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 2×10^{-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

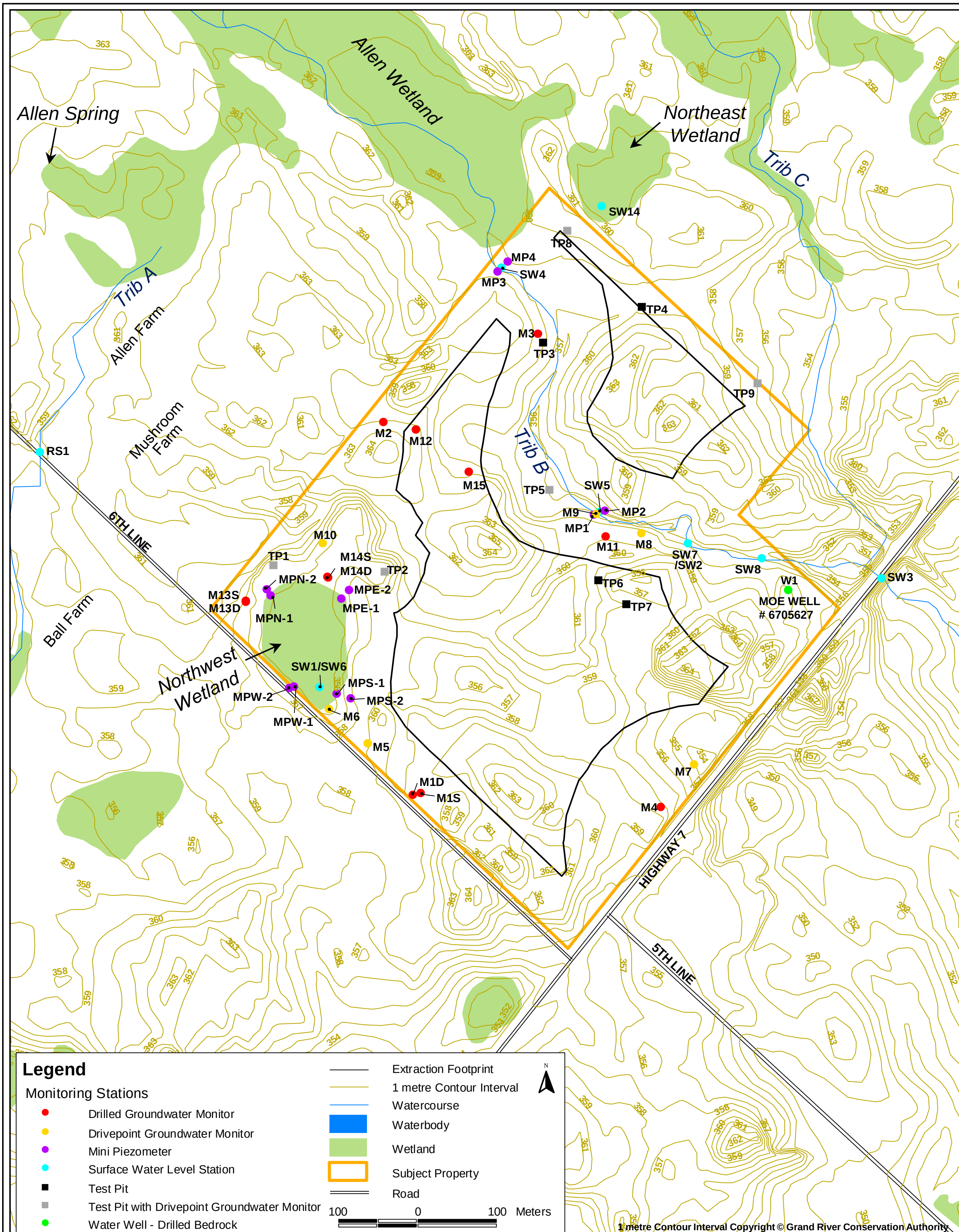
Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
101.25	30.86	closed	90	
102.00	31.09	open	90	vuggy
102.50	31.24	open	90	
102.83	31.34	closed	90	
103.42	31.52	open	90	
106.33	32.41	open	90	
108.42	33.05	closed	90	
109.25	33.30	open	90	drill stem dropped 2-3"
110.17	33.58	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	

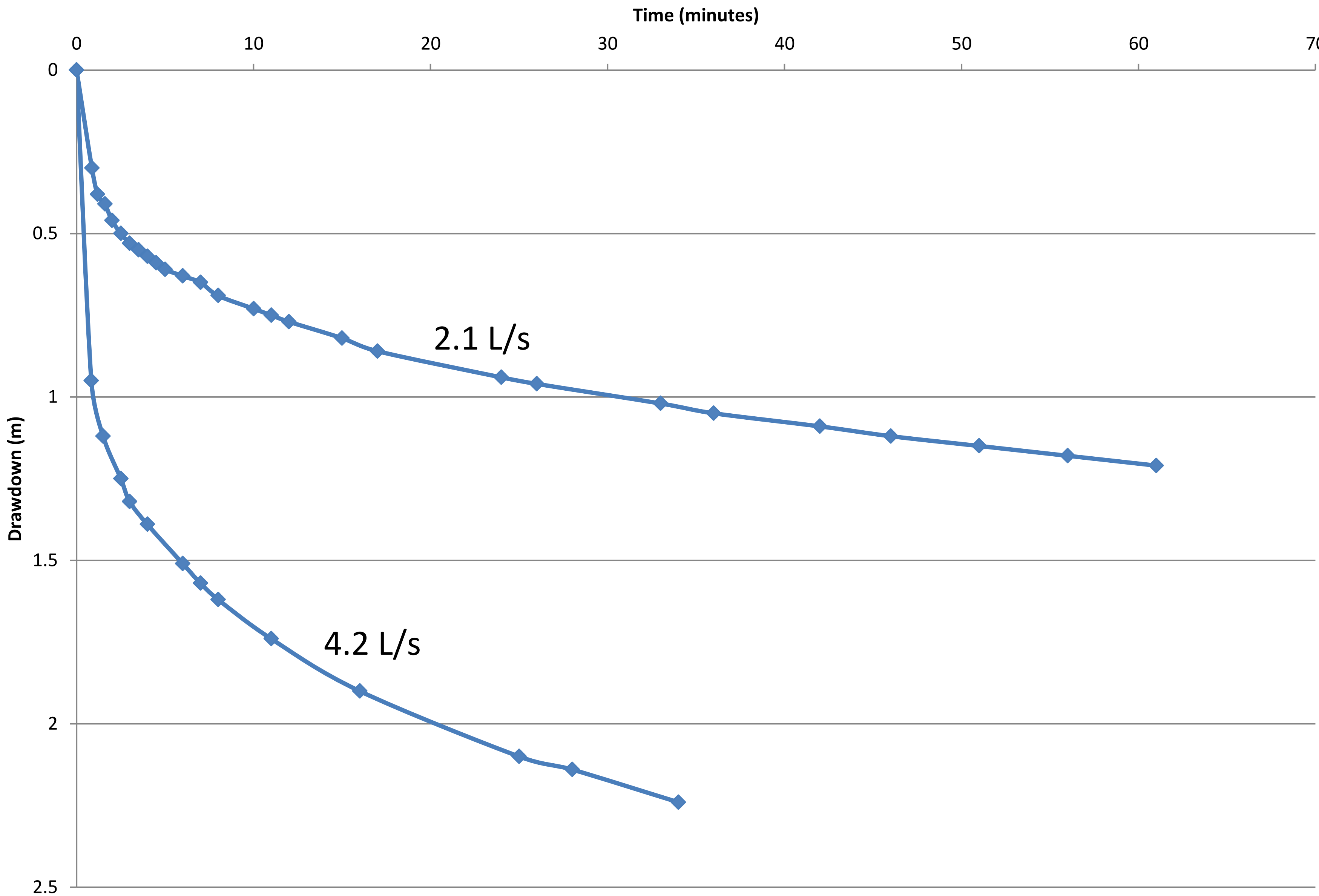
Table 4: M15 Flow Test Results

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



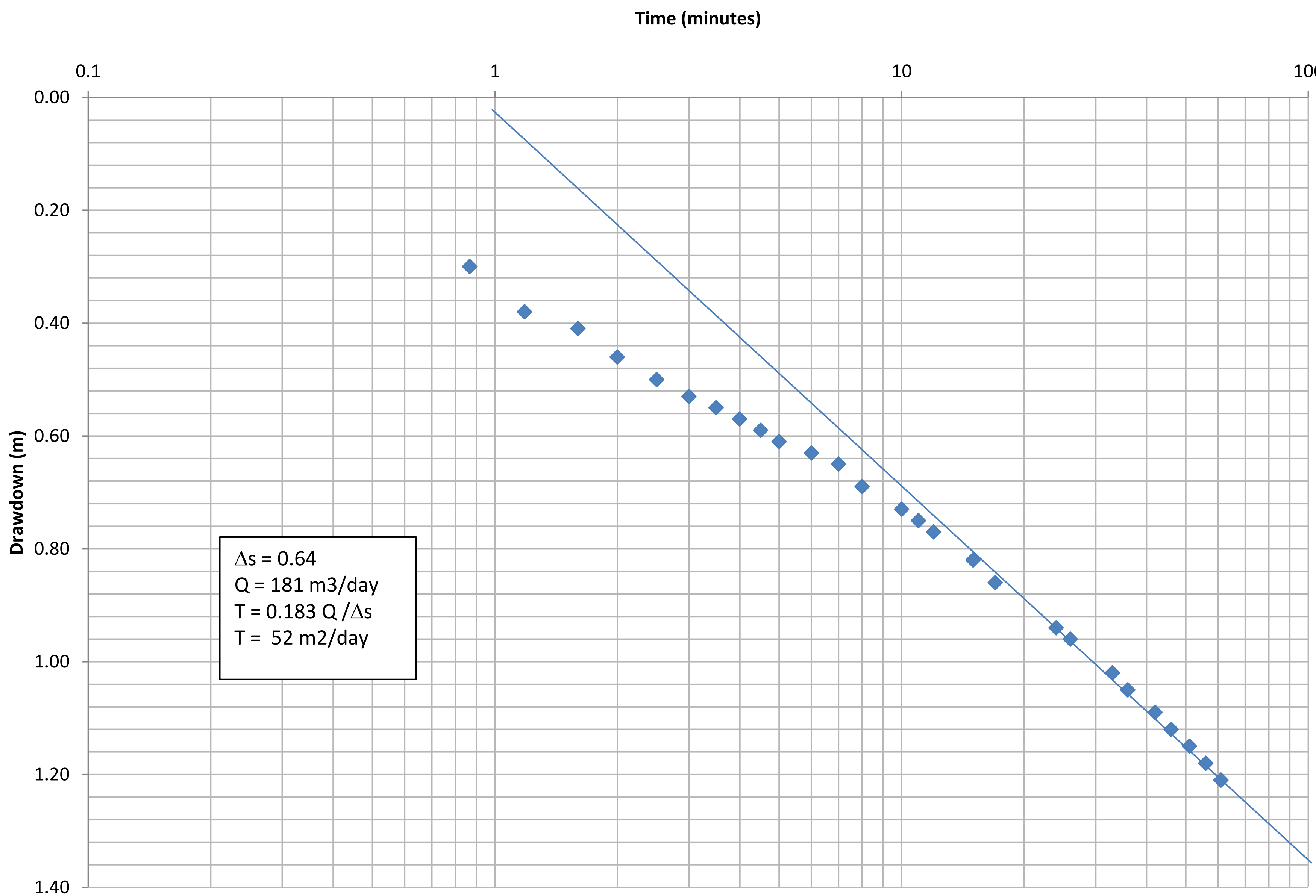
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 1:**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Monitoring Locations**
	Drawn By: AR		

Figure 2: M15 Step Test



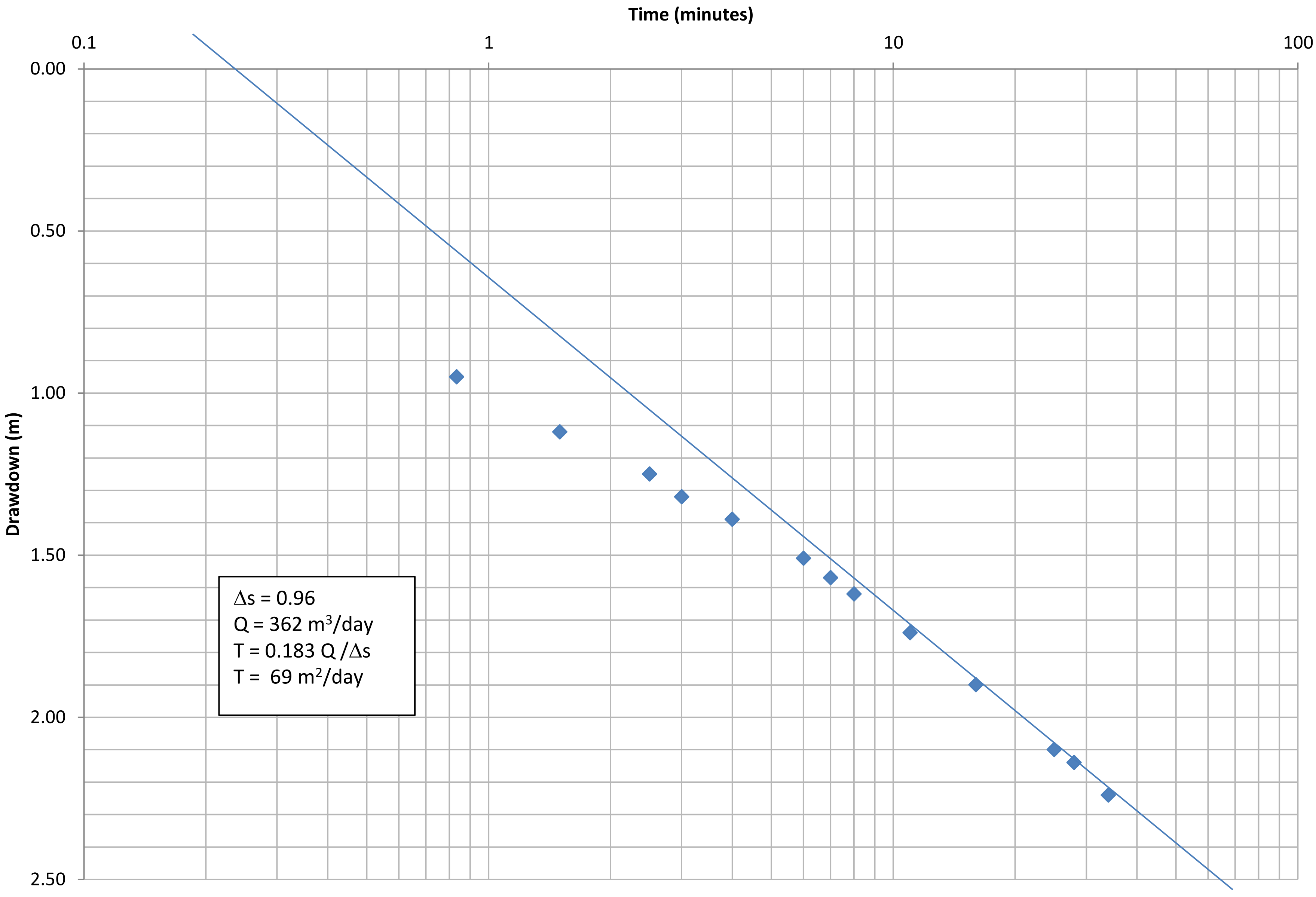
Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** June 2013 **Drawn By:** AR	Hidden Quarry Summary of Drilling and Testing New Well M15 Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure 2: M15 Step Test**

Figure 3: M15 2.1 L/s Step Test

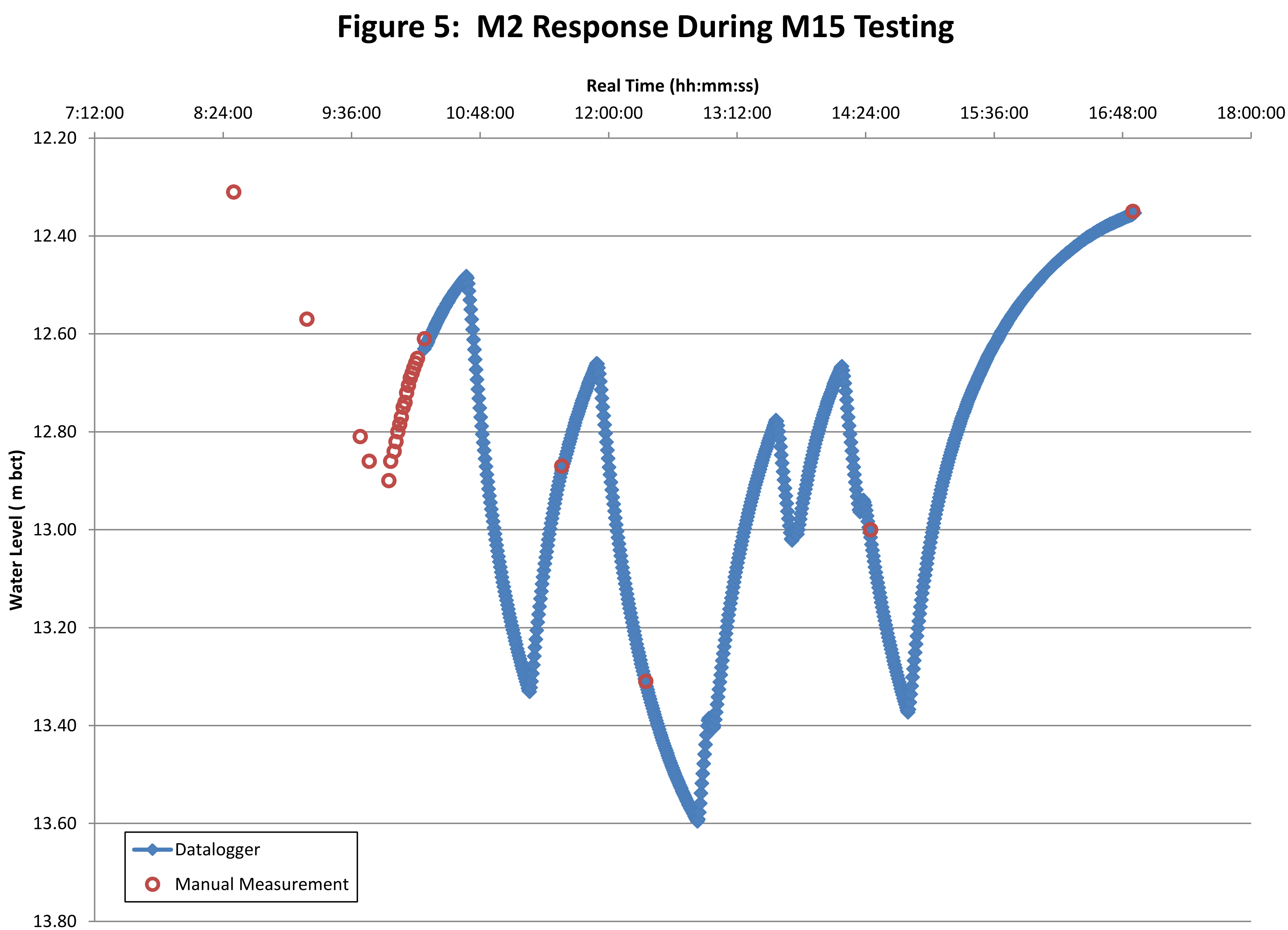


Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 3: M15 2.1 L/s Step Test Semi-log Plot**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Figure 4: M15 4.2 L/s Step Test

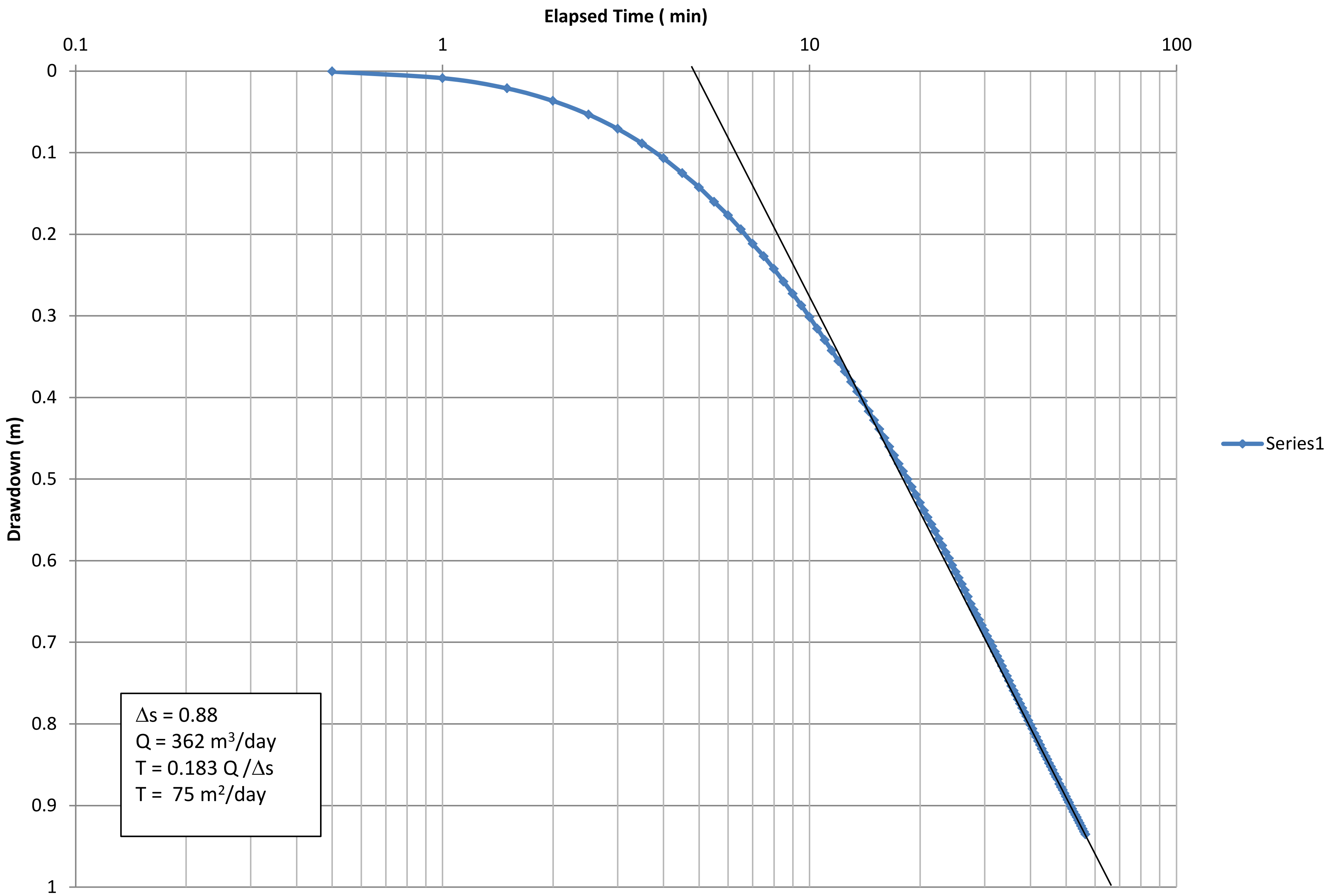


Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 4: M15 4.2 L/s Step Test Semi-log Plot**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



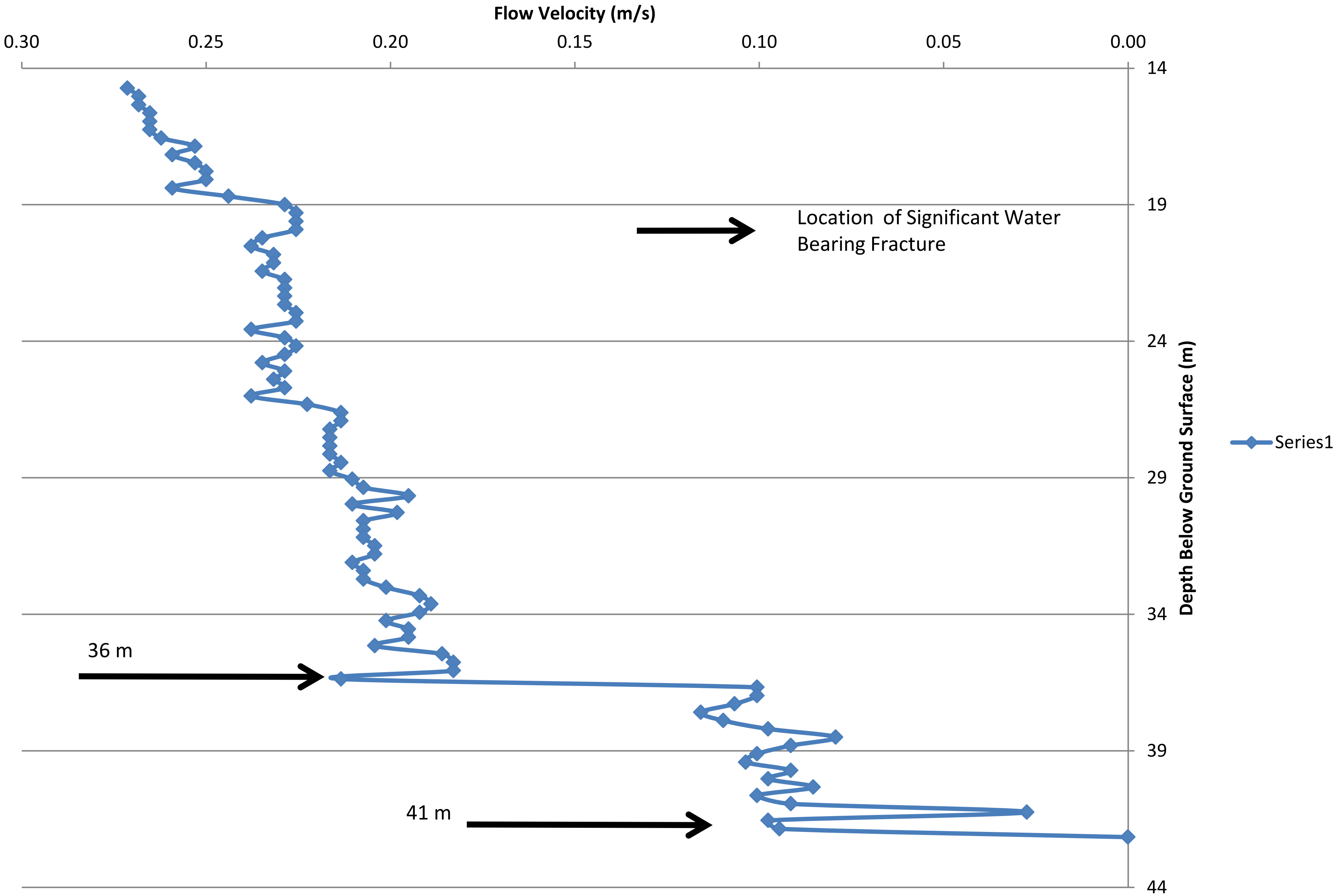
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 5: M2 Response During M15 Testing**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

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



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

LOCATION: Hidden Quarry

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

M15

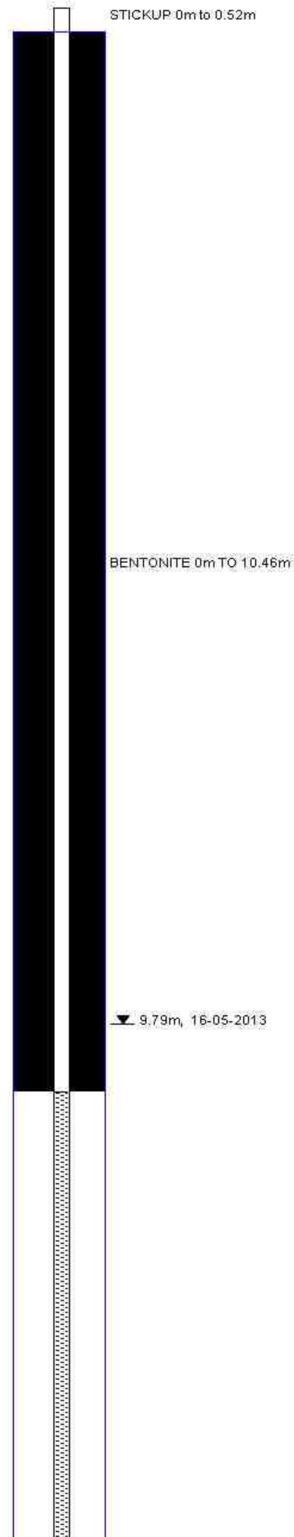
BORING METHOD: Rotary Drilling

Depth B.G.S. (m)	Description	Sample ID	Type
0	Stony Silty Sand Paleozoic-stone rich silty sand	S1	Wash
		S2	Wash
		S3	Wash
		S4	Wash
		S5	Wash
		S6	Wash
9.55	Goat Island Formation - Niagara Falls Member Dark grey non bituminous fine grained dolostone.	S7	Wash
10.03	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	C1	Core
13.11	Gasport Formation. White to blue grey dolostone. Numerous stylolites. Clay filled fracture at 14.85m. Open fracture at 14.85 m.	C2	Core

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

INSTALLATION INFORMATION

M15



Continued on next page

LOCATION: Hidden Quarry

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

BORING METHOD: Rotary Drilling

INSTALLATION INFORMATION: M15

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

DESCRIPTION	DEPTH B.G.S. (m)	ID	TYPE	RECOVERY (%)	"N" VALUE
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.	15.11	C3	Core		
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.	18.14	C4	Core		
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.	21.26	C5	Core		
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.	24.18	C6	Core		
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.	27.38	C7	Core		

Depth scale: METRES 15–30; FEET 50–98

Continued on next page

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	DEPTH B.G.S. (m)	ID	TYPE	RECOVERY (%)	"N" VALUE
30	Rotary Drilling	Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous.		C7	Core		
31–33	Rotary Drilling	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		
34–36	Rotary Drilling	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		
37–39	Rotary Drilling	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		
40–42	Rotary Drilling	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		
43–45	Rotary Drilling	Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.	42.42	C12	Core		

FEET: 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148

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

INSTALLATION INFORMATION

M15

SCREEN 10.46m TO 54.33m

Continued on next page

LOCATION: Hidden Quarry

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

DEPTH (m)	DESCRIPTION	DEPTH B.G.S. (m)	ID	TYPE
45	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	C14	Core
	Rockway Formation. Green dolostone. Finely crystalline. Pyritic. Open fractures at: 50.60 m, 50.72 m.	49.93		
	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		

BORING METHOD: Rotary Drilling

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

INSTALLATION INFORMATION: M15 — END OF HOLE

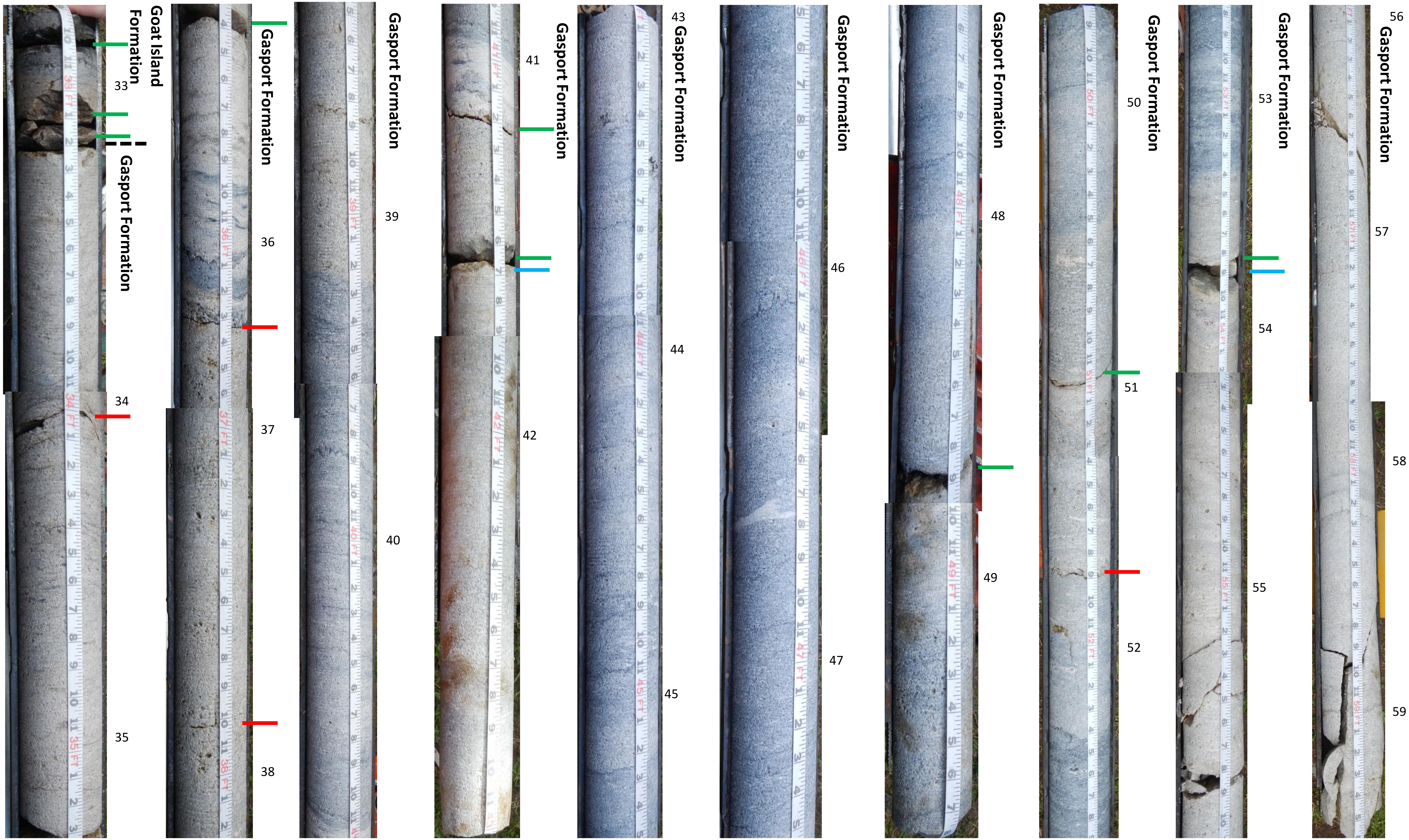
DRAWN: JD

CHECKED: SD

APPENDIX B

Core Photo Log

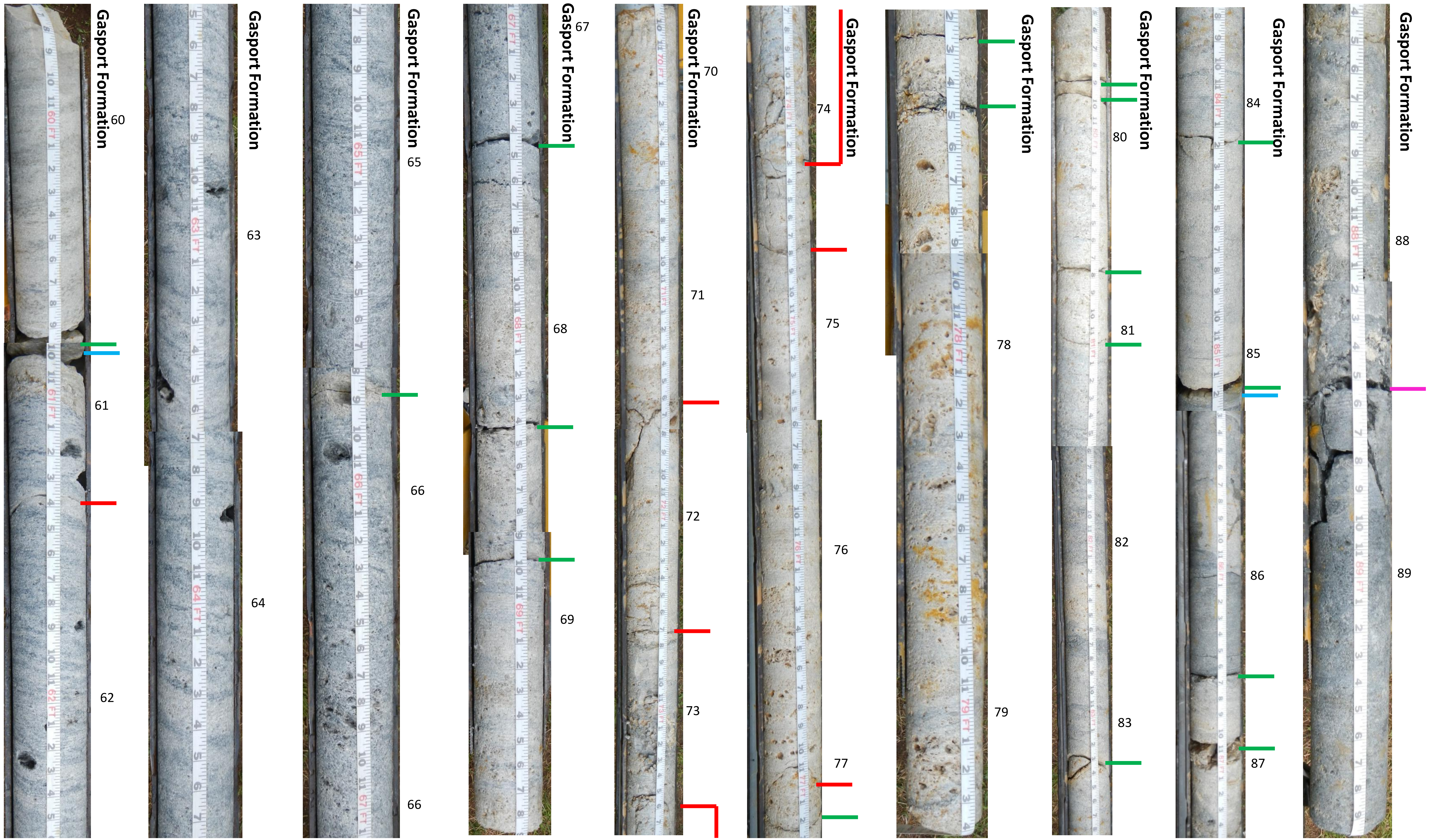
Pages 1-5 in Feet
Pages 6-10 in Metres



Legend

- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

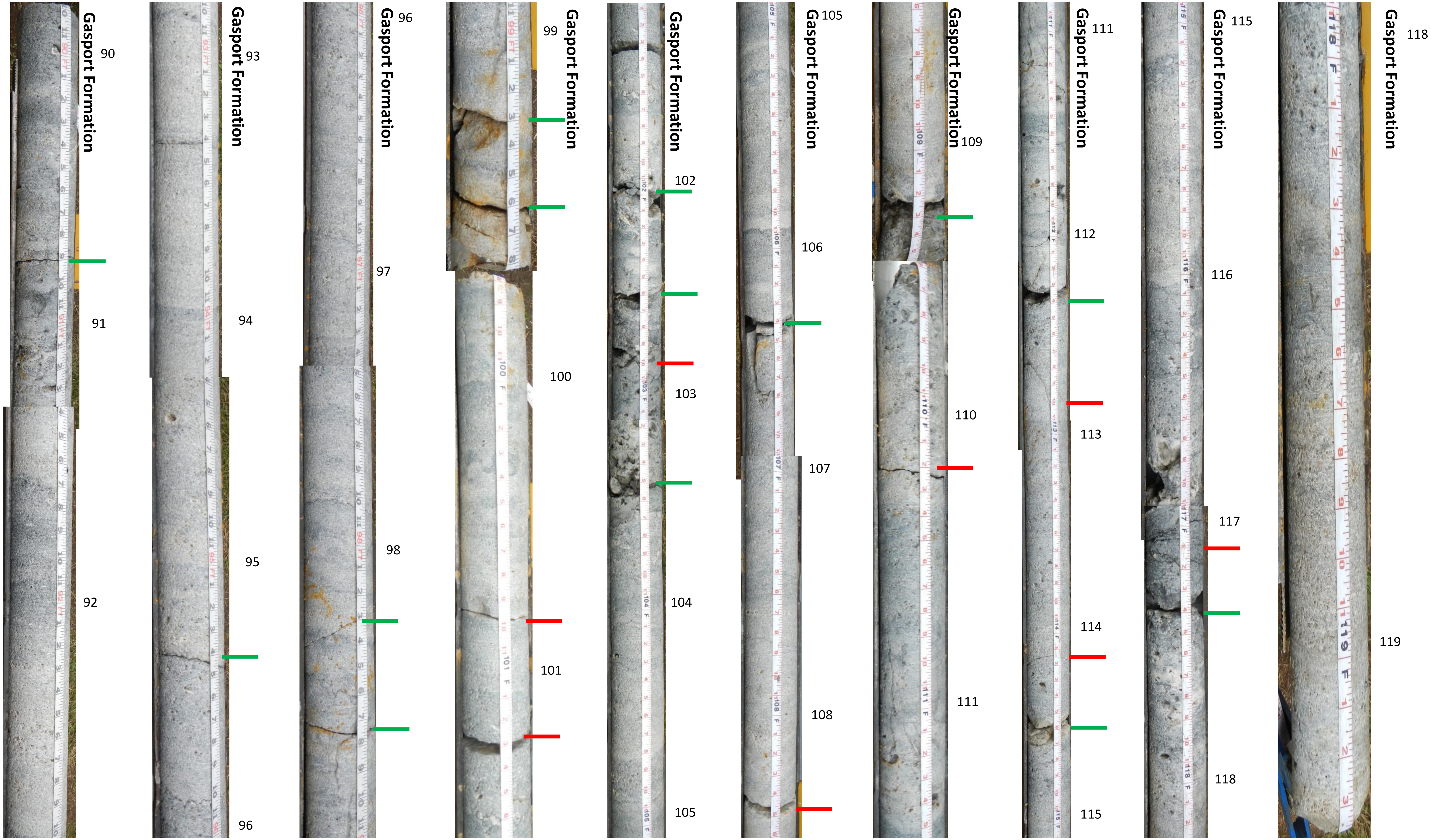
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photos (32'9"- 59'6")**
	Drawn By: JD		



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 (59'6"- 89'10")
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

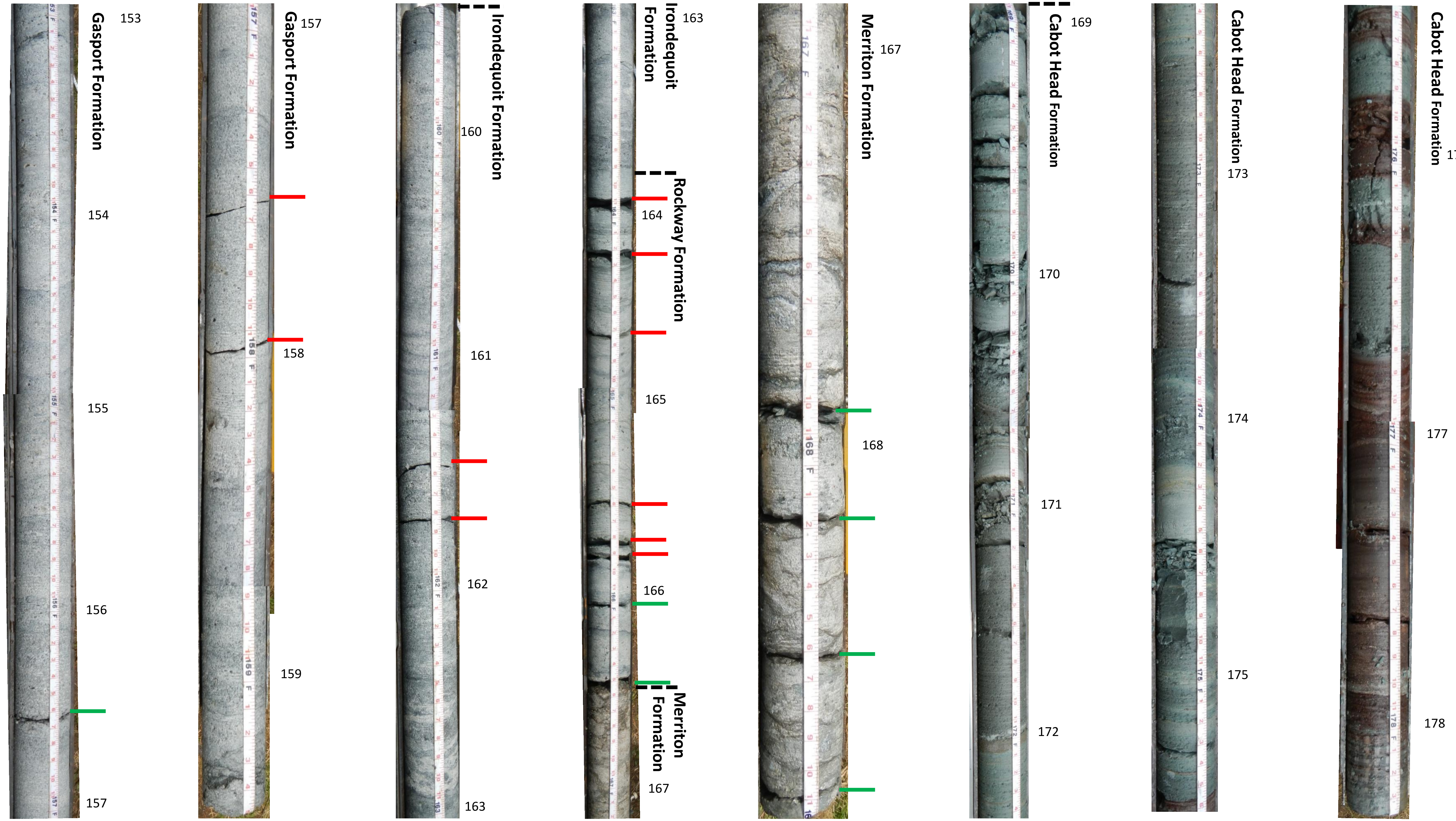
- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

Harden Environmental Services Ltd.	Project No: 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: Core Log 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

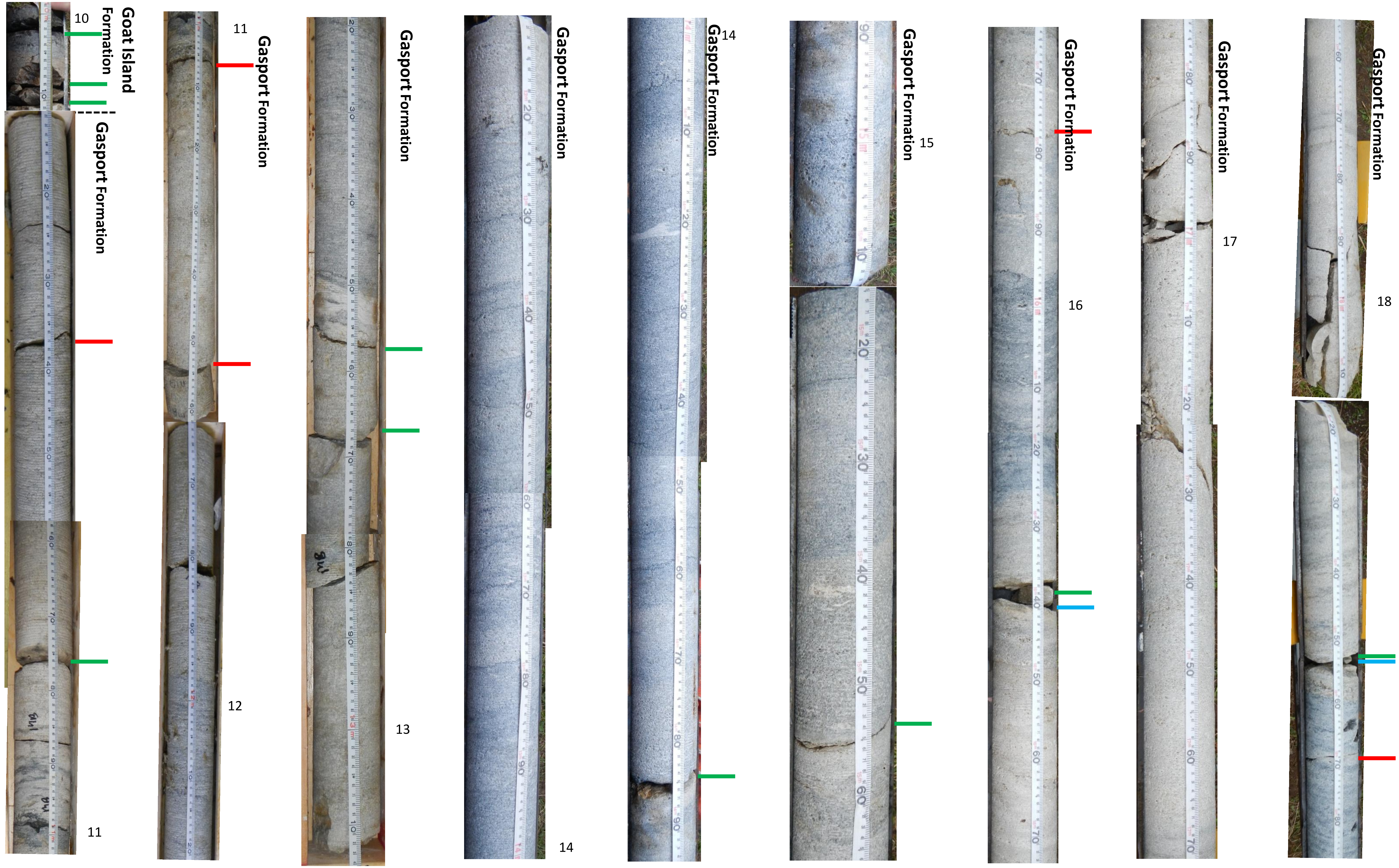
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (119'3.5"-153'1")**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

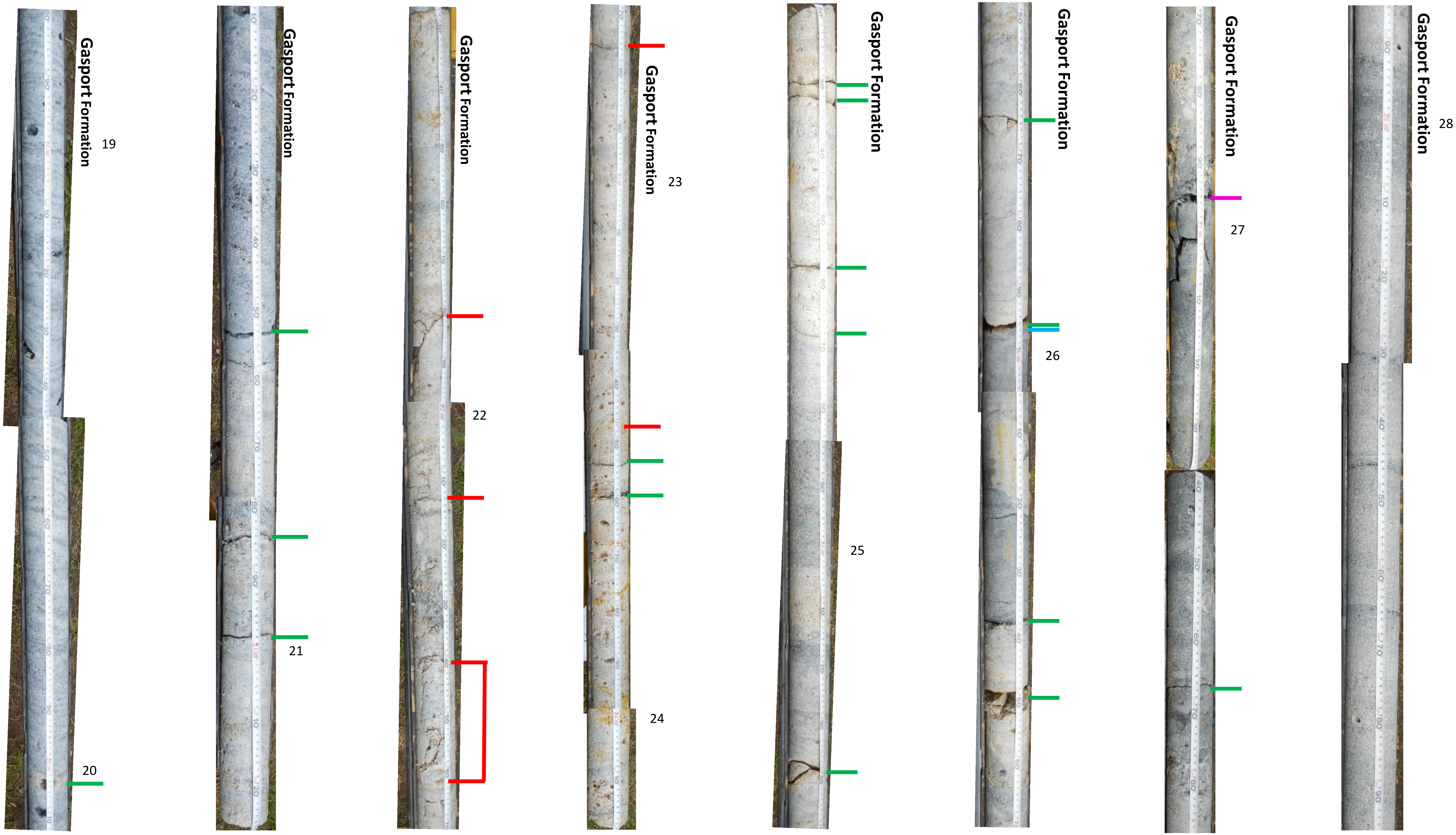
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photos (153'1"-178'4")**
	Drawn By: JD		



Legend

- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

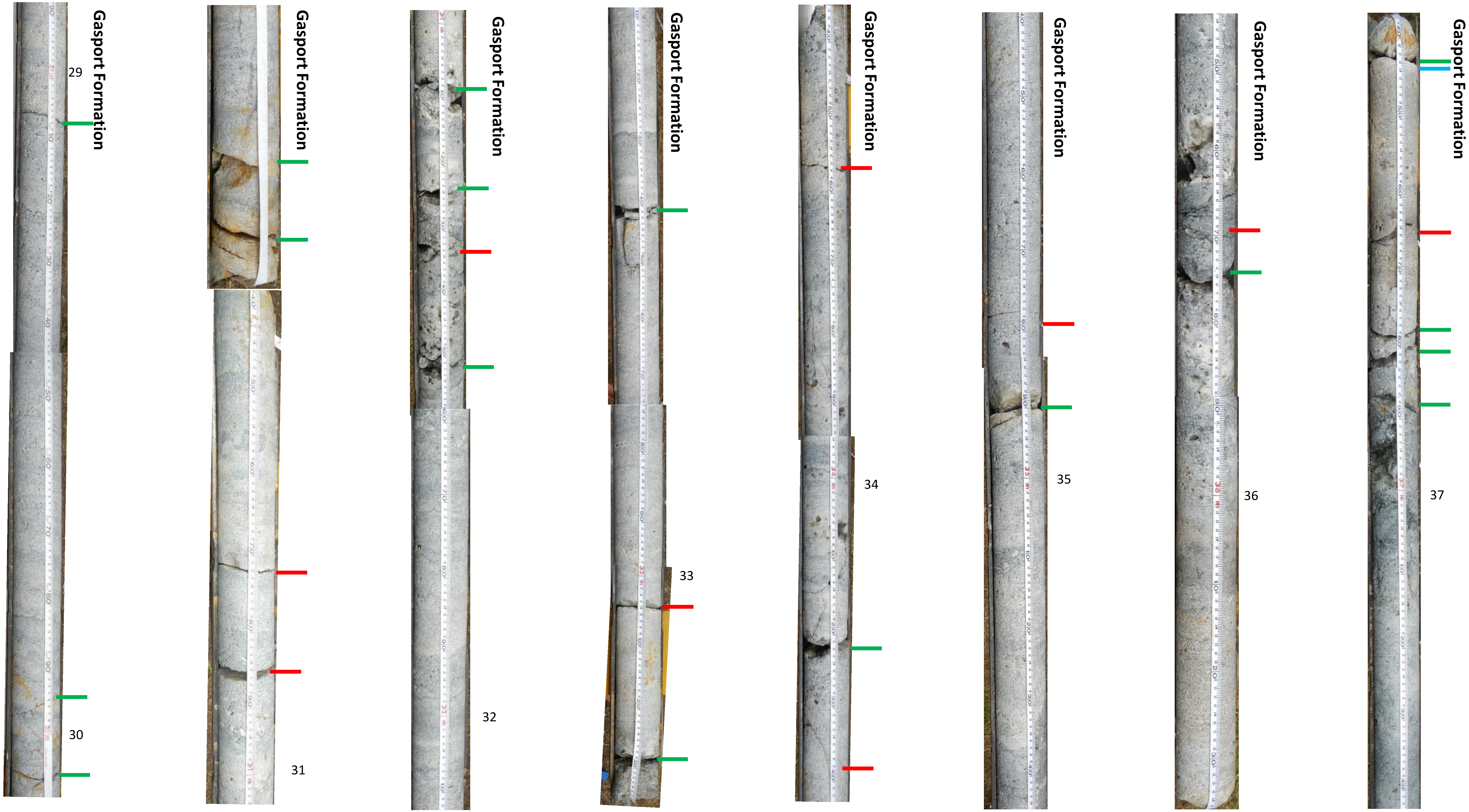
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photo's (10m – 18.84m)**
	Drawn By: JD		



Legend

- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

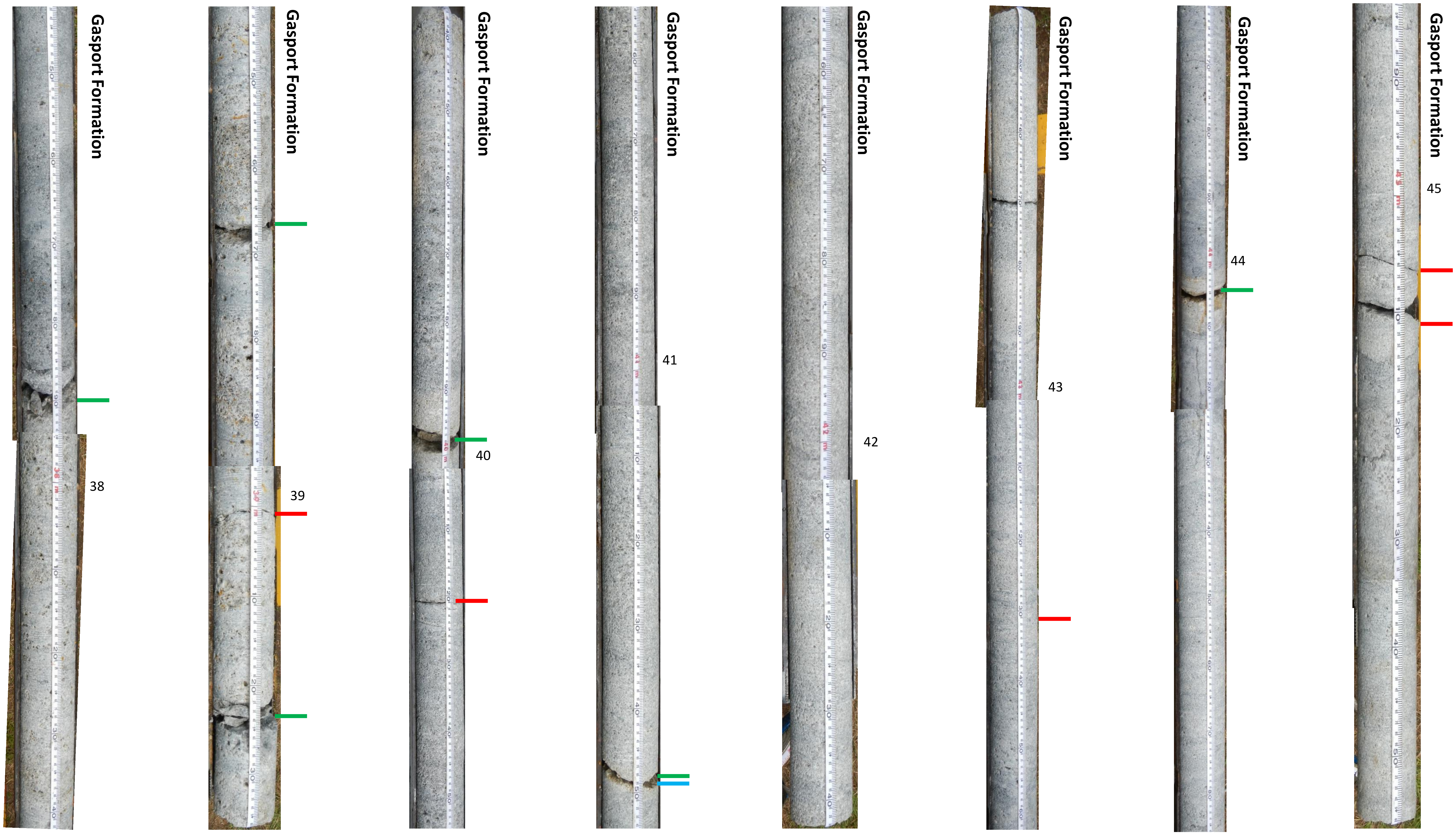
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (18.84m-28.94m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

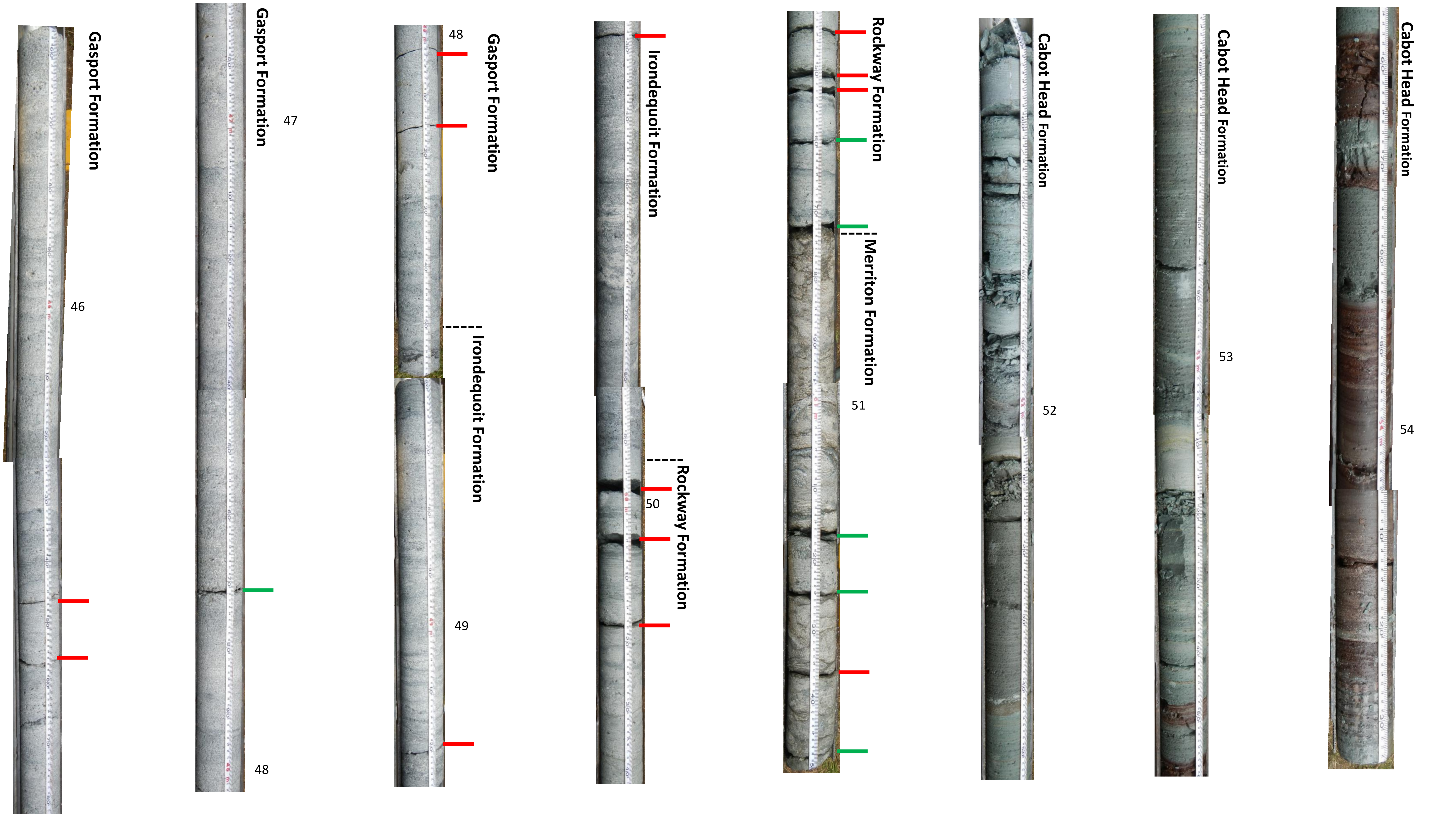
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (28.94m-37.44m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

- Open Fracture
- Closed Fracture
- Impact Fracture From Drillers
- Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (37.44m-45.56m)**
	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 Photos (45.56m-54.35m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

APPENDIX C

M15 Water Quality Results

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

Harden Environmental
Client Project #: 9506
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)

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**
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

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

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

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)