Technical Report

Title: ***Pressure and Head Monitoring in MP55 Casing Systems Installed in DGR-1 to DGR-4***

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Authors: **Sean Sterling and Kenneth Raven**

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DGR Site Characterization Document
Geofirma Engineering Project 08-200

Geofirma Engineering Ltd

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1 Introduction

Geofirma Engineering Ltd. (formerly Intera Engineering Ltd.) has been contracted by the Nuclear Waste Management Organization (NWMO) on behalf of Ontario Power Generation to implement the Geoscientific Site Characterization Plan (GSCP) for the Bruce nuclear site near Tiverton Ontario. The purpose of this site characterization work is to assess the suitability of the Bruce nuclear site to construct a Deep Geologic Repository (DGR) to store low-level and intermediate-level radioactive waste. The GSCP is described by Intera Engineering Ltd. (2006 and 2008a).

This Technical Report summarizes the measurement of bedrock formation pressures and calculations of environmental hydraulic head using Westbay MP55 casing systems in boreholes DGR-1, DGR-2, DGR-3, and DGR-4 during the period November 2007 to March 2010. Work described in this Technical Report was completed in accordance with Test Plan TP-07-09 – Phase 1 Pressure Monitoring and Groundwater Sampling in Westbay MP Systems (Intera Engineering Ltd., 2008b), and Test Plan TP-08-14 – Phase 2 Pressure Monitoring and Groundwater Sampling in Westbay MP Systems (Intera Engineering Ltd., 2009a), which were prepared following the general requirements of the Intera DGR Project Quality Plan (Intera Engineering Ltd., 2009b).

Formation pressures and environmental heads measured in DGR boreholes using MP55 casing systems are compared against equilibrium formation pressure and environmental head data estimated from analysis of borehole straddle-packer tests. Details of the analysis of straddle-packer hydraulic tests for the determination of equilibrium formation pressures are given in TR-08-32 (Geofirma Engineering Ltd., 2011a).

This report does not include any discussion of fluid pressure measurements or groundwater sampling conducted in the shallow US-series boreholes (US-3, US-7, and US-8). This information is summarized in TR-08-08 – Initial Groundwater Monitoring – US-3, US-7, and US-8 (Intera Engineering Ltd., 2010a) and TR-08-30 – Phase 2 Groundwater Monitoring – US-3, US-7, and US-8 (Geofirma Engineering Ltd., 2011b).

2 Background

The GSCP comprises three phases of borehole drilling and investigations. The Phase 1 GSCP is described in Intera Engineering Ltd. (2006) and included the drilling, logging and testing of two deep vertical boreholes, DGR-1 and DGR-2 (Drill Site #1, Figure 1), to total depths of 462.87 (Queenston Formation) and 862.12 (Precambrian bedrock) metres below ground surface (mBGS), respectively. Phase 1 drilling and testing was completed between December 2006 and December 2007.

The Phase 2 GSCP is described in Intera Engineering Ltd. (2008a). Phase 2 is divided into two sub-phases, 2A and 2B. Phase 2A consisted of drilling, logging and testing of two deep vertical boreholes, DGR-3 (Drill Site #2) and DGR-4 (Drill Site #3), which were drilled into the top of the Cambrian sandstone to total depths of 869.17 and 856.98 mBGS, respectively. Phase 2A was completed between March 2008 and September 2009. Phase 2B comprised the drilling, logging and testing of two deep inclined boreholes, DGR-5 (Drill Site #1) and DGR-6 (Drill Site #4), which were drilled into the lower Ordovician limestone formations to depths of 807.15 metres length below ground surface (mLBGS) into the Kirkfield Formation and 906.16 mLBGS into the Gull River Formation, respectively. These boreholes were targeted at angles of approximately 60 and 65 degrees from horizontal, respectively. Final total vertical depths (TVDs) of about 752 and 785 mBGS were achieved for boreholes DGR-5 and DGR-6, respectively. Phase 2B work was completed between December 2008 and June 2010.

Following drilling and testing activities in each DGR vertical borehole (DGR-1 to DGR-4) discrete-interval multi-level monitoring systems (Westbay MP55 systems) were installed to establish deep bedrock monitoring wells for the Bruce DGR project. No Westbay monitoring systems were installed in either of the inclined boreholes

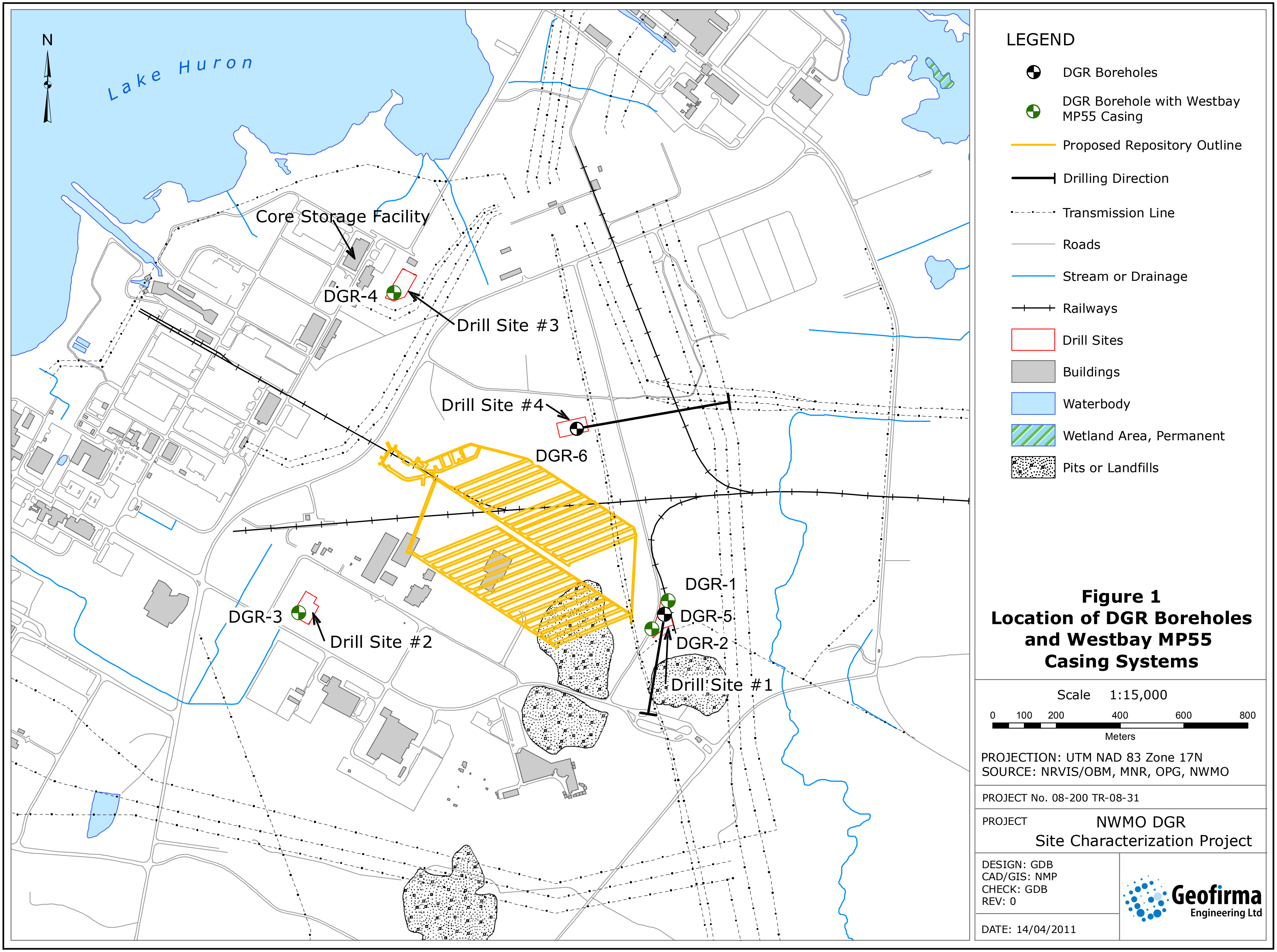


Figure 1
Location of DGR Boreholes and Westbay MP55 Casing Systems

P:\QMS_DGR\TR_WorkingFiles\TR-08-31 MP55 Pressure and Head Monitoring - DGR-1 to DGR-4\TR-08-31_Figure 1_SiteLocationDGR1-6_R0.mxd

DGR-5 and DGR-6. The multi-level monitoring systems were manufactured by Westbay Instruments Inc. (now Schlumberger Canada Limited) and allow for monitoring of formation pressures as well as the performance of groundwater sampling from packer-isolated test intervals. The multi-level monitoring systems established in DGR-1 through DGR-4 provide triangulation of bedrock formation pressure measurements from deep bedrock monitoring intervals around the perimeter of the proposed DGR.

Westbay MP55 casing systems were installed in DGR-1 and DGR-2 during September and December 2007 as summarized in TR-07-10 – Westbay MP55 Casing Completions in DGR-1 & DGR-2 (Intera Engineering Ltd., 2010b). In addition, as part of Phase 2A, the Westbay MP55 casing system installed at DGR-2 was successfully removed during May 2009 in accordance with TP-09-05 – Removal of Westbay MP55 Casing from DGR-2 (Intera Engineering Ltd, 2009c). Westbay MP55 casing systems were re-installed in DGR-2 during November 2009, and installed in DGR-3 and DGR-4 during September and April 2009, respectively as summarized in TR-08-17 – Westbay MP55 Casing Completions in DGR-2, DGR-3, and DGR-4 (Geofirma Engineering Ltd., 2011c). Appendix A provides a summary of the monitoring intervals for Westbay MP55 systems installed in boreholes DGR-1 to DGR-4.

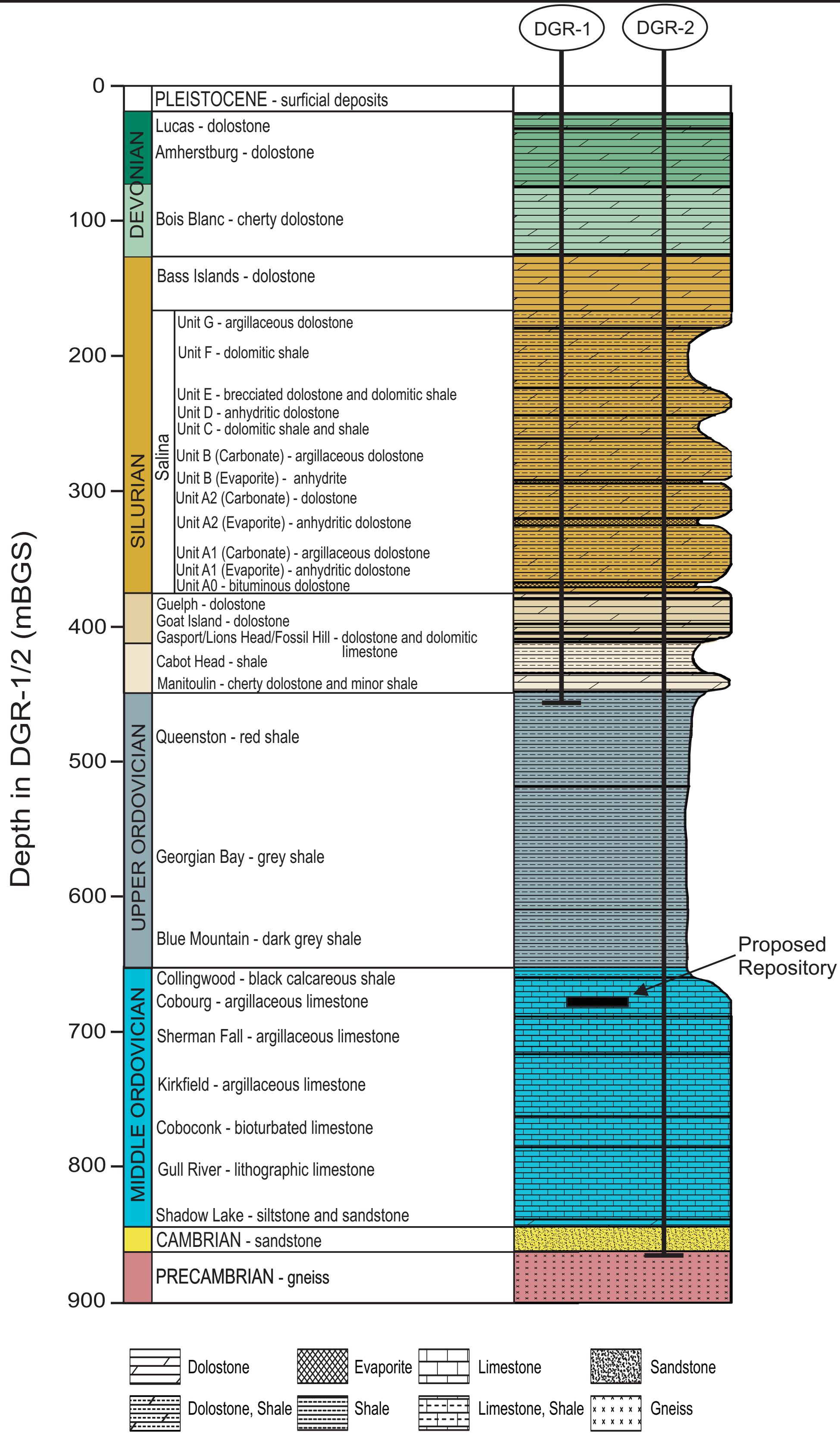
Figure 2 shows the interpreted reference bedrock stratigraphy (subsurface nomenclature based on Armstrong and Carter, 2006) for the Bruce site based on the drilling, core logging, and borehole geophysical logging activities completed during Phase 1 and Phase 2A of the GSCP. The reference stratigraphy is the stratigraphy defined based on observed bedrock conditions at boreholes DGR-1 and DGR-2. The rational for formation picks are described in TR-08-12 – Bedrock Formations in DGR-1, DGR-2, DGR-3, and DGR-4 (Intera Engineering Ltd., 2010c). The DGR facility is proposed to be constructed at a depth of approximately 680 mBGS within the argillaceous limestone bedrock of the Cobourg Formation.

3 Design of Westbay MP55 Casing Systems

Boreholes DGR-1, DGR-2, DGR-3 and DGR-4 were completed with Westbay stainless steel and PVC MP55 multi-level monitoring casings, primarily to provide access for formation pressure measurement, but also to allow for future groundwater sampling. Table 1 summarizes the design elements of the MP55 casing systems installed in DGR boreholes and the number of pressure profiles completed, excluding the post-inflation profiles.

Table 1 Major Design Elements of MP55 Casing Systems Installed in DGR Boreholes

MP55 Casing Element	***DGR-1***	***DGR-2 (old)***	***DGR-2 (new)***	***DGR-3***	***DGR-4***
Installation Date	September 2007	December 2007	November 2009	September 2009	April 2009
Monitored Depth Range (mBGS)	190.8 to 462.9	460.5 to 848.1	460.2 to 848.1	217.9 to 869.2	194.5 to 853.7
Number of Packers	23	28	27	43	43
Number of Formation Pressure Monitoring Intervals	22	25	24	42	42
Average Monitoring Interval Length (m)	11.4	14.5	15.2	14.5	14.7
Range of Monitoring Interval Lengths (m)	3.5 to 24.1	3.4 to 23.1	6.9 to 24.6	5.1 to 29.1	3.5 to 24.5
Number of Pressure Profiles Completed to End of March 2010 (summary of data presented in Appendix B)	12	4 + 13 mo. Continuous MOSDAX (March 2008 to April 2009)	1	2	3



Reference Stratigraphic Column at the Bruce Nuclear Site Based on DGR-1 and DGR-2 Borehole Data	Prepared by: SNG Reviewed by: SNS Date: 14-Apr-11
FIGURE 2 Doc. No.: TR-08-31_Figure 2_R0.cdr	

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4 Methods

As per TP-07-09 (Intera Engineering Ltd. 2008b) and TP-08-14 (Intera Engineering Ltd., 2009a), bedrock formation pressure measurements were collected by Intera staff using specialty equipment manufactured by Westbay and following Westbay user's guides and operations manuals. Formation pressures were measured in each of the MP55 systems through the measurement ports using a Westbay MOSDAX pressure probe, cable reel and MAGI unit (MOSDAX Automated Groundwater Interface).

Single pressure measurements were obtained from each port in order to construct pressure profiles that represent a snapshot of the groundwater pressure distribution in the borehole for the dates they were obtained. These pressure profiles were collected immediately (typically within days) following casing installation (reported as part of TR-07-10: Intera Engineering Ltd., (2010b) and TR-08-17: Geofirma Engineering Ltd., (2011c)), intermittently (weeks to months) following casing installation and subsequently on a quarterly (approximately every 3 months) basis for all wells that were not configured with an automated measurement system. The "snapshot" pressure profile data were manually recorded on a Piezometric Pressures/Levels Field Data and Calculation Sheet that formed a Technical Activity Record for this task. A summary of all pressure profiles collected from DGR-1 to DGR-4 between January 2008 and March 2010 is provided in Appendix B for reference. Table 1 lists the total number of pressure profiles completed in each DGR borehole up to March 2010, excluding the initial post-inflation pressure profile.

In addition to manually collected pressure measurements, a dedicated MOSDAX string of 10 pressure transducers was installed in DGR-2 to provide continuous records of formation pressure in 10 key test intervals. This MOSDAX system operated for approximately 13 months between March 4, 2008 and April 2, 2009. During this period, formation pressures were collected using the MAGI unit configured in data logger mode at a frequency of once per every six hours. Logged data was downloaded to a personal computer on a minimum quarterly basis while in operation.

5 Analysis of Formation Pressure Data

5.1 Reference Formation Fluid Density Profile

Figure 3 shows the relative distribution of fluid density (symbols) for 224 individual sample results analysed from the US-series and DGR-series boreholes, including:

- 9 measured fluid densities of opportunistic groundwater (OGW) samples (Activation Laboratories and SGS Laboratories), collected during drilling activities;
  - 3 during Phase 1 at DGR-1 and DGR-2 (TR-07-11: Intera Engineering Ltd., 2010d),
  - 6 during Phase 2A at DGR-3 and DGR-4 (TR-08-18: Intera Engineering Ltd., 2010e).
- 14 calculated fluid densities of porewater samples (University of New Brunswick, UNB) using preserved core:
  - 6 during Phase 1 at DGR-2 (TR-07-17: Intera Engineering Ltd., 2010f),
  - 8 during Phase 2A at DGR-3 (TR-08-27: Intera Engineering Ltd., 2010g).
- 16 measured fluid densities of shallow groundwater samples (SGS Laboratories) collected from Westbay MP38 systems at US-8 (TR-08-08: Intera Engineering Ltd., 2010b);
- 185 "estimated" fluid densities of porewater samples (University of Ottawa, UofO) using porewater chemistry results from preserved core samples;
  - 29 during Phase 1 at DGR-2 (TR-07-21: Intera Engineering Ltd., 2010h),
  - 78 during Phase 2A at DGR-3 (46 samples) and DGR-4 (32 samples) (TR-08-19: Intera Engineering Ltd., 2010i),
  - 78 during Phase 2B at DGR-5 (35 samples) and DGR-6 (43 samples) (TR-09-04: Geofirma Engineering Ltd., 2011d).

Fluid densities were estimated for each UofO sample by normalizing the total dissolved solids (TDS) value of a particular sample to that of the highest measured groundwater sample density (OGW sample in Guelph Formation) and, assuming the same ratio applies to fluid density, back-calculate the fluid density of the particular sample.

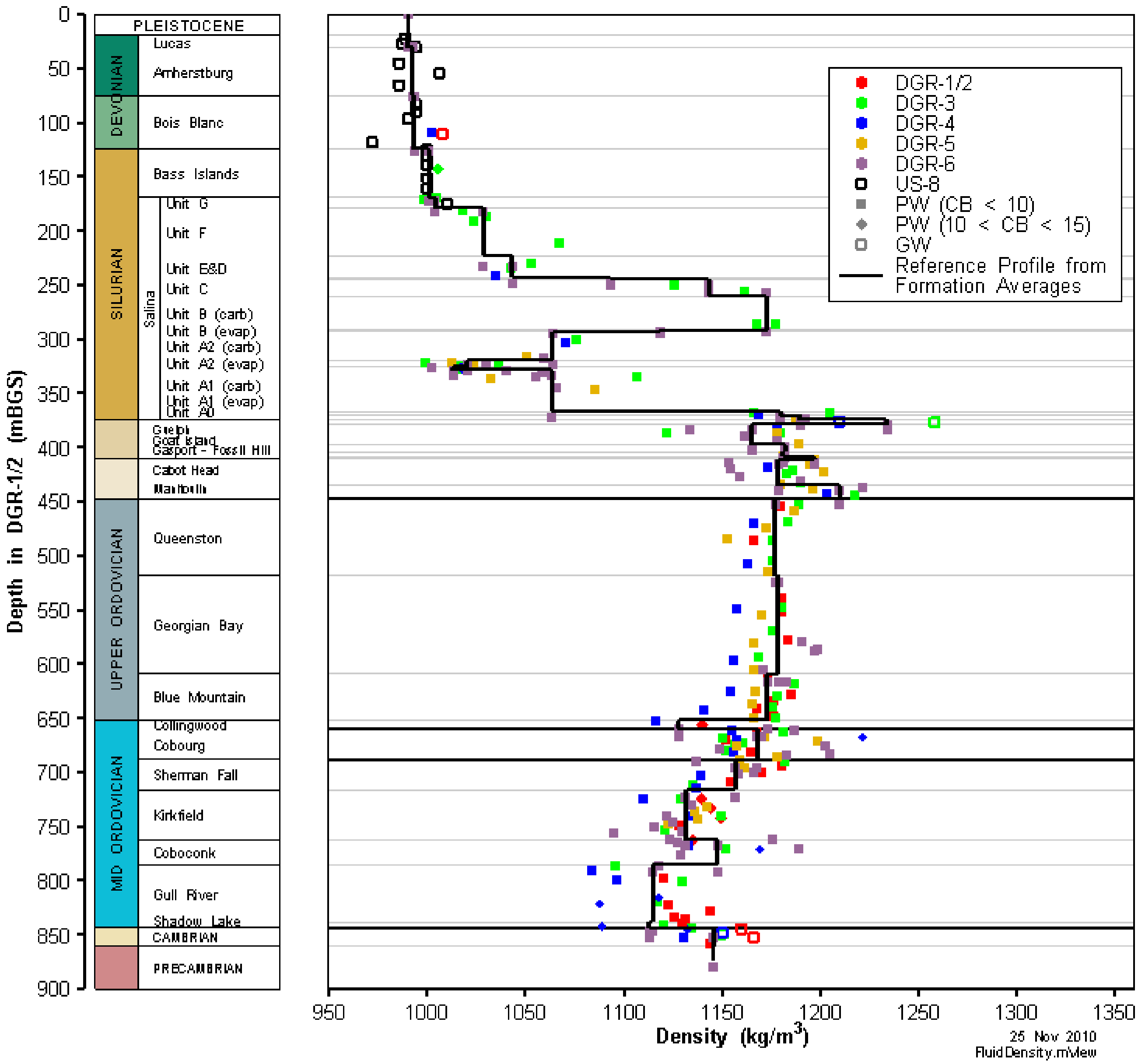

Figure 3 Reference Formation Fluid Density Profile for DGR Boreholes

This estimation required the following steps:

1. Calculate the concentration of TDS for each UofO porewater sample by summing the concentrations of major ions expressed in units of g/kg water;

2. Select two samples with known measured density and TDS values (i.e. upper and lower limits) to allow linear interpolation.

a. Upper limit - groundwater from the Guelph Formation was selected as the “upper” limit because this sample had the highest measured TDS (average 451.8 g/kg water) and density (average 1234 kg/m^3) values at the DGR site (TR-08-18, Intera Engineering Ltd., 2010e);

b. Lower limit – freshwater with assumed values (TDS = 0 g/kg water; density = 997 kg/m^3);

3. Using the calculated TDS concentration from UofO porewater samples, the density of a particular sample was estimated using the following equation:

$$\rho_{sample} = \frac{TDS_{sample}}{TDS_{Guelph}} \times \left(\rho_{Guelph} - \rho_{Freshwater}\right) + \rho_{Freshwater} \qquad [1]$$

There are two major assumptions with these calculations. One assumption is that the Guelph groundwater chemistry (NaCl dominated) is representative of the groundwater chemistry in the deeper formations (e.g. Cambrian sandstone). Although this assumption is known to be false (Cambrian groundwater is Ca-NaCl dominated) for the purpose of this normalization it is considered to be sufficient. The second assumption is that fluid density is linearly related to TDS, which is likewise approximate but considered sufficient for this purpose. These assumptions allow for a relatively straight forward estimation of fluid densities using TDS values and a consistent approach for all samples; assuming anything more complicated would introduce greater uncertainty into these values.

Figure 3 also shows the average fluid density within each bedrock formation (black vertical line). The profile created by linking these formation averages represents the reference formation fluid density profile for the DGR site that was used to calculate environmental heads as discussed in Section 5.2.2. The differentiation of these porewater samples based on charge balance error (< 10% and 10-15%) is shown in Figure 3. More confidence can be placed on porewater samples with a calculated charge balance error that is less than 10%, while less confidence should be offered to samples with charge balance errors of >15%, therefore they were not used in the calculation of the reference density profile.

5.2 Conversion of Absolute Pressures to Hydraulic Heads

The Westbay MOSDAX pressure probe measures absolute pressures in the packer-isolated borehole interval outside the MP55 casing, which is termed formation pressure (P_f). Pressures measured by this equipment are total pressures, expressed in units of pounds per square inch (psi), and include groundwater pressure and atmospheric pressure (P_a). The effect of atmospheric pressure was accounted for by measuring the atmospheric pressure with the probe at surface, and subtracting the atmospheric pressure (at the time of measurement) from the formation pressure. The MOSDAX pressure measurements were converted to metric units of Pascal (Pa or kg/ms^2) prior to calculating hydraulic heads.

Formation fluid pressures measured in variable-density groundwater systems need to be expressed as freshwater hydraulic heads for the estimation of horizontal hydraulic gradients and as environmental-water hydraulic heads for the estimation of vertical hydraulic gradients. The approach used to calculate freshwater and environmental-water hydraulic heads from formation pressures measured in Westbay MP systems, described below, is based on work by Lusczynski (1961) and Jorgensen et al., (1982). The important input data to these calculations are the depth/elevations of MP system measurement ports, measured formation fluid pressures, and the reference formation fluid density profile as discussed in Section 5.1.

5.2.1 Calculating Freshwater Heads

Hydraulic heads (H) is the sum of the elevation head (Z) and the pressure head (ψ). Freshwater heads are calculated from measured formation pressures and MP system measurement port elevations as:

$$H_f = Z + \psi = Z + \frac{P_f - P_a}{\rho_f g} \quad [2]$$

Where: H_f = freshwater head [mASL];

Z = elevation of MP pressure measurement port [mASL];

P_f = formation pressure measured in MP measurement port [Pa or kg/ms^2];

P_a = atmospheric pressure measured at ground surface [Pa or kg/ms^2];

ρ_f = density of freshwater [1000 kg/m^3 at ambient temperatures]; and

g = gravitational acceleration [9.8065 m/s^2].

5.2.2 Calculating Environmental Hydraulic Heads

Environmental heads are determined from calculated freshwater heads and the reference formation fluid density profile as:

$$H_e = H_f - \left(\frac{\rho_f - \rho_a}{\rho_f}\right)(Z - Z_r) \quad [3]$$

Where: Z_r = elevation of reference point below which an average fluid density is determined [i.e., top of the groundwater system as represented by ground surface]; and

ρ_a = average density of water between Z and Z_r defined as:

$$\rho_a = \frac{1}{Z_r - Z} \int_Z^{Z_r} \rho(z)dz \quad [4]$$

Fluid density profile functions (ρ(z)) were determined from compilations of measured fluid densities of porewater and groundwater samples from different depths or calculated from measured total dissolved solids or major ion analyses of porewater and groundwater samples as described in Section 5.1. Integrations were performed with basic trapezoid rule calculations. Function evaluation was performed as linear interpolation between tabulated points.

5.2.3 Calculation of Hydrostatic Pressure Lines

Freshwater and density-compensated hydrostatic pressures (P_h), or hydrostatic pressure heads, were calculated with depth, taking into account the density profile using the following formula:

$$P_h = g \int_Z^{Z_r} \rho(z)\mathrm{dz} \quad [5]$$

Plotting these hydrostatic pressures with depth (Figures 4 to 9) provide reference hydrostatic pressure lines that help identify bedrock formations or intervals with over-pressures or under-pressures relative to these reference line(s). The freshwater hydrostatic pressure line assumes a uniform freshwater density of 997 kg/m^3 which equates to approximately 9.78 kPa per m depth below ground surface (mBGS). The density-compensated hydrostatic pressure line uses the reference formation fluid density profile discussed in Section 5.1 to calculate a varying differential pressure with depth.

6 Formation Fluid Pressure and Environmental Head Profiles

Figures 4 to 9 show the measured pressures (MPa) and calculated environmental heads (m) for DGR-1 to DGR-4 throughout the Phase 1 and Phase 2 DGR site characterization work. Calculated environmental heads are plotted with the vertical ground surface elevation line (185.7 mASL) as a reference point for the calculated heads. For each DGR borehole the measured formation pressures are plotted relative to freshwater hydrostatic and density-compensated hydrostatic pressure lines as discussed in Section 5.2.3. These measured in situ pressures are also plotted with the best-fit estimates of test interval formation pressure from analyses of the straddle-packer hydraulic tests as described in TR-08-32 (Geofirma Engineering Ltd., 2011a).

In the very low permeability formations that characterize large sections of all DGR boreholes, formation pressures are slow to equilibrate. Consequently, measured formation pressures in DGR boreholes are presented in these figures only for selected monitoring dates that provide a representation of the temporal evolution of formation pressures. A complete set of formation pressures and environmental head calculations for each monitoring round are included in Appendix B.

6.1 DGR-1 and DGR-2 (Old)

Figure 4 shows the temporal evolution of pressures and heads in DGR-1 over a 1.5 to 29 month period after casing installation in September, 2007. Figure 4 shows that stable formation pressures and heads occur in almost all of the Salina Formation within several months after installation. Formation pressures and heads for the permeable upper Salina A1 Unit and Guelph Formation aquifers are stable in all pressure profiles.

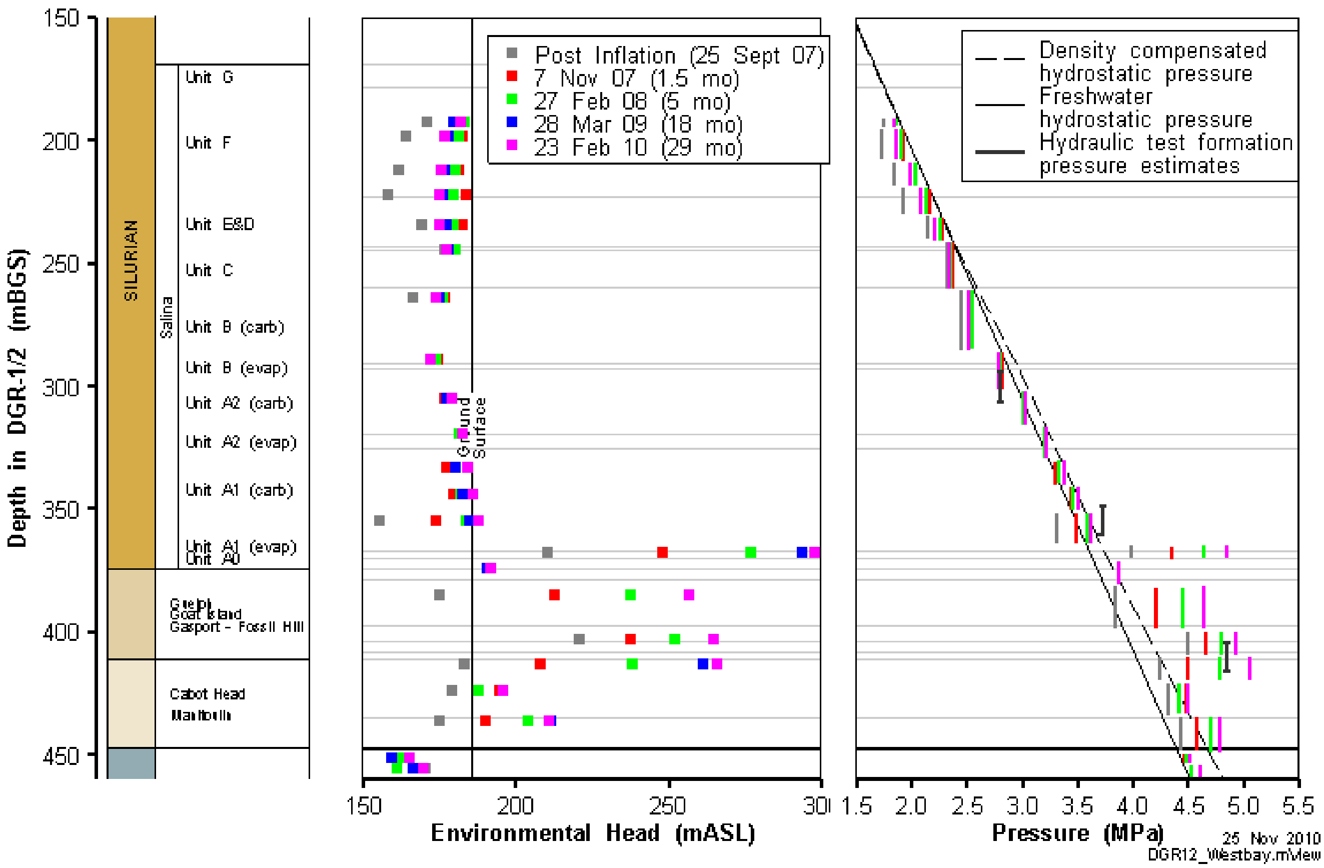

Figure 4 DGR-1 Formation Pressure and Environmental Head Profiles, September 2007 (post-inflation), February 2008, March 2009, and February 2010

Elevated pressures and environmental heads are observed within lower Salina A1 Unit carbonate and the underlying Goat Island to upper Cabot Head Formations. The Westbay pressures measured in the Lions Head, Fossil Hill and upper Cabot Head formations are very similar to the estimated formation pressure from borehole hydraulic testing. The very bottom of DGR-1 (top of Ordovician shales – upper Queenston Formation) shows environmental heads that are under-pressured relative to the vertical ground surface line and all other environmental heads in DGR-1. These under-pressures and low environmental heads are consistent with deeper data recorded in DGR-2.

Figure 5 shows the temporal evolution of pressures and heads in DGR-1 and DGR-2 as a combined plot over about a 1.5 to 26 month period after casing installation in DGR-2 in December, 2007. Figure 5 shows the development of significant under-pressures within the Ordovician shales (Queenston, Georgian Bay and Blue Mountain formations) and Trenton Group limestones (Cobourg, Sherman Fall and Kirkfield formations) with environmental heads approaching -70 mASL or 255 mBGS.

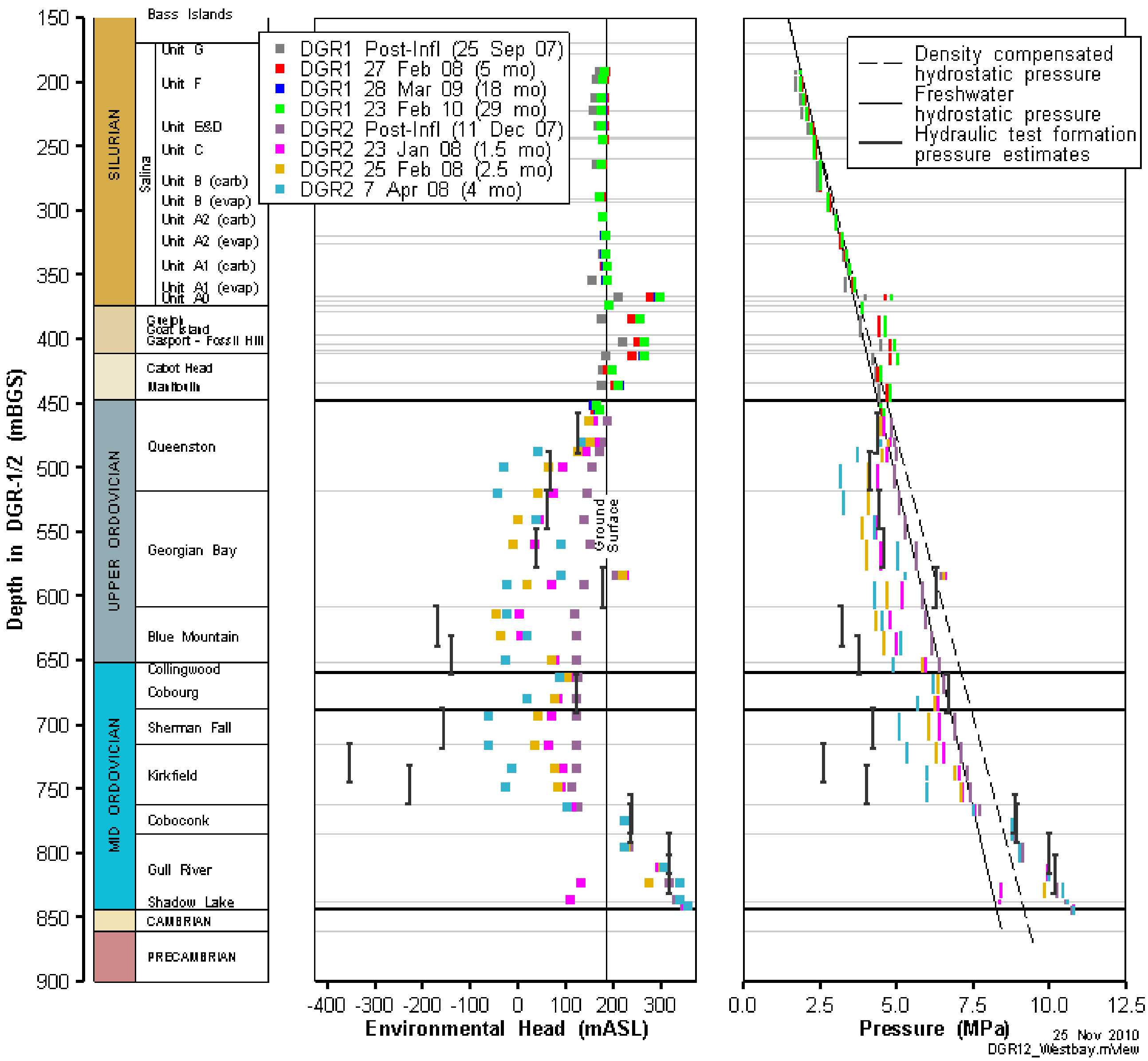

Figure 5 Combined DGR-1 and DGR-2 (Old) Formation Pressure and Environmental Head Profiles, December 2007 (old DGR2 post inflation), January 2008 (DGR1 post-inflation and DGR-2), February 2008 (DGR-1&2), April 2008 (DGR-2), March 2009 (DGR-1), and February 2010 (DGR-1).

Pressure data collected from DGR-2 also show the occurrence of a slightly over-pressured zone within the lower part of the Georgian Bay and the occurrence of large over-pressures in the Black River Group extending downward from the Coboconk Formation to the Cambrian sandstone. The deepest formation pressures in DGR-2 are equivalent to an environmental head of approximately 350 mASL or 165 m above ground surface (AGS). Both the under-pressures and over-pressures are consistent with results reported as part of borehole hydraulic testing (Intera Engineering Ltd., 2010a).

The January 23, 2008 pressure measurements from two of the deeper intervals in DGR-2 show pressures and calculated environmental heads that appear to be too low and are attributed to leakage of Shadow Lake and Gull River pressure into the MP55 casing (i.e. around MOSDAX probe) due to a poor probe seal on the pressure measurement port. This phenomenon is also observed with the continuous pressure monitoring data for the Cambrian port as discussed below.

Continuous pressure measurements were recorded in ten selected intervals of DGR-2 using dedicated MOSDAX pressure transducers with a MAGI data logging unit. Formation pressures were recorded at a frequency of once every six hours throughout the period of March 2008 to April 2009. Figure 6 shows the continuous pressure plots generated from this MOSDAX installation. This figure shows that after 18 months since installation, pressures within DGR-2 continue to show changes with decreasing pressures in the Georgian Bay, Cobourg and Kirkfield formations and apparent stabilization of pressures within the Queenston, Blue Mountain, Coboconk and Gull River formations. The step pressure increase and decrease shown in mid to late March 2008 is attributed to leakage of Cambrian pressure into the sealed casing and correction of this leakage by disconnecting the pressure transducer from the Cambrian measurement port. Figure 6 also shows periodic “bumps” or pressure increases for the upper Georgian Bay, Blue Mountain, Cobourg and Kirkfield formations that are thought to be due to leakage around packer seals and/or leakage from the inside of the MP55 casing to these under-pressured formations.

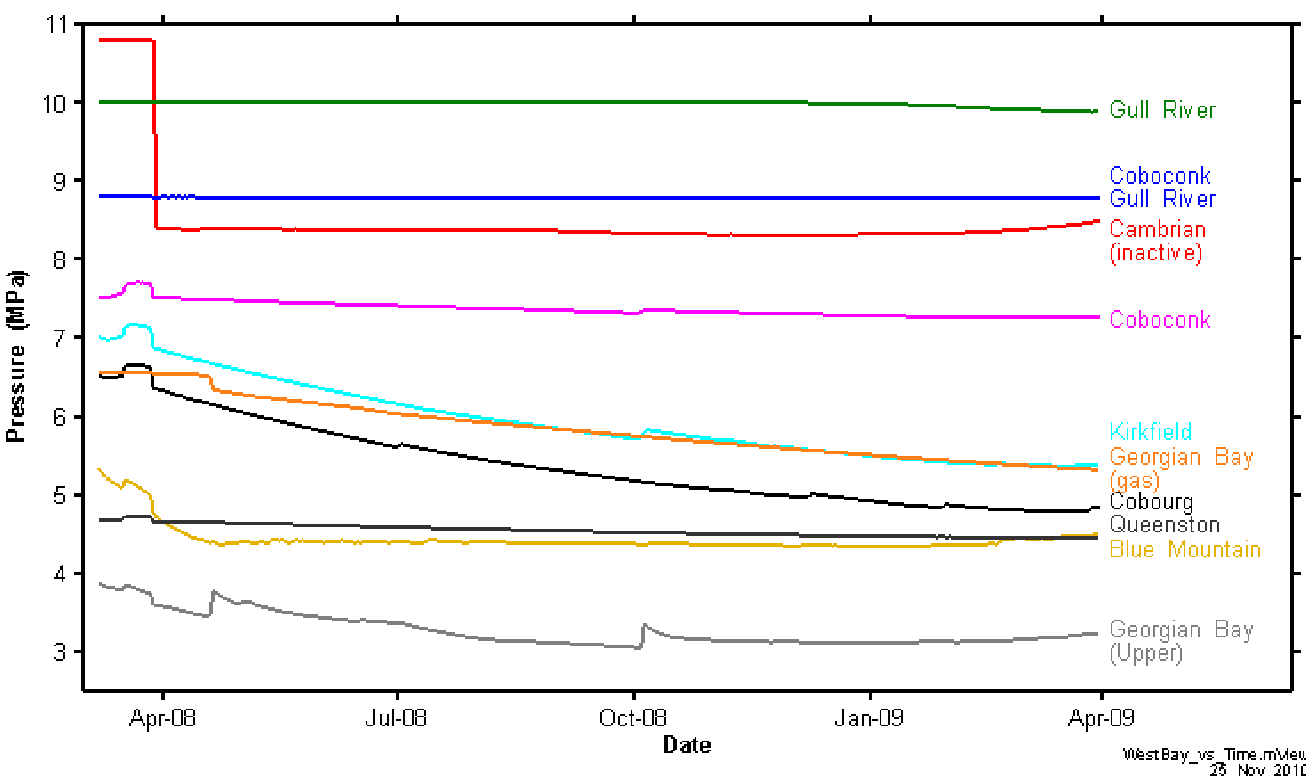

Figure 6 Continuous Formation Pressure Measurements, March 2008 to April 2009 in DGR-2

Figure 6 shows that the only truly stable formation pressures in DGR-2 during the MAGI monitoring period are in the deeper Coboconk and Gull River formations, as well as the underlying Shadow Lake Formation, whose pressures are controlled by the stable high pressure measured in the Cambrian sandstone. While environmental heads in the Ordovician shales appear close to stabilizing, the heads in the Cobourg and Kirkfield formations show near uniform pressure decreases throughout the 18 month monitoring period, therefore the Ordovician shale pressures are not thought to be at equilibrium.

6.2 DGR-1 and DGR-2 (New)

Removal of the 848 m length of MP55 casing in DGR-2 was undertaken in early June 2009 for the following reasons:

- To eliminate the suspected MP55 casing leaks by upgrading the design of the system by increasing the amount of stainless steel components and the use of high pressure Geopro^{TM} packers in zones expected to experience very high differential pressures (note: some monitoring intervals has a differential pressure across packers or between the formation and the inside of Westbay casing that exceeded the design specifications of the plastic pressure ports or regular packers).
- To allow for additional borehole acoustic televiewer logging of the borehole walls to further assess possible borehole breakouts for assessment of in situ stresses.
- To allow for retesting of DGR-2 to address concerns over possible test equipment leaks identified by comparison of test results between boreholes DGR-2 and boreholes DGR-3 and DGR-4.
- To demonstrate retrieveability of MP55 casings in DGR boreholes - which was a requirement of the Phase 1 GSCP (Intera Engineering Ltd, 2006).

The design for the new MP55 casing system for DGR-2 was changed slightly to distribute the monitoring intervals similar to those in DGR-3 and DGR-4 and was installed in DGR-2 on December 2, 2009. The new DGR-2 Westbay MP55 system design (i.e. upgraded packers and stainless components in target over-pressured intervals) successfully eliminated all of the observed exceedences of component design specifications. Figure 7 shows the temporal evolution of pressures and environmental heads in DGR-1 and DGR-2 (new) over approximately a four to 29 month period after casing installation in DGR-1 and one profile approximately 2.5 months after casing re-installation in DGR-2.

Figure 7 shows a similar distribution of over-pressures and under-pressures throughout the stratigraphic sequences compared the initial configuration of DGR-2. In addition, the magnitudes of the pressures and environmental heads in the new system approximately 2.5 months after installation are similar compared to the same duration after installation of the original system.

6.3 DGR-3

Figure 8 shows two profiles of formation pressure and environmental head in DGR-3 approximately 1.5 and 5 months after casing installation in late September, 2009.

The pressure and environmental head data illustrated in Figure 8 are very similar to data from DGR-1 and DGR-2. Figure 8 shows a minor under-pressure in the Salina formations transitioning to over-pressure in the Gasport to Fossil Hill formations and then rapidly transitioning to significant under-pressures within the Ordovician shales (Queenston, Georgian Bay and Blue Mountain formations) and limestones (Cobourg, Sherman Fall and Kirkfield formations). Similar to DGR-2, all of the deeper Ordovician limestones (Coboconk, Gull River, Shadow Lake formations) are over-pressured as a result of the over-pressured Cambrian sandstone. Figure 8 also shows that the over-pressured and under-pressured intervals measured with the MP55 casing in DGR-3 are consistent with those identified with borehole hydraulic testing analysis. In addition the pressures measured during hydraulic testing indicate that final or stable under-pressures and environmental heads in the Ordovician shales and upper limestones are likely to be much lower than those measured during March, 2010. Stable formation pressures are evident for the permeable sections of DGR-3, including the Upper Salina A1 Unit, the Guelph and the Cambrian sandstone aquifers.

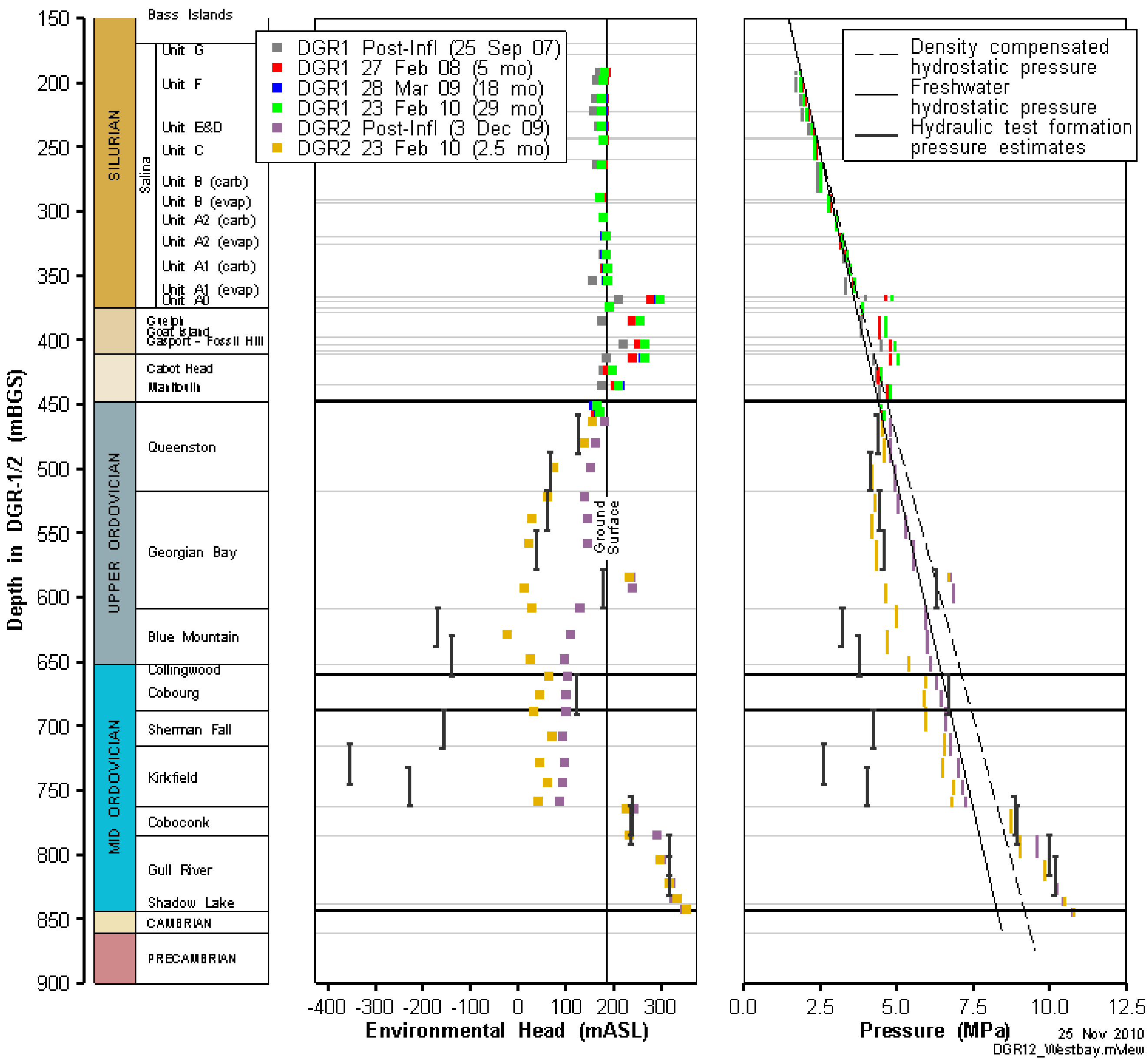

Figure 7 Combined DGR-1 and DGR-2 (New) Formation Pressure and Environmental Head Profiles, September 2007 (DGR-1 post-inflation), February 2008 (DGR-1), March 2009 (DGR-1), December 2009 (new DGR-2 post-inflation), and February 2010 (DGR-1&2).

The development of the over-pressures and under-pressures are very similar in DGR-3 compared to DGR-2. For example, environmental head profiles determined from DGR-3 approximately 1.5 months and 5 months after casing installation are very similar in both shape and magnitude to the environmental head profiles determined from DGR-2 after the same time period following casing installation.

As in DGR-2, there is one normally-pressured interval in the Ordovician shales; in DGR-3 it occurs within the Blue Mountain Formation that has an environmental hydraulic head approximately 100 to 200 m greater than heads in the surrounding shales.

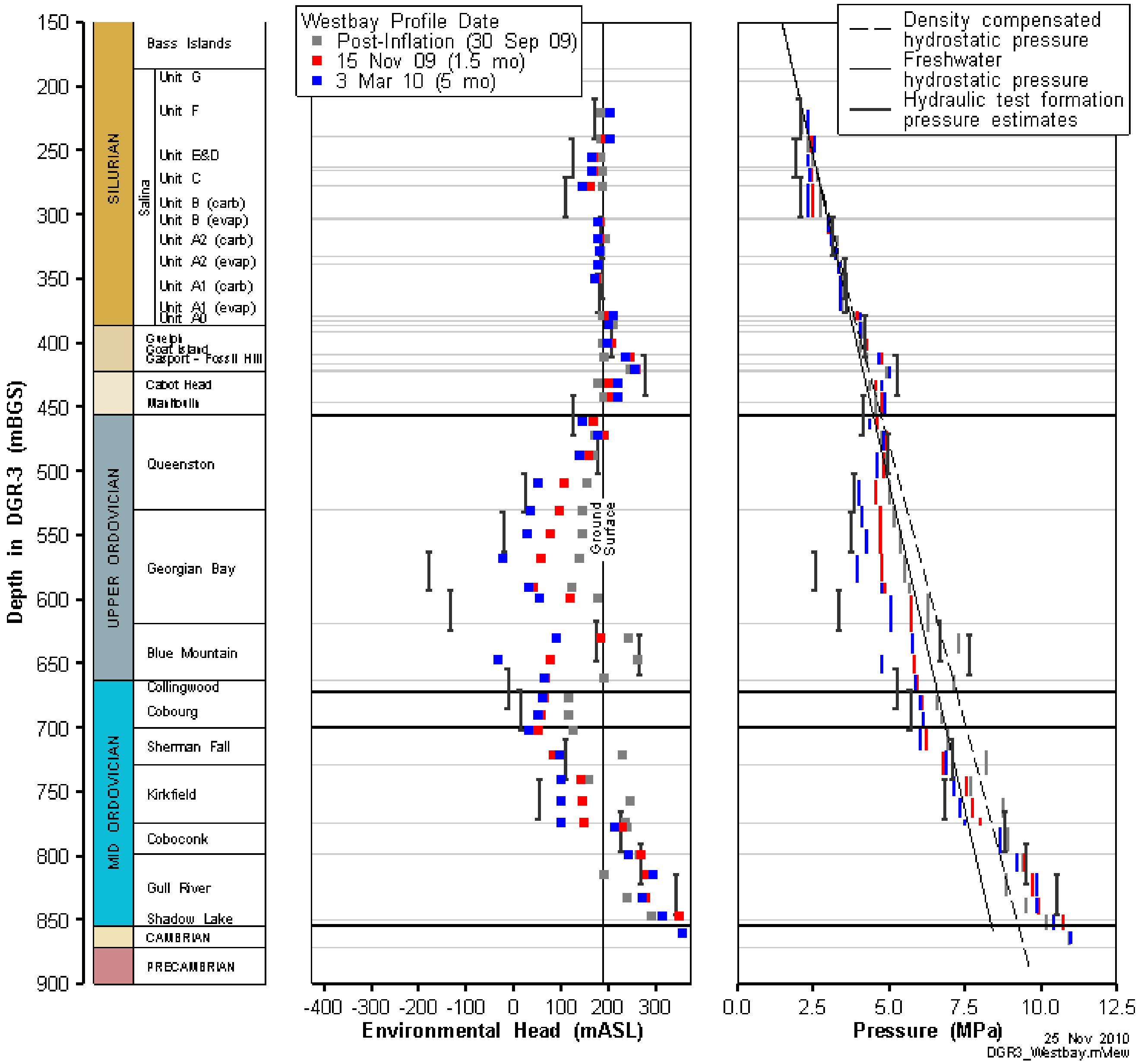

Figure 8 DGR-3 Formation Pressure and Environmental Head Profiles, September 2009 (post-inflation), November 2009 and March 2010.

6.4 DGR-4

Figure 9 shows the temporal evolution of pressures and heads in DGR-4 over the four to ten month period following casing installation (April, 2009). The temporal development and spatial distribution of over-pressures and under-pressures in DGR-4 is remarkably similar to that observed in boreholes DGR-1, DGR-2 and DGR-3.

As in other DGR boreholes, the pressure and head data for DGR-4 show under-pressure in the Salina Formation that increases to over-pressure in the Gasport to Fossil Hill formations and then rapidly transitions to significant under-pressure within the Ordovician shales and upper limestones. Similar to DGR-1, formation pressures within the permeable upper A1 Unit and Guelph aquifers are stable in all pressure surveys. Similar to DGR-2 and DGR-3, all of the deeper Ordovician limestones (Coboconk, Gull River and Shadow Lake formations) are over-pressured as a result of the over-pressured Cambrian sandstone. The pressure in the Cambrian sandstone in DGR-4 is equivalent to an environmental head of 351 mASL (165 mAGS).

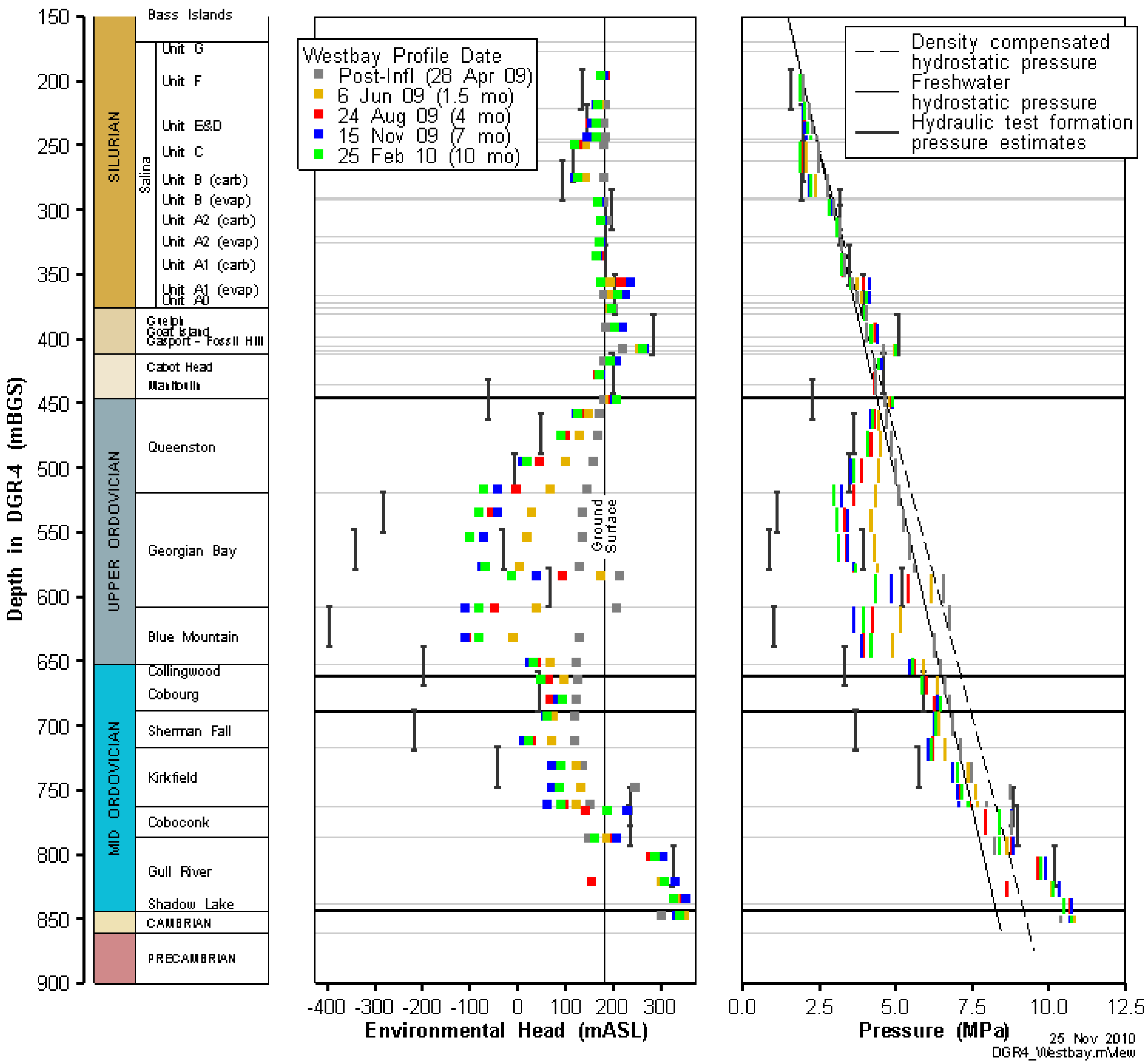

Figure 9 DGR-4 Formation Pressure and Environmental Head Profiles June (post-inflation), August, and November 2009 and February 2010.

The magnitude of the under-pressures in DGR-4 are greater than in DGR-1, DGR-2 or DGR-3, being equivalent to environmental heads of 117 mASL (69 mBGS) in the middle of the Salina Formation and -115 mASL (300 mBGS) in the Blue Mountain Formation. This observation is not unexpected as the MP55 casing in DGR-4 is a more robust design than casing in DGR-1 and DGR-2 (old) and has been in the ground longer than DGR-2 (new) and DGR-3. Figure 9 shows that the over-pressured and under-pressured intervals measured in the MP55 casing in DGR-4 were all reasonably well determined from borehole hydraulic testing. Again, comparison of the formation pressures determined from hydraulic testing to MP55 casing measurements indicates that final or stable under-pressures and environmental heads in the Ordovician shales and limestones are likely to be much lower than those measured on February 25, 2010.

As in DGR-2 and DGR-3, there is one normally-pressured interval within the Ordovician shales; in DGR-4 it occurs within the lower Georgian Bay Formation and has environmental head approximately 100 to 200 m greater than heads in the surrounding shales.

7 Summary of Under-Pressures and Over-Pressures

The available pressure measurements from borehole hydraulic testing and monitoring of MP55 casings shows the following general environmental head conditions in DGR boreholes related to over-pressures and under-pressures:

- Under-pressures in the Salina Formation with maximum under-pressures occurring within the C and B Units with environmental heads of approximately 117 mASL (70 mBGS).
- Over-pressures in the Salina A1 and A0 Units, and Gasport to Fossil Hill formations with maximum over-pressures equal to environmental heads of approximately 261 mASL (75 mAGS).
- Under-pressures in the Ordovician shales and Trenton Group limestones with maximum under-pressures occurring within the Blue Mountain Formation with environmental heads of approximately -114 mASL (300 mBGS).
- Over-pressures in the Black River Group limestones and siltstones and the Cambrian sandstone with maximum over-pressures equal to environmental heads of approximately 351 mASL (165 mAGS).

The cause of the observed under-pressures and over-pressures and heads in DGR boreholes are not evident at this time. Certainly both the under-pressures and larger over-pressures are not in hydrodynamic equilibrium with local topography and surface water elevations.

8 Horizontal Groundwater Flow Directions in Deep Permeable Bedrock Units

Borehole hydraulic testing identified three sections that are being monitored with Westbay MP55 casing systems in DGR boreholes with sufficient permeability (e.g., > 10^{-10} m/s) to support active groundwater movement or flow (Geofirma Engineering Ltd., 2011a). These aquifers and their reference depths include:

- the vuggy upper Salina A1 Unit aquifer at depths of 325.5 to 328.5 mBGS in DGR-1;
- the vuggy Guelph Formation aquifer at depths of 374.5 to 378.6 mBGS in DGR-1; and
- the over-pressured Cambrian sandstone at depths of 843.8 to 860.7 mBGS in DGR-2.

Horizontal groundwater flow directions are calculated from measured formation pressures obtained from MP55 casings considering the density of the aquifer fluids and the dip of the formations. Table 2 summarizes the results of this assessment based on formation pressure measurements obtained on October 30 and December 8 & 9, 2009, January 27 and April 26 & 27, 2010.

Groundwater flow directions and hydraulic gradients were calculated from measured in situ pressures in MP55 casings with the following steps:

1. *Correct for atmospheric pressure*. Correct absolute pressures measured in permeable interval for atmospheric pressure measured at the time of the field survey (See Section 5.2).
2. *Calculate mid-point formation pressure*. Express atmospheric-corrected MP pressures as the formation pressure at the mid-depth point of the permeable unit considering the known density of the formation

fluid based on groundwater sampling, and the elevation difference between the MP pressure measurement port the mid-depth point.

3. *Express as equivalent pressure of horizontal unit*. Express the mid-point formation pressures as an equivalent pressure for a horizontal permeable unit considering the orientation of the unit as determined from TR-08-12 (Intera Engineering Ltd., 2010f). These equivalent horizontal unit pressures are listed in Table 2.

4. *Determine strike and dip of formation pressure surface*. Solve the three-point pressure problem to determine the strike and dip of the equivalent horizontal formation pressure surface.

5. *Determine gradient and flow direction*. Express the calculated formation pressure surface as equipotential lines, groundwater flow directions and hydraulic gradients by solving the three-point problem.

The results of these calculations as listed in Table 2 show the groundwater flow directions in the Upper A1 Unit aquifer are to the northwest toward Lake Huron, which is consistent with shallow groundwater flow directions at the Bruce Site. In contrast the calculated groundwater flow directions for the Guelph Formation and the Cambrian sandstone are outward from the middle of the Michigan Basin being toward the northeast (Guelph Formation) and to the east (Cambrian sandstone).

Table 2 Formation Pressures and Groundwater Flow Directions in Deep Permeable Bedrock Units

Salina Upper A1 Unit

Parameter (Units)			
Date of Pressure Measurements	October 30, 2009	January 27, 2010	April 26 & 27, 2010
Adjusted Pressures for Mid-Depth of Horizontal Permeable Unit (kPa)	DGR-1: 3408.98 DGR-3: 3348.85 DGR-4: 3297.48	DGR-1: 3402.92 DGR-3: 3332.44 DGR-4: 3294.65	DGR-1: 3400.92 DGR-3: 3348.43 DGR-4: 3300.44
Equipotential Line (Azimuth)	231	221	232
Hydraulic Gradient (m/m)	0.0086	0.0084	0.0077
Groundwater Flow Direction (Azimuth)	321	311	322

Guelph Formation

Parameter (Units)			
Date of Pressure Measurements	October 30, 2009	January 27, 2010	April 26 & 27, 2010
Adjusted Pressures for Mid-Depth of Horizontal Permeable Unit (kPa)	DGR-1: 4066.82 DGR-3: 4103.91 DGR-4: 4060.99	DGR-1: 4036.28 DGR-3: 4079.44 DGR-4: 4058.17	DGR-1: 4036.69 DGR-3: 4071.78 DGR-4: 4056.72
Equipotential Line (Azimuth)	313	344	348
Hydraulic Gradient (m/m)	0.0039	0.0032	0.0026
Groundwater Flow Direction (Azimuth)	43	74	78

Cambrian Sandstone

Parameter (Units)			
Date of Pressure Measurements	December 8 & 9, 2009	January 27, 2010	April 26 & 27, 2010
Adjusted Pressures for Mid-Depth of Horizontal Permeable Unit (kPa)	DGR-2: 10990.64 DGR-3: 11015.98 DGR-4: 11010.58	unreliable data	DGR-2: 10984.09 DGR-3: 11022.60 DGR-4: 11012.38
Equipotential Line (Azimuth)	2	unreliable data	359
Hydraulic Gradient (m/m)	0.0020	unreliable data	0.0031
Groundwater Flow Direction (Azimuth)	92	unreliable data	89

9 Data Quality and Use

Formation pressures measured using MP55 casing systems and environmental heads calculated using a reference DGR porewater-groundwater density profile provide important data on the pressure and head distribution within DGR bedrock. Formation pressures and environmental heads for permeable intervals (i.e.., K $>10^{-12}$ m/s), are shown to reach equilibrium values within the several to many months of monitoring available for the DGR boreholes. The similarity between the MP55 pressure and heads and those reported from straddle-packer testing suggests that the formation pressures and heads determined from the pressure monitoring in permeable intervals are reliable and representative.

However, for the majority of the reported formation underpressures, the currently available MP55 data provide indications of what the actual equilibrium formation pressures may be, assuming such equilibria exist. In most instances the reported MP55 pressures in underpressured intervals are greater than those equilibrium pressures determined from straddle-packer testing and show temporal evolution of measured pressures toward those reported from hydraulic testing. The formation pressures from straddle-packer testing are values determined from analysis of the pressure transient data similar to values of formation hydraulic conductivity.

Based on the analyses of straddle packer tests it is possible to estimate the amount of time required for MP55 underpressures to reach equilibrium values. This is completed by computing the monitoring time to reach equilibrium pressures for hydraulic tests and then based on a comparative assessment of test interval compressibilities for hydraulic and MP55 test intervals, estimation of MP55 equilibrium times.

As illustrated in Figure 10, the actual time it would take to reach equilibrium formation pressures with the straddle-packer testing equipment is on the order of 1-2 years for a formation hydraulic conductivity of 9×10^{-15} m/s. Because the test interval compressibility of MP55 casing is likely an order or magnitude greater than the very stiff straddle-packer test equipment, the time to reach equilibrium formation pressures with the MP55 installations is on the order of 5-10 years.

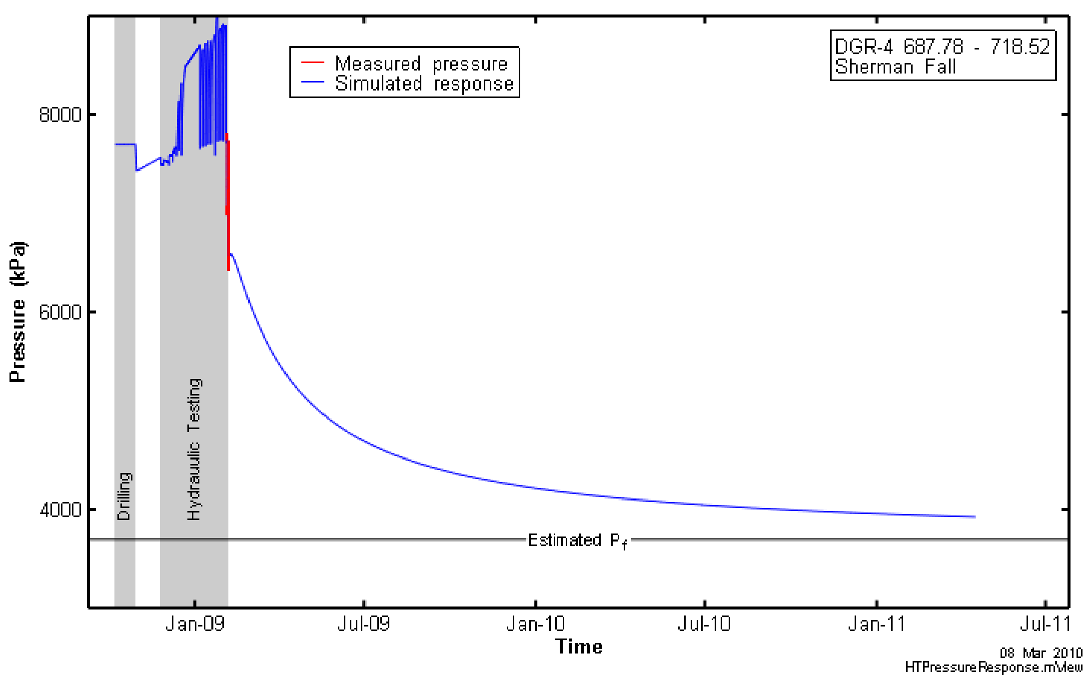

Figure 10 Calculated Time to Reach Equilibrium Formation Pressure with Straddle-Packer Testing Equipment, Sherman Fall Formation in DGR-4

Since pressure monitoring in the MP55 casing systems has only been undertaken for a maximum of approximately 2 years, the bulk of the data from these installations are overestimates of actual formation underpressures. Given these constraints, the best current estimates of formation underpressures are likely those determined from analysis of straddle-packer hydraulic tests.

Confidence in the reported groundwater flow directions and gradients in the permeable bedrock aquifers (Table 2) is moderate to high depending upon the aquifer considered. Confidence is based on the accuracy of formation pressure measurements and the accuracy in known depths and horizontal positions of the pressure measurement ports.

Groundwater flow directions and gradients within the Salina Upper A1 Unit and Guelph Formation are reported (Table 2) with moderate confidence based on similar transducer sensitivity of 0.07 kPa and accuracy of about 3 kPa and the observation that the differences in adjusted pressures between the DGR boreholes at ~ 100-110 kPa (Upper A1 Unit) and ~43 kPa (Guelph) are much greater than the accuracy or sensitivity of pressure measurement. Because the true borehole depths and horizontal positions are used in the calculation of groundwater flow directions in these aquifer units, the only uncertainty in measurement port position is that associated with stretch of MP55 casing. This uncertainty is estimated at a maximum of 10 cm given the depth of ports, which translates to a pressure uncertainty of 1.0 kPa. While these computations suggest high confidence in the accuracy of the calculated flow directions and gradients in these aquifers, moderate confidence is assigned based on the fact that formations pressures were recorded in the MP55 casings when one or both of boreholes DGR-5 and DGR-6 were open. Such open boreholes, especially in proximity to borehole DGR-1, could allow drainage from the Guelph aquifer to the Upper A1 Unit aquifer and potentially affect the measured pressures in these formations in DGR monitoring boreholes. Future pressure measurements to be obtained following sealing of boreholes DGR-5 and DGR-6 will allow for more accurate assessment of groundwater flow directions and gradients within these thin Silurian aquifers. Borehole DGR-5 was sealed on March 24-28, 2010 and borehole DGR-6 was sealed on July 12-19, 2010 (Geofirma Engineering Ltd., 2011e).

Groundwater flow directions and gradients within the Cambrian sandstone aquifer are reported (Table 2) with moderate confidence. Although the transducer sensitivity and accuracy are similar for pressure measurements in the Cambrian to those made in the Salina Upper A1 Unit and Guelph aquifers, the difference in adjusted pressures (25 -38 kPa) is less and the uncertainly in depth location of the measurement ports is greater at about 30 cm or 3 kPa.

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APPENDIX A

Summary of Westbay MP55 Monitoring Intervals in DGR Boreholes

Table A.1 Summary of Westbay MP55 Monitoring Intervals in DGR-1

Port No.	Measurement Port Elevation (mASL)	Measurement Port Elevation (mBGS)	Top of Zone (mASL)	Bottom of Zone (mASL)	Top of Zone (mBGS)	Bottom of Zone (mBGS)	Zone Length (m)	Bedrock Formation (length of interval)
1	-270.09	455.80	-268.54	-277.16	454.25	462.87	8.63	Queenston (8.63 m)
2	-265.49	451.20	-263.94	-267.49	449.65	453.20	3.55	Queenston (3.55 m)
3	-250.29	436.00	-248.74	-262.89	434.45	448.60	14.15	Cabot Head (0.35 m) + Manitoulin (12.85 m) + Queenston (0.95 m)
4	-238.19	423.90	-235.14	-247.69	420.85	433.40	12.55	Cabot Head (12.55 m)
5	-227.69	413.40	-224.64	-234.09	410.35	419.80	9.45	Fossill Hill (0.65 m) + Cabot Head (8.80 m)
6	-217.19	402.90	-214.14	-223.59	399.85	409.30	9.45	Gasport (4.40 m) + Lions Head (4.45 m) + Fossil Hill (0.60 m)
7	-199.09	384.80	-196.04	-213.09	381.75	398.80	17.05	Goat Island (15.65 m) + Gasport (1.40 m)
8	-188.39	374.10	-185.34	-194.99	371.05	380.70	9.65	Salina A0 Unit (3.45 m) + Guelph (4.10 m) + Goat Island (2.10 m)
9	-182.29	368.00	-179.24	-184.29	364.95	370.00	5.05	Salina A1 Carbonate (2.05 m) + Salina A1 Evaporite (3.00 m)
10	-168.69	354.40	-165.74	-178.19	351.45	363.90	12.45	Salina A1 Carbonate (12.45 m)
11	-158.29	344.00	-155.24	-164.69	340.95	350.40	9.45	Salina A1 Carbonate (9.45 m)
12	-147.69	333.40	-144.64	-154.19	330.35	339.90	9.55	Salina A1 Carbonate (9.55 m)
13	-133.89	319.60	-130.84	-143.59	316.55	329.30	12.75	Salina A2 Carbonate (3.15 m) + Salina A2 Evaporite (5.80 m) + Salina A1 Carbonate (3.80 m)
14	-119.39	305.10	-116.34	-129.79	302.05	315.50	13.45	Salina A2 Carbonate (13.45 m)
15	-103.39	289.10	-100.34	-115.29	286.05	301.00	14.95	Salina B Unit (7.05 m) + Salina A2 Carbonate (7.90 m)
16	-78.29	264.00	-75.24	-99.29	260.95	285.00	24.05	Salina B Unit (24.05 m)
17	-58.79	244.50	-55.74	-74.19	241.45	259.90	18.45	Salina E Unit (1.55 m) + Salina D Unit (1.60 m) + Salina C Unit (15.30 m)
18	-48.29	234.00	-45.24	-54.69	230.95	240.40	9.45	Salina E Unit (9.45 m)
19	-36.69	222.40	-33.64	-44.19	219.35	229.90	10.55	Salina F Unit (3.65 m) + Salina E Unit (6.90 m)
20	-26.19	211.90	-23.14	-32.59	208.85	218.30	9.45	Salina F Unit (9.45 m)
21	-12.59	198.30	-9.54	-22.09	195.25	207.80	12.55	Salina F Unit (12.55 m)
22	-6.59	192.30	-5.04	-8.48	190.75	194.20	3.45	Salina F Unit (3.45 m)
23**	84.91	100.80	86.87	-3.98	98.84	189.70	90.86	steel casing (83.46 m) + Salina F Unit (7.40 m)

Notes:

** = in steel casing

Total depth drilled in DGR-1 = 462.87 mBGS

DGR-1 ground surface elevation = 185.71 mASL

Steel casing set to approximately 182.3 mBGS

Table A.2 Summary of Westbay MP55 Monitoring Intervals in Old DGR-2 Installation (2007)

Port No.	Measurement Port Elevation (mASL)	Measurement Port Elevation (mBGS)	Top of Zone (mASL)	Bottom of Zone (mASL)	Top of Zone (mBGS)	Bottom of Zone (mBGS)	Zone Length (m)	Bedrock Formation (length of interval)
1*	-655.46	841.30	-654.60	-662.22	840.44	848.06	7.62	Shadow Lake (3.36 m) + Cambrian Sandstone (4.26 m)
2	-650.96	836.80	-650.20	-653.55	836.04	839.39	3.35	Gull River (2.56 m) + Shadow Lake (0.79 m)
3	-637.56	823.40	-636.80	-649.15	822.64	834.99	12.35	Gull River (12.35 m)
4	-625.66	811.50	-622.61	-635.75	808.45	821.59	13.15	Gull River (13.15 m)
5	-609.06	794.90	-606.01	-621.56	791.85	807.40	15.55	Gull River (15.55 m)
6	-589.56	775.40	-586.51	-604.96	772.35	790.80	18.45	Coboconk (12.65 m) + Gull River (5.80 m)
7	-578.76	764.60	-575.71	-585.46	761.55	771.30	9.75	Kirkfield (0.45 m) + Coboconk (9.30 m)
8	-562.16	748.00	-559.11	-574.66	744.95	760.50	15.55	Kirkfield (15.55 m)
9	-548.66	734.50	-545.61	-558.06	731.45	743.90	12.45	Kirkfield (12.45 m)
10	-530.56	716.40	-527.51	-544.56	713.35	730.40	17.05	Sherman Fall (2.75 m) + Kirkfield (14.30 m)
11	-507.96	693.80	-504.91	-526.46	690.75	712.30	21.55	Sherman Fall (21.55 m)
12	-494.46	680.30	-491.41	-503.86	677.25	689.70	12.45	Cobourg (10.85 m) + Sherman Fall (1.60 m)
13	-477.86	663.70	-474.81	-490.36	660.65	676.20	15.55	Cobourg (15.55 m)
14	-464.36	650.20	-461.31	-473.76	647.15	659.60	12.45	Blue Mountain (4.45 m) + Cobourg - Collingwood Member (7.90 m) + Cobourg (0.10 m)
15	-444.76	630.60	-441.71	-460.26	627.55	646.10	18.55	Blue Mountain (18.55 m)
16	-428.16	614.00	-425.11	-440.66	610.95	626.50	15.55	Blue Mountain (15.55 m)
17	-405.66	591.50	-402.61	-424.06	588.45	609.90	21.45	Georgian Bay (20.45 m) + Blue Mountain (1.00 m)
18	-398.06	583.90	-395.01	-401.56	580.85	587.40	6.55	Georgian Bay (6.55 m)
19	-374.06	559.90	-370.91	-393.96	556.75	579.80	23.05	Georgian Bay (23.05 m)
20	-354.46	540.30	-351.41	-369.86	537.25	555.70	18.45	Georgian Bay (18.45 m)
21	-334.86	520.70	-331.81	-350.36	517.65	536.20	18.55	Queenston (0.35 m) + Georgian Bay (18.20 m)
22	-313.86	499.70	-310.71	-330.76	496.55	516.60	20.05	Queenston (20.05 m)
23	-301.76	487.60	-298.71	-309.66	484.55	495.50	10.95	Queenston (10.95 m)
24	-294.26	480.10	-291.21	-297.66	477.05	483.50	6.45	Queenston (6.45 m)
25	-277.66	463.50	-274.61	-290.16	460.45	476.00	15.55	Queenston (15.55 m)
26**	-149.96	335.80	-146.40	-273.56	332.24	459.40	127.16	steel casing (118.46 m) + Queenston (8.70 m)
27**	-36.76	222.60	-33.30	-145.35	219.14	331.19	112.05	steel casing (112.05 m)
28**	79.34	106.50	82.80	-32.25	103.04	218.09	115.05	steel casing (115.05 m)

Notes:

* Production Injection Packer installed in bottom of borehole (top of element is at 848.06 mBGS)

** = in steel casing

Total depth drilled in DGR-2 = 862.12 mBGS

DGR-2 ground surface elevation = 185.84 mASL

Steel casing set to approximately 450.7 mBGS

Table A.3 Summary of Westbay MP55 Monitoring Intervals in New DGR-2 Installation (2009)

Port No.	Measurement Port Elevation (mASL)	Measurement Port Elevation (mBGS)	Top of Zone (mASL)	Bottom of Zone (mASL)	Top of Zone (mBGS)	Bottom of Zone (mBGS)	Zone Length (m)	Bedrock Formation (length of interval)
1*	-656.06	841.90	-655.30	-662.22	841.14	848.06	6.92	Shadow Lake (2.54 m) + Cambrian Sandstone (4.38 m)
2	-647.66	833.50	-646.80	-654.25	832.64	840.09	7.45	Gull River (5.96 m) + Shadow Lake (1.49 m)
3	-636.26	822.10	-635.40	-645.75	821.24	831.59	10.35	Gull River (10.35 m)
4	-618.36	804.20	-617.50	-634.35	803.34	820.19	16.85	Gull River (16.85 m)
5	-599.36	785.20	-598.60	-616.45	784.44	802.29	17.85	Coboconk (0.56 m) + Gull River (17.29 m)
6	-578.96	764.80	-578.10	-597.55	763.94	783.39	19.45	Coboconk (19.45 m)
7	-572.06	757.90	-569.01	-577.05	754.85	762.89	8.04	Kirkfield (7.15 m) + Coboconk (0.89 m)
8	-558.46	744.30	-555.41	-567.96	741.25	753.80	12.55	Kirkfield (12.55 m)
9	-541.96	727.80	-538.91	-554.36	724.75	740.20	15.45	Kirkfield (15.45 m)
10	-522.36	708.20	-519.31	-537.86	705.15	723.70	18.55	Sherman Fall (10.95 m) + Kirkfield (7.60 m)
11	-502.86	688.70	-499.81	-518.26	685.65	704.10	18.45	Cobourg (2.45 m) + Sherman Fall (16.00 m)
12	-489.26	675.10	-486.21	-498.76	672.05	684.60	12.55	Cobourg (12.55 m)
13	-475.76	661.60	-472.71	-485.16	658.55	671.00	12.45	Cobourg - Collingwood (0.95 m) + Cobourg (11.50 m)
14	-462.16	648.00	-459.11	-471.66	644.95	657.50	12.55	Blue Mountain (6.65) + Cobourg - Collingwood (5.90 m)
15	-442.66	628.50	-439.51	-458.06	625.35	643.90	18.55	Blue Mountain (18.55 m)
16	-423.06	608.90	-420.01	-438.46	605.85	624.30	18.45	Georgian Bay (3.05 m) + Blue Mountain (15.40 m)
17	-406.46	592.30	-402.90	-418.96	588.74	604.80	16.05	Georgian Bay (16.05 m)
18	-398.36	584.20	-394.70	-401.85	580.54	587.69	7.15	Georgian Bay (7.15 m)
19	-372.16	558.00	-369.11	-393.65	554.95	579.49	24.55	Georgian Bay (24.55 m)
20	-352.56	538.40	-349.51	-368.06	535.35	553.90	18.55	Georgian Bay (18.55 m)
21	-336.06	521.90	-333.01	-348.46	518.85	534.30	15.45	Georgian Bay (15.45 m)
22	-313.46	499.30	-310.41	-331.96	496.25	517.80	21.55	Queenston (21.55 m)
23	-293.86	479.70	-290.81	-309.36	476.65	495.20	18.55	Queenston (18.55 m)
24	-277.36	463.20	-274.31	-289.76	460.15	475.60	15.45	Queenston (15.45 m)
25	-155.76	341.60	-152.10	-273.26	337.94	459.10	121.16	steel casing (112.76 m) + Queenston (8.40 m)
26**	-42.56	228.40	-38.90	-151.05	224.74	336.89	112.15	steel casing (112.15 m)
27**	82.64	103.20	86.30	-37.85	99.54	223.69	124.15	steel casing (124.15 m)

Notes:

* Production Injection Packer installed in bottom of borehole (top of element is at 848.06 mBGS)

** = in steel casing

Total depth drilled in DGR-2 = 862.12 mBGS

DGR-2 ground surface elevation = 185.84 mASL

Steel casing set to approximately 450.7 mBGS

Prepared by: KER
Reviewed by: SEM
Date: 14-Apr-11
DGR-2 Summary_R0.xls

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Table A.4 Summary of Westbay MP55 Monitoring Intervals in DGR-3

Port No.	Measurement Port Elevation (mASL)	Measurement Port Elevation (mBGS)	Top of Zone (mASL)	Bottom of Zone (mASL)	Top of Zone (mBGS)	Bottom of Zone (mBGS)	Zone Length (m)	Bedrock Formation (length of interval)
1	-672.65	860.00	-671.79	-681.82	859.14	869.17	10.03	Cambrian Sandstone (10.03 m)
2	-659.65	847.00	-658.79	-670.74	846.14	858.09	11.95	Gull River (4.86 m) + Shadow Lake (4.50 m) + Cambrian (2.59 m)
3	-646.15	833.50	-645.29	-657.74	832.64	845.09	12.45	Gull River (12.45 m)
4	-627.15	814.50	-626.29	-644.24	813.64	831.59	17.95	Gull River (17.95 m)
5	-611.65	799.00	-610.79	-625.24	798.14	812.59	14.45	Coboconk (1.16 m) + Gull River (13.29 m)
6	-590.65	778.00	-589.79	-609.74	777.14	797.09	19.95	Coboconk (19.95 m)
7	-586.65	774.00	-583.60	-588.74	770.95	776.09	5.14	Kirkfield (4.65 m) + Coboconk (0.49 m)
8	-570.05	757.40	-567.00	-582.55	754.35	769.90	15.55	Kirkfield (15.55 m)
9	-553.55	740.90	-550.40	-565.95	737.75	753.30	15.55	Kirkfield (15.55 m)
10	-533.95	721.30	-530.90	-549.35	718.25	736.70	18.45	Sherman Fall (11.50 m) + Kirkfield (6.95 m)
11	-514.45	701.80	-511.30	-529.85	698.65	717.20	18.55	Cobourg (2.15 m) + Sherman Fall (16.40 m)
12	-503.35	690.70	-500.30	-510.25	687.65	697.60	9.95	Cobourg (9.95 m)
13	-489.85	677.20	-486.80	-499.25	674.15	686.60	12.45	Cobourg (12.45 m)
14	-474.75	662.10	-471.70	-485.75	659.05	673.10	14.05	Blue Mountain (5.25 m) + Cobourg - Collingwood Member (8.70 m) + Cobourg (0.10 m)
15	-459.75	647.10	-456.09	-470.65	643.44	658.00	14.55	Blue Mountain (14.55 m)
16	-442.55	629.90	-438.89	-455.04	626.24	642.39	16.15	Blue Mountain (16.15 m)
17	-411.85	599.20	-408.80	-437.84	596.15	625.19	29.05	Georgian Bay (23.96 m) + Blue Mountain (5.09 m)
18	-403.25	590.60	-400.20	-407.75	587.55	595.10	7.55	Georgian Bay (7.55 m)
19	-380.75	568.10	-377.70	-399.15	565.05	586.50	21.45	Georgian Bay (21.45 m)
20	-361.15	548.50	-358.10	-376.65	545.45	564.00	18.55	Georgian Bay (18.55 m)
21	-343.15	530.50	-340.10	-357.05	527.45	544.40	16.95	Queenston (3.95 m) + Georgian Bay (13.00 m)
22	-322.05	509.40	-319.00	-339.05	506.35	526.40	20.05	Queenston (20.05 m)
23	-301.05	488.40	-298.00	-317.95	485.35	505.30	19.95	Queenston (19.95 m)
24	-284.55	471.90	-281.40	-296.95	468.75	484.30	15.55	Queenston (15.55 m)
25	-273.95	461.30	-270.90	-280.35	458.25	467.70	9.45	Queenston (9.45 m)
26	-254.45	441.80	-251.40	-269.85	438.75	457.20	18.45	Cabot Head (8.75 m) + Manitoulin (9.50 m) + Queenston (0.20 m)
27	-244.35	431.70	-241.30	-250.35	428.65	437.70	9.05	Cabot Head (9.05 m)
28	-233.85	421.20	-230.80	-240.25	418.15	427.60	9.45	Lions Head (3.35 m) + Fossil Hill (1.30 m) + Cabot Head (4.80 m)
29	-223.25	410.60	-220.20	-229.75	407.55	417.10	9.55	Goat Island (2.95 m) + Gasport (6.50 m) + Lions Head (0.10 m)
30	-212.75	400.10	-209.70	-219.15	397.05	406.50	9.45	Goat Island (9.45 m)
31	-198.95	386.30	-195.90	-208.65	383.25	396.00	12.75	Salina A1 Evaporite (0.95 m) + Salina A0 Unit (2.58 m) + Guelph (5.42 m) + Goat Island (3.80 m)
32	-191.45	378.80	-188.40	-194.85	375.75	382.20	6.45	Salina A1 Carbonate (4.05 m) + Salina A1 Evaporite (2.40 m)
33	-162.85	350.20	-159.80	-187.35	347.15	374.70	27.55	Salina A1 Carbonate (27.55 m)
34	-152.15	339.50	-149.10	-158.75	336.45	346.10	9.65	Salina A2 Evaporite (2.15 m) + Salina A1 Carbonate (7.50 m)
35	-141.35	328.70	-138.30	-148.05	325.65	335.40	9.75	Salina A2 Carbonate (7.85 m) + Salina A2 Evaporite (1.90 m)
36	-131.35	318.70	-128.20	-137.25	315.55	324.60	9.05	Salina A2 Carbonate (9.05 m)
37	-118.25	305.60	-115.20	-127.15	302.55	314.50	11.95	Salina B Carbonate (0.46 m) + Salina B Evaporite (1.62 m) + Salina A2 Carbonate (9.87 m)
38	-91.25	278.60	-88.20	-114.15	275.55	301.50	25.95	Salina C Unit (2.35 m) + Salina B Carbonate (23.60 m)
39	-79.25	266.60	-76.20	-87.15	263.55	274.50	10.95	Salina D Unit (2.45 m) + Salina C Unit (8.50 m)
40	-68.65	256.00	-65.60	-75.15	252.95	262.50	9.55	Salina E Unit (9.55 m)
41	-53.65	241.00	-50.60	-64.55	237.95	251.90	13.95	Salina F Unit (1.65 m) + Salina E Unit (12.30 m)
42	-33.55	220.90	-30.50	-49.55	217.85	236.90	19.05	Salina F Unit (19.05 m)
43**	78.95	108.40	82.61	-29.45	104.74	216.80	112.06	steel casing (103.76 m) + Salina F Unit (8.30 m)

Notes:

** = in steel casing

Total depth drilled in DGR-3 = 869.17 mBGS

DGR-3 ground surface elevation = 187.35 mASL

Steel casing set to approximately 208.5 mBGS

Prepared by: KER
Reviewed by: SEM
Date: 14-Apr-11
DGR-3 Summary_R0.xls

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Table A.5 Summary of Westbay MP55 Monitoring Intervals in DGR-4

Port No.	Measurement Port Elevation (mASL)	Measurement Port Depth (mBGS)	Top of Zone (mASL)	Bottom of Zone (mASL)	Top of Zone (mBGS)	Bottom of Zone (mBGS)	Zone Length (m)	Bedrock Formation (length of interval)
1*	-665.90	847.50	-665.04	-672.08	846.64	853.68	7.04	Cambrian Sandstone (7.04 m)
2	-652.90	834.50	-652.04	-663.99	833.64	845.59	11.95	Gull River (5.36 m) + Shadow Lake (5.10 m) + Cambrian (1.49 m)
3	-639.40	821.00	-638.54	-650.99	820.14	832.59	12.45	Gull River (12.45 m)
4	-620.40	802.00	-619.54	-637.49	801.14	819.09	17.95	Gull River (17.95 m)
5	-605.60	787.20	-604.04	-618.49	785.64	800.09	14.45	Coboconk (1.16 m) + Gull River (13.29 m)
6	-583.90	765.50	-583.04	-602.99	764.64	784.59	19.95	Coboconk (19.95 m)
7	-579.90	761.50	-576.85	-581.99	758.45	763.59	5.14	Kirkfield (4.55 m) + Coboconk (0.59 m)
8	-566.30	747.90	-563.25	-575.80	744.85	757.40	12.55	Kirkfield (12.55 m)
9	-549.80	731.40	-546.75	-562.20	728.35	743.80	15.45	Kirkfield (15.45 m)
10	-530.30	711.90	-527.25	-545.70	708.85	727.30	18.45	Sherman Fall (8.45 m) + Kirkfield (10.0 m)
11	-510.70	692.30	-507.65	-526.20	689.25	707.80	18.55	Sherman Fall (18.55 m)
12	-497.70	679.30	-494.65	-506.60	676.25	688.20	11.95	Cobourg (11.95 m)
13	-482.70	664.30	-479.65	-493.60	661.25	675.20	13.95	Cobourg - Collingwood Member (0.25 m) + Cobourg (13.70 m)
14	-469.10	650.70	-466.05	-478.60	647.65	660.20	12.55	Blue Mountain (5.45 m) + Cobourg - Collingwood Member (7.10 m)
15	-449.60	631.20	-446.55	-465.00	628.15	646.60	18.45	Blue Mountain (18.45 m)
16	-427.00	608.60	-424.94	-445.50	606.54	627.10	20.55	Georgian Bay (1.46 m) + Blue Mountain (19.09 m)
17	-402.40	584.00	-400.24	-423.89	581.84	605.49	23.65	Georgian Bay (23.65 m)
18	-394.70	576.30	-391.65	-399.19	573.25	580.79	7.54	Georgian Bay (7.54 m)
19	-372.20	553.80	-369.15	-390.60	550.75	572.20	21.45	Georgian Bay (21.45 m)
20	-352.60	534.20	-349.55	-368.10	531.15	549.70	18.55	Georgian Bay (18.55 m)
21	-334.60	516.20	-331.55	-348.50	513.15	530.10	16.95	Queenston (6.15 m) + Georgian Bay (10.80 m)
22	-313.60	495.20	-310.55	-330.50	492.15	512.10	19.95	Queenston (19.95 m)
23	-292.60	474.20	-289.55	-309.50	471.15	491.10	19.95	Queenston (19.95 m)
24	-276.00	457.60	-272.95	-288.50	454.55	470.10	15.55	Queenston (15.55 m)
25	-265.50	447.10	-262.45	-271.90	444.05	453.50	9.45	Manitoulin (2.25 m) + Queenston (7.20 m)
26	-246.00	427.60	-242.95	-261.40	424.55	443.00	18.45	Cabot Head (11.15 m) + Manitoulin (7.30 m)
27	-235.90	417.50	-232.85	-241.90	414.45	423.50	9.05	Cabot Head (9.05 m)
28	-225.40	407.00	-222.35	-231.80	403.95	413.40	9.45	Gasport (1.65 m) + Lions Head (4.40 m) + Fossil Hill (1.50 m) + Cabot Head (1.90 m)
29	-208.90	390.50	-205.85	-221.30	387.45	402.90	15.45	Goat Island (11.65 m) + Gasport (3.80 m)
30	-195.10	376.70	-192.05	-204.80	373.65	386.40	12.75	Salina A0 Unit (1.95 m) + Guelph (4.90 m) + Goat Island (5.90 m)
31	-184.60	366.20	-181.55	-191.00	363.15	372.60	9.45	Salina A1 Carbonate (3.65 m) + Salina A1 Evaporite (5.00 m) + Salina A0 Unit (0.80 m)
32	-174.10	355.70	-171.05	-180.50	352.65	362.10	9.45	Salina A1 Carbonate (9.45 m)
33	-154.60	336.20	-151.55	-170.00	333.15	351.60	18.45	Salina A1 Carbonate (18.45 m)
34	-143.80	325.40	-140.75	-150.50	322.35	332.10	9.75	Salina A2 Evaporite (3.75 m) + Salina A1 Carbonate (6.00 m)
35	-127.10	308.70	-124.05	-139.70	305.65	321.30	15.65	Salina A2 Carbonate (15.25 m) + Salina A2 Evaporite (0.40 m)
36	-112.50	294.10	-109.45	-123.00	291.05	304.60	13.55	Salina B Evaporite (1.45 m) + Salina A2 Carbonate (12.10 m)
37	-93.50	275.10	-90.45	-108.40	272.05	290.00	17.95	Salina B Carbonate (17.95 m)
38	-68.00	249.60	-64.95	-89.40	246.55	271.00	24.45	Salina D Unit (0.75 m) + Salina C Unit (14.70 m) + Salina B Carbonate (9.00 m)
39	-62.00	243.60	-60.45	-63.90	242.05	245.50	3.45	Salina E Unit (3.45 m)
40	-51.40	233.00	-49.85	-59.40	231.45	241.00	9.55	Salina E Unit (9.55 m)
41	-36.40	218.00	-34.85	-48.80	216.45	230.40	13.95	Salina F Unit (4.55 m) + Salina E Unit (9.40 m)
42	-14.40	196.00	-12.85	-33.80	194.45	215.40	20.95	Salina F Unit (20.95 m)
43**	96.60	85.00	100.16	-11.80	81.44	193.40	111.96	steel casing (107.26 m) + Salina F Unit (4.70 m)

Notes:

* Production Injection Packer installed in bottom of borehole (top of element is at 853.68 mBGS)

** = in steel casing

Total depth drilled in DGR-4 = 856.98 mBGS

DGR-4 ground surface elevation = 181.60 mASL

Steel casing set to approximately 188.7 mBGS

APPENDIX B

Summary of Westbay MP55 Pressure Measurements from DGR-1 to DGR-4

Table B.1 Summary of Westbay MP55 Pressure Measurements from DGR-1 (2007 data)

Port (Zone) No.	Port Depth (Dp) (nominal, m)	Post-Inflation (25-Sep-2007) Absolute Pressure (MPa)	Post-Inflation (25-Sep-2007) Environmental Head (m)	7-Nov-2007 (Δ 1.5 months) Absolute Pressure (MPa)	7-Nov-2007 (Δ 1.5 months) Environmental Head (m)	12-Dec-2007 (Δ 2.5 months) Absolute Pressure (MPa)	12-Dec-2007 (Δ 2.5 months) Environmental Head (m)	13-Dec-2007 (Δ 2.5 months) Absolute Pressure (MPa)	13-Dec-2007 (Δ 2.5 months) Environmental Head (m)
1	455.8	4.71	170.07	4.62	161.11	4.69	168.27	4.68	167.20
2	451.2	4.58	162.32	4.56	160.60	4.63	167.62	4.59	163.59
3	436.0	4.52	174.92	4.67	190.23	4.75	197.70	4.74	197.13
4	423.9	4.42	178.91	4.58	194.85	4.65	202.41	4.64	201.37
5	413.4	4.34	182.79	4.59	208.08	4.83	232.27	4.81	230.51
6	402.9	4.59	220.65	4.75	237.17	4.98	260.17	4.95	257.75
7	384.8	3.94	175.16	4.30	212.61	4.69	252.14	4.66	248.81
8	374.1	3.96	190.66	3.96	190.60	3.96	190.77	3.96	190.79
9	368.0	4.08	210.18	4.46	248.14	4.67	269.85	4.67	269.93
10	354.4	3.40	155.40	3.58	173.71	3.67	182.72	3.67	182.69
11	344.0	3.53	179.33	3.53	179.46	3.54	180.76	3.54	180.83
12	333.4	3.40	177.39	3.40	177.34	3.42	179.27	3.42	179.25
13	319.6	3.30	181.30	3.30	181.34	3.30	181.37	3.30	181.39
14	305.1	3.12	178.09	3.10	176.63	3.11	177.60	3.11	177.42
15	289.1	2.90	173.21	2.91	174.15	2.89	172.43	2.89	172.38
16	264.0	2.54	166.03	2.64	176.69	2.62	174.49	2.62	174.46
17	244.5	2.42	176.52	2.46	180.11	2.42	176.17	2.42	176.09
18	234.0	2.24	169.20	2.37	182.71	2.31	176.02	2.31	176.21
19	222.4	2.02	158.31	2.26	183.40	2.18	175.45	2.19	175.75
20	211.9	1.94	161.73	2.13	181.06	2.07	175.05	2.08	175.44
21	198.3	1.83	163.62	2.01	182.53	1.94	175.10	1.95	175.82
22	192.3	1.84	170.99	1.95	182.76	1.93	180.01	1.91	178.59
23	100.8	1.04	180.97	1.04	181.05	1.04	181.55	1.04	181.47

Table B.1 Summary of Westbay MP55 Pressure Measurements from DGR-1 continued (2008 data)

Port (Zone) No.	Port Depth (Dp) (nominal, m)	24-Jan-2008 (Δ 4 months) Absolute Pressure (MPa)	24-Jan-2008 (Δ 4 months) Environmental Head (m)	27-Feb-2008 (Δ 5 months) Absolute Pressure (MPa)	27-Feb-2008 (Δ 5 months) Environmental Head (m)	23-May-2008 (Δ 8 months) Absolute Pressure (MPa)	23-May-2008 (Δ 8 months) Environmental Head (m)	19-Sep-2008 (Δ 12 months) Absolute Pressure (MPa)	19-Sep-2008 (Δ 12 months) Environmental Head (m)	8-Dec-2008 (Δ 14.5 months) Absolute Pressure (MPa)	8-Dec-2008 (Δ 14.5 months) Environmental Head (m)
1	455.8	4.64	162.89	4.62	161.07	4.62	160.92	4.62	161.12	4.67	166.52
2	451.2	4.57	161.31	4.57	161.45	4.57	161.45	4.57	161.72	4.59	162.81
3	436.0	4.79	202.27	4.81	203.64	4.82	205.14	4.86	209.20	4.87	209.69
4	423.9	4.52	188.49	4.51	187.36	4.46	182.13	4.49	185.17	4.57	193.50
5	413.4	4.86	236.20	4.88	238.15	4.84	233.97	4.98	248.13	5.07	257.12
6	402.9	4.90	252.55	4.90	252.20	4.97	259.11	4.94	256.50	5.00	262.08
7	384.8	4.56	239.08	4.55	237.54	4.67	249.55	4.63	246.23	4.67	250.52
8	374.1	3.95	189.68	3.96	190.45	3.96	190.79	3.96	190.10	3.96	190.86
9	368.0	4.71	274.03	4.73	276.63	4.79	282.70	4.84	287.83	4.88	291.46
10	354.4	3.68	183.71	3.68	183.87	3.69	184.85	3.69	184.30	3.69	185.10
11	344.0	3.55	181.66	3.55	181.76	3.56	182.48	3.55	181.46	3.56	182.16
12	333.4	3.42	179.47	3.42	179.88	3.43	180.94	3.42	179.80	3.43	179.99
13	319.6	3.30	181.44	3.30	181.46	3.30	181.90	3.31	182.37	3.31	182.21
14	305.1	3.11	177.23	3.11	177.20	3.11	177.54	3.11	177.49	3.11	177.68
15	289.1	2.90	173.60	2.90	173.61	2.90	172.99	2.90	173.66	2.90	173.68
16	264.0	2.63	175.60	2.64	176.08	2.63	175.55	2.67	179.08	2.66	178.65
17	244.5	2.44	178.72	2.45	179.89	2.44	178.51	2.47	181.26	2.47	181.79
18	234.0	2.33	178.68	2.35	179.80	2.33	178.29	2.35	180.59	2.35	180.02
19	222.4	2.21	178.12	2.22	179.30	2.19	176.40	2.21	178.23	2.20	177.04
20	211.9	2.14	181.31	2.13	180.36	2.10	177.64	2.13	181.16	2.11	178.82
21	198.3	2.00	181.16	2.00	181.56	1.98	179.04	1.99	180.83	1.99	180.35
22	192.3	1.94	181.05	1.95	182.84	1.95	182.29	1.96	183.11	1.95	182.18
23	100.8	1.04	181.52	1.04	180.70	1.04	181.71	1.04	181.77	1.04	181.65

Table B.1 Summary of Westbay MP55 Pressure Measurements from DGR-1 continued (2009 and 2010 data)

Port (Zone) No.	Port Depth (Dp) (nominal, m)	28-Mar-2009 (Δ 18 months) Absolute Pressure (MPa)	28-Mar-2009 (Δ 18 months) Environmental Head (m)	22-Aug-2009 (Δ 23 months) Absolute Pressure (MPa)	22-Aug-2009 (Δ 23 months) Environmental Head (m)	15-Oct-2009 (Δ 25 months) Absolute Pressure (MPa)	15-Oct-2009 (Δ 25 months) Environmental Head (m)	23-Feb-2010 (Δ 29 months) Absolute Pressure (MPa)	23-Feb-2010 (Δ 29 months) Environmental Head (m)
1	455.8	4.67	166.27	4.68	167.23	4.68	167.03	4.70	169.42
2	451.2	4.55	159.43	4.57	160.93	4.60	163.82	4.61	165.12
3	436.0	4.88	211.55	4.88	211.35	4.88	211.54	4.87	210.55
4	423.9	4.59	195.73	4.59	196.13	4.58	195.23	4.59	195.92
5	413.4	5.11	261.05	5.13	263.03	5.13	263.31	5.15	265.70
6	402.9	5.02	264.61	5.01	263.94	5.03	265.76	5.02	264.93
7	384.8	4.73	256.49	4.75	257.72	4.73	256.00	4.74	256.70
8	374.1	3.96	190.73	3.97	191.60	3.98	192.45	3.97	191.60
9	368.0	4.90	293.50	4.92	295.66	4.93	296.27	4.94	297.49
10	354.4	3.69	184.96	3.69	184.49	3.70	186.08	3.72	187.64
11	344.0	3.56	182.59	3.56	182.71	3.58	184.06	3.59	185.88
12	333.4	3.43	180.35	3.43	180.91	3.45	182.45	3.47	184.35
13	319.6	3.31	182.21	3.31	182.59	3.32	183.86	3.31	182.62
14	305.1	3.11	177.47	3.12	178.40	3.12	178.22	3.12	178.87
15	289.1	2.89	172.27	2.89	172.07	2.89	172.02	2.89	172.15
16	264.0	2.63	174.99	2.62	174.02	2.62	174.11	2.62	173.96
17	244.5	2.44	178.07	2.42	176.41	2.42	176.51	2.43	176.99
18	234.0	2.32	176.98	2.30	175.51	2.31	176.00	2.30	175.06
19	222.4	2.19	176.04	2.18	174.83	2.18	175.39	2.18	174.89
20	211.9	2.09	176.59	2.08	175.43	2.08	175.72	2.08	175.26
21	198.3	1.96	177.57	1.95	175.85	1.95	176.45	1.95	176.39
22	192.3	1.92	179.37	1.90	177.52	1.92	179.30	1.94	181.69
23	100.8	1.04	180.79	1.04	181.51	1.04	181.55	1.04	180.67

Table B.2. Summary of Westbay MP55 Pressure Measurements
Old DGR-2 Installation (December 2007)

Port (Zone) No.	Port Depth (Dp) (nominal, m)	Post- Inflation (11-Dec-2007) Absolute Pressure (MPa)	Post- Inflation (11-Dec-2007) Environmental Head (m)	23-Jan-2008 (Δ 1.5 mo) Absolute Pressure (MPa)	23-Jan-2008 (Δ 1.5 mo) Environmental Head (m)	25-Feb-2008 (Δ 2.5 mo) Absolute Pressure (MPa)	25-Feb-2008 (Δ 2.5 mo) Environmental Head (m)	3-Mar-2008 (Δ 2 mo) Absolute Pressure (MPa)	3-Mar-2008 (Δ 2 mo) Environmental Head (m)	7-Apr-2009 (Δ 15 mo) Absolute Pressure (MPa)	7-Apr-2009 (Δ 15 mo) Environmental Head (m)
1	841.3	10.84	349.72	10.88	353.53	10.89	354.12	10.89	354.14	10.89	354.67
2	836.8	10.62	332.19	8.45	110.41	9.93	276.02	10.27	296.40	10.71	340.70
3	823.4	10.33	317.00	8.51	131.39	10.07	303.73	10.21	305.37	10.54	339.12
4	811.5	10.04	300.54	10.01	297.65	9.11	225.16	10.07	304.01	10.09	306.47
5	794.9	9.20	233.52	9.12	225.54	8.89	223.78	9.12	225.28	9.10	223.66
6	775.4	8.97	232.69	8.87	222.26	7.59	103.80	8.89	223.99	8.88	222.79
7	764.6	7.79	124.20	7.67	111.99	7.20	82.69	7.57	101.95	7.58	103.29
8	748.0	7.49	112.43	7.26	88.99	6.99	77.17	7.30	92.94	6.12	-27.08
9	734.5	7.42	121.02	7.16	94.75	6.38	35.67	7.05	83.61	6.09	-15.25
10	716.4	7.23	121.55	6.66	63.44	6.17	39.97	6.37	34.70	5.44	-60.85
11	693.8	6.98	122.65	6.48	71.67	6.37	75.98	6.14	37.30	5.18	-61.02
12	680.3	6.81	121.39	6.46	85.00	6.44	102.54	6.49	88.06	5.80	18.32
13	663.7	6.66	125.16	6.46	104.77	5.96	69.04	6.55	113.64	6.29	87.34
14	650.2	6.48	122.20	6.05	78.52	4.69	-37.53	6.24	97.25	5.01	-27.69
15	630.6	6.24	121.04	5.11	5.16	4.41	-46.06	5.44	38.82	5.23	17.58
16	614.0	6.04	120.19	4.89	2.18	4.80	19.55	4.54	-33.03	4.63	-24.18
17	591.5	5.95	136.99	5.29	69.75	6.67	219.53	4.69	8.73	4.37	-23.92
18	583.9	6.55	207.63	6.69	221.80	4.13	-11.54	6.66	218.85	5.40	89.87
19	559.9	5.72	150.63	4.57	33.31	4.00	-1.58	4.07	-17.54	5.12	89.68
20	540.3	5.39	139.85	4.44	43.72	4.19	41.08	3.94	-7.23	4.38	36.85
21	520.7	5.21	144.57	4.52	74.49	4.17	63.80	4.16	37.45	3.36	-43.83
22	499.7	5.06	154.21	4.47	94.16	4.65	126.58	4.15	61.89	3.25	-29.87
23	487.6	5.09	171.50	4.79	141.09	4.81	152.05	4.67	129.14	3.82	42.30
24	480.1	5.02	173.16	4.90	160.83	4.58	147.98	4.78	148.82	4.61	131.42
25	463.5	4.95	185.86	4.68	158.56	3.82	214.79	4.56	146.17	n/a	n/a
26	335.8	3.84	216.71	3.83	215.53	2.71	226.61	3.82	214.55	n/a	n/a
27	222.6	2.63	218.52	2.67	222.72	1.53	225.60	2.72	227.09	n/a	n/a
28	106.5	1.36	207.55	1.49	221.44	n/a	n/a	1.53	225.54	n/a	n/a

Table B.3. Summary of Westbay MP55 Pressure Measurements New DGR-2 Installation (November 2009)

Port (Zone) No.	Port Depth (Dp) (nominal, m)	Post-Inflation (3-Dec-2009) Absolute Pressure (MPa)	Post-Inflation (3-Dec-2009) Environmental Head (m)	23-Feb-2010 (Δ 1.75 mo) Absolute Pressure (MPa)	23-Feb-2010 (Δ 1.75 mo) Environmental Head (m)
1	841.9	10.84	348.82	10.89	353.63
2	833.5	10.53	327.02	10.59	332.22
3	822.1	10.34	319.77	10.30	315.50
4	804.2	9.95	299.89	9.92	296.98
5	785.2	9.65	290.46	9.10	234.03
6	764.8	8.96	243.32	8.79	226.57
7	757.9	7.35	87.62	6.91	42.63
8	744.3	7.25	92.42	6.94	60.87
9	727.8	7.09	95.13	6.60	45.01
10	708.2	6.86	93.78	6.63	70.73
11	688.7	6.70	100.03	6.04	32.59
12	675.1	6.53	98.73	6.00	44.12
13	661.6	6.42	103.21	6.05	64.91
14	648.0	6.20	96.22	5.50	24.36
15	628.5	6.09	108.12	4.79	-24.44
16	608.9	6.06	127.62	5.09	28.50
17	592.3	6.97	240.09	4.75	13.28
18	584.2	6.84	236.80	6.80	231.93
19	558.0	5.63	143.95	4.44	22.77
20	538.4	5.41	144.90	4.28	29.46
21	521.9	5.15	137.80	4.39	60.18
22	499.3	5.02	151.13	4.26	73.13
23	479.7	4.88	159.90	4.68	139.37
24	463.2	4.89	180.04	4.63	153.34
25	341.6	4.20	247.54	4.13	239.71
26	228.4	2.91	240.33	2.91	240.50
27	103.2	1.46	221.30	1.74	249.52

Table B.4 Summary of Westbay MP55 Pressure Measurements from DGR-3

Port (Zone) No.	Port Depth (Dp) (nominal, m)	Post-Inflation (30-Sep-2009) Absolute Pressure (MPa)	Post-Inflation (30-Sep-2009) Environmental Head (m)	16-Nov-2009 (Δ 1.5 mo) Absolute Pressure (MPa)	16-Nov-2009 (Δ 1.5 mo) Environmental Head (m)	3-Mar-2010 (Δ 5 mo) Absolute Pressure (MPa)	3-Mar-2010 (Δ 5 mo) Environmental Head (m)
1	860.0	11.05	354.08	11.07	356.29	11.07	356.81
2	847.0	10.29	291.21	10.84	347.95	10.51	313.92
3	833.5	9.63	239.04	9.99	276.33	9.96	272.94
4	814.5	8.94	189.93	9.83	280.73	9.95	292.85
5	799.0	9.49	263.53	9.54	268.94	9.30	243.77
6	778.0	9.02	239.28	8.92	229.82	8.77	214.64
7	774.0	8.93	234.56	8.09	149.32	7.60	99.83
8	757.4	8.84	244.84	7.86	144.53	7.42	99.98
9	740.9	7.79	156.66	7.64	141.11	7.24	100.23
10	721.3	8.30	230.71	6.86	84.12	6.98	95.84
11	701.8	7.05	125.94	6.30	49.55	6.14	32.97
12	690.7	6.83	116.65	6.24	56.04	6.20	51.68
13	677.2	6.67	115.73	6.15	63.11	6.12	59.30
14	662.1	7.22	189.56	6.01	65.70	5.98	62.88
15	647.1	7.75	261.02	5.94	76.15	4.86	-33.77
16	629.9	7.36	241.47	6.79	183.18	5.89	91.23
17	599.2	6.38	176.90	5.82	120.64	5.18	55.15
18	590.6	5.76	123.79	4.95	41.48	4.85	31.12
19	568.1	5.63	136.96	4.85	58.07	4.06	-22.52
20	548.5	5.47	144.01	4.80	76.11	4.35	29.90
21	530.5	5.27	144.63	4.78	95.62	4.19	35.37
22	509.4	5.12	154.28	4.66	107.44	4.12	52.25
23	488.4	5.00	166.73	4.89	156.43	4.72	138.84
24	471.9	4.86	172.27	5.03	189.25	4.91	177.73
25	461.3	4.71	169.07	4.70	168.45	4.46	461.30
26	441.8	4.67	188.98	4.84	205.52	4.97	218.89
27	431.7	4.45	178.43	4.66	199.72	4.85	218.77
28	421.2	5.00	246.21	5.12	258.62	5.08	255.07
29	410.6	4.33	191.01	4.86	244.36	4.77	410.60
30	400.1	4.17	186.32	4.36	206.16	4.28	198.20
31	386.3	4.23	209.20	4.15	201.24	4.13	199.48
32	378.8	3.92	186.80	4.04	198.74	4.14	208.94
33	350.2	3.52	175.85	3.50	174.09	3.48	172.34
34	339.5	3.43	178.07	3.42	177.08	3.44	178.76
35	328.7	3.37	183.63	3.34	180.56	3.33	179.23
36	318.7	3.36	193.19	3.24	180.76	3.20	176.51
37	305.6	3.14	183.93	3.10	179.90	3.08	178.14
38	278.6	2.85	185.88	2.60	160.53	2.44	144.64
39	266.6	2.72	187.06	2.52	166.83	2.50	164.08
40	256.0	2.57	182.70	2.42	167.45	2.41	166.05
41	241.0	2.44	185.26	2.52	193.23	2.61	201.95
42	220.9	2.24	184.99	2.41	202.25	2.42	202.27
43	108.4	1.09	0.00	1.32	0.00	1.33	0.00

Table B.5 Summary of Westbay MP55 Pressure Measurements from DGR-4

Port (Zone) No.	Port Depth (Dp) (nominal, m)	Post-Inflation (28-Apr-09) Absolute Pressure (MPa)	Post-Inflation (28-Apr-09) Environmental Head (m)	6-Jun-2009 (Δ 1.25 mo) Absolute Pressure (MPa)	6-Jun-2009 (Δ 1.25 mo) Environmental Head (m)	24-Aug-2009 (Δ 4 mo) Absolute Pressure (MPa)	24-Aug-2009 (Δ 4 mo) Environmental Head (m)	15-Nov-2009 (Δ 6.75 mo) Absolute Pressure (MPa)	15-Nov-2009 (Δ 6.75 mo) Environmental Head (m)	25-Feb-2010 (Δ 10 mo) Absolute Pressure (MPa)	25-Feb-2010 (Δ 10 mo) Environmental Head (m)
1	847.5	10.48	301.90	10.96	350.40	10.77	331.32	10.78	332.92	10.83	337.97
2	834.5	NA	NA	10.76	345.26	10.79	348.58	10.83	352.44	10.58	326.87
3	821.0	NA	NA	10.18	301.22	8.74	154.06	10.45	328.09	10.24	307.30
4	802.0	NA	NA	9.99	302.55	9.74	277.43	10.00	303.52	9.83	286.48
5	787.2	8.31	147.61	8.71	188.10	8.85	202.57	8.90	207.92	8.45	162.44
6	765.5	8.89	231.72	8.87	229.59	8.01	141.84	8.87	230.30	8.45	187.47
7	761.5	8.05	150.34	7.78	122.71	7.52	96.33	7.17	60.92	7.46	90.33
8	747.9	8.82	244.27	7.73	133.05	7.13	72.76	7.12	71.15	7.27	86.64
9	731.4	7.58	136.48	7.44	122.93	6.95	72.94	6.94	72.17	7.12	89.92
10	711.9	7.19	118.99	6.72	71.44	6.30	28.22	6.15	13.78	6.24	22.14
11	692.3	6.98	120.27	6.52	73.33	6.39	60.89	6.36	57.79	6.41	62.29
12	679.3	6.85	121.81	6.46	82.62	6.32	68.65	6.46	82.33	6.56	93.36
13	664.3	6.71	125.63	6.42	96.52	6.11	65.06	5.96	49.43	5.95	48.50
14	650.7	6.53	122.27	5.98	66.70	5.71	39.78	5.56	24.18	5.64	32.30
15	631.2	6.35	127.46	5.00	-10.06	4.05	-107.48	4.00	-111.96	4.29	-82.34
16	608.6	6.85	205.13	5.23	39.41	4.34	-50.70	3.75	-111.54	4.05	-80.67
17	584.0	6.64	212.33	6.26	173.65	5.47	93.66	4.94	39.37	4.43	-12.31
18	576.3	5.72	127.27	4.51	4.03	3.73	-75.48	3.73	-75.61	3.80	-67.87
19	553.8	5.55	136.53	4.39	18.40	3.49	-73.25	3.50	-72.07	3.21	-101.71
20	534.2	5.32	136.47	4.26	28.16	3.42	-56.90	3.55	-43.96	3.16	-83.27
21	516.2	5.19	144.43	4.45	68.70	3.74	-3.55	3.34	-44.41	3.08	-71.09
22	495.2	5.07	156.97	4.52	101.27	3.97	45.08	3.61	8.02	3.72	19.72
23	474.2	4.92	166.44	4.56	130.01	4.26	98.78	4.16	88.48	4.18	91.03
24	457.6	4.79	172.04	4.55	148.39	4.37	130.41	4.29	121.26	4.32	124.66
25	447.1	4.74	179.34	4.88	193.97	4.95	201.17	4.98	204.05	4.99	205.51
26	427.6	4.45	173.49	4.43	171.78	4.41	169.20	4.44	173.22	4.42	170.97
27	417.5	4.41	180.89	4.54	194.22	4.64	204.71	4.65	205.84	4.52	192.52
28	407.0	4.66	219.44	5.02	255.68	5.08	262.07	5.10	264.22	5.06	260.59
29	390.5	4.12	183.61	4.39	211.18	4.43	215.68	4.46	218.19	4.30	202.25
30	376.7	4.14	201.48	4.07	195.09	4.08	195.56	4.08	195.57	4.07	195.33
31	366.2	3.82	181.61	3.97	197.32	4.15	215.68	4.25	225.61	4.11	211.15
32	355.7	3.68	178.77	3.82	192.75	4.04	215.90	4.22	234.13	3.62	172.92
33	336.2	3.41	171.65	3.39	169.80	3.39	169.76	3.38	169.31	3.33	164.17
34	325.4	3.31	173.26	3.30	172.29	3.30	172.09	3.31	173.02	3.30	172.53
35	308.7	3.28	187.43	3.19	178.41	3.17	176.89	3.16	175.86	3.16	175.03
36	294.1	3.07	181.95	2.97	171.80	2.96	170.82	2.95	169.85	2.94	168.54
37	275.1	2.85	180.94	2.46	141.15	2.30	125.13	2.24	119.25	2.30	124.81
38	249.6	2.57	182.28	2.18	142.38	2.02	126.46	1.96	119.87	1.95	118.69
39	243.6	2.51	182.80	2.18	149.04	2.14	145.27	2.15	146.57	2.33	164.43
40	233.0	2.39	181.58	2.16	157.94	2.11	152.90	2.12	153.59	2.23	165.05
41	218.0	2.26	183.55	2.13	170.80	2.09	166.43	2.07	164.47	2.11	168.84
42	196.0	2.05	185.14	2.05	185.04	2.03	182.68	2.00	179.74	1.95	174.89
43	85.0	0.89	177.74	1.20	208.69	1.20	209.47	1.18	206.76	1.15	203.50

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