden comprises a very stony sand deposit. Detailed descriptions of the overburden are available from M11 and M12 drilled nearby. The borehole logs for M11 and M12 indicate that the overburden is mainly a stony silty sand.

2.2 Bedrock

The top of bedrock was encountered at a depth of 9.55 m bgs. Coring of the borehole commenced at a depth of 9.98 mbgs. Detailed descriptions of the core are found in the borehole record (Appendix A) and a photo log of the entire core is found in Appendix B. In regards to bedrock nomenclature, all of the dolostone geological units encountered belong to the formerly un-subdivided Amabel Formation. We have attempted to assign individual formation names based on recent work by the Ontario Geological Survey (OGS, 2008)[1] .

Goat Island Formation – Niagara Falls Member

A dark grey non bituminous fine grained dolostone is found in the core between 9.98 m bgs and 10.03 m bgs. This is interpreted to be the Niagara Falls Member of the Goat

---

[1] Summary of Field Work and Other Activities, 2008, OFR 6226, Frank Brunton

Island Formation. Based on a comparison of this core with core of the Eramosa Formation obtained from the Dolime Quarry in Guelph, this core is not representative of the Eramosa Formation.

Gasport Formation

The Gasport Formation is found between 10.03 m bgs and 48.50 m bgs. The Gasport comprises of white to blue grey coarse grained dolostone. The porosity of the Gasport Formation varies from openly porous to tightly packed. There are numerous stylolites within this formation. The formation has visible fossilization of which crinoid stems and brachiopod shell castings were found. Portions of the Gasport Formation are vuggy. No significant loss of core occurred. The driller noted two water bearing fractures at 16 and 18.5 metres depth during the drilling.

Irondequoit Formation

The Irondequoit Formation is found between 48.50 m bgs and 49.93 m bgs. This formation is found to be blue grey dolostone, pyritiferous.

Rockway Formation

The Rockway Formation is found between 49.93 and 50.72 m bgs. The Rockway Formation is a finely crystalline green dolostone. The formation is pyritiferous.

Merriton Formation

The Merriton Formation is found between 50.72 m and 51.51 m bgs. The Merriton Formation is a buff brown finely crystalline dolostone.

Cabot Head Formation

The Cabot Head formation was found below 51.51 m bgs. The Cabot Head formation comprised red and green shale beds.

A summary of the depths and elevations of the geological units is provided in Table 1.

Table 1: Geological Summary

Geological Unit	Depth (m bgs)		Elevation (m AMSL)	
	From	To	From	To
Overburden	0	9.55	360.03	350.48
Goat Island: Niagara Member	9.55*	10.03	350.48	350.00
Gasport Formation	10.03	48.50	350.00	311.53
Irondequoit Formation	48.50	49.93	311.53	310.10
Rockway Formation	49.93	50.72	310.10	309.31
Merriton Formation	50.72	51.51	309.31	308.52
Cabot Head Formation	51.51		308.52	

* Geological unit between top of rock and beginning of core is assumed to be Goat Island Formation

2.3 Description of Core Breaks

Each core break was looked at in the field and at our office and recorded as a machine break, closed fracture or open fracture. The record of core breaks will only include naturally occurring core breaks. The distinction between an open and closed fracture is made where there is evidence of water movement through the break (discolouration, mineral oxidation etc..), imperfect fit of the core and infilling or mineralization along the fracture wall. Where possible, any material found within the fracture was noted, however, the water circulation around the core during the drilling process, likely removed this material, if any was present.

Table 2 (located following the text of this report) is a summary of the core breaks. A total of ninety three natural core breaks are recorded over the 44.35 metres of core. Eighty five percent of core breaks occurred at 90 degree angle relative to the axial length of the core. Two vertical fractures were identified in the core.

The frequency of open fractures is summarized in Table 3.

Table 3: Frequency of Open Fractures

Depth (m bgs)		Number of Open Fractures
From	To	
10	15	7
15	20	3
20	25	9
25	30	8
30	35	10

Depth (m bgs)		Number of Open Fractures
From	To	
35	40	9
40	45	2
45	50	1
50	55	5

The greatest concentration of open fractures occurs between the depth of 20 and 40 metres below ground surface.

2.4 Photo Log of Core

A photo log of the core is found in Appendix B. The photo log is provided in both metric and imperial units. Open and closed fractures are noted on the photo log as well as the interpreted geological contacts. Significant water bearing zones as identified from the downhole flow test and video log are also identified on the photo log.

3.0 Pumping Tests

Monitoring well M15 was pumped prior to and during the flow testing and video logging procedures. Prior to flow testing, the well was pumped at 2.1 and 4.2 litres per second for approximately 60 minutes and 30 minutes respectively. The drawdown curves for these pumping rates are shown on Figure 2. The drawdown after 60 minutes of pumping at 2.1 L/s was 1.21 m. The drawdown after 34 minutes at the 4.2 L/s rate was 2.24 m. Semi-log graphs of the 2.1 L/s and 4.2 L/s test are shown on Figures 3 and 4 respectively. Straight line analysis (Jacob semi log method) suggests that the transmissivity of the aquifer is between 50 and 70 m^2/day. This translates to an estimated hydraulic conductivity of 2 x 10^{-5} m/s (using relationship of T = k/b where b = aquifer thickness of 38.5 metres). The maximum drawdown in M15 was observed at the end of the flow testing at 2.67 metres.

Manual measurements and an automatic logger installed in M2 recorded the effects of pumping. The hydrograph for M2 is shown on Figure 5. M2 also penetrates the entire thickness of the aquifer. The maximum response in M2 was approximately 1.23 metres. The semi-log graph of the drawdown of M2 from the pumping at 4.2 L/s is shown on Figure 6. The straight-line analysis of the data results in an estimated transmissivity of 83 m^2/day in the aquifer.

As shown in Table 3, no response was measured in M1D, M3 or M13D.

Table 3: Water Levels in Shallow Bedrock Monitors on May 24, 2013

Time	M1D (mbct)	Time	M3 (mbct)	Time	M13D (mbct)
10:43	7.875	10:15	10.295	10:48	2.95
10:59	7.875	11:39	10.295	10:55	2.95
11:09	7.875	12:27	10.295	11:14	2.95
11:25	7.875	14:22	10.28	11:22	2.95
14:48	7.88	15:03	10.28	14:43	2.95

3.1 Flow Test

The velocity of water moving through the borehole was measured with a down-hole flow meter. The flow meter was installed in the well and the pump was installed above the flow meter. The pump was operated with a flow rate of approximately 4.2 L/s during the flow measurements. Flow measurements were obtained every 0.30 metres. The results of the flow test are provided in Table 4 following this report and shown graphically on Figure 7. The flow velocity steadily declines between 15 and 36 m bgs. At 36 metres depth, the flow velocity decreases by 0.1 m/s followed by another significant drop in velocity at 42 m bgs. Below 42 mbgs there is negligible flow in the well.

The flow test shows that approximately one third of the yield of the well is derived from various fractures between 10 m and 36 m bgs (350 to 324 m AMSL), one third of the well yield is obtained from a single set of fractures at 36 m bgs (324 m AMSL) and a third of the well yield is obtained from a fracture at 42 m bgs (318 m AMSL) (Table 5).

The maximum flow measured by the flow meter was approximately 0.27 m/s. The area of the borehole is 0.0153 m^2. Thus the volume of water flowing through the well beneath the pump was approximately 4.1 L/s. This is similar to the pumping rate of 4.2 L/s and thus the majority of water removed by the pump was derived from below the pump.

Table 5: Flow Test Summary

Interval (m AMSL)	Interval (m bgs)	Approximate % Yield
324 to 350	10 to 36	33
324	36	33
318	42	33

4.0 Video Log

A video camera was introduced to the well both above and below the pump. The video log is another method that can be used to identify discrete zones of water movement. Two videos were taken by Geokamp Ltd.

4.1 Video 1 – Above Pump Video

Video 1 was taken above the pump before and after pumping occurred. This video shows the bottom of the casing where contact with the rock is made. When the pump is turned on at 5:58 (minutes:seconds) of the video, the water can be observed to recede below the casing/bedrock contact. There is no observable movement of water at that contact. Turbid water can be observed to flow into the wellbore at time 8:46 of the video at a depth of 42' (12.80 m).

4.2 Video 2 – Below Pump Video

The pump was installed at a depth of approximately 12 metres below the top of casing. The video log identifies that below a depth of 45 metres (148'), the water is stagnant despite the continual operation of the pump. This confirms that the lower portion of the aquifer is not an active part of the flow system. This includes the Irondequoit, Merriton, Rockway and Cabot Head formations.

The video identifies water movement into the well at 52' (15.8 m).

5.0 Water Levels

Water levels were obtained from M15 on several occasions as summarized in Table 6. The stabilized groundwater elevation in M15 was measured to be 350.69 m AMSL on May 24, 2013. This value correlates to the contoured bedrock water levels as shown on Figure 3.17 of the Level I and Level II hydrogeology report.

Table 7: Water Level Monitoring M15

Date	Water Level (m bgs)	Water Level (m AMSL)
May 14, 2013	9.26	350.77
May 15, 2013	9.12	350.91
May 16, 2013	9.28	350.75
May 24, 2013	9.34	350.69

6.0 Water Quality Results

The water quality results for a sample obtained during the pumping are presented in Appendix C. The water has a nitrate value of 2.0 mg/L and chloride value of 16 mg/L. The low nitrate and chloride concentration indicates relatively low impact from anthropogenic activity. The water quality is typical for the dolostone aquifer in this area.

7.0 Recommended Multi-Level Installation Details

Monitoring Well M15 will be converted into a multi-level monitoring station using 40 mm PVC pipe. The main water bearing zones will be targeted for the discrete monitoring zones. We recommend the following zones for monitoring.

Monitoring Level	Interval (m bgs)		Interval (m AMSL)	
	From	To	From	To
Shallow	10	28	350.03	332.03
Intermediate	33	38	327.03	322.03
Deep	40	55	320.03	305.03

The shallow monitoring level represents the upper water bearing zone and is the zone where the majority of local wells obtain their water. The intermediate zone covers the major water bearing fracture located at a depth of 36 metres. The deep monitoring interval covers the major water bearing fracture at 42 metres. The majority of water movement through the quarry will occur between the elevation of 332 and 350 m AMSL. The maximum proposed depth of the quarry is 30 metres to an elevation of 320 m AMSL. It is more likely that the quarry will be limited to a depth of 25 metres or an elevation of 325 m AMSL. Thus the shallow and intermediate monitoring intervals will monitor water level changes and water quality changes occurring downgradient of the quarry and the deep monitoring zone will be able to monitor water level changes in the water bearing zone beneath the quarry. The intervals will be separated by a bentonite seal. A coarse sand will be used to fill the annulus between the screen and the borehole wall.

8.0 Discussion

The installation of M15 was a useful exercise as it confirmed the following about hydrogeological conditions within the proposed Hidden Quarry site;

1) There are no significant karst features identified in the geological profile. This is in keeping with the observations at M1, M2, M3, M4, M13D and M14D. The core obtained from M15 contains fractures, however, none suggest karstification of the dolostone aquifer.

2) Water bearing zones occur throughout the geological profile. The Gasport Formation is well known for its water bearing ability and this characteristic was confirmed at M15. Water bearing zones occur from the top of bedrock at an elevation of 350 m AMSL to an elevation of 318 m AMSL. There was no indication of preferential flow through the upper three metres of the geological profile.

3) Lateral hydraulic connectivity within the aquifer occurs at depth. There was a hydraulic response noted in monitor M2 to the pumping of M15. M2 and M15 fully penetrate the dolostone aquifer and the response in M2 verifies that water transmission will occur through the aquifer. This proves that M2 will be a useful monitor during the quarry operation to observe changes in the aquifer during extraction.

4) Hydraulic responses were not observed within the shallow bedrock at M1D, M13D or M3 whose completion elevations are all above 346 m AMSL. These wells are completed in the upper three metres of the bedrock. The lack of immediate hydraulic response is due to a relatively poor hydraulic connectivity between the shallow bedrock and deeper fractures; and poor lateral connectivity in the shallow zone. It is anticipated that the shallow bedrock zone will ultimately experience a hydraulic response after a prolonged water level change.

5) Although pumping periods were short, the response in the pumping well and in M2 were used to estimate transmissivity of the aquifer. The near-well transmissivity is estimated to range from 50 m^2/day to 80 m^2/day. This correlates well to the bulk hydraulic conductivity used in the model for the dolostone aquifer. These values also correlate well to the hydraulic testing conducted on the adjacent Mudge property where transmissivity of the aquifer was found to range from 20 to 150 m^2/day.

9.0 Response to Burnside Comments

We provide the following for inclusion in the response matrix for issues raised by Burnside.

Matrix #	Burnside Comment	Harden Response
72	There is not sufficient information on the bedrock in the extraction areas to allow for a reliable prediction of drawdown to be made. The vertical spacing and contribution of the water bearing fractures is not known and as a result, inflow into the pit may result in temporary dewatering of shallow fractures. The length of time for water levels to stabilize is not estimated. There is also a potential that bedrock water quality will be affected if cascading occurs within the extraction area.	The drilling of M15 along with the drill core, video log and down-hole flow monitoring provides confirmation that hydrogeological conditions beneath the quarry are satisfactorily understood. Open fractures and thus water yield for residential wells comes from a wide depth range and the concern regarding dewatering of shallow fractures is not a significant impact as there are numerous water sources at depth in the aquifer. There is not an indication from water well records that nearby wells only obtain water from the portion of the aquifer predicted to be impacted. The maximum off-site impact is predicted to be in the order of 1.5 metres. This is insufficient to significantly change the yield in any bedrock well. The mining process is relatively slow and occurs only for the working portion of the day allowing for daily recovery (at least, partial recovery) of water levels. Thus stabilization of water levels will occur relatively rapidly (days to months) following cessation of mining. The maximum water level change within the quarry is predicted to be 2.45 m at the northern edge of the west pond. This penultimate drawdown will only occur at the end of the quarry life and there will be many years of monitoring to verify that the slow change in water levels is not having an impact on the environment and local wells. It is unlikely that there will be water cascading into the quarry. Our observations of several dolostone quarries in southern Ontario suggest that there is more likely to be water movement behind the rock face. Even so, this cascading can only occur in the upper three metres of the bedrock along the

Matrix #	Burnside Comment	Harden Response
		northern most quarry edge. It is our prediction that at the edge, these three metres will be dewatered and no cascading will occur. The quarry will allow water from various zones within the bedrock to mix but no more than a water well mixes water from the full length of aquifer intersected by the well.
60	The Guelph Eramosa Study used significantly higher hydraulic conductivity values. Since the bedrock is heterogeneous significant variations in hydraulic conductivity can be expected. Additional data from within the extraction area is needed to confirm on-site conditions.	Based on the short term tests conducted in M15, the transmissivity of the aquifer is 50 to 80 m^2/day and within the range as originally predicted. The hydraulic conductivity of the aquifer based on this transmissivity is estimated to be 2×10^{-5} m/s, the same value used in the groundwater model. The data from M15 confirms that there are no unexpected onsite geological or hydrogeological conditions.
54	The bedrock surface is shown in Figure 3.5. The proposed extraction area should be added to this map. It appears that there are few (if any) bedrock monitoring wells within the two extraction areas. Given the heterogeneity of the bedrock, it is recommended that monitoring wells be installed within the extraction areas.	M15 was drilled to satisfy this comment. M15 will be instrumented on several different levels. The testing of M15 confirms that as with all bedrock aquifers, there is vertical heterogeneity with water being produced both diffusely from broad areas and discretely from single fractures. M15 is located centrally to the site between the proposed extraction areas and provides confirmation of hydrogeological conditions already anticipated in the Level I and Level II Hydrogeology Report.
56	It is noted in the report that the Brydson Spring likely represents discharge directly from the bedrock and can be considered to be the re-emergence of Tributaries B and C. There are	The water levels obtained from M2, M12, M3, M15 and M11 confirm that geological conditions are such that groundwater does not occur in the overburden in the eastern two

Matrix #	Burnside Comment	Harden Response
	limited bedrock wells on the proposed quarry site and there is no data that confirms that the tributary loses water to the bedrock. Tracer testing should be considered to confirm this statement.	thirds of this site despite the loss of water from Tributary B. The static water level at the on-site home (MOE Well # 6705627) is below the top of rock. This well is situated very close to Tributary B and downstream of the losing portion of the stream. There is no evidence to suggest that water lost from Tributary B does anything but contribute to the bedrock aquifer. The Brydson Spring is the nearest discharge point and thus a likely destination for water infiltrating local to the quarry. There is no appreciable thickness of overburden at the Brydson Spring or in the Blue Springs Creek valley, thus all infiltrating waters at the site and nearby must contribute to the bedrock. It is our opinion that a tracer test will not yield any meaningful information.

Respectully submitted,
Harden Environmental Services Ltd.

Stan Denhoed

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

Table 2: Log of Core Breaks

Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
32.83	10.01	open	90	
33.08	10.08	open	90	
33.17	10.11	open	90	
34.00	10.36	closed	90	
35.29	10.76	open	90	
36.25	11.05	open	90	calcite mineralization
37.83	11.53	closed	90	
41.17	12.55	open	90	iron staining
41.50	12.65	open	90	
48.71	14.85	open	90	clay infilling
50.96	15.53	open	30	brown staining
51.67	15.75	closed	90	
53.67	16.36	open	90	
60.83	18.54	open	90	
61.33	18.69	closed	10	
65.75	20.04	open	90	discolouration along fracture
67.33	20.52	open	90	
68.33	20.83	open	90	
68.83	20.98	open	90	
71.54	21.81	closed	0-90	
72.58	22.12	closed	90	
73.50 - 74.25	22.40 - 22.63	closed	vertical	
74.67	22.76	closed	90	
77.00	23.47	closed	45	
77.21	23.53	open	90	iron staining
77.38	23.58	open	90	iron staining
79.71	24.30	open	90	
79.79	24.32	open	90	
80.63	24.57	open	90	
81.00	24.69	open	90	
83.25	25.37	open	45	
84.17	25.65	open	30	
85.17	25.96	open	90	
86.54	26.38	open	90	
86.92	26.49	open	90	
88.42	26.95	closed	impact fract from driller	
90.75	27.66	open	90	
95.33	29.06	open	20	
98.25	29.95	open	45	
98.63	30.06	open	90	
99.25	30.25	open	45	
99.50	30.33	open	90	
100.83	30.73	closed	90	

Table 2: Log of Core Breaks

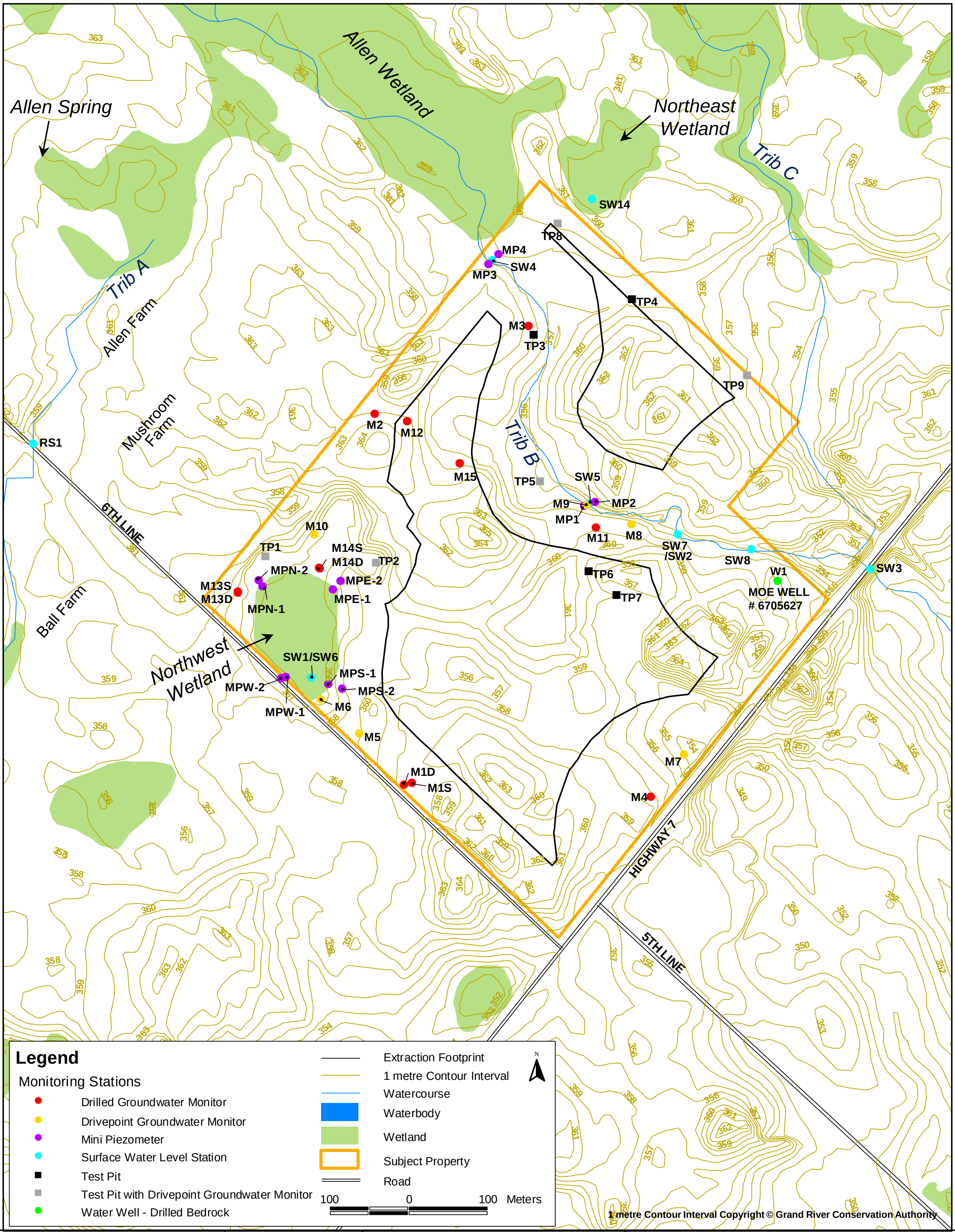
Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
101.25	30.86	closed	90	
102.00	31.09	open	90	vuggy
102.50	31.24	open	90	
102.83	31.34	closed	90	
103.42	31.52	open	90	
106.33	32.41	open	90	
108.42	33.05	closed	90	
109.25	33.30	open	90	drill stem dropped 2-3"
110.17	33.58	closed	90	
112.33	34.24	open	90	
112.83	34.39	closed	vertical	
114.17	34.80	closed	90	
114.50	34.90	open	90	discoloured
117.08	35.69	closed	90	
117.33	35.76	open	90	
119.50	36.42	open	90	
120.25	36.65	closed	90	
120.71	36.79	open	90	
120.79	36.82	open	90	
121.00	36.88	open	90	
124.33	37.90	open	90	
126.83	38.66	open	90	
128.00	39.01	closed	90	
128.75	39.24	open	90	
131.17	39.98	open	90	discolouration around fract-whiter
131.92	40.21	closed	90	
136.08	41.48	open	90	
142.08	43.31	closed	90	
144.50	44.04	open	90	white discolouration around fracture
147.83	45.06	closed	10	
148.00	45.11	closed	90	
152.42	46.46	closed	90	
152.75	46.56	closed	90	
156.50	47.70	open	90	
157.50	48.01	closed	30	
157.96	48.15	closed	30	
161.42	49.20	closed	90	
161.67	49.28	closed	90	
163.92	49.96	closed	90	
164.17	50.04	closed	90	
164.58	50.17	closed	90	
165.50	50.44	closed	90	
165.67	50.50	closed	90	

Table 2: Log of Core Breaks

Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
165.75	50.52	closed	90	
166.00	50.60	open	90	
166.42	50.72	open	90	
167.83	51.16	open	90	
168.17	51.26	open	90	
168.50	51.36	closed	90	
168.92	51.49	open	90	

Table 4: M15 Flow Test Results

Depth (Feet b.c.t.)	Velocity (ft/sec)	Depth m bgs	Velocity (m/s)	Depth (Feet b.c.t.)	Velocity (ft/sec)	Depth m bgs	Velocity (m/s)
50	0.89	14.73	0.27	96	0.71	28.75	0.22
51	0.88	15.03	0.27	97	0.69	29.06	0.21
52	0.88	15.34	0.27	98	0.68	29.36	0.21
53	0.87	15.64	0.27	99	0.64	29.67	0.20
54	0.87	15.95	0.27	100	0.69	29.97	0.21
55	0.87	16.25	0.27	101	0.65	30.27	0.20
56	0.86	16.56	0.26	102	0.68	30.58	0.21
57	0.83	16.86	0.25	103	0.68	30.88	0.21
58	0.85	17.17	0.26	104	0.68	31.19	0.21
59	0.83	17.47	0.25	105	0.67	31.49	0.20
60	0.82	17.78	0.25	106	0.67	31.80	0.20
61	0.82	18.08	0.25	107	0.69	32.10	0.21
62	0.85	18.39	0.26	108	0.68	32.41	0.21
63	0.8	18.69	0.24	109	0.68	32.71	0.21
64	0.75	19.00	0.23	110	0.66	33.02	0.20
65	0.74	19.30	0.23	111	0.63	33.32	0.19
66	0.74	19.61	0.23	112	0.62	33.63	0.19
67	0.74	19.91	0.23	113	0.63	33.93	0.19
68	0.77	20.22	0.23	114	0.66	34.24	0.20
69	0.78	20.52	0.24	115	0.64	34.54	0.20
70	0.76	20.83	0.23	116	0.64	34.85	0.20
71	0.76	21.13	0.23	117	0.67	35.15	0.20
72	0.77	21.44	0.23	118	0.61	35.46	0.19
73	0.75	21.74	0.23	119	0.6	35.76	0.18
74	0.75	22.05	0.23	120	0.6	36.07	0.18
75	0.75	22.35	0.23	121	0.7	36.37	0.21
76	0.75	22.65	0.23	122	0.33	36.68	0.10
77	0.74	22.96	0.23	123	0.33	36.98	0.10
78	0.74	23.26	0.23	124	0.35	37.29	0.11
79	0.78	23.57	0.24	125	0.38	37.59	0.12
80	0.75	23.87	0.23	126	0.36	37.89	0.11
81	0.74	24.18	0.23	127	0.32	38.20	0.10
82	0.75	24.48	0.23	128	0.26	38.50	0.08
83	0.77	24.79	0.23	129	0.3	38.81	0.09
84	0.75	25.09	0.23	130	0.33	39.11	0.10
85	0.76	25.40	0.23	131	0.34	39.42	0.10
86	0.75	25.70	0.23	132	0.3	39.72	0.09
87	0.78	26.01	0.24	133	0.32	40.03	0.10
88	0.73	26.31	0.22	134	0.28	40.33	0.09
89	0.7	26.62	0.21	135	0.33	40.64	0.10
90	0.7	26.92	0.21	136	0.3	40.94	0.09
91	0.71	27.23	0.22	137	0.09	41.25	0.03
92	0.71	27.53	0.22	138	0.32	41.55	0.10
93	0.71	27.84	0.22	139	0.31	41.86	0.09
94	0.71	28.14	0.22	140	0	42.16	0.00
95	0.7	28.45	0.21				



Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

Drawn By: AR

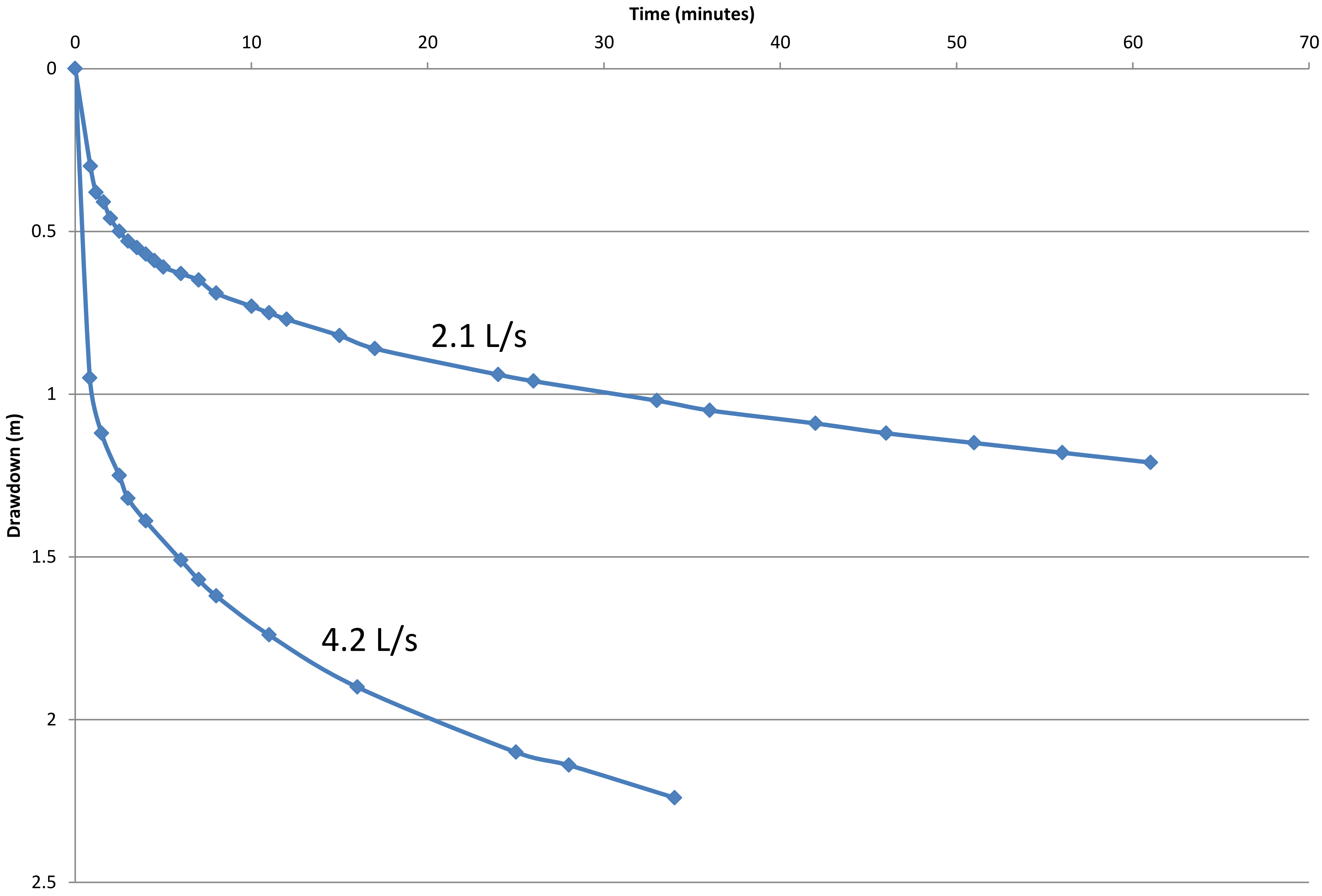
Hidden Quarry Summary of Drilling and Testing
New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1:

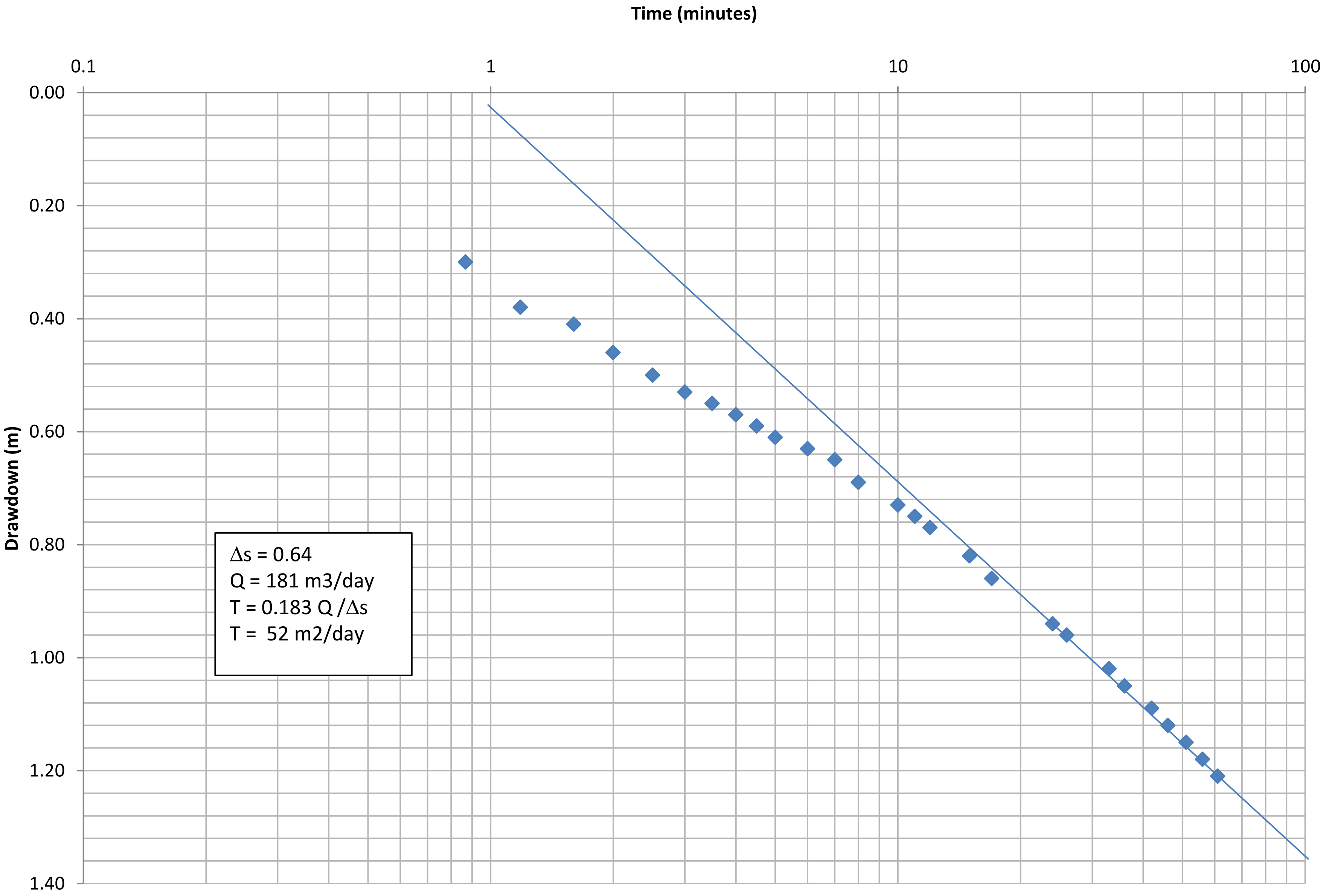
Monitoring Locations

Figure 2: M15 Step Test



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 2: M15 Step Test**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Figure 3: M15 2.1 L/s Step Test



Δs = 0.64
Q = 181 m3/day
T = 0.183 Q /Δs
T = 52 m2/day

Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

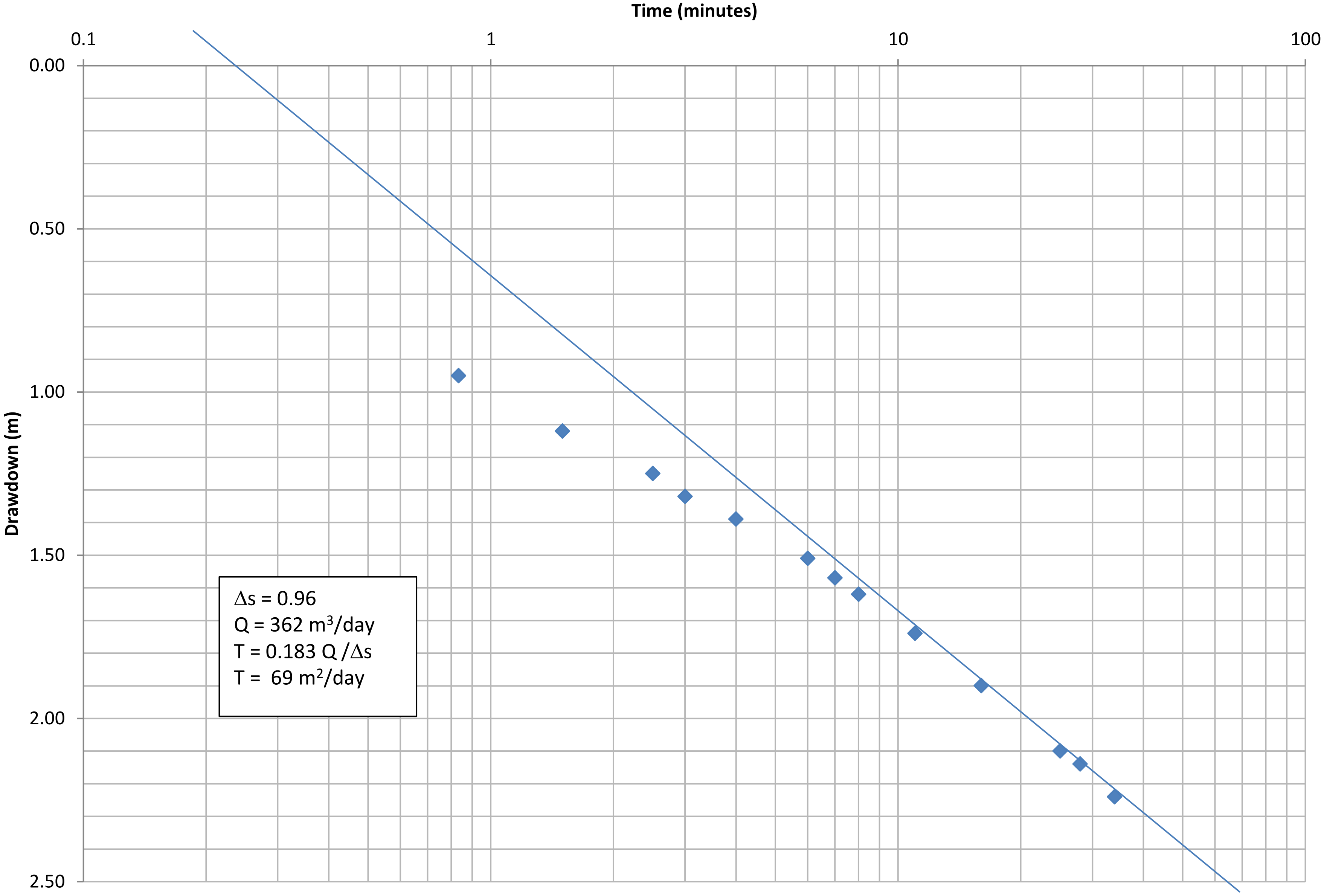
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3: M15 2.1 L/s Step Test Semi-log Plot

Figure 4: M15 4.2 L/s Step Test



$\Delta s = 0.96$

$Q = 362\ m^3/day$

$T = 0.183\ Q / \Delta s$

$T = 69\ m^2/day$

Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

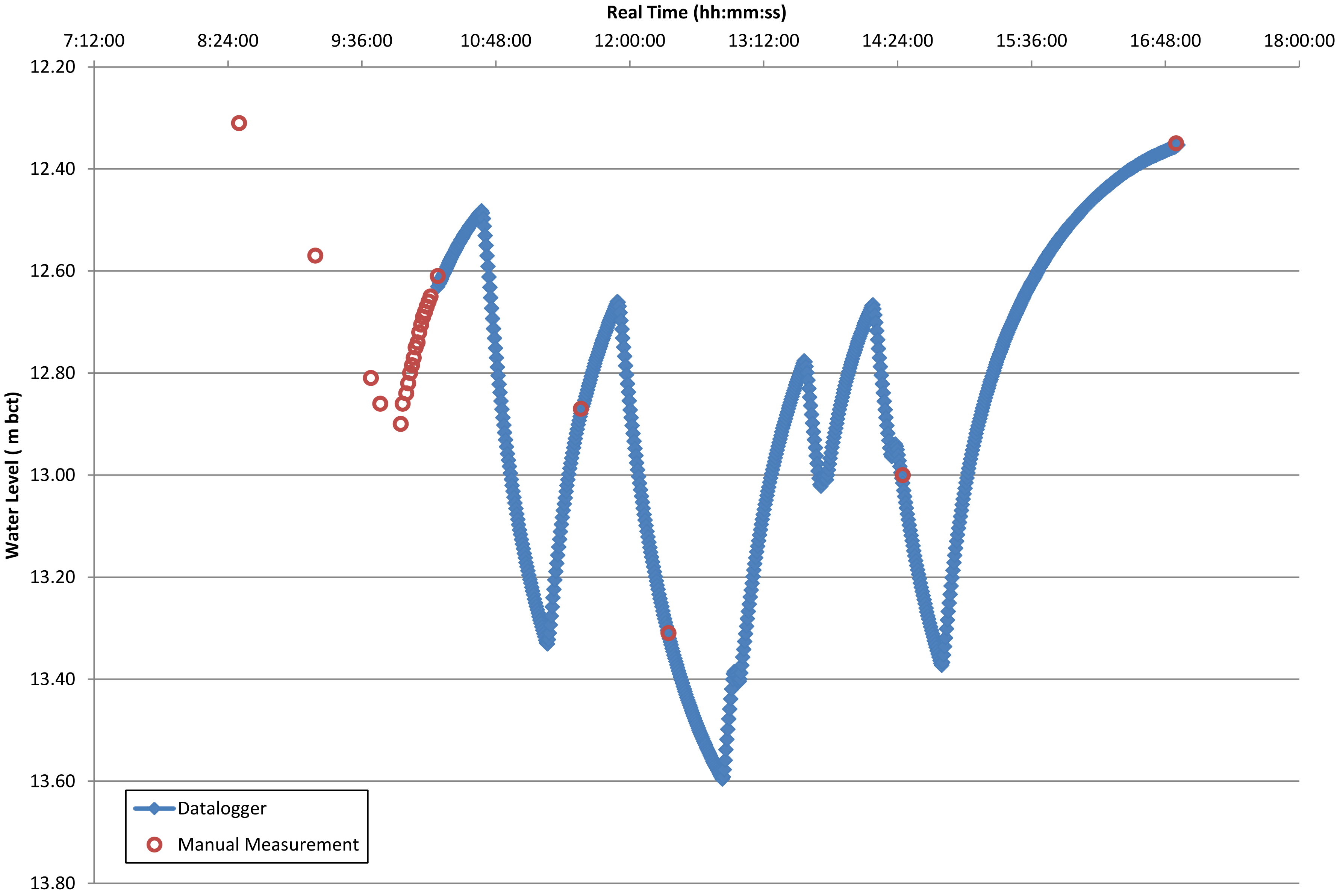
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

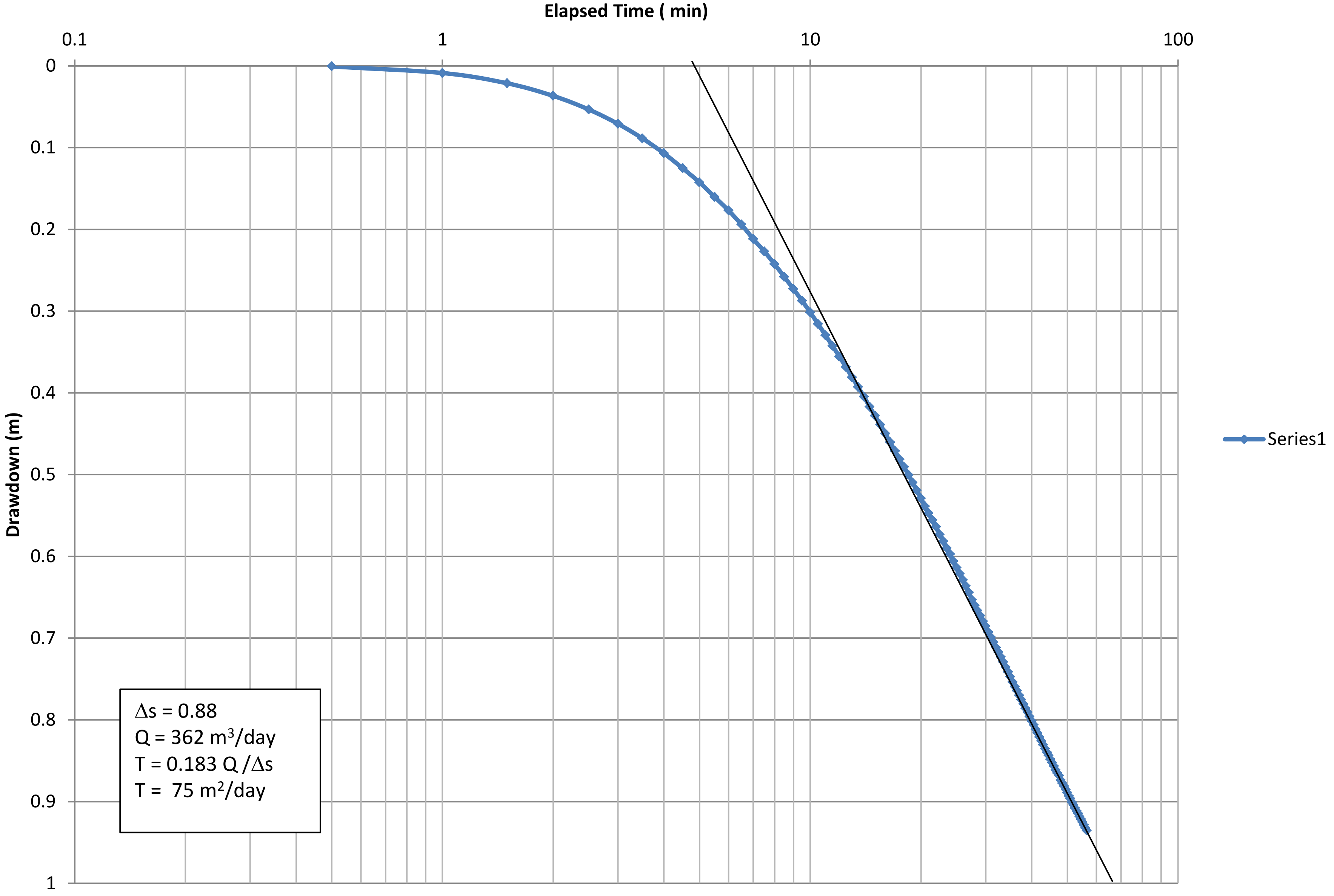
Figure 4: M15 4.2 L/s Step Test Semi-log Plot

Figure 5: M2 Response During M15 Testing



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

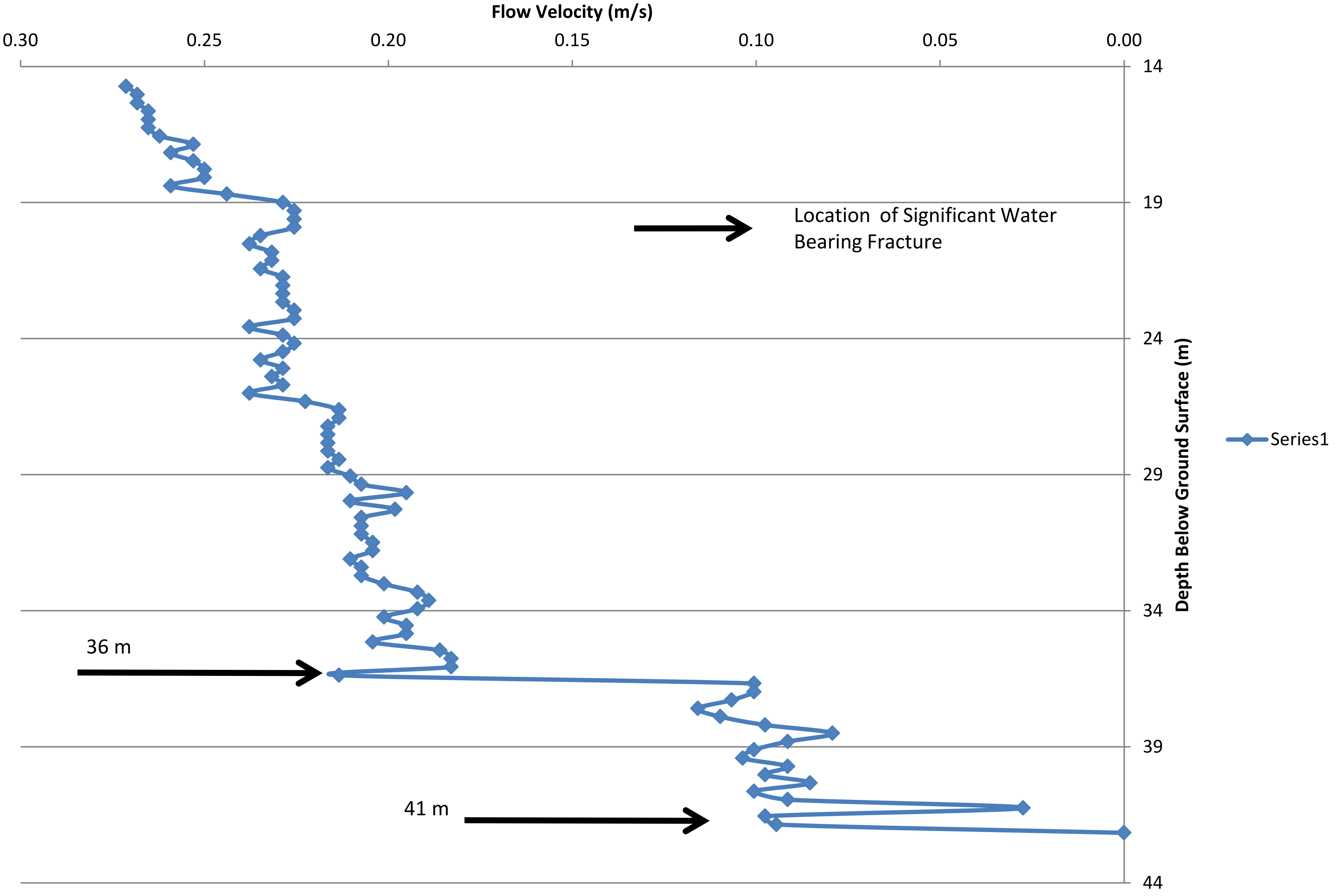
Figure 6: M2 Response to 4.2 L/s Pumping in M15



Δs = 0.88
Q = 362 m^3/day
T = 0.183 Q /Δs
T = 75 m^2/day

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 6: M2 Response to 4.2 L/s Pumping in M15**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Figure 7: Results of Flow Test



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 7: Results of Flow Test**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

APPENDIX A

M15 Borehole Log

PROJECT: 9506

M15

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 DATUM: GROUND SURFACE DIP: LOGGED: SD

BORING METHOD: Rotary Drilling

SOIL PROFILE		SAMPLES			
DESCRIPTION	DEPTH B.G.S. (m)	ID	TYPE	RECOVERY (%)	"N" VALUE
Stony Silty Sand Paleozoic-stone rich silty sand	0	S1	Wash		
		S2	Wash		
		S3	Wash		
		S4	Wash		
		S5	Wash		
		S6	Wash		
Goat Island Formation - Niagara Falls Member Dark grey non bituminous fine grained dolostone.	9.55	S7	Wash		
Gasport Formation. 0.2 to 0.3 metres thick beds of white dolostone and blue grey dolostone. Iron staining at 12.54 metres. Open fractures at 10.08 m, 10.11 m, 10.76 m, 11.05 m, 12.55 m, 12.65 m	10.03	C1	Core		
Gasport Formation. White to blue grey dolostone. Numerous stylolites. Clay filled fracture at 14.85m. Open fracture at 14.85 m.	13.11	C2	Core		

CONCENTRATION (%)

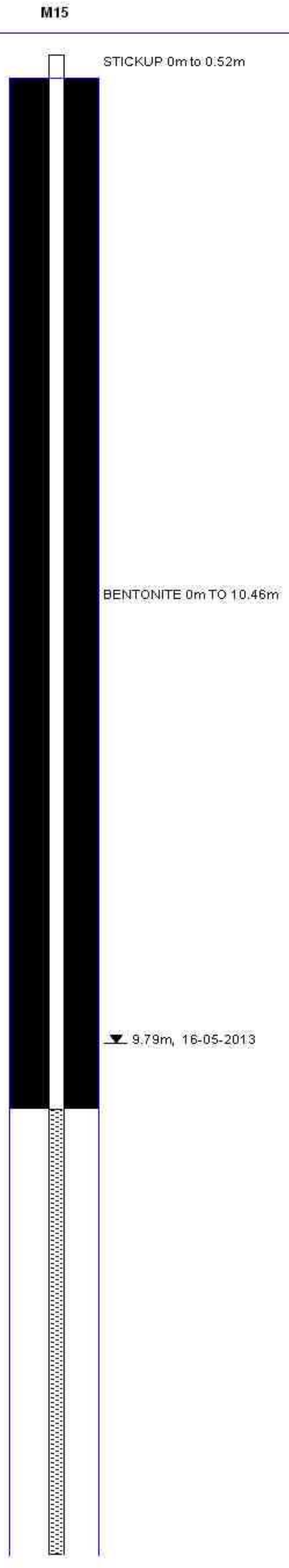
LEL ◆

MOISTURE CONTENT ●

GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION



Continued on next page

PROJECT: 9506

M15

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 DATUM: GROUND SURFACE DIP: LOGGED: SD

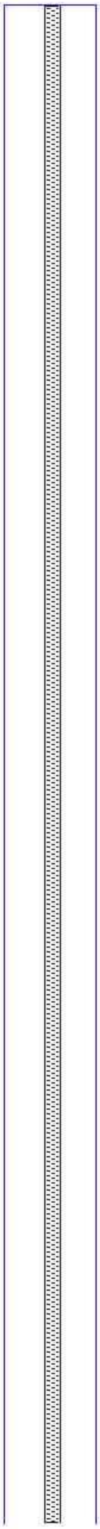
BORING METHOD: Rotary Drilling

CONCENTRATION (%): LEL ◆ MOISTURE CONTENT ● GAS CONCENTRATION ■ (0 20 40 60 80 100)

DEPTH B.G.S. (m)	DESCRIPTION	ID	TYPE	RECOVERY (%)	"N" VALUE
15.11	Gasport Formation. 0.2 to 2.0 metre thick beds of white and blue grey dolostone. Fossiliferous. Openly porous below 16.24 m. Open fractures at: 15.53 m, 16.36 m. Water bearing fracture at 16.36 m.	C3	Core		
18.14	Gasport Formation. White and blue grey beds of dolostone. Vuggy below 18.54 m. Fossiliferous. Brachiopod castings and crinoid stems. Open fractures at: 18.54 m, 20.04 m, 20.52 m, 20.83 m, 20.98 m. Water bearing fracture at 18.54 m.	C4	Core		
21.26	Gasport Formation. White and blue grey dolostone. Thick zones of crinoid stems. More openly porous below 22.80 m. Open fractures at: 23.53 m, 23.58.	C5	Core		
24.18	Gasport Formation. Blue grey dolostone. Large visible fossils. Openly porous. Open fractures at: 24.30 m, 24.32 m, 24.57 m, 24.69 m, 25.37 m, 25.65 m, 25.96 m, 26.38 m, 26.49 m. Water bearing fracture at 25.96 m.	C6	Core		
27.38	Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous. Large crinoid stems from 26.50 to 26.90 metres. Open fractures at: 27.66 m, 29.06 m, 29.95 m, 30.06 m, 30.25 m, 30.33 m.	C7	Core		

DEPTH SCALE: METRES 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30; FEET 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98

INSTALLATION INFORMATION



Continued on next page

PROJECT: 9506

LOCATION: Hidden Quarry

M15

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

DEPTH SCALE METRES	DEPTH SCALE FEET
30	100
31	102
	104
32	106
33	108
	110
34	112
	114
35	116
36	118
	120
37	122
	124
38	126
39	128
	130
40	132
	134
41	136
42	138
	140
43	142
	144
44	146
45	148

BORING METHOD	SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
Rotary Drilling	Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous.		C7	Core		
	Gasport Formation. Blue grey dolostone. Large visible fossils. Openly porous. Grey vuggy section from 31.30 to 31.60 metres. Open fractures at: 31.09 m, 31.24 m, 31.52 m, 32.41 m, 33.30 m.	30.38	C8	Core		
	Gasport Formation. Blue grey dolostone. Vuggy. Large Fossil grains. Openly porous. Open fractures at: 34.24 m, 34.90 m, 35.76 m.	33.38	C9	Core		
	Gasport Formation. Beds of white and blue grey dolostone. Vuggy. Large fossil grains. Open fractures at: 36.42 m, 36.79 m, 36.82 m, 36.88 m, 37.90 m, 39.24 m. Water bearing fracture at 36.42 m.	36.37	C10	Core		
	Gasport Formation. Mottled blue grey dolostone. Not vuggy. Openly porous. Large fossil grains. Open fractures at: 39.98 m, 41.48 m. Water bearing fracture at 41.48 m.	39.37	C11	Core		
	Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.	42.42	C12	Core		

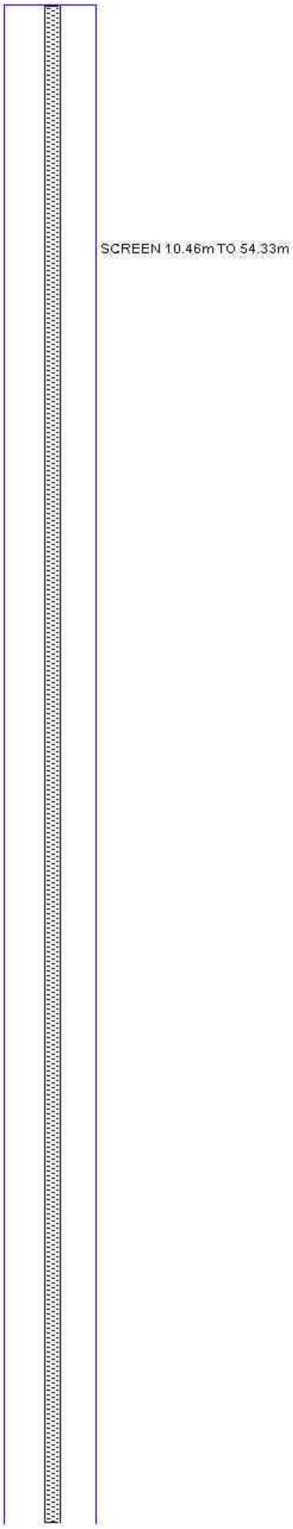
CONCENTRATION (%)

LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

M15



Continued on next page

PROJECT: 9506

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

M15

Page 4 OF 4

DEPTH SCALE — METRES: 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60 — FEET: 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196

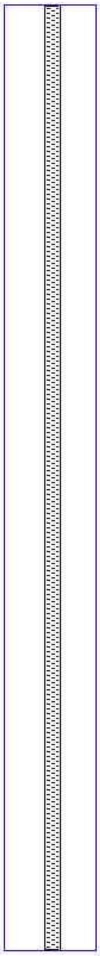
BORING METHOD: Rotary Drilling

SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.		C12	Core		
Gasport Formation. Grey dolostone. Not vuggy. Minor open porosity. Open fracture at: 47.70 m.	45.57	C13	Core		
Irondequoit Formation. Blue grey dolostone. Pyritic.	48.50				
Rockway Formation. Green dolostone. Finely crystalline. Pyritic. Open fractures at: 50.60 m, 50.72 m.	49.93	C14	Core		
Merriton Formation. Buff brown finely crystalline dolostone. Open fractures at: 51.16 m, 51.26 m, 51.49 m.	50.72				
Cabot Head Formation. Red and green shale.	51.51	C15	Core		
END OF HOLE @ 54.33m	54.33				

CONCENTRATION (%)
LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

INSTALLATION INFORMATION

M15



DRAWN: JD

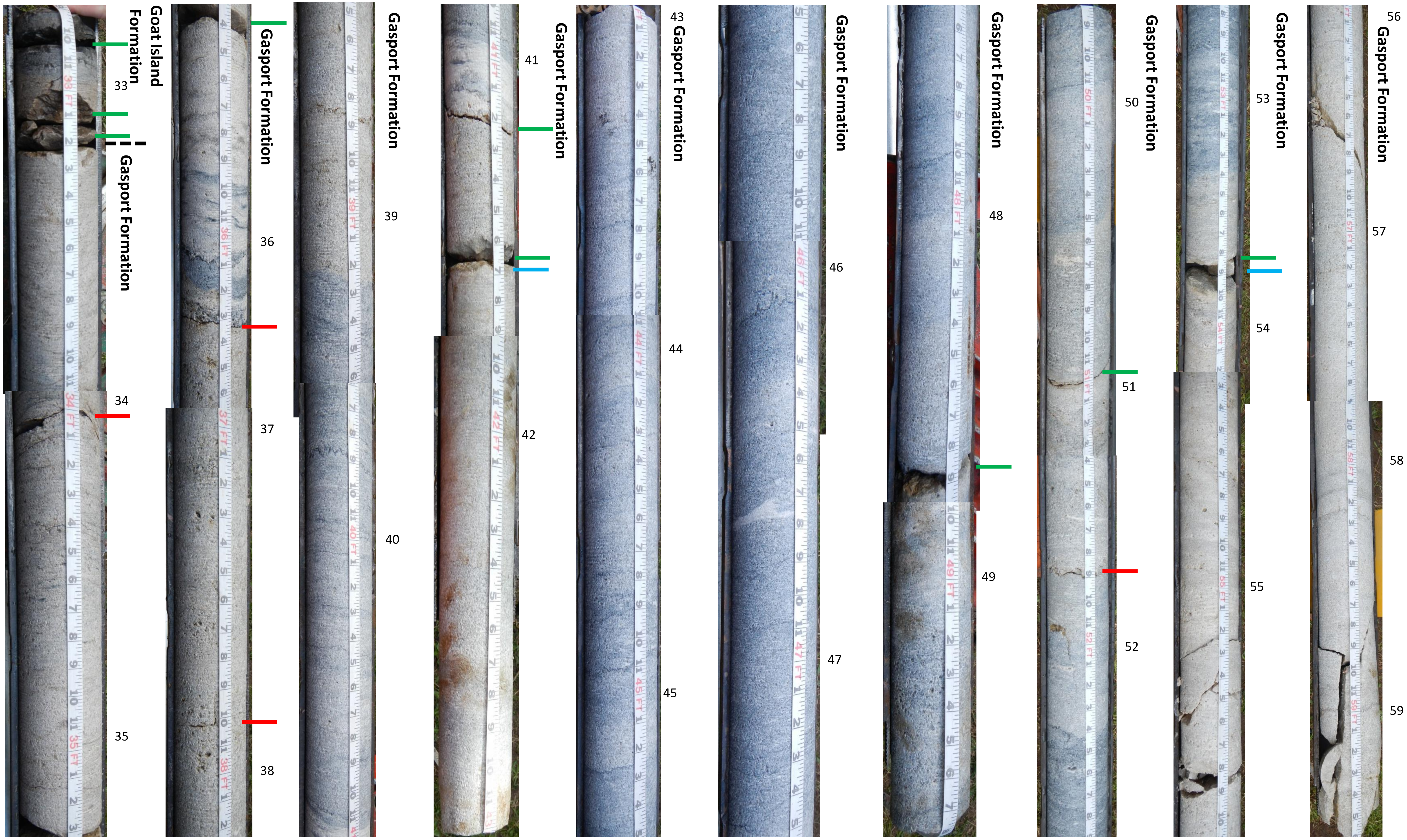
Harden Environmental Services LTD.

CHECKED: SD

APPENDIX B

Core Photo Log

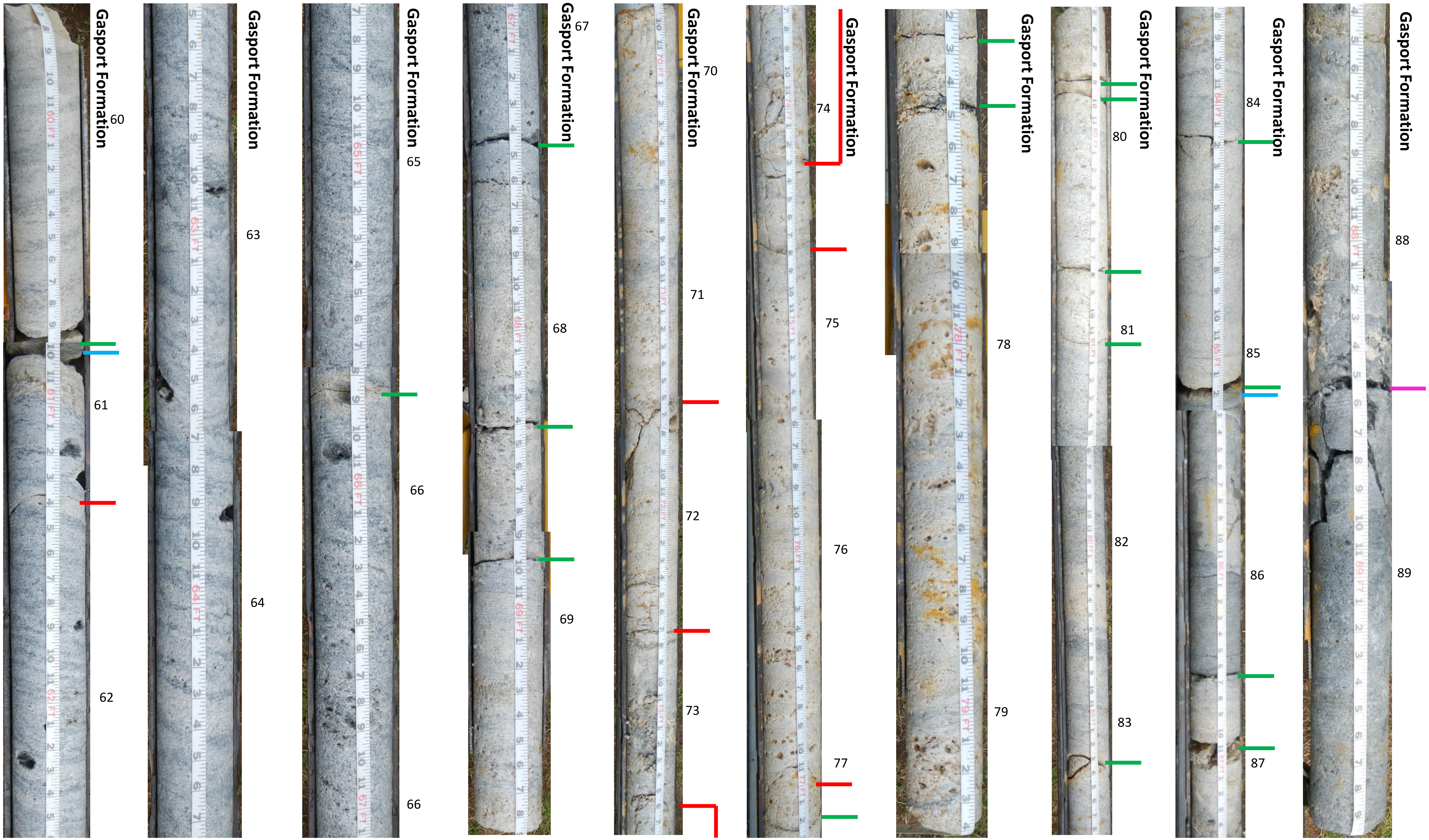
Pages 1-5 in Feet
Pages 6-10 in Metres



Legend

- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** May 2013 **Drawn By:** JD	Hidden Quarry Summary of Drilling and Testing New Well M15 Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	Appendix B: **Core Log Photos (32'9"- 59'6")**



Legend

- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

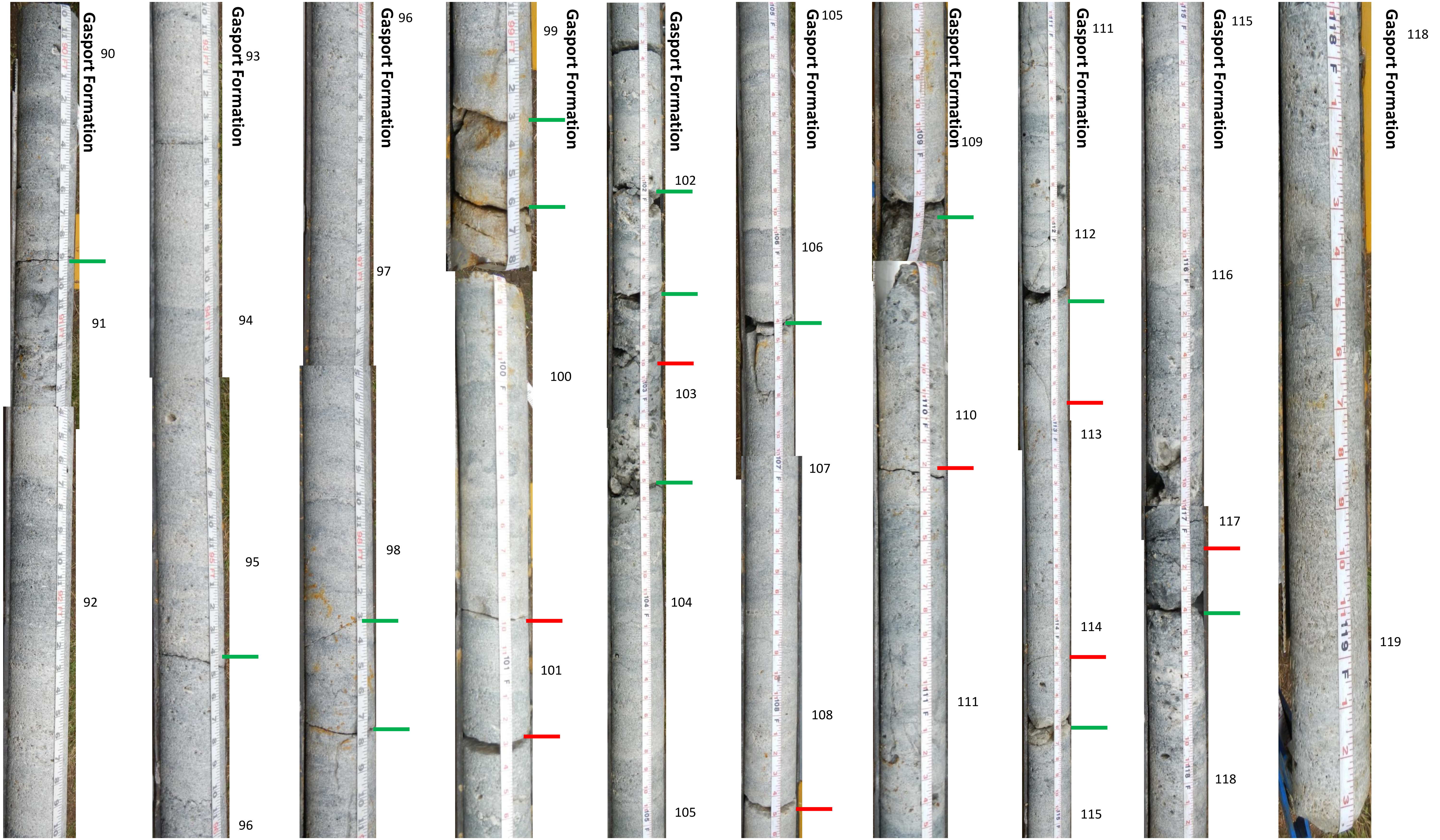
Project No: 9506
Date: May 2013
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

Core Log Photos (59'6"- 89'10")



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (89'10"- 119'3.5")**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

Legend

- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

Project No: 9506

Date: May 2013

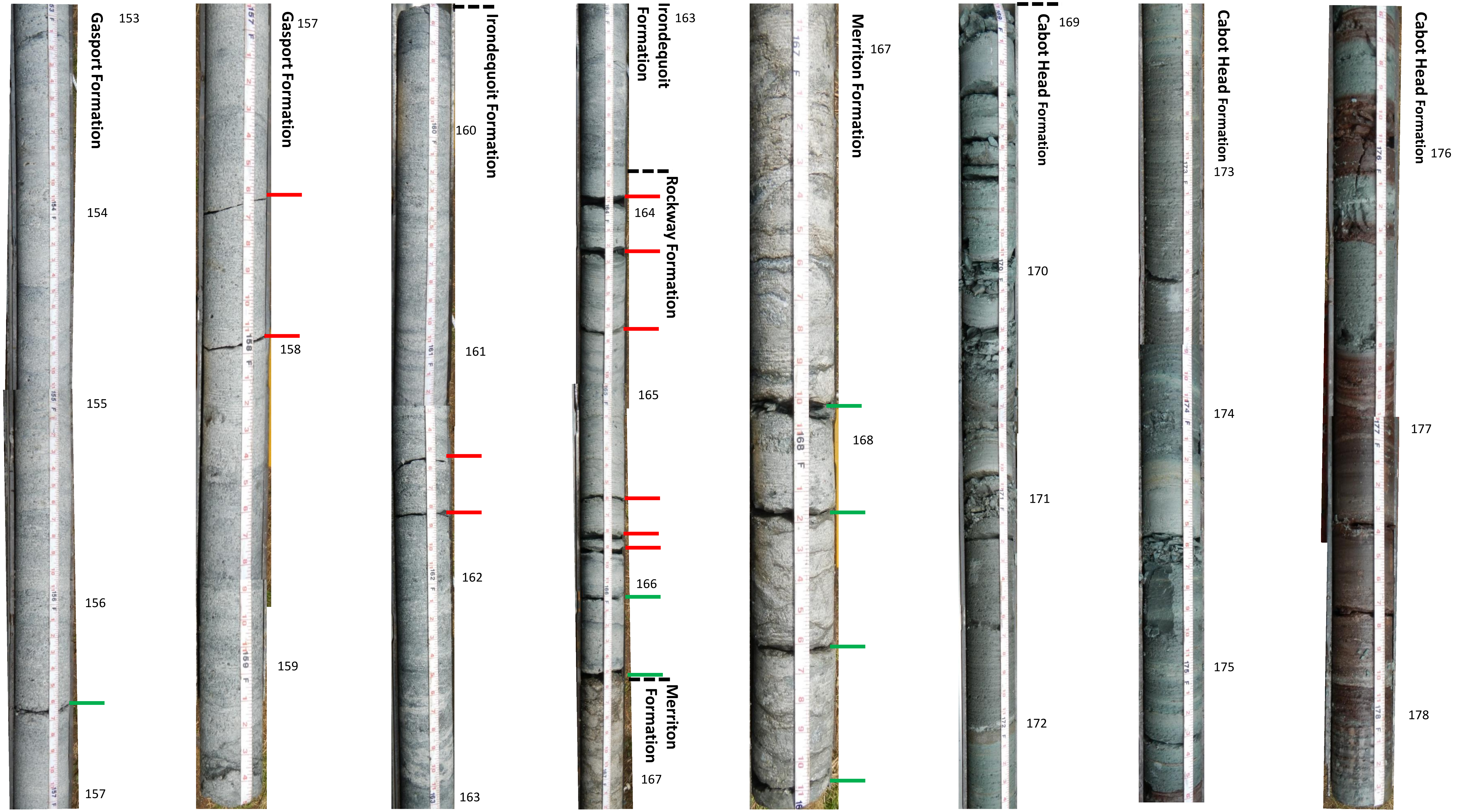
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

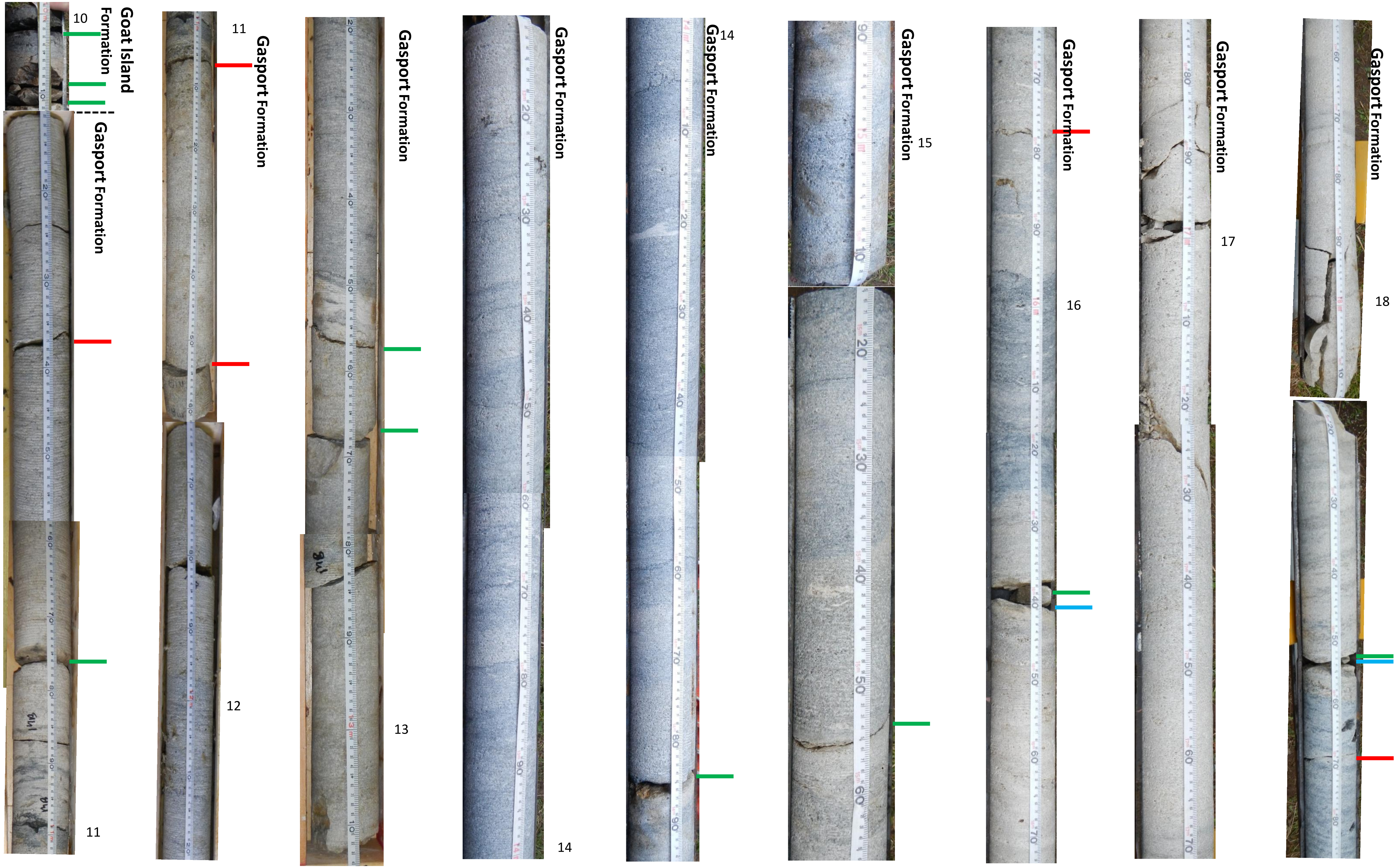
Core Log Photos (119'3.5"-153'1")



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

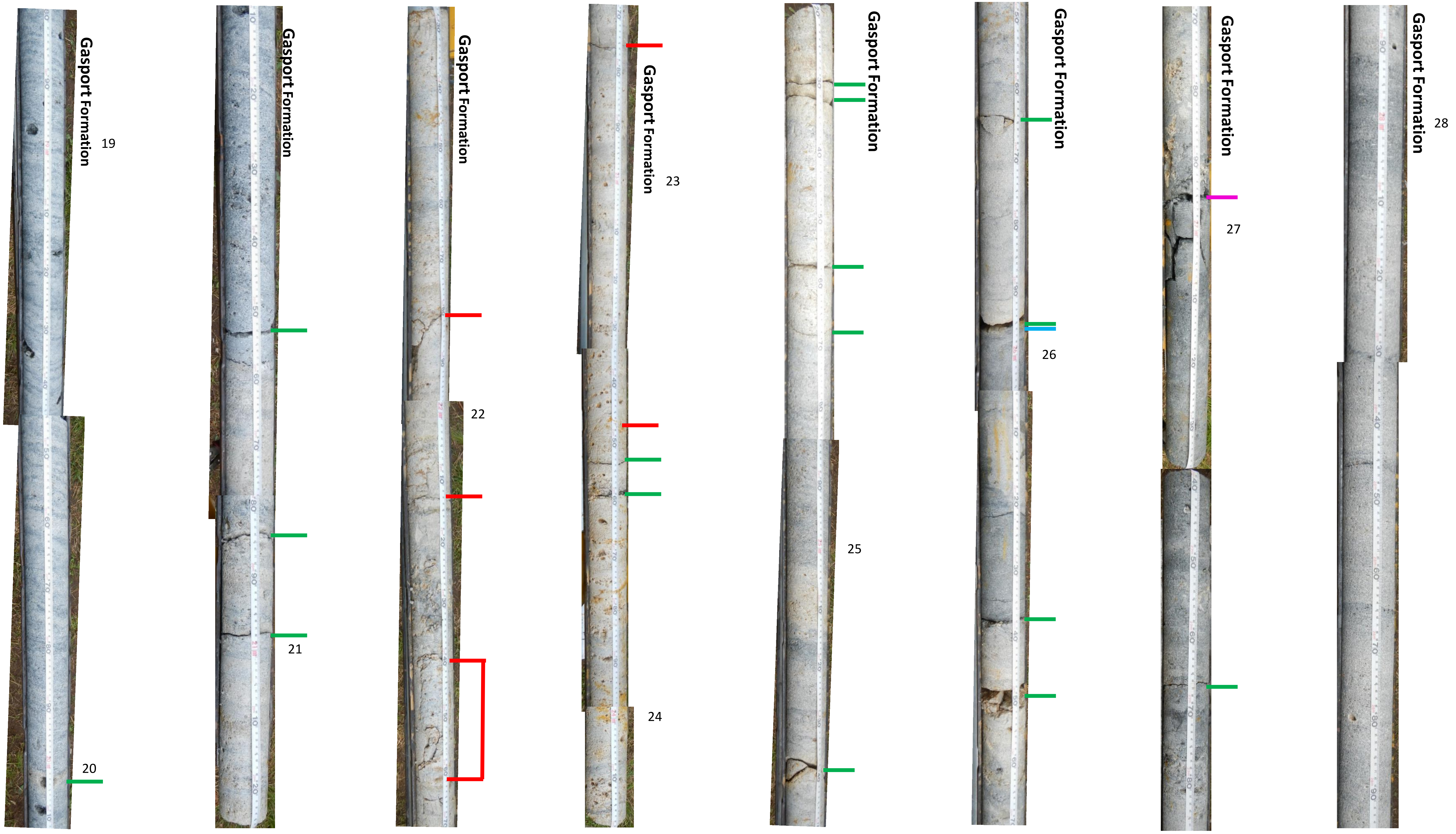
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (153’1”-178’4”)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photo's (10m – 18.84m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

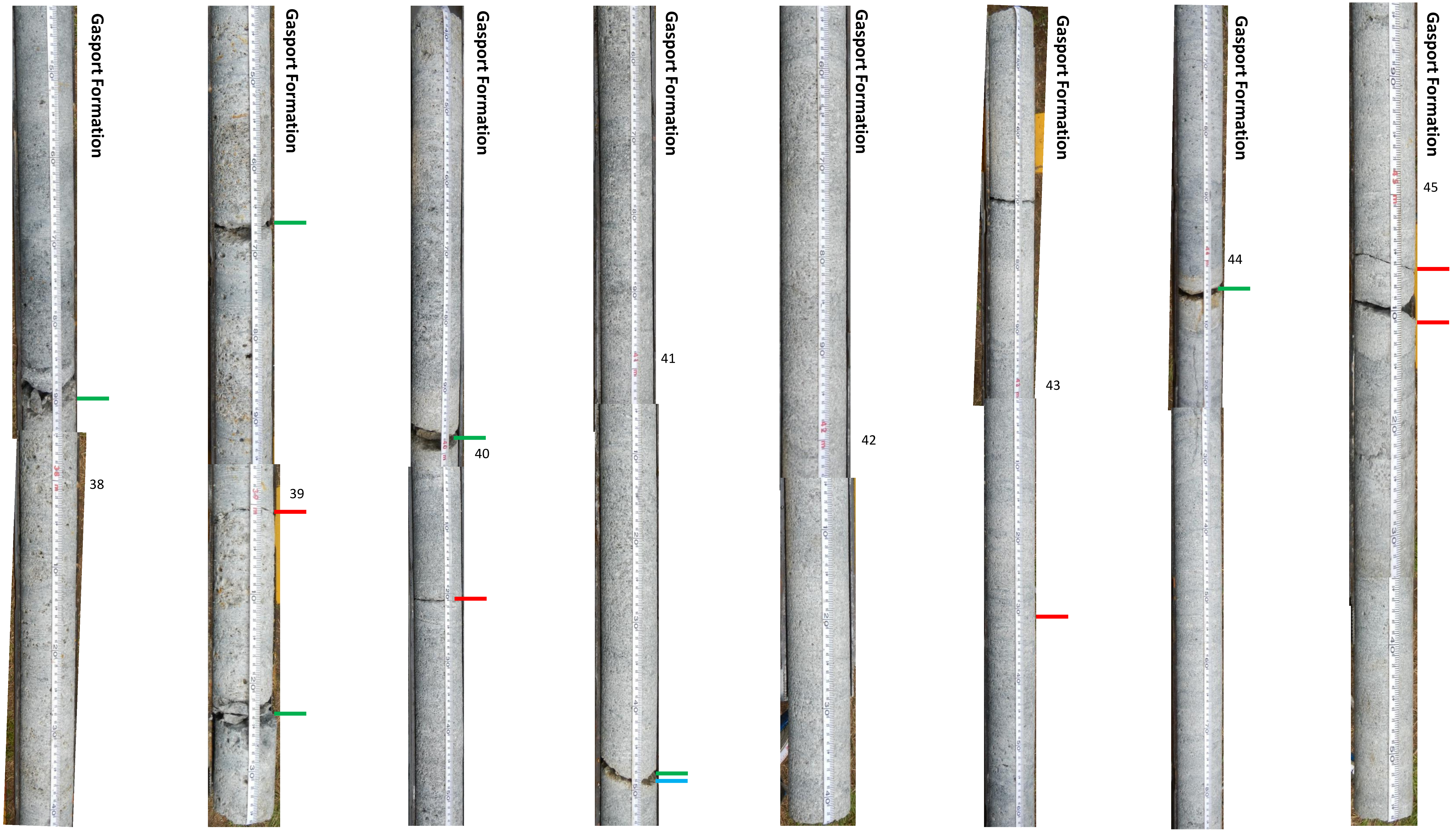
- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

HARDEN Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photos (18.84m-28.94m)**
	Drawn By: JD		

Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (28.94m-37.44m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

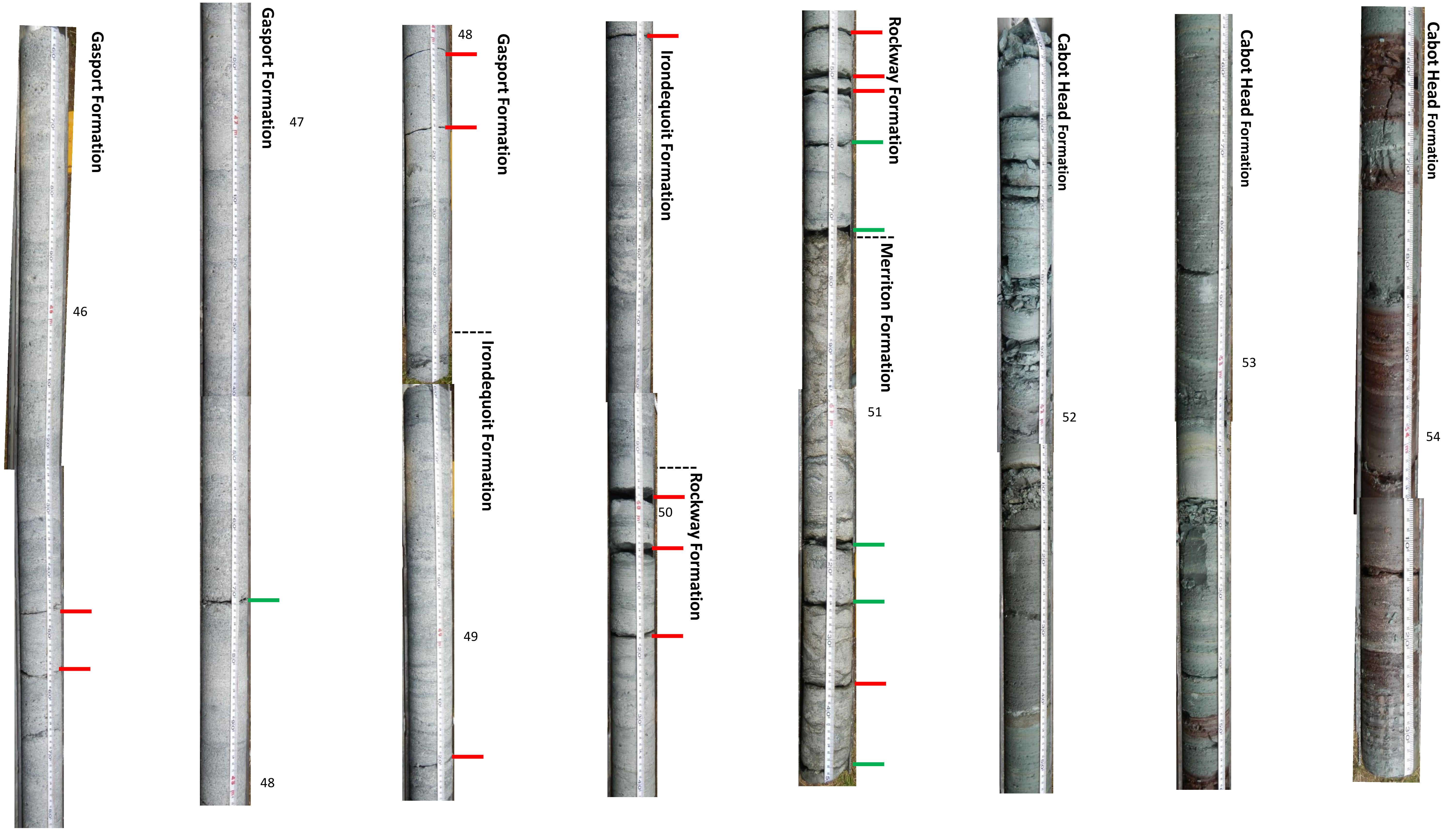
Project No: 9506
Date: May 2013
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

Core Log Photos (37.44m-45.56m)



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photos (45.56m-54.35m)**
	Drawn By: JD		

APPENDIX C

M15 Water Quality Results

Harden Environmental
Maxxam Job #: B383273 Client Project #: 9506
Report Date: 2013/06/06 Site Location: ROCKWOOD

RESULTS OF ANALYSES OF WATER

Maxxam ID				RS1829		
Sampling Date				2013/05/24 12:30		
COC Number				na		
	Units	**Criteria A**	**A/O**	**PW1**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L	**-**	-	7.87	N/A	3229791
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	**-**	-	250	1.0	3230462
Calculated TDS	mg/L	**-**	500	439	1.0	3229794
Carb. Alkalinity (calc. as CaCO3)	mg/L	**-**	-	2.4	1.0	3230462
Cation Sum	me/L	**-**	-	8.30	N/A	3229791
Hardness (CaCO3)	mg/L	**-**	80:100	390	1.0	3229982
Ion Balance (% Difference)	%	**-**	-	2.68	N/A	3229790
Langelier Index (@ 20C)	N/A	**-**	-	0.995		3229792
Langelier Index (@ 4C)	N/A	**-**	-	0.747		3229793
Saturation pH (@ 20C)	N/A	**-**	-	7.01		3229792
Saturation pH (@ 4C)	N/A	**-**	-	7.26		3229793
Inorganics						
Total Ammonia-N	mg/L	**-**	-	0.060	0.050	3232665
Conductivity	umho/cm	**-**	-	750	1.0	3232541
Total Kjeldahl Nitrogen (TKN)	mg/L	**-**	-	0.20	0.10	3235497
Dissolved Organic Carbon	mg/L	**-**	5	1.0	0.20	3232526
Orthophosphate (P)	mg/L	**-**	-	ND	0.010	3232548
pH	pH	**-**	6.5:8.5	8.01		3232543
Dissolved Sulphate (SO4)	mg/L	**-**	500	100	1	3232547
Alkalinity (Total as CaCO3)	mg/L	**-**	30:500	260	1.0	3232539
Dissolved Chloride (Cl)	mg/L	**-**	250	16	1	3232546
Nitrite (N)	mg/L	**1**	-	ND	0.010	3232529
Nitrate (N)	mg/L	**10**	-	2.0	0.10	3232529
Nitrate + Nitrite	mg/L	**10**	-	2.0	0.10	3232529

ND = Not detected
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)

Harden Environmental
Maxxam Job #: B383273
Client Project #: 9506
Report Date: 2013/06/06
Site Location: ROCKWOOD

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					RS1829		
Sampling Date					2013/05/24 12:30		
COC Number					na		
	Units	**Criteria A**	**IMC**	**A/O**	**PW1**	**RDL**	**QC Batch**

Metals							
Dissolved Aluminum (Al)	mg/L	**-**	-	0.1	ND	0.0050	3236227
Dissolved Antimony (Sb)	mg/L	**-**	0.006	-	0.00067	0.00050	3236227
Dissolved Arsenic (As)	mg/L	**-**	0.025	-	ND	0.0010	3236227
Dissolved Barium (Ba)	mg/L	**1**	-	-	0.067	0.0020	3236227
Dissolved Beryllium (Be)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Bismuth (Bi)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Boron (B)	mg/L	**-**	5	-	0.013	0.010	3236227
Dissolved Cadmium (Cd)	mg/L	**0.005**	-	-	ND	0.00010	3236227
Dissolved Calcium (Ca)	mg/L	**-**	-	-	110	0.20	3236227
Dissolved Chromium (Cr)	mg/L	**0.05**	-	-	ND	0.0050	3236227
Dissolved Cobalt (Co)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Copper (Cu)	mg/L	**-**	-	1	ND	0.0010	3236227
Dissolved Iron (Fe)	mg/L	**-**	-	0.3	ND	0.10	3236227
Dissolved Lead (Pb)	mg/L	**0.01**	-	-	ND	0.00050	3236227
Dissolved Lithium (Li)	mg/L	**-**	-	-	ND	0.0050	3236227
Dissolved Magnesium (Mg)	mg/L	**-**	-	-	30	0.050	3236227
Dissolved Manganese (Mn)	mg/L	**-**	-	0.05	0.0022	0.0020	3236227
Dissolved Molybdenum (Mo)	mg/L	**-**	-	-	0.0020	0.00050	3236227
Dissolved Nickel (Ni)	mg/L	**-**	-	-	0.0035	0.0010	3236227
Dissolved Phosphorus (P)	mg/L	**-**	-	-	ND	0.10	3236227
Dissolved Potassium (K)	mg/L	**-**	-	-	4.5	0.20	3236227
Dissolved Selenium (Se)	mg/L	**0.01**	-	-	ND	0.0020	3236227
Dissolved Silicon (Si)	mg/L	**-**	-	-	3.6	0.050	3236227
Dissolved Silver (Ag)	mg/L	**-**	-	-	ND	0.00010	3236227
Dissolved Sodium (Na)	mg/L	**20**	-	200	6.9	0.10	3236227

ND = Not detected
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)

Maxxam Job #: B383273
Report Date: 2013/06/06

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					RS1829		
Sampling Date					2013/05/24 12:30		
COC Number					na		
	Units	**Criteria A**	**IMC**	**A/O**	**PW1**	**RDL**	**QC Batch**
Dissolved Strontium (Sr)	mg/L	**-**	-	-	1.0	0.0010	3236227
Dissolved Tellurium (Te)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Thallium (Tl)	mg/L	**-**	-	-	0.000077	0.000050	3236227
Dissolved Tin (Sn)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Titanium (Ti)	mg/L	**-**	-	-	ND	0.0050	3236227
Dissolved Tungsten (W)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Uranium (U)	mg/L	**0.02**	-	-	0.00052	0.00010	3236227
Dissolved Vanadium (V)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Zinc (Zn)	mg/L	**-**	-	5	0.062	0.0050	3236227
Dissolved Zirconium (Zr)	mg/L	**-**	-	-	ND	0.0010	3236227

ND = Not detected
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)

APPENDIX C

Revised Monitoring Program

HARDEN

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

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES

1.0 ON-SITE MONITORING PROGRAM

Monitoring has been taking 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,	Manually Monthly April to November, February Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following

Parameter	Monitoring Locations	Frequency
	M16	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	Weekly during first 3 months of extraction
Surface Water Levels	SW6, SW4, SW8	Monthly April to November *coincident with groundwater monitoring
Surface Water Flow	SW4, SW8, SW3	Semi-Monthly April to November *coincident with groundwater monitoring
Groundwater Quality	M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond	Annually

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	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98

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

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.

A seasonal analysis of the data reveals that low water levels in the wetland can occur at any time of the year. The historical low value in the wetland is 354.20 m AMSL and this is the recommended trigger value. The warning value is recommended to be 354.35 m AMSL. Manual water level measurements will increase to bi-weekly if the warning level is exceeded. As shown on Figure C6, this would result in escalated monitoring three times in the past fifteen years.

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.

2) 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.

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

3.2 Groundwater Quality

The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, bacteria, 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 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 or drilling a new well and isolating the water supply to the deeper aquifer

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 C7. 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

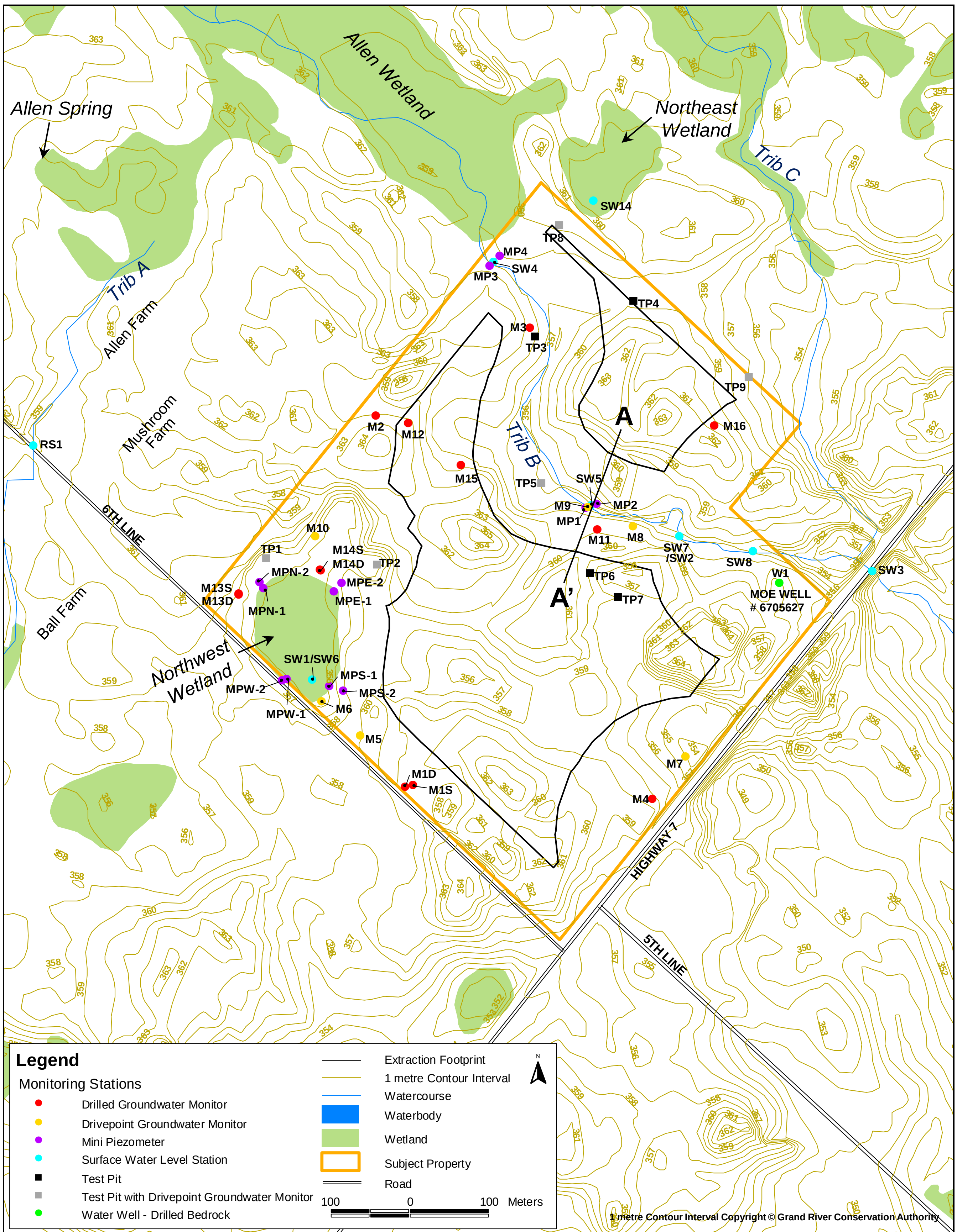
- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

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.

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.



1 metre Contour Interval Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

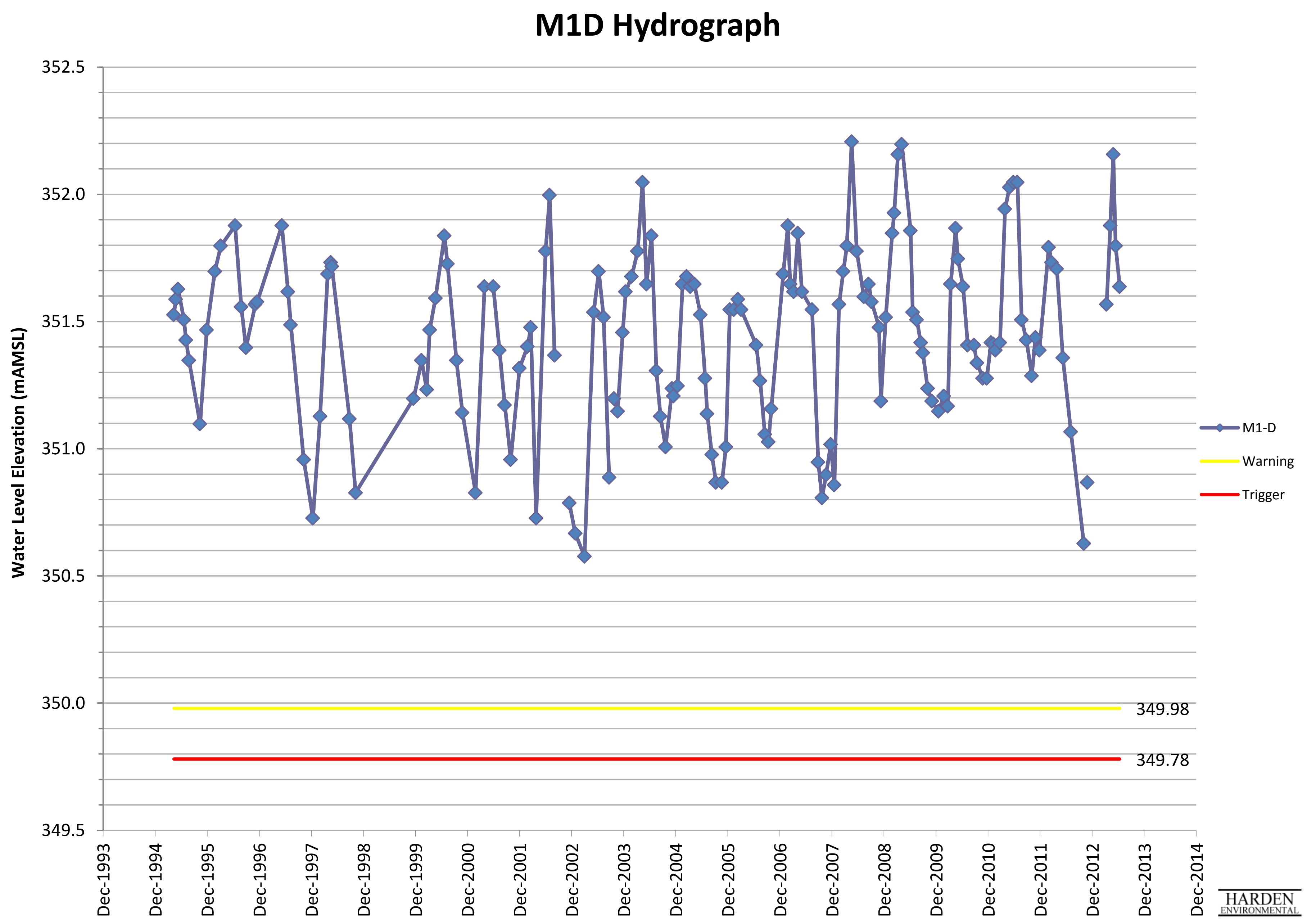
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

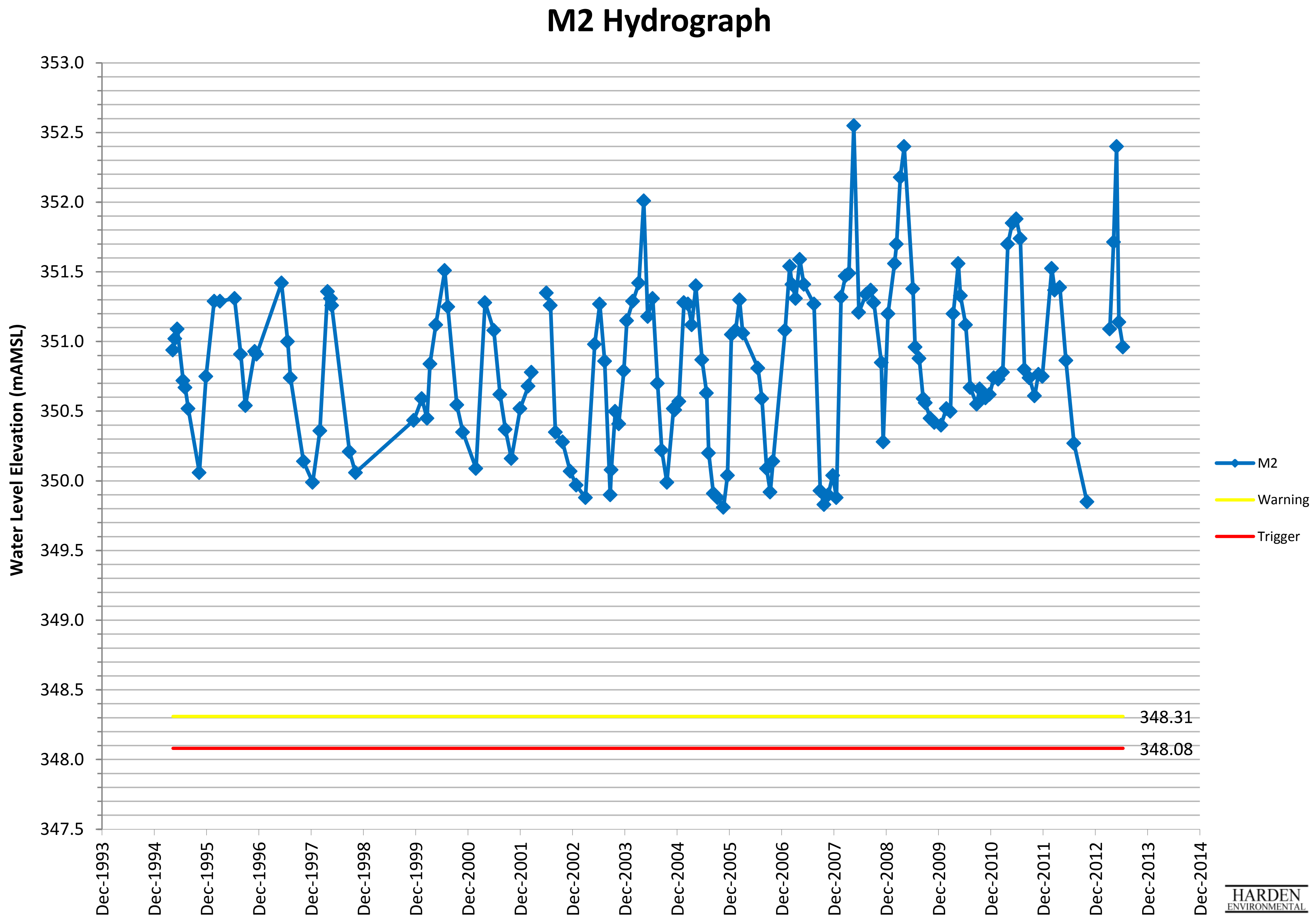
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C1:

Monitoring Locations



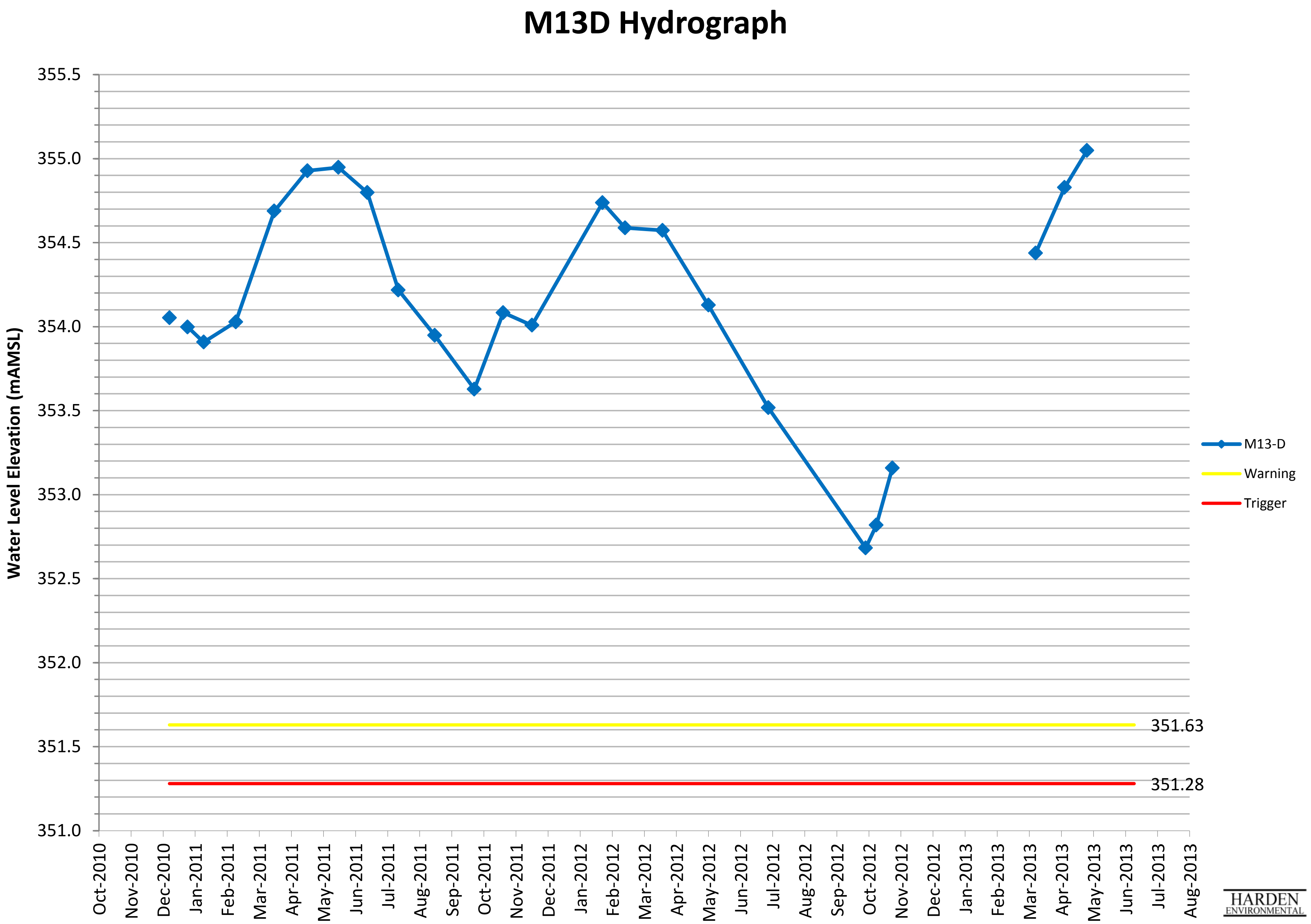
Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C2: M1D Trigger Level**
	Date: Jul 2013		
	Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	



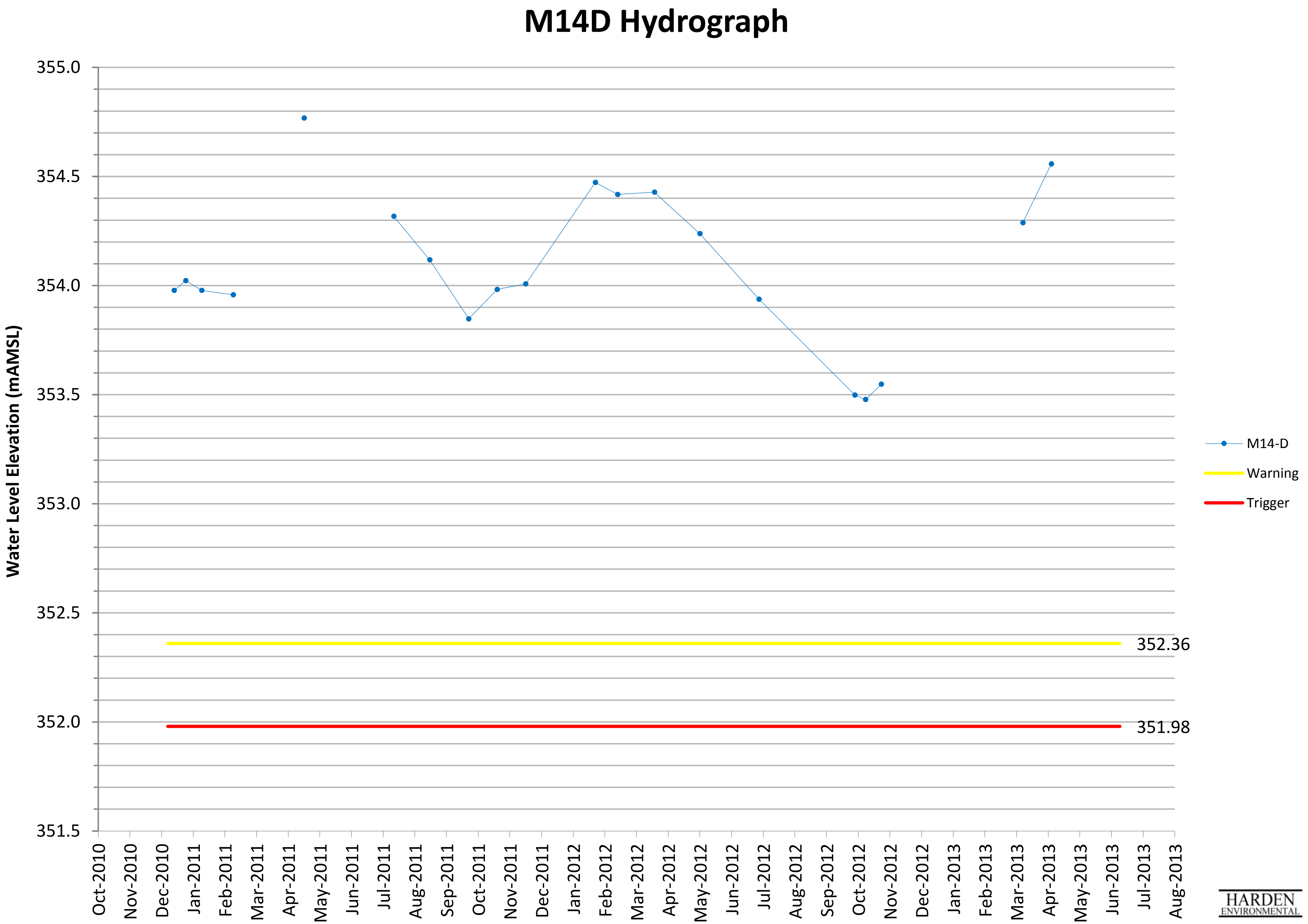
Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction
Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: AR	

Figure C3: M2 Trigger Level

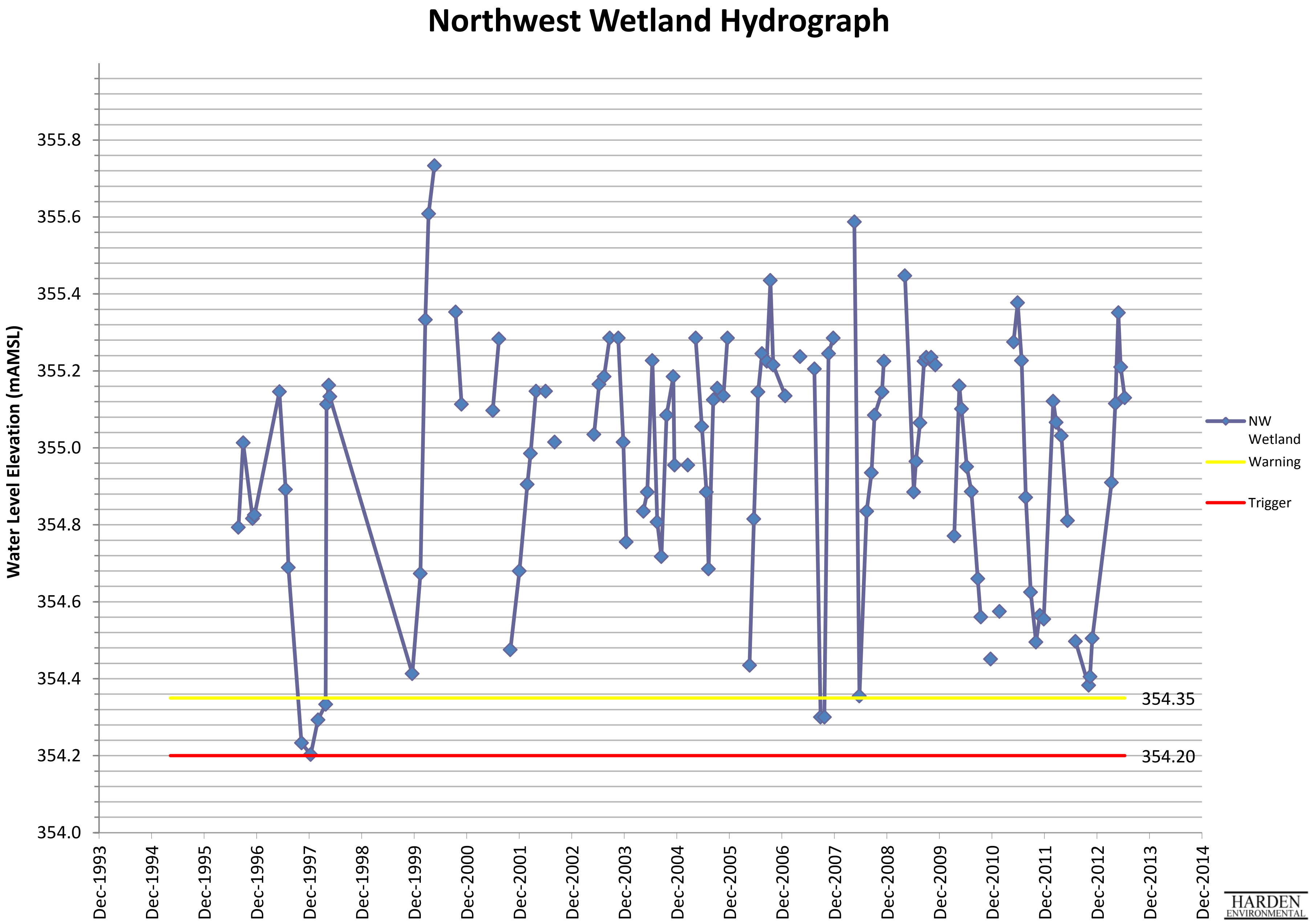


Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C4: M13D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



HARDEN
ENVIRONMENTAL

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



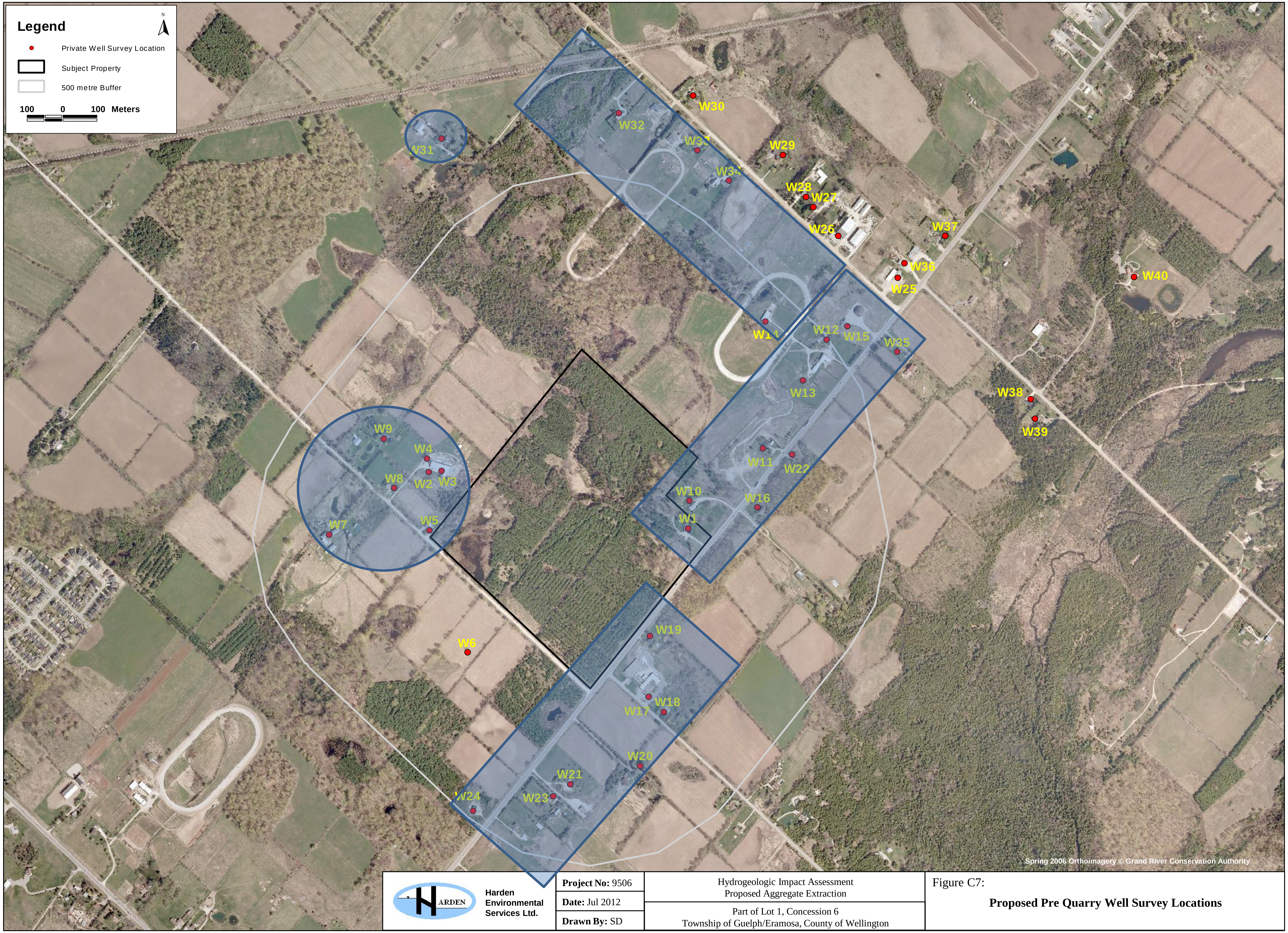
Harden Environmental Services Ltd.

Project No: 9506
Date: Jul 2013
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C6: Northwest Wetland Trigger Level



Spring 2006 Orthoimagery © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction
Date: Jul 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: SD	

Figure C7:

Proposed Pre Quarry Well Survey Locations