KEPPEL QUARRY

2016 Adaptive Management Plan Compliance Monitoring Report

Project Location:
Proposed New Keppel Quarry
Harold Sutherland Construction
Part Lots 26, 27 and 28
Concession 10, Township of Georgian Bluffs
Grey County, Ontario

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1.0 INTRODUCTION

MTE Consultants Inc. (MTE) was retained by Harold Sutherland Construction Ltd. (HSCL) to complete an annual monitoring report to comply with the Adaptive Management Plan (AMP) dated April 10, 2015 and the approved Aggregate Resources Act (ARA) Site Plans dated December 11, 2014 for the Keppel Quarry (ARA License Number 609501). The approved ARA Site Plans are found in **Appendix A**. The AMP, including monitor locations, triggers, and actions are summarized on page 5 of the Site Plans.

The Keppel Quarry also operates under: Permit to Take Water (PTTW, Number 4028-8RCKTY); Environmental Compliance Approval (ECA, Number 3515-8M4PWM); and Niagara Escarpment Development Permit (NEC, Number 6468/G/E/2011-2012/9072). These permits are found in **Appendix B**. An application for a new PTTW was submitted in 2016 to permit dewatering in Area 1b, which is undergoing technical review.

As per the AMP, the monitoring program is intended to minimize potential impacts on water resources, ecological features and monitor the effects of blasting to ensure that proposed mitigation measures are sufficient. There are three components to the monitoring program:

1. Water Resources Monitoring (including Private Well Monitoring);
2. Ecological Monitoring; and
3. Blast Monitoring.

Monitoring data associated with the Water Resources Monitoring Program was collected by HSCL staff and then forwarded to MTE for review, interpretation, and reporting. Ecological monitoring data was collected and interpreted by AWS Environmental Consulting Inc. Blast monitoring was completed by Austin Powder and HSCL staff.

The objectives of this report are to:

1. Present the monitoring data collected to track the performance of the Keppel Quarry and ensure the AMP is effectively monitoring the existing conditions;
2. Evaluate the performance monitoring data for indicators of change to groundwater resources, the Shouldice Wetland; and the Glen Management Area; and
3. Provide recommendations for future monitoring and mitigation (if required).

1.1 Site Description

The Keppel Quarry is located on Part Lots 26, 27, and 28, Concession 10, in the Township of Georgian Bluffs, County of Grey, hereby referred to as the 'Site'. **Figure 1** shows the Site approximately eight kilometres northwest of Owen Sound, ON. **Figure 2** shows the licensed area, which is bisected by County Road 17.

Figure 2 also shows the Water Resources Monitoring Network including monitoring well locations, private residential water supply wells, the Shouldice Wetland, and the Glen Management Area. **Figure 3** shows the Ecological Monitoring Locations and **Figure 4** shows the Blasting Monitoring Locations.

1.2 Extraction Activities

ARA License Number 609501 was issued to HSCL on February 18, 2015 and extraction activities commenced in the spring of 2015. The aggregate reserve in the Keppel Quarry (including Area 1a, 1b, 2 and 3) is approximately 14,110,000 tonnes that will require approximately 23.5 years to extract at the maximum annual extraction limit of 600,000 tonnes. However, the actual annual rate of extraction is market dependent. The following is a summary of the extraction activities that occurred in 2016.

Area 1a

Removal of aggregate was exclusive to Area 1a in 2016. The current elevation of the quarry floor in Area 1a is approximately 234 masl, which is consistent with the floor elevation of the existing Keppel Quarry. Area 1a is an extension of the existing Keppel Quarry and is located east of County Road 17 (**Figure 5**). Due to its small area, connection to the existing Keppel Quarry, and distance from any environmental receptors, data collected while this area was being extracted is considered to represent baseline conditions.

Area 1b

Clearing and stripping activities in Area 1b was on going in 2016. Extraction of aggregate occurred in Area 1b with the removal of cap rock. After the construction of the berm along County Road 17, a sinking cut was made in the northeast corner of Area 1B on January 4, 2017 so that the more competent bedrock of the Amabel Formation under the cap rock could be extracted in subsequent years. The current elevation of Area 1b is approximately 249 - 250 masl.

Area 2 and Area 3

Clearing and stripping activities occurred in 2016 in Area 2, and Area 3 but no aggregate was removed from these areas. Stripping in Area 2 and 3 was exclusive to the area of the proposed berm along County Road 17 and the boundary of each Area to allow for surveying, proposed fencing and erecting signage.

2.0 WATER RESOURCES MONITORING PROGRAM

The Water Resources Monitoring Program is designed to track the performance of the Keppel Quarry and the potential impacts on water resources. The Water Resources Monitoring Program including monitor locations and measurement frequencies are summarized in **Table 1**. The Water Resources Monitoring Program tracks changes in each of the following environmental receptors:

- The bedrock groundwater flow system;
- The Shouldice Wetland; and
- The Glen Management Area.

Tables and hydrographs showing seasonal trends in groundwater chemistry (electrical conductivity and temperature), water levels, and flows are found in **Appendix C**. This database will be used as a baseline for comparison to data collected following extraction in subsequent phases (Areas 1b, 2, and 3 – see **Figure 5**). The following is a list of the tables and hydrographs found in **Appendix C**:

- **Appendix C-1** – Photo Log
- **Appendix C-2 –** Groundwater Monitor Details
- **Appendix C-3 –** Groundwater Levels and Elevations and Hydrographs
- **Appendix C-4 –** Groundwater Vertical Hydraulic Gradients
- A**ppendix C-5 –** Flow observations – Springs, Sinkhole, and Surface Water Culverts
- **Appendix C-6 –** Electrical Conductivity Measurements
- **Appendix C-7 –** Temperature Measurements
- **Appendix C-8 –** Private Well Monitoring Data
- **Appendix C-9** – Distance-Elevation Plots
- **Appendix C-10** – Interim Reports and Notifications
- **Appendix C-11** – Sentry Wells and Trigger Values – Hydrographs

While private water supply wells are related to water resources, the results of the Private Well Monitoring Program are described separately in Section 3.0.

2.1 The Bedrock Groundwater Flow System

The purpose of monitoring the bedrock groundwater flow system is to observe trends in groundwater levels over time, confirm the lateral extent of the zone of influence and avoid potential impacts related to interfering with larger water-bearing fractures (if present), which may cause issues with local natural functions and/or water management issues in the quarry. Key indicators used to monitor the bedrock groundwater flow system include:

- Quarry face fractures;
- Groundwater levels;
- Groundwater vertical hydraulic gradients;

- Interpreted Zone of influence;
- Pumping records; and
- Precipitation records.

The following describes the results of the Water Resources Monitoring Program using these key indicators.

2.1.1 Quarry Face Fractures

The AMP requires visual inspections along the active quarry face after each blast for water bearing fractures. The intent is to ensure that the quarry does not interfere with potential epikarst pathways that might otherwise deliver water to surface water features such as springs found in the Shouldice Wetland (i.e. springs s8 and s13 – see **Figure 2** for locations).

Visual inspections were made by HSCL staff after each blast in 2016. There were eight blasts in total, which took place on:

1. May 19, 2016;
2. June 14, 2016;
3. July 21, 2016;
4. August 18, 2016
5. September 22, 2016;
6. October 14, 2016;
7. November 10, 2016; and
8. December 8, 2016.

No concerns related to water (i.e. high flows observed in new and/or existing fractures) were reported after any of the blasts. Photos documenting the condition of the working face after each blast were taken by HSCL and are presented in **Appendix C-1**.

2.1.2 Groundwater Levels – Observation Wells

The AMP requires the measurement of groundwater levels from on-Site observation wells on a monthly basis from January to December, inclusive. Their locations are shown on **Figure 2.** The current monitoring program includes seventy-nine observation wells (OW) including:

- OW3, OW4, OW7s, OW7d, OW8s, OW8d, OW9s, OW9d, OW10s, OW10d, ~~OW11s, OW11d~~[1], OW12s, OW12d, OW13s, OW13d, OW14s, OW14d, OW15s, OW15d, ~~OW16s, OW16d~~[2], OW24, OW25s, OW25d, OW26, OW27s, OW27d, OW28s, OW28d, OW29s, OW29d, OW30s, OW30d, OW31s, OW31d, OW32s, OW32d, OW33s, OW33d, ~~OW34~~[3], ~~OW35~~[4], OW36, OW37, OW38, OW39,

[1] Destroyed by clearing and stripping activities in 2015
[2] Destroyed in 2007 by extraction
[3] Destroyed in 2016 by extraction in Area 1a

~~OW40~~[5], OW41s, OW41d, OW42s, OW42d, OW43s, OW43d, OW44s, OW44d, OW45, OW46k, OW46s, OW46d, OW47s, OW47d, OW48, OW49, OW50, OW51, OW52, OW53, OW58s, OW58d, OW59s, OW59d, OW60s, OW60d, OW62k, OW62s, OW62d, OW63s, OW63d, OW64s, OW64d, OW65s, OW65d, OW71k, OW71s, OW71d, OW72s.

Shallow wells (designated by the letter 's') extend five to 10 metres below ground surface (mBGS), while deep wells (designated by the letter 'd') are between 10 and 22 mBGS. Deep wells are screened at an elevation close to the current quarry floor elevation (234 mAMSL), while shallow screens are placed about half way between the natural grade and the finished quarry floor elevation.

Groundwater levels have been monitored in the shallow and deep bedrock using observation wells since 2004. Groundwater elevations collected in 2016 are found in **Table 2** and **Table 3**. Historical water levels dating back to 2004 are presented in **Appendix C-3** (**Hydrographs C-3.1** though **C-3.48** and tabulated in **Table C-3.1**).

The general year-over-year seasonal groundwater pattern (hereby referred to as 'baseline seasonal fluctuations') is comprised of higher water levels in winter and/or during the spring freshet (snowmelt), decreasing through the summer and early-autumn, followed by a smaller increase during the mid to late-autumn. As expected, monitors located close to the quarry showed lower water levels than those further away from the quarry.

In 2016, OW34 and OW35 were destroyed during extraction in Area 1a. OW72s was installed to replace OW11s, which was destroyed along with OW11d in 2015 while clearing and stripping Area 2. An attempt was made to replace OW11d as well but mechanical issues prevented its installation. Replacing OW11d was deferred until such time the AMP deems it to be required. The borehole log for OW72s is found in **Appendix C-2**.

The AMP had proposed additional observation wells which have not yet been constructed. For example:

- OW61 - HSCL has committed to installing this observation well after logging and grading is completed in Area 1B (MTE, 2015b).
- OW66, OW67, OW68 – These observation wells are located in a part of the ANSI that is too sensitive for the installation of monitoring points without causing significant disturbance to the Natural Environment (Hearts-tongue Fern habitat[6]). As such, MTE recommended that these locations be removed from the AMP (MTE, 2015b).

[4] Destroyed in 2016 by extraction in Area 1a
[5] Destroyed by clearing and stripping activities in 2015
[6] Heart-Tongue Fern has a "Special Concern" status, which means the species lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats.

- OW69 and OW70 - Given the presence of existing observation wells in proximity to their proposed locations, MTE recommended that their installation be deferred until such time that the AMP indicates the extra water level data is required (MTE, 2015b).

2.1.3 Observation Wells - Sentry Wells

To augment the manual monthly measurements, the AMP required the installation and maintenance of data loggers in the Sentry Wells including:

- OW8s, OW8d, OW9s, OW9d, OW12s, OW12d, OW13s, OW13d, OW33s, OW33d, OW45, OW47s, OW47d, OW51, ~~OW67s, OW67d~~[7], OW71K, OW71s, and OW71d.

These wells were identified as ‘Sentry Wells’ because they are located along the boundary where water level impacts due to the development of the zone of influence of the quarry are not interpreted to occur (MTE, 2015a). Their locations are shown on **Figure 2**.

Data loggers were installed in the Sentry Wells on March 10, 2015. Hydrographs showing measurements from the Sentry wells are found in **Appendix C-3**. Water levels measured at the Sentry wells showed seasonal trends for bedrock. No fluctuations in water levels in the bedrock were related to extraction in the quarry. The AMP identified trigger values for the Sentry Wells that, if exceeded, will trigger action by HSCL so that mitigation can occur before any negative effects to the natural environment can occur. Groundwater levels with respect to the trigger values are discussed in **Section 2.4** and **2.5**.

2.1.4 Groundwater Vertical Hydraulic Gradients

Condition 4.1 of the AMP requires vertical hydraulic gradients to be calculated using water level measurements from observation wells installed in the shallow and deep bedrock flow systems. This calculation was used to evaluate the potential for vertical movement of groundwater from the shallow to the deep bedrock or vice versa. The calculated vertical gradients are presented in **Table 5** and historical data is presented in **Table C-4.**

The calculations showed that vertical gradients changed near the active face of Area 1a (less than 400 m) as seen at OW7 (**Hydrograph C-3.2, Appendix C-3**) and OW30 (**Hydrograph C-3.16**), but beyond this distance, they remain unaffected as seen at OW9 and OW10 (**Hydrograph C-3.4**, **Appendix C-3**). The vertical gradients indicate that groundwater resources are not being affected beyond 400 m from Area 1a, which is consistent with historical data.

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[7] Removed from the AMP

The vertical gradient for OW43 on May-17-16 was lower than average (negative 0.35 vs. negative 0.08 on average). This value is attributed to a field measurement error at OW43d because the gradient returned to normal levels in June and for the rest of the year.

The vertical gradient for OW28 on Mar-30-17 and OW65 on Aug-31-17 were higher than average (negative 0.17 vs. negative 0.56 for OW28 and negative 0.05 vs. negative 0.18 for OW65). These peaks in vertical gradient are not considered abnormal because they have been observed in the past when the water level for the deep bedrock spikes due to stoppages in dewatering or a recharge event.

2.1.5 Groundwater Flow

Groundwater flow in the shallow and deep bedrock regimes was assessed throughout 2016 using groundwater flow maps. **Figure 6 through 13** show the seasonal changes to the shallow and deep bedrock groundwater regimes in 2016 using groundwater data collected in the winter (Jan-29-16), spring (April-28-16), summer (Jul-27-16) and fall (Oct-31-16).

Shallow Bedrock Groundwater Regime

Figures 6 through 9 show that shallow bedrock groundwater consistently flows towards the west and southwest in 2016 with little influence by the quarry on the horizontal groundwater gradient throughout the year.

As in previous years, even the closest observation well (OW30s) maintained a water level that was 13 m (247 mAMSL) above the elevation of the existing quarry floor (on average), which was approximately ~234 mAMSL in Area 1a. This observation well is situated less than 50 m from the edge of the working face in Area 1a.

Deep Bedrock Groundwater Regime

Figures 10 through 13 showed that the flow of the deep bedrock groundwater remained consistent throughout 2016 with the magnitude of drawdown the greatest close to the extraction area and decreasing quickly with distance away from the quarry face.

Throughout 2016 (and consistent with previous years), there remains a groundwater divide marking the horizontal extent of the zone of influence. Beyond the divide, groundwater flowed towards the Shouldice Wetland and the Glen Management Area. The location of the groundwater divide to the west remained approximately 400 m from the face of the quarry, except in July when it migrated out to approximately 600m. This migration is attributed to July being an abnormally dry month, which caused lower groundwater levels.

The location of the groundwater divide to the north followed a similar seasonal pattern. Through the winter and spring, this divide remained about 200 m from the quarry face but in the summer it migrated to about 300 m. This migration is not unexpected given the abnormally dry summer and resulting lower amounts of groundwater recharge. The deep groundwater regime had not fully recovered from this dry spell until late fall, as observed at OW51 (**Hydrograph C-3.30**).

This groundwater divide migration in the deep groundwater flow system is due in part to the flux in groundwater recharge. Recharge was higher in the spring due to snow melt and lower in the summer due to fewer precipitation events and higher evaporation rates. This groundwater divide migration is also due to a lower hydraulic conductivity in the deep bedrock, which is not able to buffer the same way as the immediate recharge shallow zone.

2.1.6 Distance-Elevation Plots

The migration of the groundwater divide was assessed using distance-elevation plots (**Appendix C-8**). These plots compare water elevations with respect to distance at select observation wells along assessment lines shown in **Figure C-8.1** (**Appendix C-8**). These plots show a hinge-point for each assessment line, which represents the location of the groundwater divide.

The number and location of the assessment lines differ from those presented in Figure 3 of the AMP and the following explains the changes:

- **Line 1** starts at OW37 instead of OW36 because OW36 will be destroyed when Area 1a is extracted.
- **Line 2** was changed and oriented towards the Shouldice Wetland rather than along County Road 17. Since the Shouldice Wetland is the receptor, this orientation was more useful.
- **Lines 3 and 4** were combined and re-labeled **Line 3** because OW65, OW66, and OW68 could not be installed due to ground conditions (MTE Tech Memo – April 10, 2015).
- **Line 5** was re-labeled **Line 4**.
- **Line 6** was removed from the assessment because OW61 could not be installed due to ground conditions (MTE Tech Memo – April 10, 2015).
- **Line 7** was re-labeled **Line 5**.
- **Line 8** was re-labeled **Line 6**.
- **Line 9** was removed from the assessment because a true static condition at Private well 7253 and 3447 was unattainable due to constant operation of the pump in these wells. Instead the groundwater condition near these private wells was assessed using Line 8, which is in close proximity.

The following summarizes the results of the distance-elevation plots using the new assessment lines as presented in **Figure C-8.1**:

- **Line 1** had a distinct hinge point at OW50 throughout the winter and spring but it was not apparent in June because the divide had moved north of OW52;
- **Line 2** had a hinge point at OW28 up to April and then it was not apparent in May, because the divide moved west to OW13d;
- **Line 3** had a distinct hinge point at OW41d throughout 2016;
- **Line 4** had a hinge point between OW63d and OW64d throughout 2016;
- **Line 5** had a hinge point at OW43d with the exception of February and May when access was an issue; and
- **Line 6** had a distinct hinge point at OW10d throughout 2016.

2.1.7 Zone of Influence

Figure 14 provides an illustration of the interpreted zone of influence around the quarry footprint based on the results of the distance elevation plots and groundwater data collected on Oct-31-16 for the deep bedrock groundwater regime.

Bedrock extraction below the water table resulted in a zone of influence on the local groundwater system that is variable and due in part to the hydraulic interconnectivity of the fractures within the bedrock mass. As such, **Figure 14** breaks the zone of influence up into three zones. Zone one has the greatest amount of drawdown (4-10 m); followed by Zone 2 (0-4 m of drawdown); and then Zone 3 (no impact).

Zone 1 varies in distance as observed at a number of on-site observation wells. Zone 1 presently does not extend beyond 200 m from the working face in Area 1a. The zone of influence is indistinguishable from normal seasonal climatic trends beyond a distance of about 300 m at OW51 (north), 200 m at OW14 (west), 120 m at OW7 (south) and 200 m at OW53 (east). Beyond 400 m there is no impact related to the Keppel Quarry.

Zone 1 and 2 extended farther north in October 2016 when compared to October 2015. This change in area is attributed to the reduced amount of recharge during the summer and early fall of 2016 vs. 2015 which caused water levels to remain lower than previous years. The bedrock groundwater regime started to recover in November, 2016.

The zone of influence in the deep bedrock groundwater flow regime was previously mapped to be approximately 400 m (MTE, 2011a). In 2016, the zone of influence remains at around the same distance even though the size of the extraction area has increased. This lack of change indicates that the extraction did not cause any additional impacts to groundwater resources in the area.

2.1.8 Pumping Records

Pumping records are used to track dewatering volumes at the Keppel Quarry. HSCL has incorporated a flow meter into the dewatering system to allow for the retrieval of accurate pumping data.

Condition 4.1 of the AMP requires pumping records to be downloaded on a monthly basis. HSCL downloaded and compiled the pumping records, which are presented in **Table 6**. The maximum amount pumped in a day for 2016 was 2,159,011L/day and the total volume pumped in 2016 was 277,428,086L. The total volume pumped in 2016 represents 35% of the total volume allowed by the PTTW. The PTTW also specifies an allowable pumping rate of 3,000 L/min, which was the pumping rate used by HSCL in 2016.

No water issues were encountered while extraction occurred in 2016. In fact, no pumping occurred in July, 2016 and only sporadically in August and September after storm events.

All dewatering was done within the specification of the Permit, which supports the finding that the quarry did not intercept any large water-bearing fractures that may affect groundwater resources. **Table 7** compares the 2016 pumping records to the limits of the PTTW.

2.1.9 Precipitation Data

Condition 4.1 of the AMP requires a weather station to be installed on-Site so that precipitation data can be collected. HSCL installed a rain gauge (rain logger + tipping bucket system) on June 16, 2015. To complete the data set for 2016, precipitation data was obtained from Wiarton Airport (Environment Canada Weather Station) located approximately 15.5 km northwest of the Site. **Table 8** shows the combined 2016 precipitation dataset (Wiarton Airport [Jan-Feb, Dec] + Keppel Quarry [Mar-Nov]).

Figure 15 shows the combined 2016 precipitation values for the Site vs. the Climate Normals (1981 – 2010) as recorded at the Wiarton Airport. Overall, the annual total for the Site (832 mm) was below the Climate Normal (1,048 mm), with only three months (March, August, and September) having above average precipitation, indicating that 2016 was a 'dry' year for precipitation. Figure 15 also shows abnormally low precipitation values in July of 2016 where the Site received less than half the Normal amount of precipitation.

Table 9 shows annual precipitation values compared to Climate Normals over the last 10 years. This table shows that 2015 was also a dry year. The last time the site had two dry years in a row was 2009/2010.

2.2 The Shouldice Wetland

The Shouldice Wetland is a Provincially Significant Wetland (PSW). The wetland has been identified as an environmental receptor due to its ecological importance and its unique hydraulic and hydrogeologic characteristics (MTE, 2009). Key indicators used to monitor the Shouldice Wetland include:

- Bedrock Groundwater levels;
- Groundwater recharge;
- Groundwater vertical hydraulic gradients using mini-piezometers;

- Springs (s8 and s13) and the dugout pond;
- Shouldice Wetland culverts; and
- Beaver dam and sinkhole.

2.2.1 Bedrock Groundwater Levels

Observation wells installed in the shallow and deep bedrock are used to monitor groundwater levels under the Shouldice Wetland. Hydrographs showing groundwater levels at these locations are found in **Appendix C-3**:

- OW24 & OW26 (Hydrograph C-3.11);
- OW25s, OW25d (Hydrograph C-3.12);
- OW27s, OW27d (Hydrograph C-3.13);
- OW58s, OW58d (Hydrograph C-3.32);
- OW59s, OW59d (Hydrograph C-3.33);
- OW60s, OW60d (Hydrograph C-3.34); and
- OW71k, OW71s, OW71d. (Hydrograph C-3.39)

Observation well nests OW58 through OW60 are installed near s8, while observation well nest OW71 is installed into the lobe of the Shouldice Wetland encompassing spring s13 and the dugout pond. Groundwater levels from these monitors are presented in **Table 2** and **Appendix C-3.**

Water levels at these locations exhibited baseline seasonal fluctuations indicating that the movement of groundwater into the wetland was unaffected by extraction in 2016. Given that 2016 was a dry year, bedrock groundwater levels under the Shouldice Wetland were expected to be lower on average but the groundwater levels were comparable to previous years at most of the observation wells. Lower summer groundwater levels were observed only at OW9s, OW9d and OW71k, OW71s, and OW71d. Groundwater levels at OW9s and OW9d reached lows that have not been seen since 2007, while groundwater levels observed at OW71k, OW71s, and OW71d were the lowest on record.

This information suggests that the bedrock groundwater levels in the wetland were not significantly affected by the lack of precipitation in 2016. As long as the Shouldice Wetland receives sufficient melt water in the spring, then it appears to be able to sustain bedrock groundwater levels even during drought years.

2.2.2 Groundwater Recharge

Condition 4.2 of AMP requires the measurement of groundwater levels from four test pits with stand pipes (TP) installed in the overburden within 100 m of the wetland boundary. These test pits include:

- TP16, TP17, TP18, TP19.

Their locations are shown on **Figure 2.** These test pits are used to measure groundwater levels in the glaciofluvial overburden materials found on Lot 25, Concession 10. Monitoring groundwater levels in this overburden is important because it has been identified as a potential source of groundwater recharge for the Shouldice Wetland springs, particularity spring s8 (Cowell, 2009).

Groundwater levels measured from the test pits are shown in **Tables 10** and historical data is presented in **Appendix C-3**. **Table 11** compares the 2016 groundwater levels to historical data. The results showed baseline seasonal trends in water levels fluctuations indicating that extraction did not affect this recharge zone.

2.2.3 Groundwater Vertical Hydraulic Gradients

Condition 4.2 of the AMP requires the measurement of groundwater levels from four mini-piezometers (MP) installed in the wetland deposits on a monthly basis from January to December, inclusive. These mini-piezometers include:

- MP54, MP55, MP56, MP57.

Their locations are shown on **Figure 2.** These mini-piezometers are used to measure groundwater levels in the wetland deposits so that the vertical hydraulic gradients can be calculated to determine the vertical movement of groundwater into the Shouldice Wetland. Vertical gradients calculated using water levels measured from the mini-piezometers are shown in **Table 10** and historical data is presented in **Appendix C-3**. **Table 11** compares the 2016 vertical groundwater gradients to historical data.

Slightly upward vertical groundwater gradients were observed in the spring of 2016 at the mini-piezometers. These gradients are consistent with historical data, which shows the Shouldice Wetland as a groundwater discharge zone. Wetland water levels at all mini-piezometers dried up in July 2016, which has not been observed since 2009, suggesting that 2016 was a particular dry year.

Groundwater vertical hydraulic gradients were also calculated using observation wells installed in the bedrock underlying the Shouldice Wetland including observation wells OW58s/d, OW59s/d, OW60s/d, and OW71k/s/d (shown in **Table 5** and historical data is presented in **Appendix C-4)**.

The calculated values for OW58, OW59, and OW60 showed neutral to slightly upward gradients on average (0.01 to 0.03 m/m) in 2016. The average vertical gradient for the karst bedrock to the shallow bedrock at OW71 was slightly downward (-0.04 m/m), while the average vertical gradient for the shallow bedrock to deep bedrock at OW71 was neutral. These gradients were consistent with historical data at these locations. This information coupled with the gradients calculated from the mini-piezometers indicates that the groundwater vertical hydraulic gradients in the Shouldice Wetland or the bedrock underneath the wetland were not affected by extraction in 2016.

2.2.4 Spring (s8 and s13) and the Dugout Pond

Condition 4.2 of the AMP requires the following parameters to be measured at springs s8, s13, and the dugout pond using dataloggers on a monthly basis from January to December, inclusive:

- Water levels;
- Flows - observed as 'flowing'; 'no apparent flow'; or 'dry';
- Electrical conductivity (EC); and
- Water temperature.

Spring s8 is located along the edge of the Shouldice Wetland approximately 850m west of Area 1a (**Figure 2**). Spring s13 is located approximately one kilometer southwest of Area 1a on Lot 26, Concession 9. The Dugout pond is located adjacent to s13 (**Figure 2**).

Water levels collected in 2016 at spring s8, s13 and the dugout pond are found in **Table 13.** Historical water levels dating back to 2009 are presented in **Appendix C-3** (**Hydrographs C-3.46, C-3.47, and C-3.48**). Water levels measured in 2016 at s8 were comparable to historical values fluctuating around 240 mAMSL. Water levels at spring s13 and the dugout pond fluctuated around 243 mASML, which was also consistent with historical values. Water levels at these locations were not affected by extraction in 2016.

Manual measurements on Apr-28-16, June-22-16 and Sep-29-16 at s8 showed some disagreement with the water levels measured by the data logger. The source of the error is unknown but consideration should be given to installing a new staff gauge at this location to ensure the manual measurements and the logger readings are in-sync.

Flows collected in 2016 at spring s8, s13 and the dugout pond are found in **Table 14.** Historical flows dating back to 2007 are presented in **Appendix C-5**. Based on the 2016 flow data, the hydroperiod for s9 and s13 ended in April while the hydroperiod for s8 ended in May. In June and for the remainder of 2016, all three locations were dry. Historically, the hydroperiod for these springs ended in late spring/early summer (i.e. June). Since 2016 was a particularly dry spring, an early end to the hydroperiod is expected and consistent with the localized nature of the flow to these springs.

EC values collected in 2016 at the springs and dugout pond are found in **Table 15.** Historical EC values dating back to 2009 are presented in **Appendix C-6**. EC values ranged from 496 to 604 at spring s8, 453 to 1160 at spring s13 and 470 to 1202 at the dugout pond. These values are comparable to historical data collected at these locations.

Water temperature values collected in 2016 at the springs and dugout pond are found in **Table 16.** Historical water temperatures dating back to 2009 are presented in **Appendix C-7**. Water temperature at spring s8 ranged from 7 to 12 degrees Celsius in

2016. Similarly, water temperatures at spring s13 ranged from 4 to 15 degrees Celsius, while temperatures in the dugout pond ranged from 5 to 15 degrees Celsius. These springs and the dugout pond were dry in July, August and September, which has not happened since 2009. When these features had water, the temperatures measured in 2016 were comparable to historical data collected at these locations.

2.2.5 Shouldice Wetland Culverts

There are several culverts (culverts 4 through 7) that allow water to cross under a snowmobile trail constructed at the end of Gun Club Road, which runs in a northwesterly direction through the Shouldice Wetland **(Figure 2)**. Condition 4.2 of the AMP requires that the following parameters to be measured at these culverts on a monthly basis from January to December, inclusive:

- Flows - observed as ‘flowing’, ‘no apparent flow’, ‘dry’;
- Electrical conductivity (EC); and
- Water temperature.

Monitoring flows through these culverts aides in understanding the hydroperiod of the Shouldice Wetland.

Flows collected in 2016 at the culverts are found in **Table 14.** Historical flows dating back to 2007 are presented in **Appendix C-5**. Based on the 2016 flow data the hydroperiod for these culverts ended in late spring/early summer (June), with some residual flow observed at Culvert 6 and 6a in July and August of 2016. This hydroperiod ended earlier than previously observed. Historical data shows that the hydroperiod for these culverts typically ended in July but there were some years when these culverts flowed all year (2010, 2011, and 2012).

This information combined with the flows observed at the springs (s8 and s13) and the dugout pond indicated that the hydroperiod for the Shouldice Wetland ended in late spring in 2016. Historically, the hydroperiod ends in the summer and resumes again in the fall but no flows were observed in the fall of 2016 at the culverts. Since 2016 was an abnormally dry year, the hydroperiod ended early and there was insufficient water for it to resume in the fall.

EC values collected in 2016 at the culverts are found in **Table 15.** Historical EC values dating back to 2009 are presented in **Appendix C-6**. EC values ranged from 401 to 690 at the culverts. These values are comparable to historical data collected at these locations (**Appendix C-5**).

Water temperature values collected in 2016 at the culverts are found in **Table 16.** Historical water temperatures dating back to 2009 are presented in **Appendix C-7**. Water temperatures at the culverts ranged from 4 to 23 degrees Celsius in 2016. Historically, temperatures have risen as high as 30 degrees Celsius in the summer but some of the culverts reported dry conditions in July and August in 2016 (i.e. culverts 4, 5 and 6). As such, the upper limit was lower in 2016.

2.2.6 Beaver Dam and Sinkhole

The beaver dam and sinkhole are located approximately 850 m north of the Keppel Quarry (**Figure 2**) in the Shouldice Wetland. The beaver dam is an attempt by beavers to maintain water levels in the north portion of the Shouldice Wetland which would otherwise be drained by the sinkhole at the edge of the wetland. Water from the Shouldice Wetland drains over the dam where it flows into a small ‘cove’. The south edge of the cove is formed by a prominent joint in the limestone bedrock and water sinks into the bedrock all along the south shore. This sinkhole is a discrete karst feature that is connected to springs s1-s3 in the Glen Management Area. This feature serves to drain the northeast lobe of the Shouldice Wetland during peak recharge periods.

Condition 4.2 of the AMP requires that the following parameters to be measured at the beaver dam and sinkhole on a monthly basis from January to December, inclusive:

- Flows - observed as ‘flowing’, ‘no apparent flow’, ‘dry’;
- Electrical conductivity (EC); and
- Water temperature.

Monitoring flow conditions at the beaver dam and sinkhole aides in understanding the hydroperiod of the Shouldice Wetland at this location.

Flows collected in 2016 at the beaver dam and sinkhole are found in **Table 14.** Historical flows dating back to 2007 are presented in **Appendix C-5**. Based on the flow data collected at the beaver dam, water was observed flowing through and into the cove up to May-17-16. Flow observations at the sinkhole are made at the eastern extent of the cove and flows ended in March (**Table 13**). Even though flows at the sinkhole ended in March, the hydroperiod for the sinkhole is tied to the flow through the beaver dam because the bedrock joint extends through the entire cove and water sinks along its entire length (Cowell, 2008).

EC values collected in 2016 at the culverts are found in **Table 15.** Historical EC values dating back to 2009 are presented in **Appendix C-6**. EC values ranged from 392 to 600 at the beaver dam and sinkhole; 482 us/cm and 438 us/cm, on average. These values are comparable to historical data collected at these locations.

Water temperature values collected in 2016 at the beaver dam and sinkhole are found in **Table 16.** Historical water temperatures dating back to 2009 are presented in **Appendix C-7**. Water temperatures at the beaver dam ranged from 2 to 21 degrees Celsius in 2016. The water temperatures measured at the beaver dam and sinkhole in 2016 were comparable to historical data collected at these locations.

2.2.7 Area 3 Monitoring

With the exception of clearing and stripping for the purpose of constructing the berm, no extraction activities occurred in Area 3 in 2016. Condition 4.7 of the AMP indicates that there is a holding provision on Area 3, which can only be lifted if the monitoring and triggers of the AMP clearly indicate that there will be no significant negative impact to the Shouldice Wetland as determined by the Ministry of Natural Resources and Forestry (MNRF) and the Ministry of the Environment and Climate Change (MOECC).

2.2.8 Infiltration Pond Monitoring

The purpose of the infiltration pond is to augment flow to the lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond if the results of the AMP deem this mitigation measure is required (MTE, 2015a). If required, then the infiltration pond shall be constructed in the headwater recharge area for spring s13.

Monitoring data collected in 2016 did not trigger the construction of the infiltration pond. As such, the infiltration pond has yet to be constructed and no monitoring was required in 2016.

2.3 The Glen Management Area

The north portion of the Glen Management Area located approximately 500 m north of the Area 1a is monitored as part of the AMP. The key indicators that are used to monitor this feature include:

- Bedrock Groundwater Levels;
- Glen Management Area Springs s1-s3;
- Mud Creek;
- Flow over the weir at the dam regulated by Ducks Unlimited; and
- Beaver Dam Sinkhole.

2.3.1 Bedrock Groundwater Levels

The following observation wells are used to monitor groundwater levels between the Keppel Quarry and the Niagara Escarpment. Hydrographs showing groundwater levels for these wells are found in Appendix C:

- OW49 & OW50 (Hydrograph C-3.29); and
- OW51 & OW52 (Hydrograph C-3.30).

Groundwater levels in these observation wells exhibited baseline seasonally fluctuations until the fall when the groundwater regime remained subdued and did not start to recover until the winter. This extended recovery period is attributed to 2016 being a dry year.

2.3.2 Glen Management Area Springs s1, s2, s3

The Glen Management Area contains springs (s1-s3) located on the top of the Amabel Plateau that are derived from infiltrating water at the beaver dam sinkhole. They are located 550 m north of the existing Keppel Quarry along the Niagara Escarpment (**Figure 2**). The current interpretation is that these springs will not be impacted by the New Keppel Quarry (Cowell, 2009). However, water emanating from these springs is dependent on water sinking at the beaver dam sinkhole and so natural changes may occur while the New Keppel Quarry is operating. As a result, springs s1-s3 are included in the Water Resources Monitoring Program so that natural changes can be noted (if any) while extraction occurs.

Condition 4.3 of the AMP requires the following parameters to be measured at these springs a monthly basis from January to December, inclusive:

- Flows - observed as ‘flowing’; ‘no apparent flow’; or ‘dry’;
- Electrical conductivity (EC); and
- Water temperature.

Flows collected in 2016 at springs s1-s3 are found in **Table 14.** Historical flows are presented in **Appendix C-5**. Based on the flow data collected, the hydroperiod for these springs extended from January through to December in 2016 with the exception of s2, which stopped flowing in July and August. This information is consistent with the historical data, which indicated that these springs flow all year with the exception of 2013 when spring s1 and s2 stopped flowing in July and August. No flow at s2 in July and August is attributed to 2016 being a dry year.

Since the springs (s1-s3) flowed almost all year, there may have been water sinking upstream of the beaver dam along the joint that makes up the sinkhole as these two features are connected by a discrete karst feature.

EC values collected in 2016 at the springs are found in **Table 15.** Historical values are presented in **Appendix C-6**. EC values at these springs in 2016 ranged from 361 to 682, 553 us/cm on average, which is comparable to historical data. Conductivity values in this range means there is a mix of groundwater and surface water flowing from these features (Cowell, 2009).

Water temperature values collected in 2016 at the springs are found in **Table 16.** Historical water temperatures dating back to 2009 are presented in **Appendix C-7**. Water temperature at spring s1, s2, and s3 ranged from 2 to 13 degrees Celsius in 2016. Due to inputs from groundwater at these springs, their temperatures do not raise much beyond 15 degrees Celsius. The water temperatures recorded at these springs in 2016 were comparable to historical data collected at these locations.

2.3.3 Mud Creek

The headwaters for Mud Creek include springs s1-s3. There are two channels that flow from these springs into Mud Creek:

- Channel A, the main channel; and
- Channel B, a secondary channel that flows intermittently.

Condition 4.3 of AMP requires the following parameters to be measured at these springs a monthly basis from January to December, inclusive:

- Flows – estimated at Channel A using velocity-area measurements;
- Electrical conductivity (EC); and
- Water temperature.

Flows collected in 2016 at Mud Creek (Channel A and B) are found in **Table 14.** Historical flows are presented in **Appendix C-5**. Based on the 2016 flow data collected, the hydroperiod for Channel A extended from December through to January, while Channel B was dry all year. This information is consistent with historical data, which saw Channel B dried up regularly after the spring melt, whereas Channel A flowed almost all year.

EC values collected in 2016 at Mud Creek (Channel A and B) are found in **Table 15.** Historical values are presented in **Appendix C-6**. EC values ranged from 375 to 669 at these channels in 2016, which is comparable to historical data collected at these locations.

Water temperature values collected in 2016 at Mud Creek (Channel A and B) are found in **Table 16.** Historical water temperatures are presented in **Appendix C-7**. Water temperature in Channel A ranged from 3 to about 14 degrees Celsius in 2016. Water temperatures at these locations are regulated by groundwater. The water temperatures recorded in Mud Creek (Channel A and B) in 2016 were comparable to historical data collected at these locations.

2.4 Trigger Values – Performance Assessment

Approved trigger values for each Sentry Well, s8, s13 and SG1 can be seen in **Table 17**. These values were established based on data collected from 2004 to 2009. Since then, new groundwater levels have been measured that show more recent seasonal trends. As such, a recommendation was made in the 2015 AMP Compliance Report to revise the trigger values to reflect the updated baseline data. Amended trigger values as shown in the 2015 AMP Compliance Report are found in **Table 18** (hereby referred to as the 2016 trigger values).

As per Condition 10.3 of the AMP, a Site Plan Amendment application must be submitted to the MNRF so that the 2016 trigger values can be considered. To ensure the 2016 values performed properly, HSCL deferred the amendment application until the 2016 monitoring season was complete. Instead, the switch was made internally in consultation with MNRF. The following sections describe how the 2016 trigger values performed.

2.4.1 Trigger Values - Definitions

As outlined in the AMP there are three categories of trigger values; green, yellow and red. Each trigger value is accompanied by a set of actions that are implemented if these values are exceeded.

Green Trigger Values

Green trigger values are set at 15 cm above observed seasonal lows (spring, summer, autumn, and winter) for each of the Sentry Wells and for springs s13 and s8. An exceedance of a green trigger value indicates no significant negative impacts have been observed and water levels are still within the normal historical range. This will trigger a 'Green Action' as an early response action (i.e. increase monitoring frequency and investigate).

Yellow Trigger Values

Yellow trigger values are equal to observed seasonal lows for each location. An exceedance of a yellow trigger value indicates water levels are slightly below seasonal lows, but no significant negative impacts have been observed. This is used to trigger a 'Yellow Action' or a precautionary mitigation measure.

Red Trigger Values

Red trigger values are set at 15 cm below observed seasonal lows. Fifteen centimeters was selected since this amount of change may result in the extension of the zone of influence into Zone 3, which could result in a negative impact to the Shouldice Wetland. An exceedance of a red trigger value is used to trigger 'Red Actions' or immediate responses in the event that the yellow actions fail to correct or reverse the impact.

2.4.2 Trigger Values – Exceedances

Since 2016 was an abnormally dry year, even the 2016 trigger values were exceeded at some of the Sentry Wells. As such, as data was being compiled month to month, the exceedances were considered false alarms. The observed exceedances are summarized in **Table 20.**

Green exceedances occurred for several brief periods throughout the monitoring season (starting on Apr-25-16 and ending on Dec-27-16) at almost every Sentry Well including:

- OW8s, OW8d;
- OW9s, OW9d;
- OW12s, OW12d;
- OW33s, OW33d;
- OW45;
- OW47s, OW47d;
- OW51;
- OW71k, OW71s, OW71d; and
- SG1.

Since green trigger values are set at 15 cm above observed seasonal lows, water levels are still within the normal historical range. Hydrographs comparing water levels against the proposed amended trigger values are found in **Appendix C-11 (Hydrographs C-11.1 though C-11.20)**.

Yellow trigger values were exceeded between June-18-16 and Aug-17-16 at:

- OW33d;
- OW45;
- OW47s, OW47d; and
- OW71k, OW71s, OW71d.

Red trigger values were exceeded between Jul-21-16 and Aug-16-16 at:

- OW71k, OW71s, OW71d.

As per Condition 10.3 and Appendix B of the AMP, no yellow or red actions are required if it can be shown through Green Actions that the exceeded trigger values are related to climate influences. As such, no yellow or red actions were recommended even though exceedances were observed.

2.4.3 Trigger Values – Required Notifications

Condition 4.6 of the AMP requires the quarry operator to be notified if green trigger values are breeched. The Hydrogeologist and the Ecologist/Biologist are also to be notified. Condition 10.1 also requires that the MNRF, MOECC, NEC and SON be notified if trigger values are exceeded.

Appendix B of the AMP requires more immediate notifications if Yellow and Red triggers are breeched, for example there is:

- A 72 hour notification requirement if a Yellow Trigger is breeched; and
- A 24 hour reporting requirement if a Red Trigger is breeched.

MTE notified HSCL of the breeched trigger values on Sept-14-16, and the MNRF were informed immediately after (**see Appendix C-9**). Climatological information was provided to MNRF on Sept-20-17.

Given that the breeched values occurred as early as Apr-25-16, notification should have occurred sooner, even though the breeched values were interpreted to be false alarms. MTE will work to improve the notification process going forward.

Since monitoring is completed on a monthly basis, notifications targets can only be met after the data has been compiled and checked against trigger values. In addition, exceedances may be recorded by data loggers in Sentry wells and not realized until the end of the month when the monitoring is completed. Clarification should be built into the AMP to allow for proper data assessment with notifications being delivered afterwards. To this end, MTE will investigate ways to improve the efficiency at which data is compiled and checked so that the notices can be delivered sooner.

The notification process in the AMP should also be revised to eliminate the need to notify agencies when Green triggers are breeched. Removal of this notification will eliminate unnecessary notifications while water levels dip above and below this value during dry summers.

2.5 Mitigation Measures

Mitigation measures are shown as a sequence of green, yellow and red actions as shown in Appendix B of the AMP.

2.5.1 Green Actions

As per Condition 4.6 of the AMP, Green Actions are required to determine the reason for the exceedance, with the results of the analysis being reported to MNRF.

After receiving and checking the July and August monitoring data against the 2016 trigger values, the following actions were taken:

- Checked climatological records using the on-site precipitation gauge and compared against climatological Normals for the area as well as groundwater levels;
- Reviewed pumping records; and
- Tracked the zone of influence using a combination of groundwater flow maps (**Figures 6 through 13)** and distance-elevation plots (**Appendix C8)**.

The precipitation records showed a downward trend throughout the summer of 2016 which coincided with groundwater level declines at the Sentry wells. In particular, there was a large precipitation event in mid-August which has caused groundwater levels to rebound again **(see Hydrographs C-10.1** through **C-10.20)**. The pumping records showed that no pumping had occurred during the month of July and only nominal pumping in response to storm events in August. All the while, the zone of influence was remaining fairly consistent in size but it did extend farther north as the summer remained dry (see **Figure 15**). These checks confirmed that the exceedances were tied to climatological conditions and the results of this analysis were reported to the MNRF via email on Sept-14-16 and Sept-20-16.

After receiving and checking the September monitoring data against the 2016 trigger values, green triggers were again exceeded at OW71, which was interpreted to be related to the groundwater system still recovering from a prolonged drought period. To confirm, the following actions were taken on Oct-19-17:

- Increased frequency of monitoring from monthly to weekly at designated locations as specified in Appendix B of the AMP. This additional data was used to:
    - Compare groundwater levels in the triggered Sentry Wells to others wells in close proximity; and
    - Assess water levels against historical patterns.

Appendix B of the AMP specifies that the extra monitoring is required until the groundwater flow system recovers or dewatering has stopped for the season. The AMP defines *recovered* as three monitoring events in a row above the Green Trigger. As such, the frequency of monitoring remained weekly until the end of the dewatering season at:

- OW7s OW7d, OW9s OW9d, OW10s OW10d, OW27s OW27d, OW30s OW30d, OW39, OW40, OW43s OW43d, OW44s OW44d, OW45, OW46s OW46d, OW47s OW47d, OW48s OW48d, OW62k OW62s OW62d, OW70s OW70d, SG1 and Spring S13.

The results of this extra monitoring showed widespread low values and similar trends in nearby monitoring wells, which is a typical response when there is a lack of recharge to the bedrock groundwater system. For example, OW8 is in close proximity to OW9 which both showed similar patterns (**Hydrographs C-10.1 and C-10.2).** All the above observation wells listed above showed a downward trend in groundwater levels throughout the summer months, which remained subdued into the fall until the end of November when more frequent precipitation events recharged the bedrock groundwater system and caused water levels to rise again. The hydrographs also show one storm event in mid-August which caused a spike in water levels.

The extra monitoring showed that water levels rose above green trigger values at all Sentry Wells except OW51 and OW71 where water levels bounced above and below the green trigger value throughout the fall until the end of the pumping season.

2.5.2 Yellow and Red Actions

As per Condition 10.3 and Appendix B of the AMP, no yellow or red actions are required if it can be shown through Green Actions that the exceeded trigger values are related to climate influences. As such, no yellow or red actions were recommended.

2.6 Revised Trigger Values - 2017

Trigger values are calculated using the seasonal lows (spring, summer, autumn, and winter) for each of the Sentry Wells and for springs s13 and s8. Since new climate influenced lows were observed in 2016, the trigger values should be revised to reflect this new data otherwise, HSCL will risk ongoing false alarms. The proposed new trigger values are found in **Table 20**. As with 2016, MTE recommends collecting another year of data using these trigger values before submitting a Site Plan Amendment application to ensure they have been appropriately re-assigned.

2.7 Ephemeral Pond

There is an ephemeral pond on Lot 26 Concession 10. The AMP requires that three years of baseline water levels be measured using a staff gauge in this feature prior to extraction occurring within Area 1B. Water levels shall be measured during the amphibian breeding season which extends from April 1 to June 30.

Water levels collected in 2016 at the ephemeral pond are found in **Table 21.** Water levels in this pond were measured on a monthly basis from April to June, after which the pond was dry. Going forward, HSCL will measure weekly water levels during these months.

3.0 PRIVATE WELL MONITORING PROGRAM

A Private Well Monitoring Program has been developed to monitor water supplies of residents within one kilometer of the Keppel Quarry. Private wells are be separated into two categories:

- **Category A wells** – includes those wells within or just outside the predicted zone of influence for the deep bedrock aquifer when the Keppel Quarry is at its full extent.
- **Category B wells** - includes those wells within 1 km of the Keppel Quarry license boundaries but outside the predicated zone of influence.

3.1 Category A Private Wells

Category A Private Wells include:

- Private well no. 3345 (the Ritchie well);
- Private well no. 3447 (owned by HSCL – rented by McGregor);

- Private well no. 5197 (the Ruthven well); and
- Private well no. 7253 (the Cramp well)

The locations of the private wells are shown on **Figure 2**. With the exception of Private Well no. 3447, baseline data dating back as far as 2006 has been collected as part of previous studies (WGC, 2003, 2007). Water levels collected in 2016 at the private wells are found in **Table 22** and also shown on **Hydrographs C-11.1** to **C-11.4** found in **Appendix C-11**.

There were no well interference complaints received by HSCL from any of the Category A private wells in 2016. The following is a summary of the water level data collected from Category A Private Wells in 2016 compared to the historical baseline data.

Private well no. 3345 (the Ritchie well)

As stated in the 2015 AMP Compliance Assessment Report, the resident declined to be a part of the monitoring program in 2016. Water levels measured from this well up to October 2015 are found in **Hydrograph C-11.1.**

Private well no. 3447 (owned by HSCL – rented by McGregor)

Water levels in Private Well no. 3447 were measured manually using an electric water level tape on a monthly basis starting on May-17-16 basis by HSCL staff. Water levels in 2016 fluctuated around 246.8 mAMSL on average (**Hydrograph C-11.2**), which was slightly lower than 2015 by about 0.7 m. At least 8 m of water column remained in this well while extraction occurred in Area 1a in 2016. This information indicates that the water supply in Private well no. 3447 was not affected by extraction. MTE understands that the dwelling at Private Well no. 3447 is owned by HSCL and is occupied by a renter.

Private well no. 5197 (the Ruthven well)

Water levels in Private Well no. 5197 were measured using a data logger. Water levels were similar to historical values fluctuating around 248 mAMSL on average (**Hydrograph C-11.3**). Water levels fluctuated seasonally in this well with high water levels in the spring (peaking at 251.2 mAMSL) and progressively lower water levels throughout the summer. The lowest water level measured was 243.4 mAMSL in August, 2016. At least 4.75 m of water column remained in this well while extraction occurred in 2016, which is similar to previous years. This information indicates that the water supply in Private well no. 5197 was not affected by extraction.

Private well no. 7253 (the Cramp well)

Water levels in Private Well no. 7253 were measured using a data logger. Water levels measured in 2016 were similar to historical values fluctuating around 248 mAMSL on average (**Hydrograph C-11.4**). Water levels as low as 245.4 mAMSL were measured in August due to the household use of the well. Water levels as high as 249.8 mAMSL were measured in the April. At least 14 m of water column remained in this well while extraction occurred in 2016. This information indicates that the water supply in Private well no. 7253 was not affected by extraction.

3.2 Category B Private Wells

Category B Private Wells include:

- Private well no. PW1 (the Jenks well);
- Private well no. PW2 (the Thompson well); and
- Private well no. PW3 (the Porter well).

The AMP requires that water levels be measured manually from each of the participating Category B private wells on a seasonal basis (4 times per year). The results of the monitoring are presented on **Hydrograph C-11.5** found in **Appendix C-11**.

There were no well interference complaints received by HSCL from any of the Category B private wells in 2016.

PW1, PW2, and PW3 fluctuated seasonally in 2016 with the highest water levels being measured in the spring, the lowest water level in the summer and then a small amount of recharge in the fall. Water levels measured at the Category B wells in 2016 were comparable to 2015.

The well head for each Category B well is to be surveyed for elevation with respect to meters above sea-level using total station or GPS survey equipment. Currently, reference elevations have been estimated based on the nearest contour shown on Ontario Base Mapping.

3.3 Private Well Trigger values and Mitigation Measures

Condition 7.3 of the AMP requires that yellow trigger values be established for all Category A and B Private Wells. Yellow trigger values have been calculated for the Category A wells but the Category B wells require one more year of monitoring before a trigger value can be calculated.

No yellow trigger values were exceeded at the any of the Category A Private Wells. Once trigger values have been established for Category B wells, they will be incorporated into the AMP.

Condition 7.3 of the AMP indicates that a well interference complaint from a private well owner constitutes a red trigger action. No complaints were received by HSCL related to extraction in 2016. As such, no mitigation measures were required.

Condition 7.1 of the AMP requires the replacement of private well no. 7253 owned by Cramp and that a new yellow trigger value is to be established for this new well. MTE understands that HSCL approached Cramp in 2016 about replacing the well and is waiting on their authorization to proceed.

4.0 ECOLOGICAL MONITORING PROGRAM

An Ecological Monitoring Program has been developed to evaluate the ecological health of selected natural features throughout the life cycle of the quarry and ensure that their ecological function is maintained. As per Condition 5.0 of the AMP, year one reporting data is considered to be "normal" for flora community diversity and was used to establish trigger threshold levels for comparison to future monitoring results. The results of the program after two years are presented in a report completed by AWS Environmental Consulting Inc. found in **Appendix D.**

The Ecological Monitoring Program is focused on features in the woodlands of the Area of Natural and Scientific Interest (ANSI), the Shouldice Wetland and the upper Glen Management Area. Ecological monitoring areas (EMA) are shown on **Figure 3**. Monitoring activities were conducted in both terrestrial ecological features (EMA-1 and EMA-2) and wetland ecological features (EMA-2 through EMA-6) as outlined below:

- EMA-1: Woodland Tree Health, Woodland Regeneration and Woodland Flora Species Diversity;
- EMA-2: Woodland Breeding Birds;
- EMA-3: The Glen Area s1 to s3 groundwater discharge feature;
- EMA-4: The Shouldice Wetland at the s8 groundwater discharge feature;
- EMA-5: The Woodland Ephemeral Pond amphibian breeding surface water feature; and
- EMA-6: The lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek.

The following is a summary of the results of the ecological monitoring.

EMA-1: Woodland Tree Health, Woodland Regeneration and Woodland Flora Species Diversity:

- In 2016 three fixed forest plots (F-1, F-2 & F-3) were established in Lots 26 and 27, north of Area 1b of the Keppel Quarry. (**Figure 3**). All trees which were >10cm diameter at breast height (dbh) were tagged for long-term monitoring. All monitoring aspects of points I (a - i), II (a - d) and III (a - c) noted within the AMP-Ecological Monitoring Plan were completed. Year 2 Ecological data are provided under Appendix 1 of the AWS report (**Appendix D**). The Ecological monitoring report noted that in the main plot of all three forest plots there has been no change in the 'Upper Canopy Live Tree', 'Canopy Layer Composition', 'Standing dead Tree' or 'Downed trees & woody Debris' data. In addition some minor growth advancement in seedlings was noted in the regeneration plots at all three locations with some minor composition changes from growth advancement of seedlings occurring in the ground vegetation composition plots.

EMA-2: Woodland Breeding Birds:

- No woodland breeding bird monitoring data was collected in 2016 because all baseline data on breeding birds was collected in 2015 and documented in the 2015 Ecological Monitoring Report. The next breeding birds inventory will occur in 2017 with the data being compared to Year 1 baseline data.

EMA-3: The Glen Area s1 to s3 Groundwater Discharge Feature:

- Flora diversity in the Glen Area was not inspected in 2016 because all required baseline data was collected in 2015 and documented in the 2015 Ecological Monitoring Report. The next flora diversity inventory will occur in 2017 with the data being compared to Year 1 baseline data.

EMA-4: The Shouldice Wetland at the s8 groundwater discharge feature:

- Anuran night time calling surveys were completed on April 22, May 30 and June 29, 2016. A total of five species were identified over the three Anuran surveys. A summary of the findings is presented in Table No. 1 of the AWS report (**Appendix D**).

EMA-5: The Woodland Ephemeral Pond amphibian breeding surface water feature:

- Anuran night time calling surveys were completed on April 22, May 30 and June 29, 2016. A total of three species were identified over the three Anuran surveys. A summary of the findings is presented in Table No. 2 of the AWS report (**Appendix D**).
- Anuran egg mass surveys were also undertaken on April 22, May 30 and June 27, 2016. No adult salamanders or salamander egg masses were noted during the three surveys. Numerous frog egg masses were noted on April 22, with numerous tadpoles being noted on May 30 and few being noted on June 27 as the ephemeral pond had decreased significantly from its maximum extent by this time. A summary of the findings is presented in Table No. 3 of AWS report (**Appendix D**).

EMA-6: The lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek:

- Anuran night time calling surveys were completed on April 22, May 30 and June 29, 2016. A total of five species were identified over the three Anuran surveys. A summary of the findings is presented in Table No. 4 of the AWS report (**Appendix D**).
- No measureable difference in flora composition at any of the Wetland Community monitoring plots was noted in 2016 compared to 2015.
- Macro-Invertebrate diversity data was collected on June 27, 2016 as collection of data was unsuccessful in August, 2015 due to excess vegetation growth.
- A 500 mc mesh hand dip net was used to sample a 1 m^2 area within the dugout pond area and the discharge channel bottom.
- It was noted that Macro-Invertebrate sampling did not capture target levels for proper annual data trend analysis. A summary of the findings is presented in Table No. 5 of the AWS report (**Appendix D**).
- The AWS Report recommends that if insufficient Macro-Invertebrate collection continues in Year three the steering committee in conjunction with the MNRF should consider the value of continued monitoring.

5.0 TREE PRESERVATION PLAN

Condition 6.0 of the AMP requires the implementation of the Tree Preservation Plan (TPP) for the Keppel Quarry. This plan requires the preservation of trees within the three zones of the TPP Corridor along County Road 17 and Concession Road 10 (**Figure 11**). The results of the TPP after year two are presented in Section 4.0 of the AWS Report (**Appendix D).** The following is a summary of the results of the TPP.

Zone 1

Zone 1 of the TPP Corridor is the front line of existing trees in Area 1a (**Figure 11**). This front line of trees is approximately 5 m wide and serves to protect successive trees, which visually screen Area 1a along County Road 17.

Trees in this zone were assessed in September 2014. Appendix 4 of the AWS report (**Appendix D**) provides the 2014 data summary and identifies which trees require replacement and trees that will require replacement in the future due to poor growing or health standards. Zone 1 Tree Screening-Preservation data is to be updated in the summer of 2017.

Zone 2

Zone 2 of the TPP Corridor is a stand of existing trees that shall remain at least 20 m wide to visually screen Areas 1B, Area 2 and Area 3 along County Road 17.

Year 2 monitoring data is presented in Appendix 3 of the AWS report (**Appendix D**). Nine trees were identified as meeting replacement protocol with an additional 111 trees identified for pending action requirement protocols.

Zone 3

Zone 3 of the TPP Corridor is a stand of existing trees that shall remain at least 30 m wide to visually screen Areas 2 and Area 3 along Concession Road 10. No monitoring data on the trees in this zone was collected in 2016. The Ecological Monitoring Report states that this data will be collected prior to extraction operations commencing in Area 2.

6.0 BLASTING MONITORING PROGRAM

Condition 8.2 of the AMP requires the implementation of the Blasting Monitoring Program to ensure that blasting operations are carried out in a safe and productive manner and to ensure no damage to any buildings, structures or residences surrounding the Keppel Quarry.

Blasts were designed by Austin Powder Ltd. so that the seismic activity (vibrations) and noise induced by blasting operations remain within the guidelines set by the MOECC. Austin Powder Ltd. set up the primary monitors and HSCL we set up any additional monitors as required.

As per Condition 8.1 of the AMP, all blasts were monitored for vibration and overpressure using digital seismographs at the following Blasting Receptors (BR):

- BR1 - Ritchie Property; and
- BR2 - Cramp Property.

Although not required by the AMP, the following blasting receptors were also monitored as required:

- BR3 - McGregor residence;
- BR4 - Ruthven residence; and
- BR5 – Wilde residence.

The location of each blasting receptor is shown on **Figure 4**. The following is a summary of the results of the Blasting Monitoring Program.

6.1 Blast Monitoring Results

There were eight blasts in 2016 while on the following dates:

1. May 19, 2016;
2. June 14, 2016;
3. July 21, 2016;
4. August 18, 2016
5. September 22, 2016;
6. October 14, 2016;
7. November 10, 2016; and
8. December 8, 2016.

No flyrock was generated beyond the blast area in any of the blasts in 2016.

Event Reports showing noise and vibration readings measured in 2016 during each blast are found in **Appendix E-1** and the results are summarized in **Table 23**. Seismograph readings showed that vibrations levels ranged from 0.2 mm/sec (BR3) to 11.2 mm/sec (BR5). On average the vibration levels were 3.2 mm/sec. Overpressure readings ranged from to 94 dB (BR5) to 139.6 dB (BR1), 121.3 dB on average.

The recommended limit set by the MOECC for vibration and overpressure (noise) are as follows:

- Vibration - 12.5 mm/sec; and
- Overpressure (Noise) - 128 dB.

All measured vibration levels were below the recommended MOECC limit in 2016.

There were four overpressure exceedances in 2016. The first exceedance occurred during the blast on May-19-16 at BR1 (139.6 dB). The other three exceedances occurred on Dec-8-16 at BR1 (133.6 dB), BR3 (131.7 dB), and BR4 (128.3 dB). Austin Powder Ltd. reviewed the blast monitoring data to determine the cause of each exceedance (**Appendix E-2**). The exceedance that occurred on May-19-16 was attributed to insufficient charge confinement in the front row of blast holes. The exceedances that occurred on Dec-8-16 were attributed to low ceiling (cloud) height.

To ensure no negative impact related to blasting, Condition 8.3 of the AMP requires private well no. 3345 (the Ritchie well) and the replacement water supply well for Private well no. 7253 (the Cramp well) to be sampled annually for the following parameters:

- hardness, alkalinity, pH, conductivity, chloride, nitrite, nitrate, calcium, magnesium, iron, ammonia and sodium.

Since the resident at Private Well 3345 declined to be part of the program in 2016, a sample was not obtained. No sample has been collected from the replacement well on Cramp's property because its installation is pending authorization from Cramp (discussed **Section 3.3**).

7.0 SITE PLAN AMENDMENTS

Trigger values for the Sentry Wells require revisions. As per Condition 10.3 of the AMP, a Site Plan Amendment application must be submitted to the MNRF so that the amended trigger values can be considered. Since 2016 was an abnormally dry year, even the amended 2016 trigger values were exceeded at some of the Sentry Wells. Since new lows were observed in 2016, the amended trigger values should be revised again to reflect this new data, otherwise HSCL will risk ongoing false alarms. The proposed new (2017) trigger values are found in **Table 20**. As with 2016, MTE recommends collecting another year of data using these trigger values before submitting a Site Plan Amendment application to ensure they perform properly.

8.0 SUMMARY

8.1 Water Resources Monitoring

- 2016 was a 'dry' year for precipitation. Total annual precipitation for the Site was below the Climate Normal (832 mm vs. 1,048 mm) with only three months (January, June and August) having above average precipitation.
- 2015/2016 was the first time since 2009/2010 when two drought years occurred in sequence.
- Two observation wells were destroyed in 2016 (OW34 and OW35) during extraction in Area 1a.
- OW72s was installed in 2016 to replace OW11s, which was destroyed in 2015.

Shouldice Wetland

- Bedrock groundwater levels under the Shouldice Wetland showed baseline seasonal trends indicating that the movement of groundwater into the wetland was unaffected by extraction in 2016.
- Based on flow data collected at the Shouldice Wetland springs (s8, s9 and s13) and the culverts, the hydroperiod ended in April for the springs, while the culverts continued to flow until June in 2016. No flow was observed in the fall in the wetland. This hydroperiod was shorter than in previous years due to 2016 being a dry year.
- EC and water temperatures measured in the Shouldice Wetland 2016 were comparable to historical data.

Glen Management Area

- Bedrock groundwater levels measured between the Keppel Quarry and the Glen Management Area showed baseline seasonal trends but remained subdued through the fall and did not start to recover until the winter. This extended recovery period is attributed to 2016 being a dry year.

- EC and water temperatures measured in the Glen Management Area were comparable to historical data collected.
- Even though the hydroperiod for the beaver dam and sinkhole ended in May, 2016, the springs found in the Glen Management Area flowed all year, with the exception of s2, which stopped flowing in July. There may have been water sinking upstream of the beaver dam along the joint that makes up the sinkhole as these two features are connected by a discrete karst feature.

Zone of Influence

- Groundwater flow mapping showed that the zone of influence for the shallow bedrock flow regime was negligible in 2016 (less than 40m) while the zone of influence for the deep bedrock groundwater flow regime extended approximately 400 m from the quarry face, which is consistent with predictions made in previous reports (MTE, 2011a and MTE, 2015).
- The zone of influence expanded to the north towards the Glenn Management Area in 2016 to a distance of 300 m compared to 200 m in 2015. This migration is attributed to 2016 being a drought year, particularly the month of July, which caused water levels to be lower through the fall in 2016 compared to previous years.
- Groundwater horizontal and vertical gradients measured in 2016 were comparable to previous years.
- Beyond 400 m there is no impact to groundwater resources related to the Keppel Quarry.

Trigger Values

- Several trigger values were exceeded in 2016 at the Sentry Wells, which were all attributed to 2016 being a dry year. No exceedances were related to extraction.
- With the exception of an increased monitoring frequency to confirm that exceeded trigger values were climatic related, no mitigation actions were required in 2016.
- Since new lows were observed in 2016, the trigger values should be revised to reflect the new data otherwise HSCL will risk ongoing false alarms.
- Green exceedances occurred as early as Apr-25-16 but notification was not provided until Sept-14-16. Even though the breeched values were interpreted to be false alarms, notification should have occurred sooner. To this end, MTE will investigate ways to improve the efficiency at which data is compiled and checked so that the notices can be delivered sooner.

Private Well Monitoring

- There were no well interference complaints received by HSCL in 2016.
- Water levels measured in private wells showed normal baseline seasonal fluctuations or drawdown related to the normal household use of the well. No water fluctuations were observed related to extraction.

8.2 Ecological Monitoring

- Ecological monitoring completed in the ANSI (EMA-1) showed no change in the 'Upper Canopy Live Tree', 'Canopy Layer Composition', 'Standing dead Tree' or 'Downed trees & woody Debris' data.
- No woodland breeding bird monitoring data (EMA-2) was collected in 2016 because it was not required in Year 2.
- Flora diversity in the Glen Management Area (EMA-3) around springs s1 and s3 was not inspected in 2016 because all required baseline data was collected in 2015.
- Anuran surveys completed in the Shouldice Wetland near spring s8 (EMA-4) and spring s13 (EMA-6) found a total of five and five species of frogs, respectively.
- Anuran surveys completed in the Ephemeral Pond (EMA-5) found a total of three species of frogs. No salamanders were found.
- There was no measureable difference in flora composition in the lobe of the Shouldice Wetland encompassing s13 and the dugout pond (EMA-6).
- Macro-Invertebrate sampling in EMA-6 was unsuccessful because there were insufficient amounts available to meet required capture targets. If insufficient collection continues in Year 3, then the ongoing monitoring should be reconsidered.

Tree Preservation Plan

- Zone 1 Tree Screening-Preservation data is to be updated in the summer of 2017.
- In Zone 2, there were nine trees identified as meeting replacement protocol with an additional 111 trees identified for pending action requirement protocols.
- Zone 3 Tree Screening-Preservation data is to be updated prior to extraction in Area 2.

8.3 Blast Monitoring

- There were eight blasts at the Keppel Quarry in 2016 which took place in Area 1a With the exception of the removal of cap rock in Area 1b, most extraction activities occurred in Area 1a.
- No water issues were encountered while extraction occurred. All dewatering was done within the specification of the Permit.
- No fly-rock was generated beyond the blast area in any of the blasts in 2016.
- There were two noise exceedances for overpressure in 2016, which were mitigated by altering the blast design.
- All measured values for vibration were below the recommended MOECC limit.

9.0 CONCLUSIONS

Based on the monitoring data, MTE concludes that:

1. Extraction did not cause any negative impacts to groundwater resources in 2016;
2. Ecological monitoring showed no impacts related to quarry activities in 2016; and
3. No negative impacts relating to blasting occurred in 2016 (i.e. no water issues and no fly-rock).

10.0 RECOMMENDATIONS

MTE offers the following recommendations:

1. Now that OW11s has been replaced with OW72s, the replacement of OW11d can be deferred until it is deemed required by the AMP.
2. Consider replacing the staff gauge at s8 to ensure the manual measurements and the data logger are in-sync.
3. Survey the staff gauge installed in the ephemeral pond for elevation and location with respect to meters above sea-level using total station or GPS survey equipment.
4. Survey the well head of all Category B Private Wells for elevation and location with respect to meters above sea-level using total station or GPS survey equipment so that trigger values can be established.
5. Revise the seasonal trigger values proposed in the 2015 AMP compliance Report to reflect the new seasonal low water levels observed during the 2016 monitoring program as per **Table 20** of this report.
6. Collect another year of data using the 2017 trigger values proposed in this report (**Table 20**) before submitting a Site Plan Amendment application to ensure they perform properly.
7. MTE should investigate ways to improve the efficiency at which data is compiled and checked so that the notices can be delivered sooner.
8. Collect one more year of water level data from all Category B Private Wells before a yellow trigger value is calculated.
9. Collect monitoring data on the trees in Zone 1 as per the TPP and provide the results of this monitoring in the Ecological Monitoring Report for Year 3.
10. Revise the blast design as per recommendations made by Austin Powder Ltd. to ensure noise levels meet MOECC guidelines.

11.0 LIMITATIONS

Services provided by **MTE Consultants Inc**. (MTE) were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Environmental Engineering & Consulting profession. No other warranty or representation, expressed or implied, as to the accuracy of the information, conclusions or recommendations is included or intended in this report.

This report was completed for the sole use of MTE and their client. It was completed in accordance with the scope of work identified in the introduction of the text. As such, this report may not deal with all issues potentially applicable to the Site and may omit issues, which are, or may be, of interest to the reader. MTE makes no representation that the present report has dealt with any and all of the important features, including any or all important environmental features, except as provided in the Introduction. All findings and conclusions presented in this report are based on Site conditions, as they existed during the time period of the investigation. This report is not intended to be exhaustive in scope or to imply a risk-free facility.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based upon it, are the responsibility of such third parties. MTE accepts no responsibility for liabilities incurred by or damages, if any, suffered by any third party as a result of decisions made or actions taken, based upon this report. Others with interest in the site should undertake their own investigations and studies to determine how or if the condition affects them or their plans.

It should be recognized that the passage of time may affect the views, conclusions and recommendations (if any) provided in this report because environmental conditions of a property can change. Should additional information become available, MTE recommends that it be brought to our attention in order that we may re-assess the contents of this report.

We trust this meets your current requirements. If you have any questions or comments, please do not hesitate to contact the undersigned directly at (519) 743-6500.

Respectfully submitted,

MTE CONSULTANTS INC.

PROFESSIONAL GEOSCIENTIST PETER A. GRAY PRACTISING MEMBER 0335 ONTARIO

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12.0 GLOSSARY OF TERMS

Bedrock (epikarst) - The epikarst is a zone of bedrock openings enhanced by solution weathering that directs flow to local surface features located on the top of the Amabel Plateau. Epikarst found in the Study Area is typically three to five metres deep and is highly efficient at redirecting recharge water (i.e. snow melt water and/or precipitation) infiltration laterally to natural features, such as the Shouldice Wetland. The epikarst component has been described in detail by Daryl W. Cowell & Associates Inc. (Cowell, 2009).

Bedrock (shallow) - Groundwater in the shallow bedrock has shown a delayed response to the presence of the existing Keppel Quarry. Current evaluations showed that shallow groundwater remained unaffected until the existing Keppel Quarry face was within approximately 40 m of an observation well (MTE, 2010). The reduced effect in the shallow bedrock may be, in part, due to recharge received through the epikarst system.

Bedrock (deep) - Current interpretations (MTE, 2009) have shown that the extreme outer edge of the zone of influence for the deep bedrock groundwater was observed up to approximately 400 m away from the face of the existing Keppel Quarry (MTE, 2009 and WGC, 2009). The hydraulic properties (Hydraulic Conductivity and Transmissivity) of the bedrock at the Keppel Quarry are similar to those surrounding the existing Keppel Quarry, and so it is predicted that the Keppel Quarry will exert a similar drawdown on the surrounding deep bedrock groundwater flow system.

Biologist/Ecologist – A scientist who studies living organisms and their relationship to their environment.

Blast Induced Peak Particle Velocity – The rate of change of the velocity amplitude usually measured in mm/sec or in/sec. This is the excitation of the particles in the ground resulting from vibratory motion induced by the blasting operations.

Blast Induced Overpressure – A compression wave in air caused by:

a) The direct action of the unconfined explosive; or
b) The direct action of the confining material subjected to explosive loading.

Co-dominant Tree – a tree that extends its crown into the canopy and receives direct sunlight from above but limited sunlight from the sides. One or more sides of a co-dominant tree are crowded by the crowns of dominant trees.

Cone of Influence – a pumping cone or cone of depression formed in an aquifer around a pumping well as the water level declines. In the case of a quarry, the excavation acts similar to a large well in that surrounding water levels decline in proximity to the quarry resulting in a depressed groundwater surface.

Coniferous Tree – any tree that produces seeds in cones.

Crown – the uppermost branches and foliage of a tree.

Cumulative Caliper – calculated by adding the DBH of several smaller trees planted to replace a Preservation Tree.

Deciduous Tree – shedding or losing leaves annually; the opposite of evergreen. Trees such as maple, ash, cherry, and larch are deciduous.

Diameter at Breast Height (DBH) – is a standard method of expressing the diameter of the trunk of a standing tree, usually taken at 4 1/2 feet above the ground.

Crown Class – see: Co-dominant Tree, Dominant Tree, Intermediate Tree, and Suppressed Tree.

Dominant Trees – trees that extend above surrounding individuals and capture sunlight from above and around the crown.

Emerald Ash Borer – is a green beetle native to Asia and Eastern Russia. Outside its native region, the emerald ash borer (also referred to as EAB) is an invasive species, and emerald ash borer infestation is highly destructive to ash trees in its introduced range. The emerald ash borer was first discovered in America in June 2002 in Michigan. It is believed to have been brought to America unintentionally in ash wood which was used to stabilize crates during shipping.

Environmental Receptor – a groundwater or surface water feature where the quarry influence may have an effect.

Groundwater Sink – a depression in the water table that causes water to be drawn from surrounding groundwater resources.

Hydraulic Conductivity – the rate of flow of water through a porous medium such as bedrock fractures or bedding planes.

Hydraulic Gradient – is the change in static head per unit of distance in a given direction.

Hydrogeologist - a professional geoscientist or a licensed professional engineer specializing in hydrogeology.

Hydroperiod – the flow period over which surface water features such as a springs or water courses receives inputs from groundwater and/or overland runoff from surrounding lands.

Infiltration Gallery – a pond or nest of wells drilled into the bedrock that allows water back into the bedrock groundwater flow system.

Intermediate Crown Class – trees with crowns that extend into the canopy with dominant and codominate trees. These trees receive little direct sunlight from above and none from the sides. Crowns generally are small and crowded on all sides.

Karst Flow – the movement of groundwater through preferentially-enhanced fracture zones within the overall bedrock mass. Typically flow rates (as expressed by the hydraulic conductivity) are significantly greater than within non-karst areas of the bedrock aquifer.

Key Indicator – a feature or thing that is used to help evaluate the performance of the quarry with respect to the natural environment.

Live Crown – is the top part of a tree, the part that has green leaves (as opposed to the bare trunk, bare branches, and dead leaves). The ratio of the size of a tree's live crown to its total height is used in estimating its health and its level of competition with neighboring trees.

Long-Term Monitoring Program – a sequence of regular field activities carried out on a monthly basis to collect data on groundwater and surface water to ensure that there are no significant negative impacts to natural features while the quarries proceeds.

'Natural' Spring Flow – water coming from a spring without being artificially augmented. The spring must be flowing in its natural state or in a manner that is comparable to pre-quarry conditions.

Performance Monitoring – an evaluation of the extent of the quarry influence on the surrounding environment. data collected through the groundwater/surface water monitoring program will be compared to baseline conditions (data collected before extraction started).

Pathway – a karst conduit, fracture or bedding plane of bedrock that potentially connects a receptor to the quarry.

Preservation Tree – a tree found in the TPP Corridor that has a minimum DBH of 15 cm or a minimum crown height of 5 m.

Qualified Person (for the Water Resources Monitoring Program) – an independent Hydrogeologist.

Qualified Person (for the Ecological Monitoring Program) – an independent biologist or person specializing in ecology.

Qualified Person (for the Blasting Monitoring Program) – a blasting specialist.

Qualified Person (for the Tree Preservation Plan) – an Ecologist, Landscape Architect, arborist, or forester.

Replacement Tree – A tree(s) found in the TPP Corridor (planted or natural) counted as a replacement for a lost Preservation Tree. The Replacement Tree(s) shall have a minimum DBH of 15 cm or a cumulative caliper DBH of at least 15 cm.

Recovery – water level(s) in an observation well(s) that are equal to or higher than green trigger values for at least three monitoring events space one week apart.

Suppressed Tree – a tree condition characterized by low growth rate and low vigor as a result of competition with overtopping trees.

Transmissivity – the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Water Table – is the water surface in an unconfined aquifer at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the aquifer. In wells penetrating the aquifer to greater depths, the water level will stand above or below the water table if an upward or downward component of groundwater flow exists. It should be noted that the technical standards defined in the *Aggregate Resource Act* for reporting Hydrogeological Information define the water table as the static level or surface that the water rises to within any aquifer (confined or unconfined aquifer), which is also referred to as the potentiometric level, and the upper surface as the potentiometric surface.

Water-bearing Fracture – high or turbulent flows from a fracture or bedding plane. Turbulent flow from a water-bearing fracture may be an indication that water is being intercepted from surface water features such as springs. Signs of groundwater inputs in the form of minor leakage and wetted surfaces are not considered turbulent flow.

Well Interference – an unacceptable reduction in groundwater quantity and/or degradation in water quality to a private well caused by dewatering the quarry.

Zone of Influence – the area of influence around a well or the land area above a cone of influence.

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FIGURES

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV15.DWG EV4.4 May 29, 2017 — 2:06 p.m. — Plotted By: kmadsen

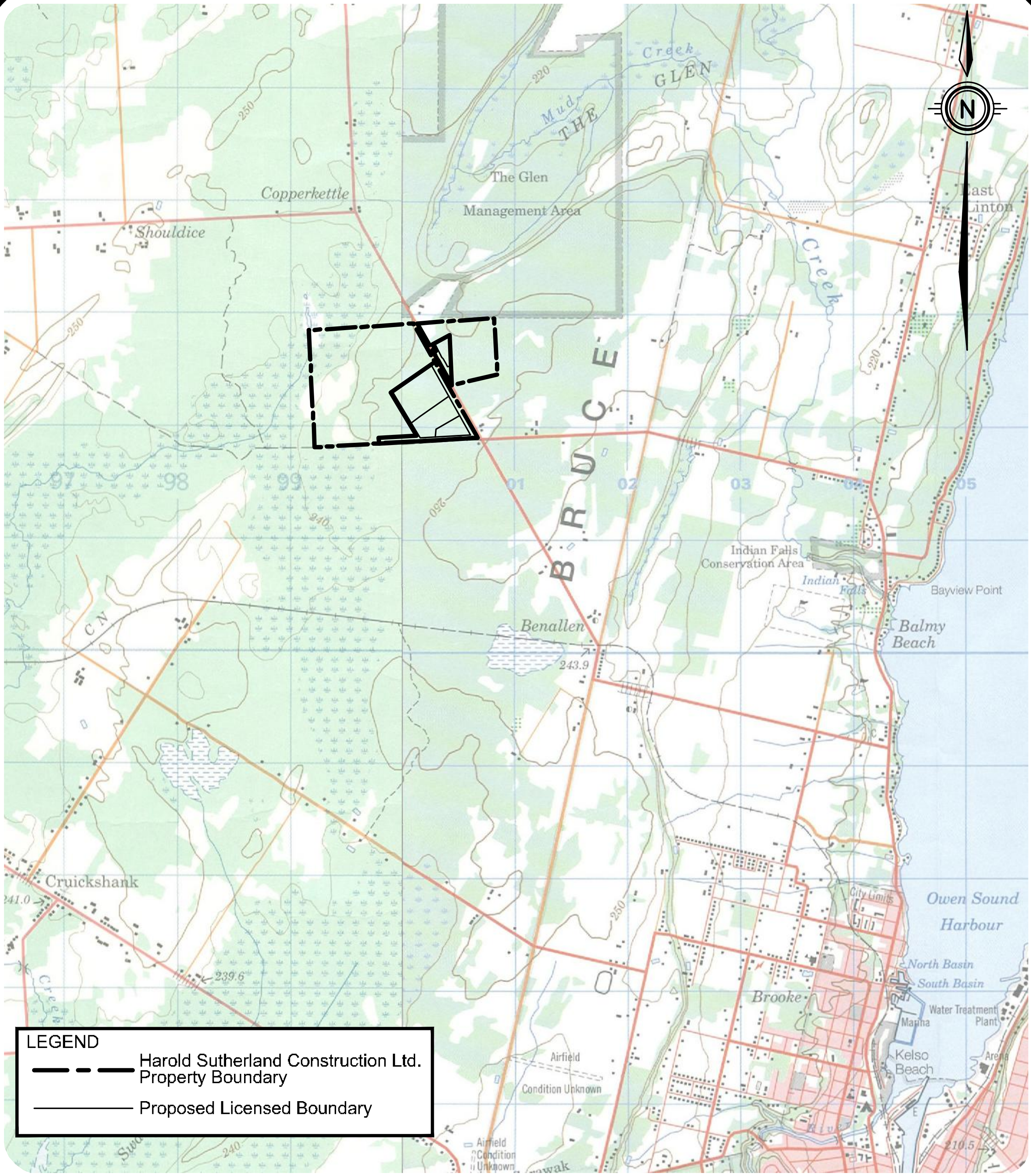

Figure 1 KEY MAP

Project Name			
Keppel Quarry			
Site		Client	
Georgian Bluffs, Ontario		Harold Sutherland Construction Limited	
Scale.	MTE Project No.	Date	Layout No.
1:50,000	33862-100	May 2017	EV4.4

MTE
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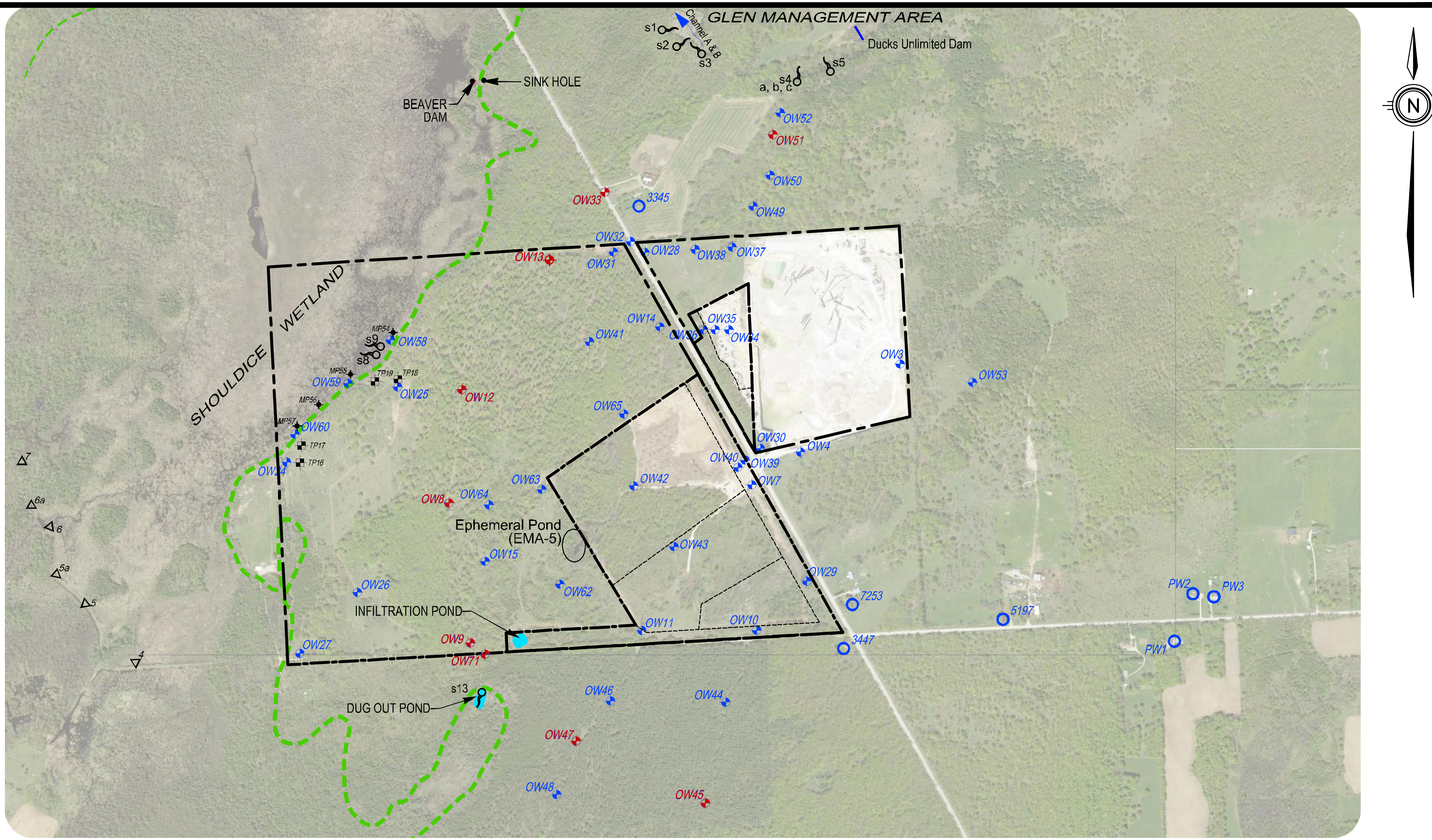

LEGEND

Extraction Area

Licensed Boundary

HSCL owned lands

Culvert Monitoring Locations

Wetland Boundary

OW45 Sentry Well

OW15 Observation Well

3447 Private Well (Category A)

PW1 Private Well (Category B)

TP18 Test Pit

MP55 Mini Piezometer

Spring Location

Figure 2 WATER RESOURCES MONITORING NETWORK

MTE
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Project Name	
Keppel Quarry	
Site	Client
Georgian Bluffs, Ontario	Harold Sutherland Construction Limited

Scale	MTE Project No.	Date	Layout No.
1:10,000	33862-100	May 2017	EV30.3

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV30.DWG

EV30.3

June 5, 2017 – 10:16 a.m. – Plotted By: kmodsen

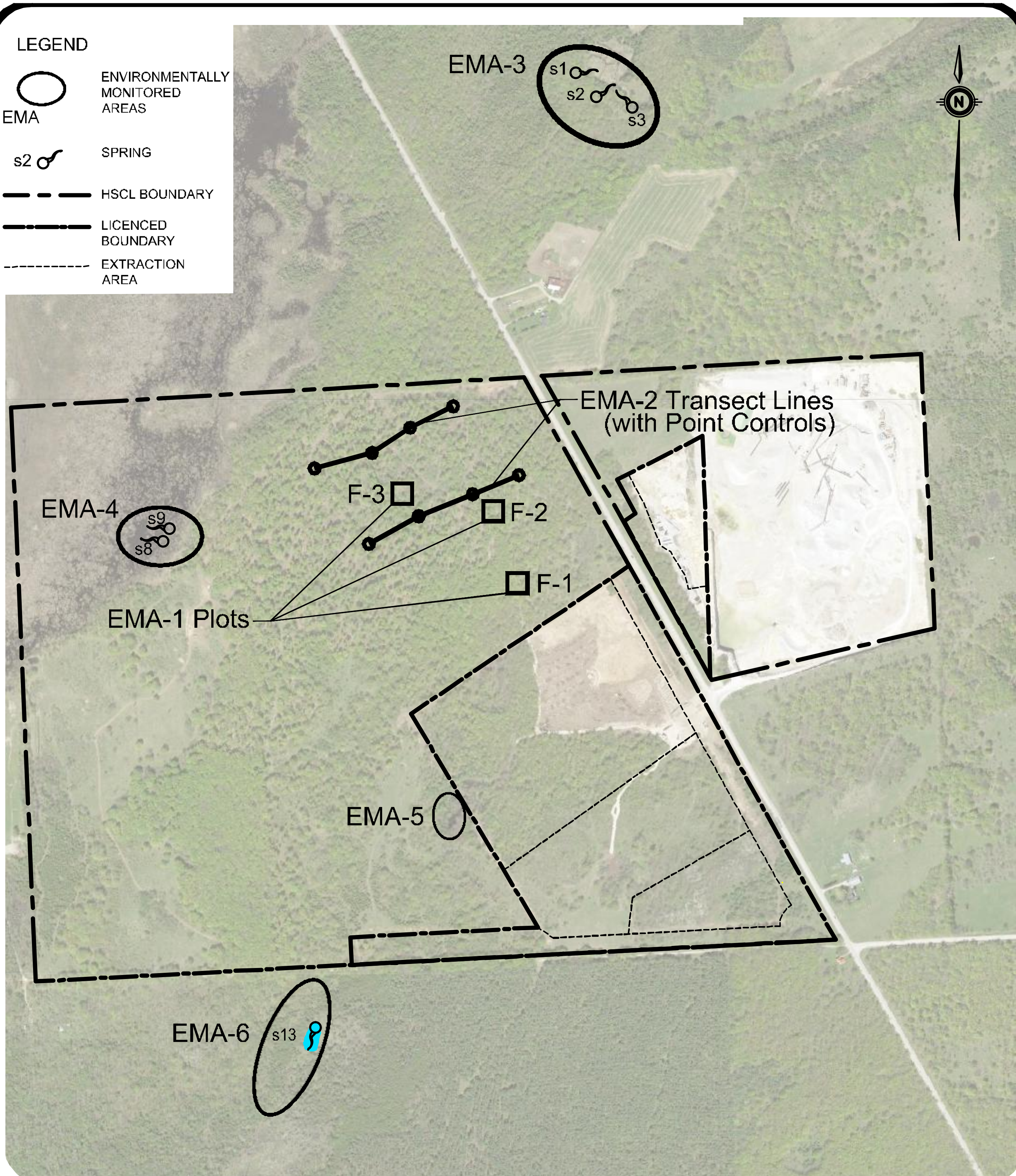

Figure 3 ECOLOGICAL MONITORING NETWORK

MTE
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Project Name	
Keppel Quarry	
Site	**Client**
Georgian Bluffs, Ontario	Harold Sutherland Construction Limited

Scale. (8.5x11)	MTE Project No.	Date	Layout No.
1:5000	33862-100	May 2017	EV14.1

June 5, 2017 — 10:25 a.m. — Plotted By: kmadsen EV14.1 Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV14.DWG

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV15.DWG
EV15.9
June 5, 2017 – 1:31 p.m. – Plotted By: kmadsen

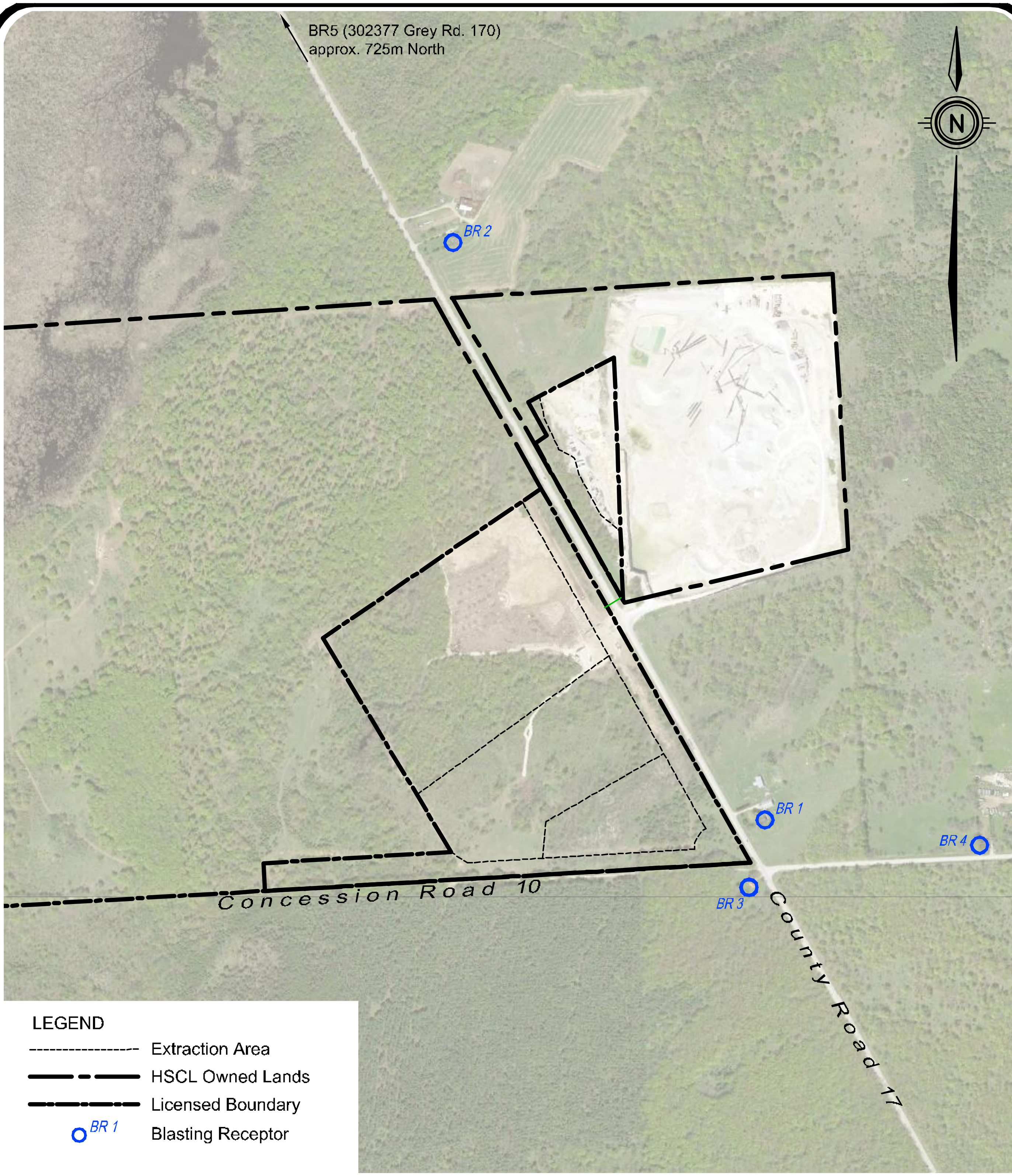


Figure 4 BLASTING MONITORING LOCATIONS

MTE
Engineers | Scientists | Surveyors

Project Name			
Keppel Quarry			
Site		Client	
Georgian Bluffs, Ontario		Harold Sutherland Construction Limited	
Scale. (8.5x11)	MTE Project No.	Date	Layout No.
1:10,000	33862-100	May 2017	EV15.9

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV13.DWG

June 5, 2017 - 1:38 p.m. - Plotted By: kmadsen

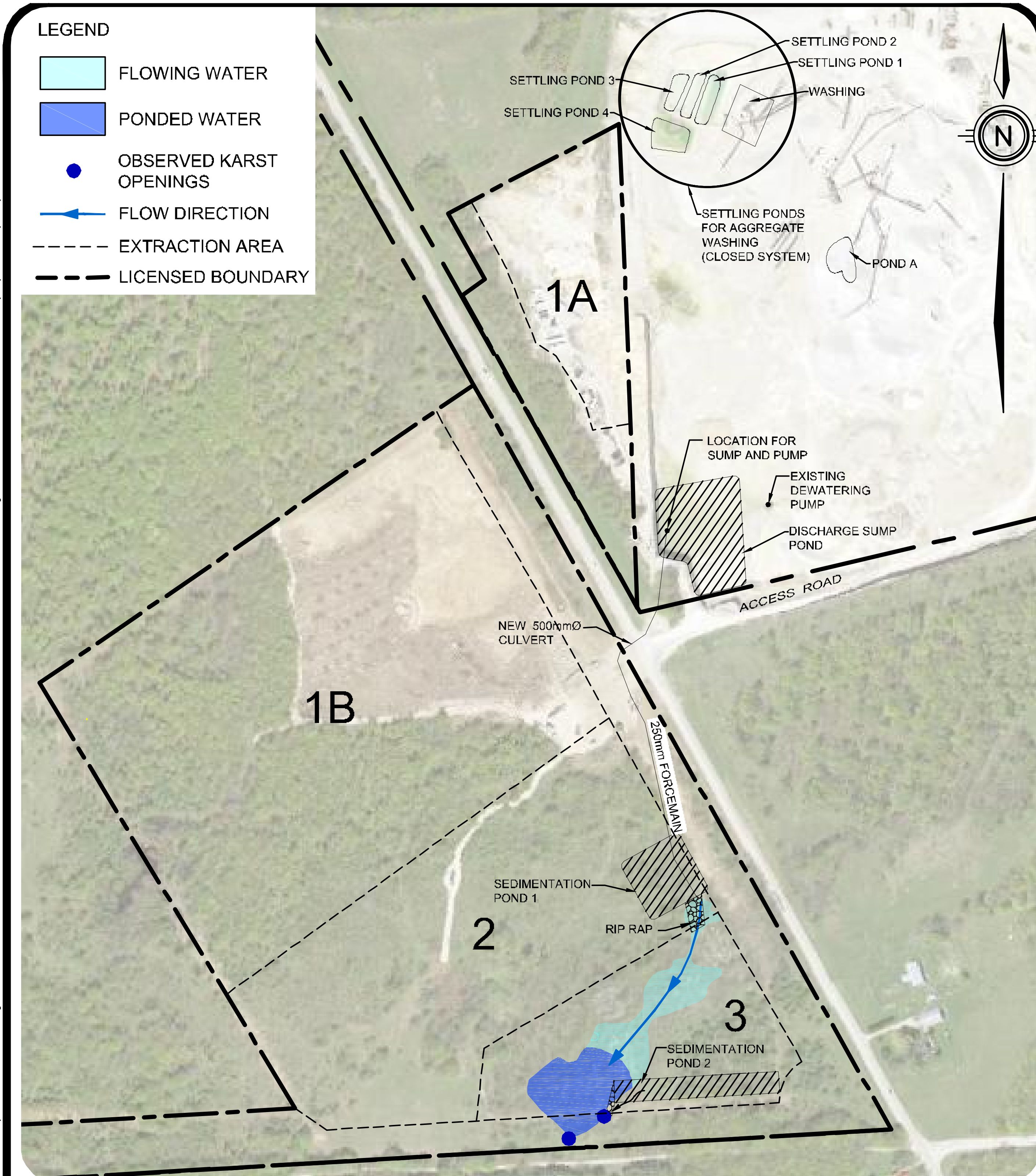


Figure 5 SEQUENCE OF OPERATIONS MAP

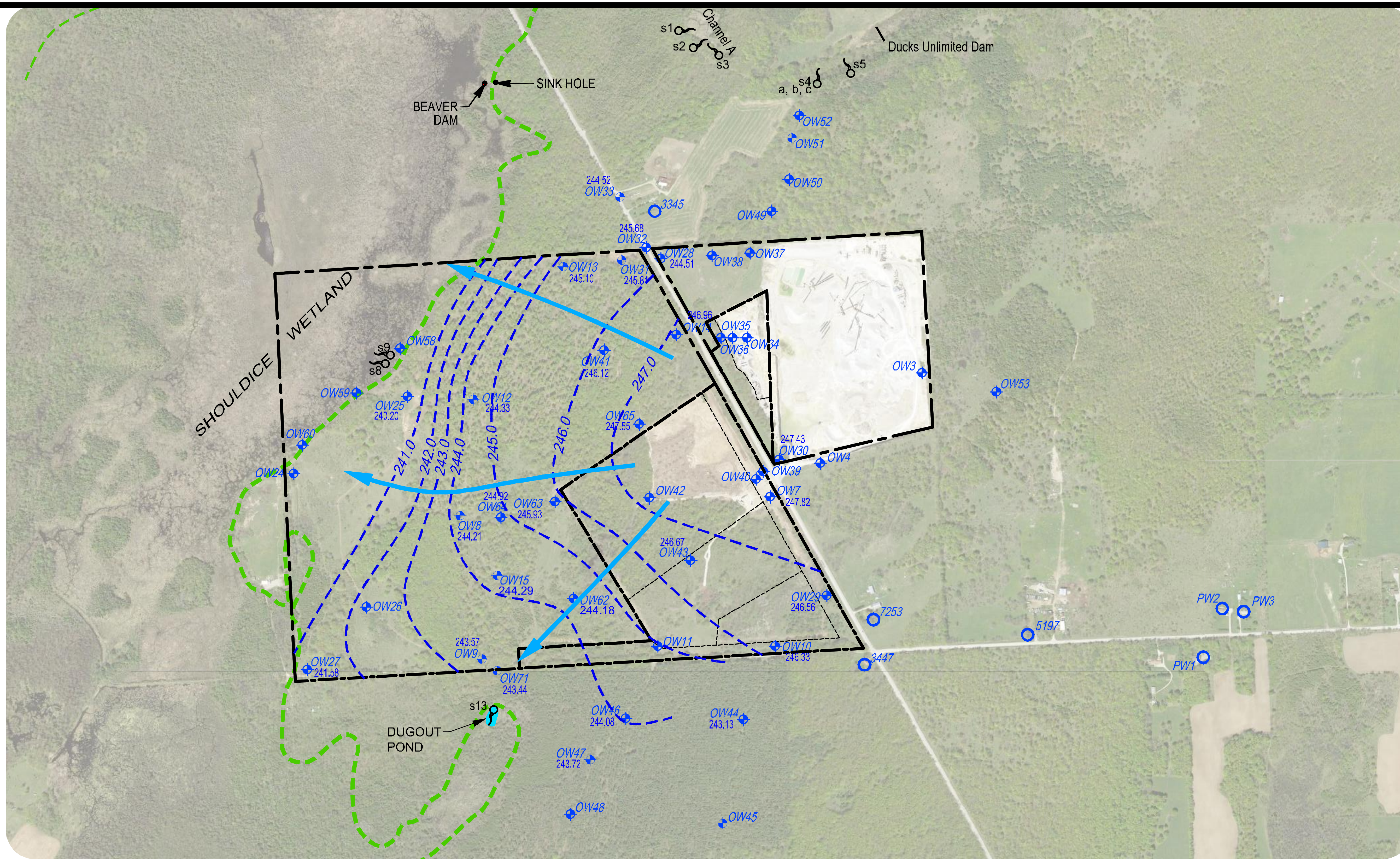
MTE Engineers | Scientists | Surveyors

Project Name			
Keppel Quarry			
Site		Client	
Georgian Bluffs, Ontario		Harold Sutherland Construction Limited	
Scale.	MTE Project No.	Date	Layout No.
1:5000	33862-100	May 2017	EV12.2

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV37.DWG

EV37.3

May 30, 2017 – 1:29 p.m. – Plotted By: kmadsen



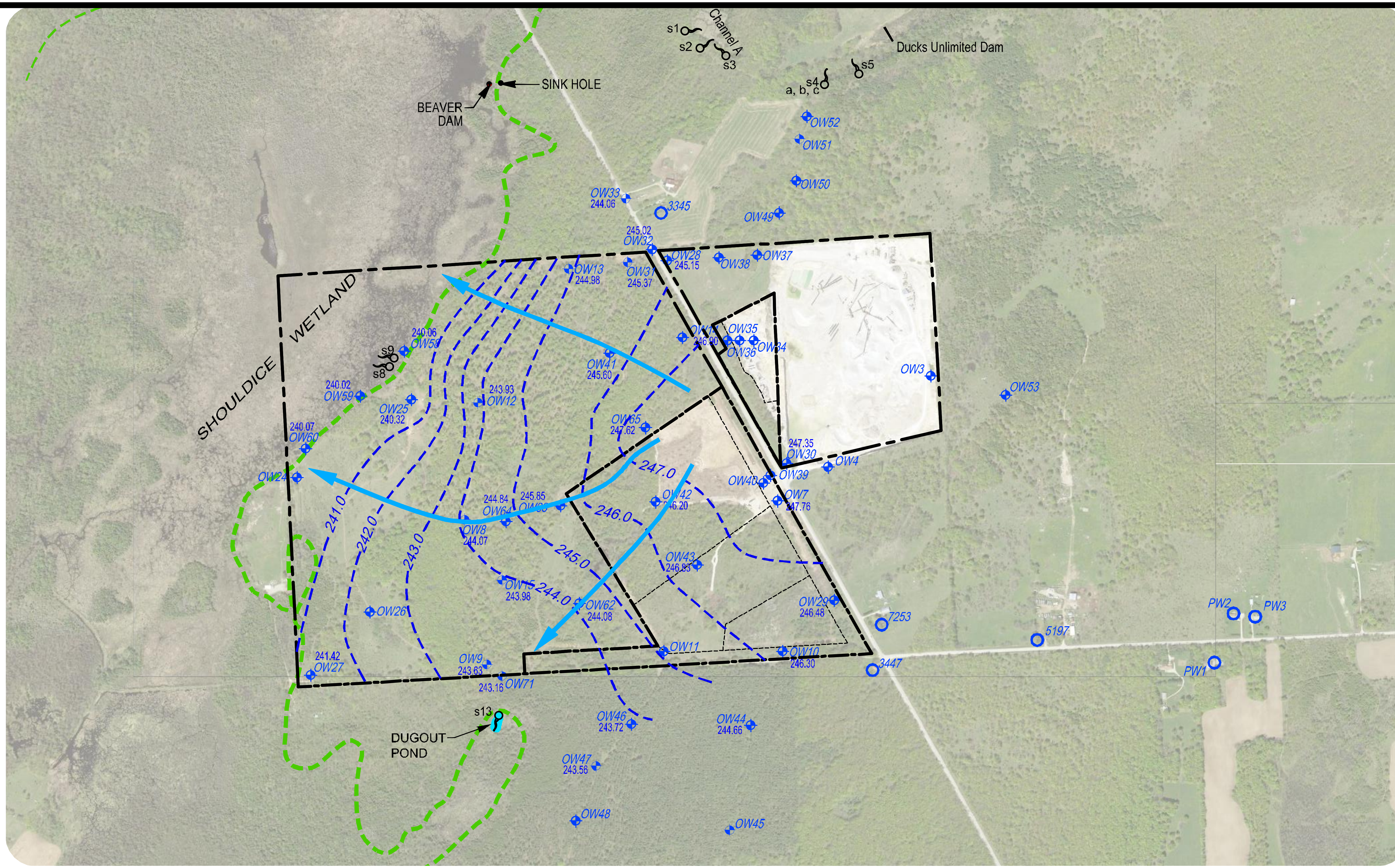
LEGEND

Extraction Area	
Licensed Boundary	
HSCL owned lands	
Wetland Boundary	
OW15 243.47	Monitoring Well Groundwater Elevation (masl) on January 29, 2016
244.0	Groundwater Contour
	Direction of Groundwater Flow
OW15	Monitoring Well
3447	Private Well (Category A)
PW1	Private Well (Category B)
	Spring Location

SHALLOW BEDROCK GROUNDWATER REGIME JANUARY, 2016

MTE Engineers | Scientists | Surveyors

Project Name	Keppel Quarry
Site	Georgian Bluffs, Ontario
Client	Harold Sutherland Construction Limited
Scale.	1:10,000
MTE Project No.	33862-100
Date	May 2017
Figure No.	6



LEGEND

Extraction Area

Licensed Boundary

HSCL owned lands

Wetland Boundary

OW15 243.47 Monitoring Well Groundwater Elevation (masl) on April 28, 2016

244.0 Groundwater Contour

Direction of Groundwater Flow

OW15 Monitoring Well

3447 Private Well (Category A)

PW1 Private Well (Category B)

Spring Location

SHALLOW BEDROCK GROUNDWATER REGIME APRIL, 2016

MTE Engineers | Scientists | Surveyors

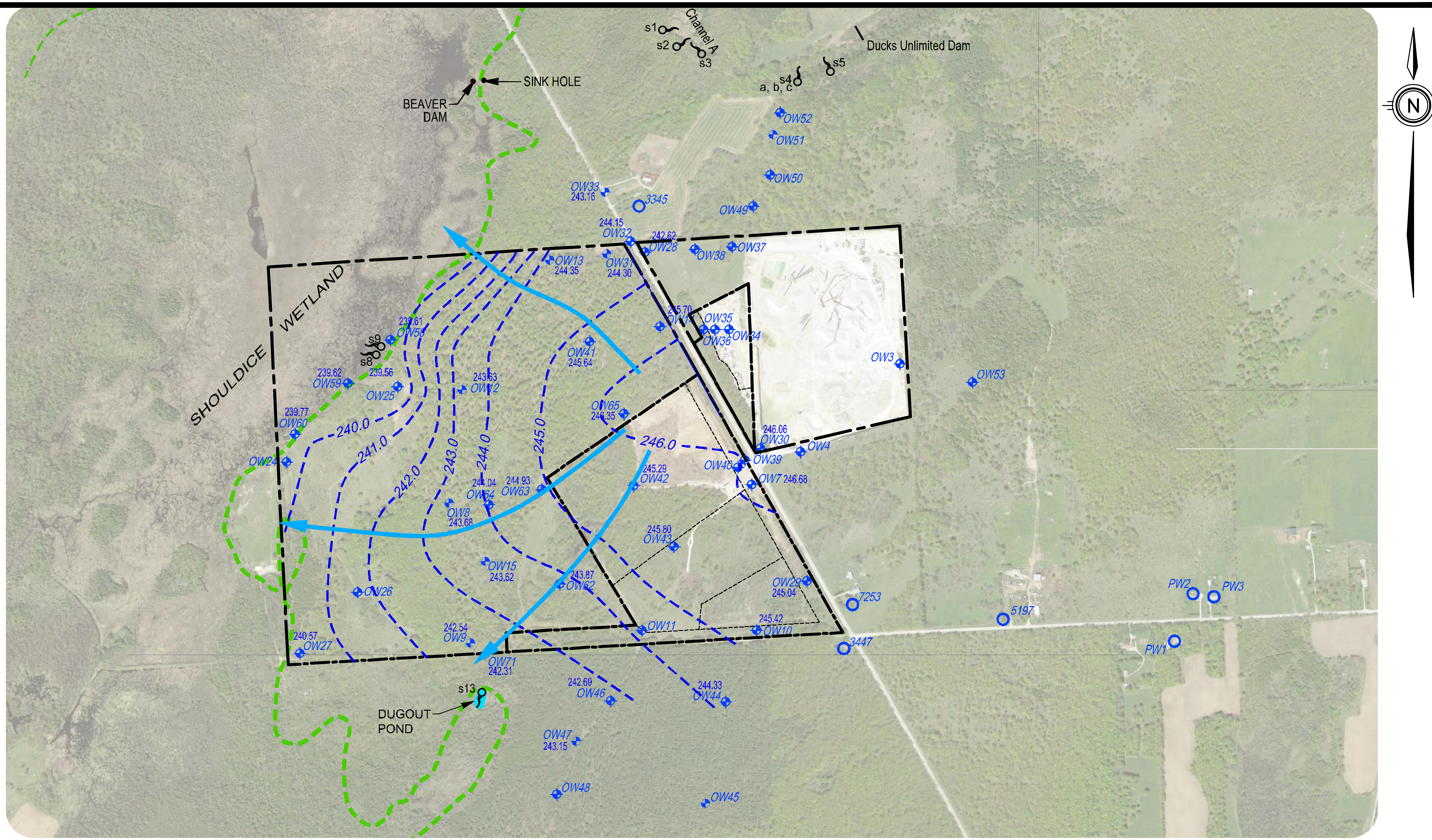
Project Name	
Keppel Quarry	
Site	Client
Georgian Bluffs, Ontario	Harold Sutherland Construction Limited

Scale	MTE Project No.	Date	Figure No.
1:10,000	33862-100	May 2017	7

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV37.DWG

EV37.5

May 29, 2017 – 4:33 p.m. – Plotted By: kmodsen



LEGEND

Extraction Area

Licensed Boundary

HSCL owned lands

Wetland Boundary

OW15 243.47 Monitoring Well Groundwater Elevation (masl) on July 27, 2016

244.0 Groundwater Contour

Direction of Groundwater Flow

OW15 Monitoring Well

3447 Private Well (Category A)

PW1 Private Well (Category B)

Spring Location

SHALLOW BEDROCK GROUNDWATER REGIME
JULY, 2016

MTE Engineers | Scientists | Surveyors

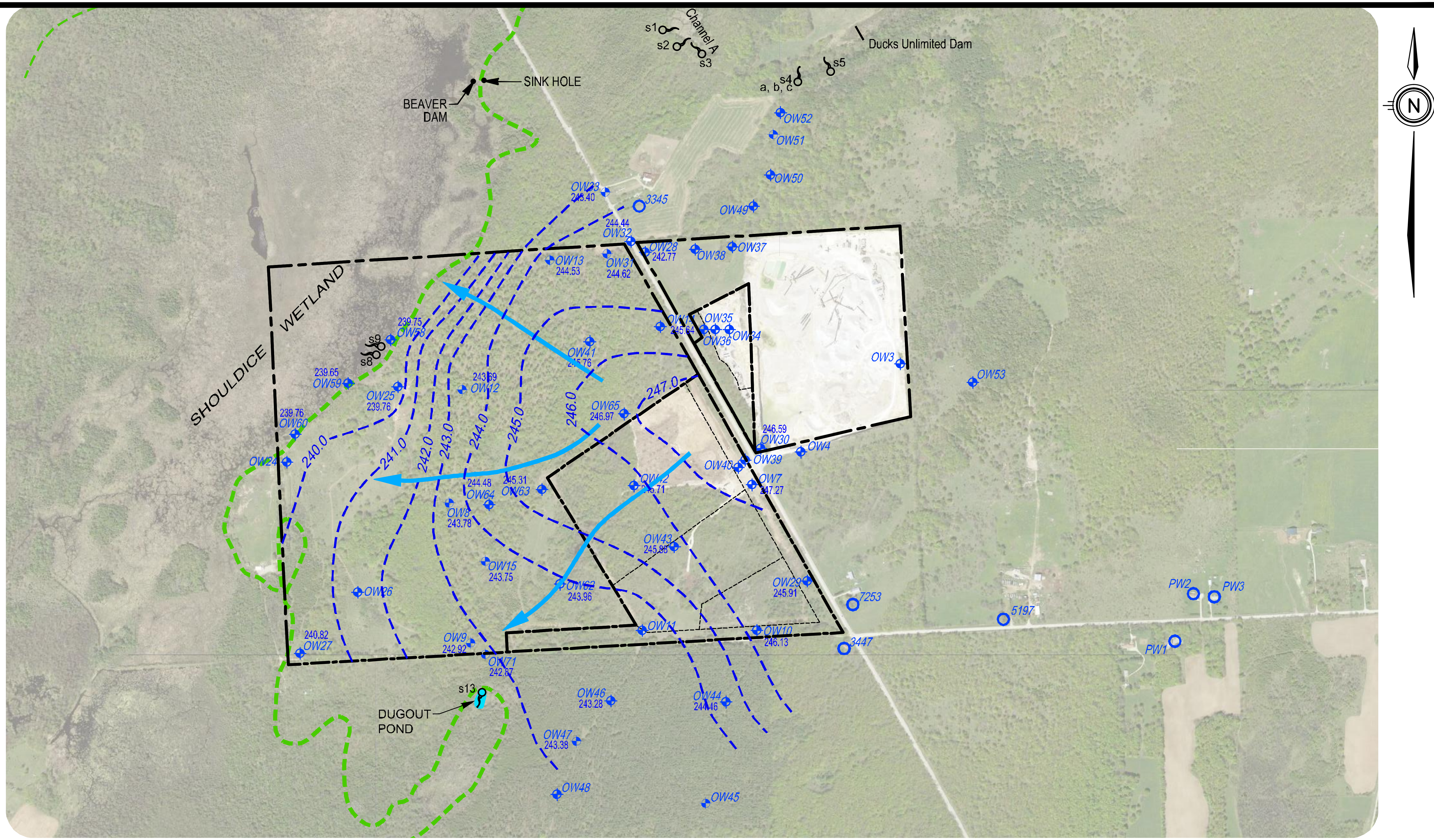
Project Name	
Keppel Quarry	
Site	Client
Georgian Bluffs, Ontario	Harold Sutherland Construction Limited

Scale	MTE Project No.	Date	Figure No.
1:10,000	33862-100	May 2017	8

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV38.DWG

EV38.1

June 5, 2017 – 1:27 p.m. – Plotted By: kmodsen



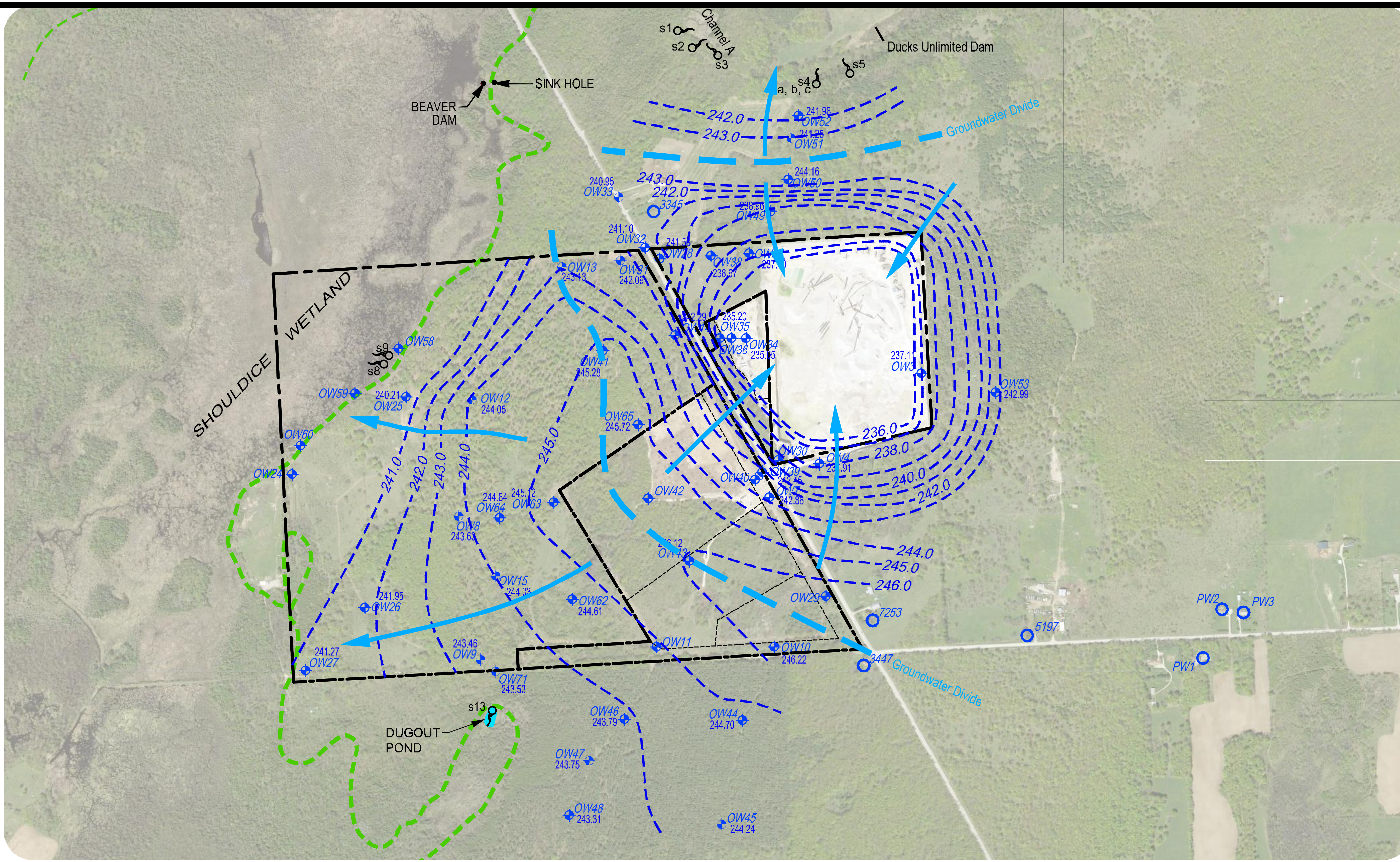
LEGEND

- Extraction Area
- Licensed Boundary
- HSCL Owned lands
- Wetland Boundary
- OW15 243.47 — Monitoring Well Groundwater Elevation (masl) on October 31, 2016
- 244.0 — Groundwater Contour
- Direction of Groundwater Flow
- OW15 — Monitoring Well
- 3447 — Private Well (Category A)
- PW1 — Private Well (Category B)
- Spring Location

SHALLOW BEDROCK GROUNDWATER REGIME OCTOBER, 2016

MTE Engineers | Scientists | Surveyors

Project Name			
Keppel Quarry			
Site: Georgian Bluffs, Ontario		Client: Harold Sutherland Construction Limited	
Scale: 1:10,000	MTE Project No.: 33862-100	Date: May 2017	Figure No.: 9



LEGEND

- Extraction Area
- Licensed Boundary
- HSCL owned lands
- Wetland Boundary
- OW15 243.47 Monitoring Well Groundwater Elevation (masl) on January 29, 2016
- 244.0 Groundwater Contour
- Direction of Groundwater Flow
- OW15 Monitoring Well
- 3447 Private Well (Category A)
- PW1 Private Well (Category B)
- Spring Location

DEEP BEDROCK GROUNDWATER REGIME JANUARY, 2016

MTE Engineers | Scientists | Surveyors

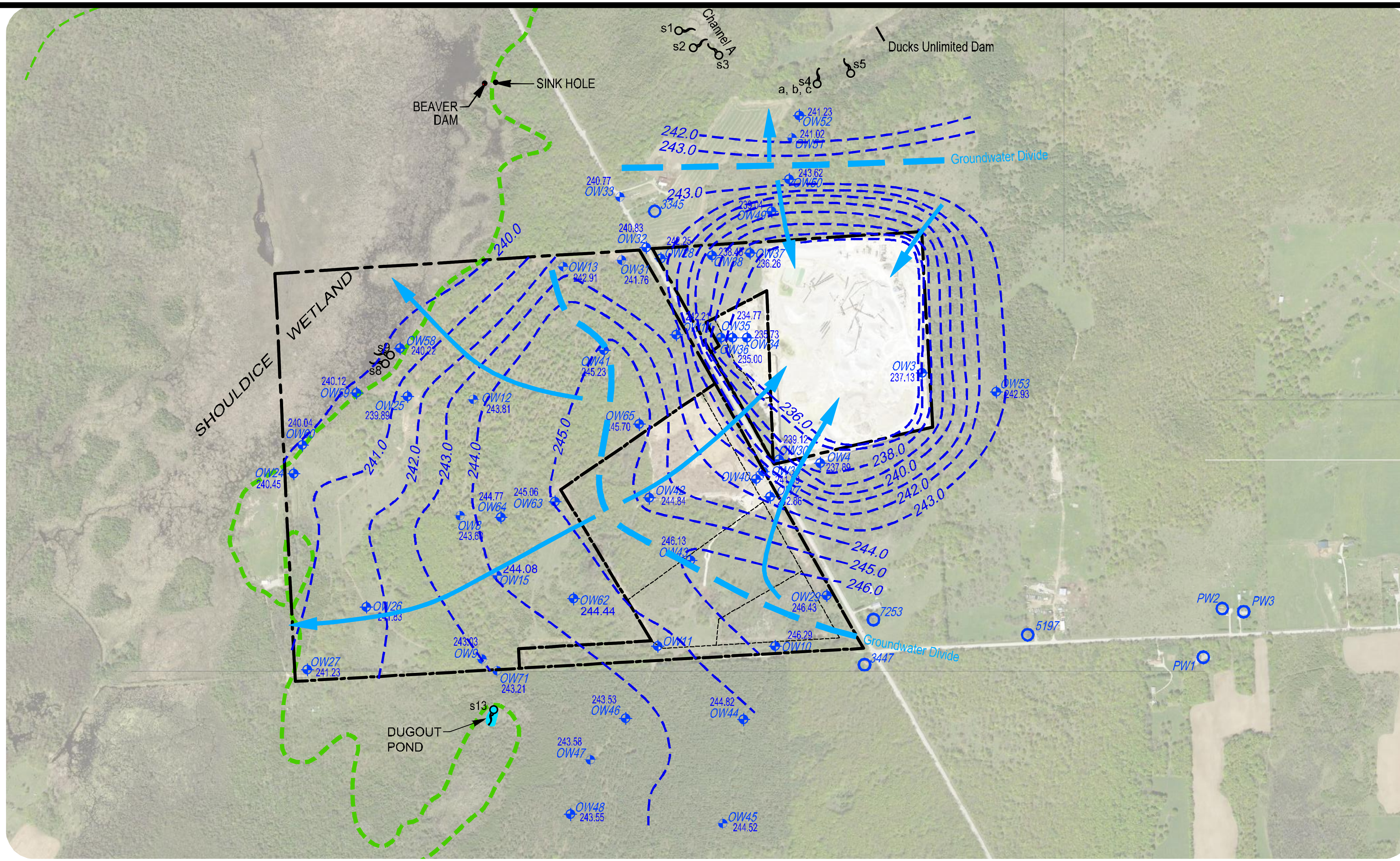
Project Name	
Keppel Quarry	
Site: Georgian Bluffs, Ontario	Client: Harold Sutherland Construction Limited

Scale	MTE Project No.	Date	Figure No.
1:10,000	33862-100	May 2017	10

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV37.DWG

EV37.2

May 30, 2017 – 1:28 p.m. – Plotted By: kmadsen



LEGEND

Extraction Area

Licensed Boundary

HSCL owned lands

Wetland Boundary

OW15 243.47 Monitoring Well Groundwater Elevation (masl) on April 28, 2016

244.0 Groundwater Contour

Direction of Groundwater Flow

OW15 Monitoring Well

3447 Private Well (Category A)

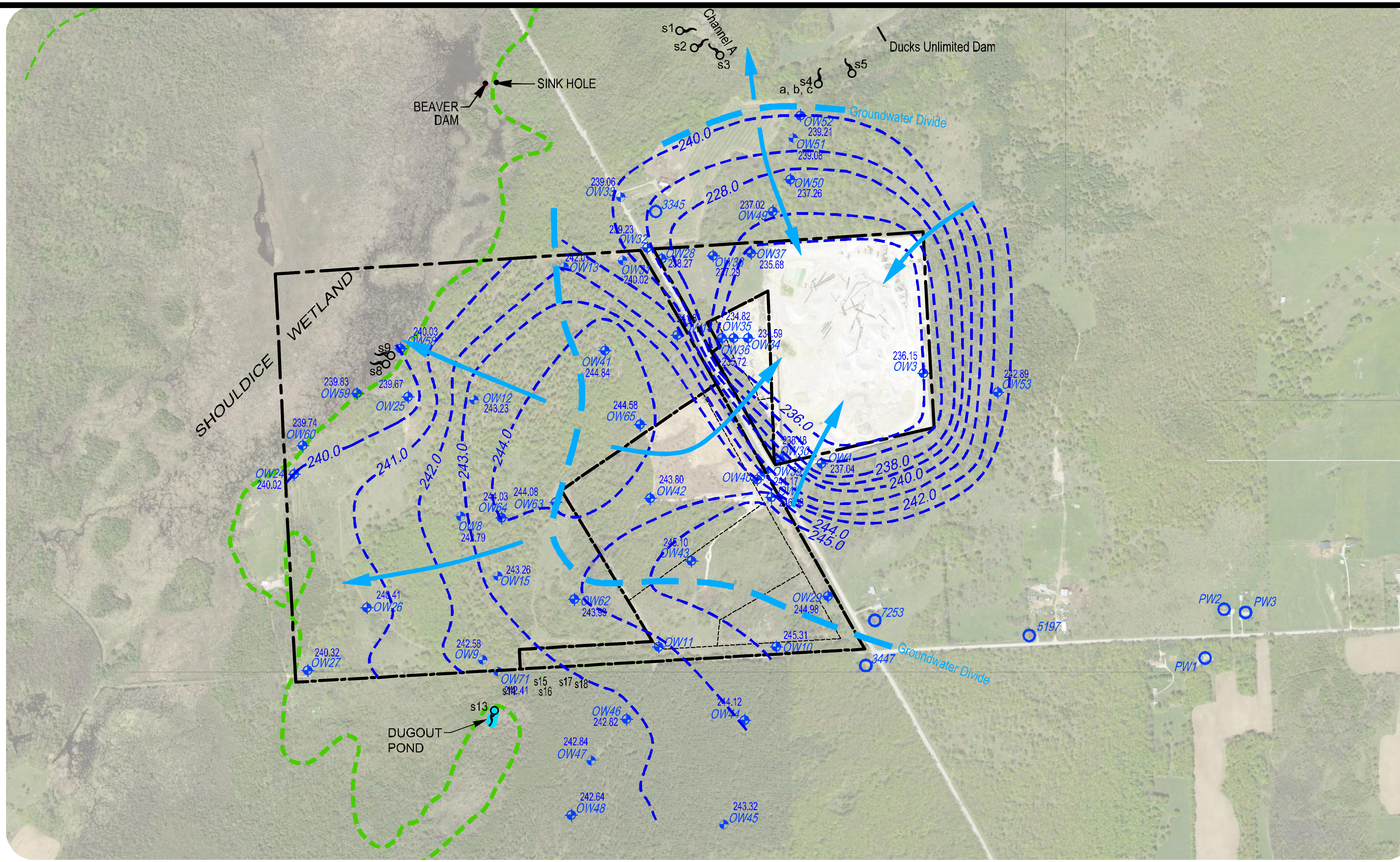
PW1 Private Well (Category B)

Spring Location

DEEP BEDROCK GROUNDWATER REGIME APRIL, 2016

MTE Engineers | Scientists | Surveyors

Project Name			
Keppel Quarry			
Site: Georgian Bluffs, Ontario		Client: Harold Sutherland Construction Limited	
Scale. 1:10,000	MTE Project No. 33862-100	Date May 2017	Figure No. 11



LEGEND

Extraction Area

Licensed Boundary

HSCL owned lands

Wetland Boundary

OW15 243.47 Monitoring Well Groundwater Elevation (masl) on July 27, 2016

244.0 Groundwater Contour

Direction of Groundwater Flow

OW15 Monitoring Well

3447 Private Well (Category A)

PW1 Private Well (Category B)

Spring Location

DEEP BEDROCK GROUNDWATER REGIME JULY, 2016

MTE Engineers | Scientists | Surveyors

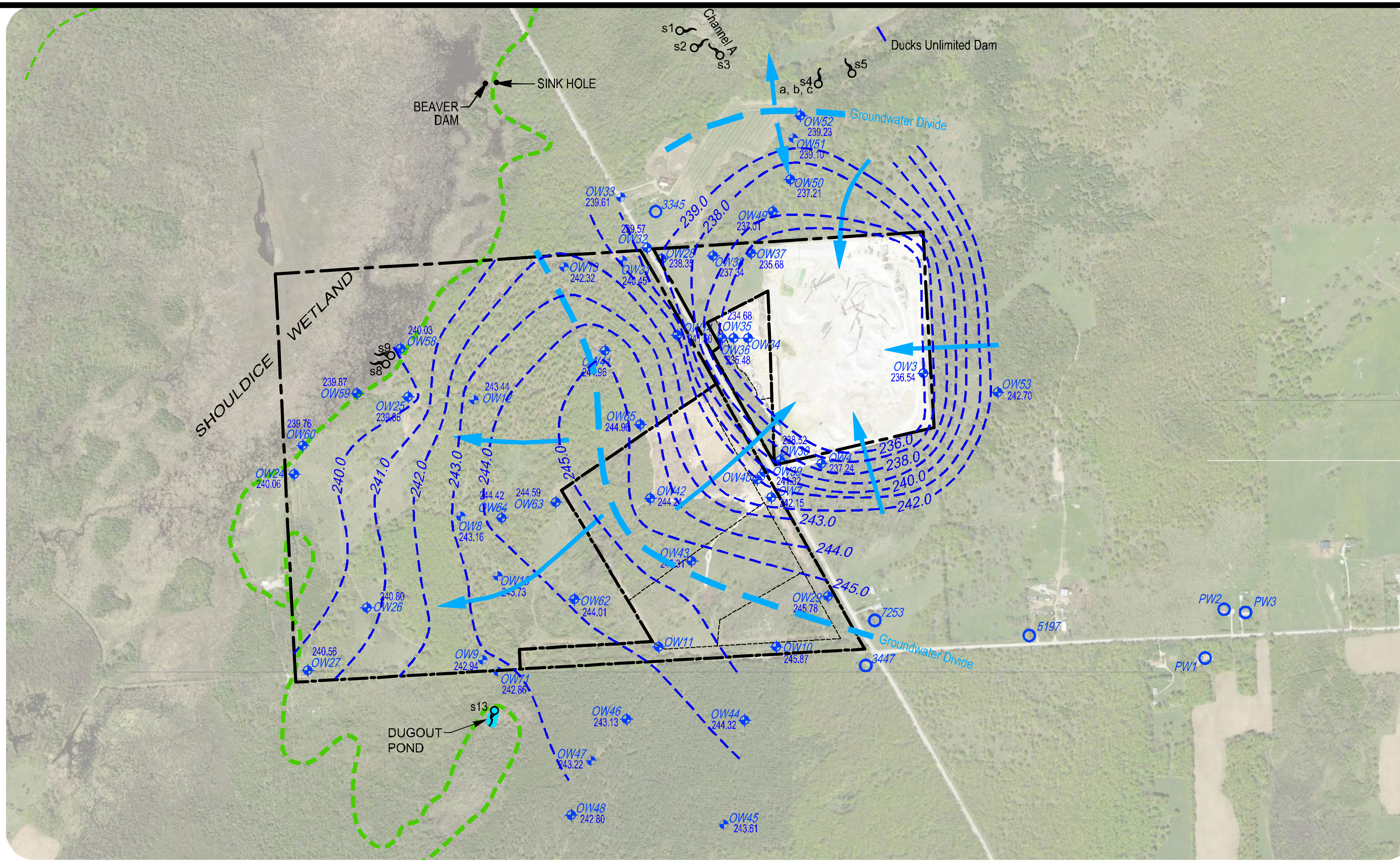
Project Name	
Keppel Quarry	
Site	Client
Georgian Bluffs, Ontario	Harold Sutherland Construction Limited

Scale	MTE Project No.	Date	Figure No.
1:10,000	33862-100	May 2017	12

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV37.DWG

EV37.6

June 9, 2017 – 10:43 a.m. – Plotted By: kmadsen



LEGEND

Extraction Area

Licensed Boundary

HSCL Owned lands

Wetland Boundary

OW15 243.47 Monitoring Well Groundwater Elevation (masl) on October 2016

244.0 Groundwater Contour

Direction of Groundwater Flow

OW15 Monitoring Well

3447 Private Well (Category A)

PW1 Private Well (Category B)

Spring Location

DEEP BEDROCK GROUNDWATER REGIME OCTOBER, 2016

MTE Engineers | Scientists | Surveyors

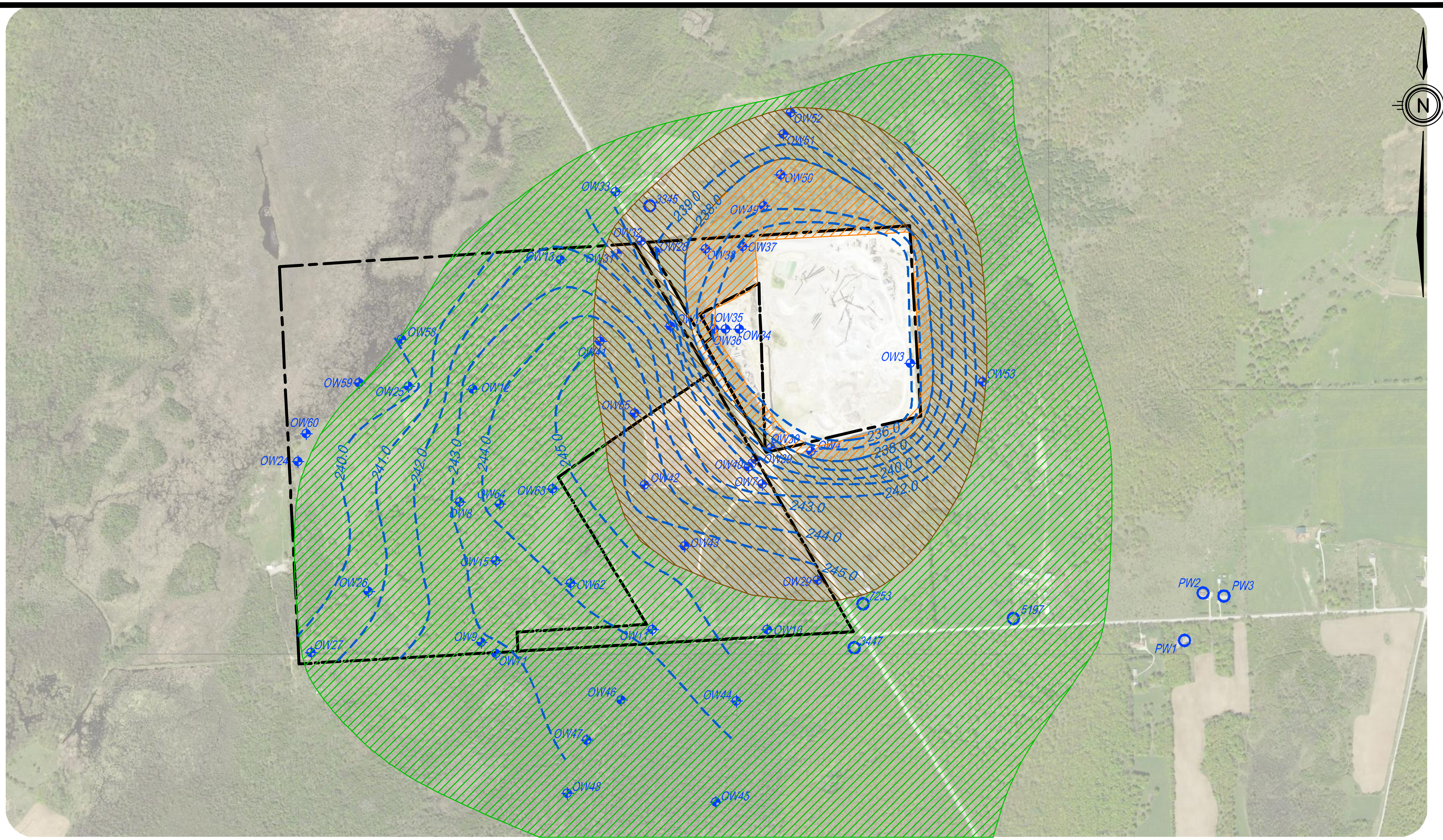
Project Name	
Keppel Quarry	
Site	Client
Georgian Bluffs, Ontario	Harold Sutherland Construction Limited

Scale	MTE Project No.	Date	Figure No.
1:10,000	33862-100	May 2017	13

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV38.DWG

EV38.2

June 12, 2017 – 10:13 a.m. – Plotted By: kmadsen



LEGEND

Extraction Area

Licensed Boundary

HSCL owned lands

OW15 Monitoring Well

3447 Private Well (Category A)

PW1 Private Well (Category B)

ZONE 1
4 - 10m predicted drawdown

ZONE 2
0 - 4m predicted drawdown

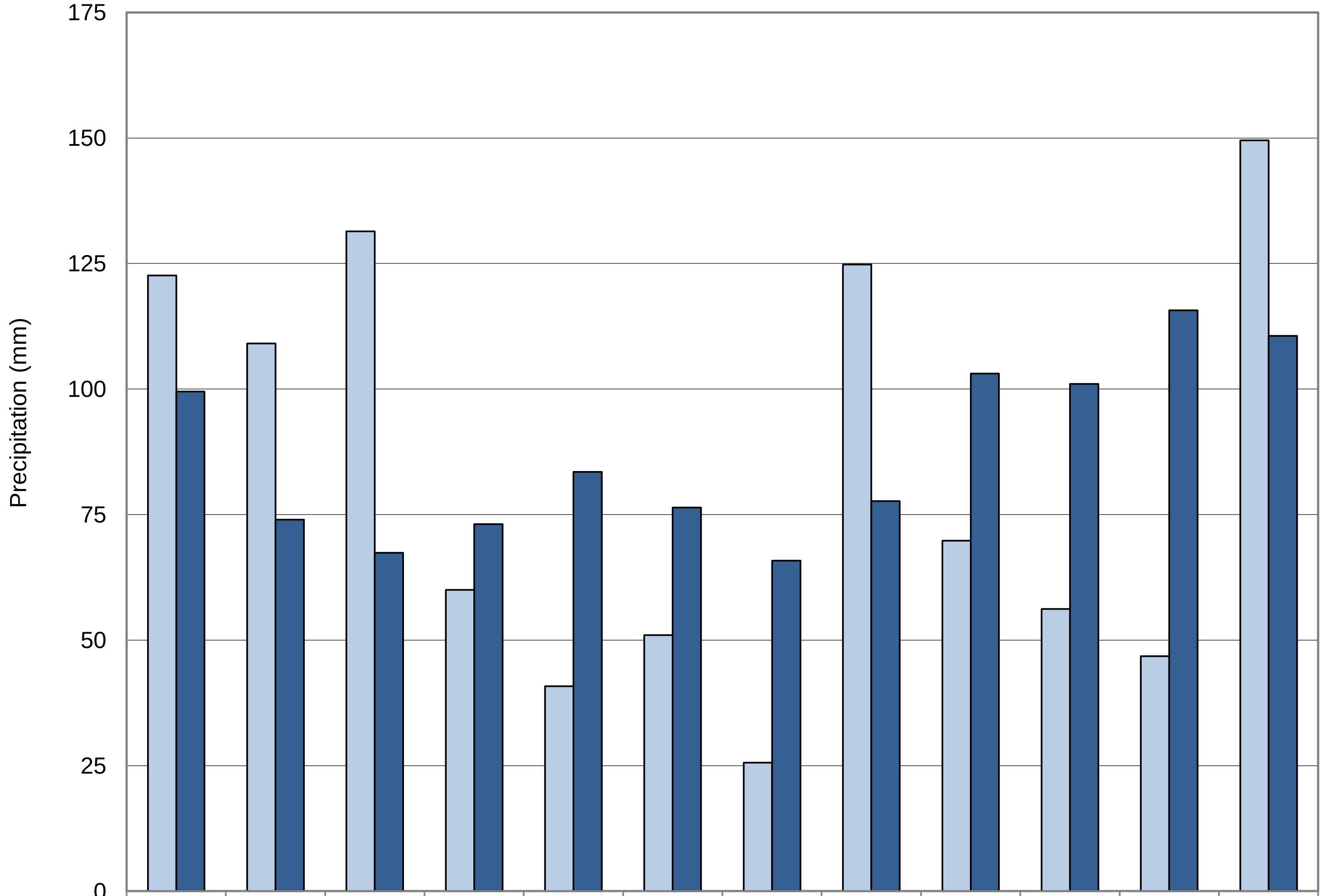
ZONE 3
No Impact predicted

Figure 8 INTERPRETED ZONE OF INFLUENCE - 2016

MTE
Engineers | Scientists | Surveyors

Project Name			
Keppel Quarry			
Site		Client	
Georgian Bluffs, Ontario		Harold Sutherland Construction Limited	
Scale	MTE Project No.	Date	Figure No.
1:10,000	33862-100	May 2017	14

Figure 15 - Monthly Precipitation (mm) - Keppel Quarry (2016) vs. Climate Normals (1981 - 2010)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Keppel Quarry	122.6	109.1	131.4	60.0	40.8	51.0	25.6	124.8	69.8	56.2	46.8	149.5
Climate Normals 1981-2010	99.5	74	67.4	73.1	83.5	76.4	65.8	77.7	103.1	101	115.7	110.6

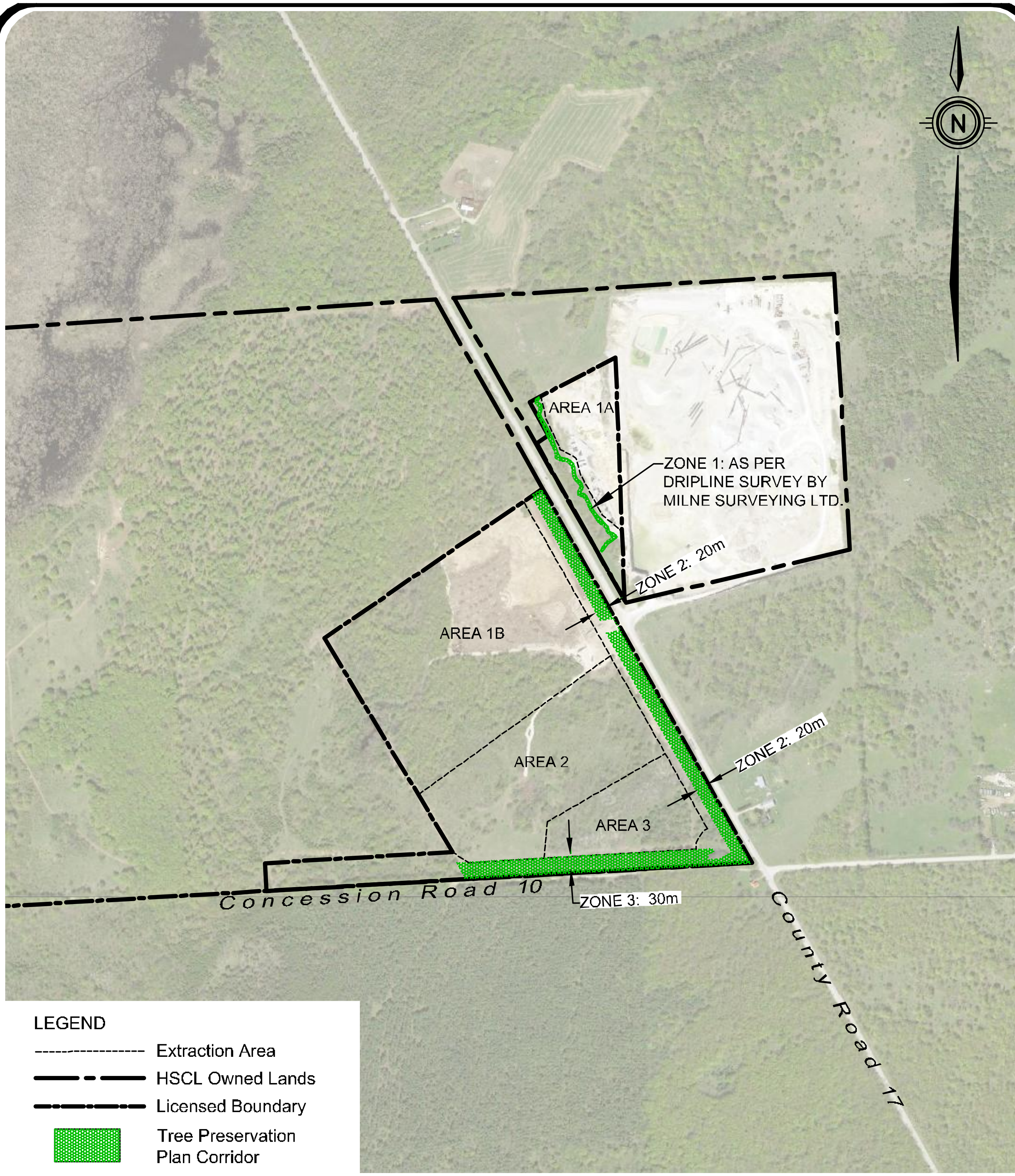


Figure 16 TREE PRESERVATION PLAN

MTE Engineers | Scientists | Surveyors

Project Name	Keppel Quarry
Site	Georgian Bluffs, Ontario
Client	Harold Sutherland Construction Limited
Scale (8.5x11)	1:10,000
MTE Project No.	33862-100
Date	May 2017
Layout No.	EV15.8

June 5, 2017 — 10:56 a.m. — Plotted By: kmadsen EV15.8 Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV15.DWG

TABLES

Table 1: Water Monitoring Program

Item	Station	Type of Monitoring	Number of Events											
			Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Groundwater Monitors	OW3, OW4, OW7s, OW7d, OW8s, OW8d, OW9s, OW9d, OW10s, OW10d, ~~OW11s, OW11d~~, OW12s, OW12d, OW13s, OW13d, OW14s, OW14d, OW15s, OW15d, ~~OW16s, OW16d~~, OW24, OW25s, OW25d, OW26, OW27s, OW27d, OW28s, OW28d, OW29s, OW29d, OW30s, OW30d, OW31s, OW31d, OW32s, OW32d, OW33s, OW33d, ~~OW34, OW35~~, OW36, OW37, OW38, OW39, ~~OW40~~, OW41s, OW41d, OW42s, OW42d, OW43s, OW43d, OW44s, OW44d, OW45, OW46k, OW46s, OW46d, OW47s, OW47d, OW48, OW49, OW50, OW51, OW52, OW53, OW58s, OW58d, OW59s, OW59d, OW60s, OW60d, OW62k, OW62s, OW62d, OW63s, OW63d, OW64s, OW64d, OW65s, OW65d, OW71k, OW71s, OW71d, OW72s	Water Level	1	1	1	1	1	1	1	1	1	1	1	1
	OW8s, OW8d, OW9s, OW9d, OW12s, OW12d, OW13s, OW13d, OW33s, OW33d, OW45, OW47s, OW47d, OW51, ~~OW67s, OW67d~~, OW71k, OW71s, OW71d	Logger Download												
	TP16, TP17, TP18, TP19, MP54, MP55, MP56, MP57	Water Level												
Category A Private Wells	~~3345 (Ritchie)~~, 7253 (Cramp), 5197 (S.Ruthven), 3447 (HSC – rental house)	Water Level	1	1	1	1	1	1	1	1	1	1	1	1
	7253 (Cramp), 5197 (S. Ruthven)	Logger Download												
Category B Private Wells	Thompson (283249 Indian Acres Rd), ~~McCutcheon (283230 Indian Acres Rd),~~ Porter 283253 Indian Acres Rd), Jenks (283242 Indian Acres Rd)	Water Level			1			1			1			1
Shouldice Wetland Surface Water Stations	Culvert 4, Culvert 5, Culvert 5a, Culvert 6, Culvert 6a, Culvert 7	Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1
Shouldice Wetland Dugout Pond	SG1 (plate), SG1 (pvc)	Water Level, Flow, EC, temp Logger Download	1	1	1	1	1	1	1	1	1	1	1	1
	Outflow	Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1
Shouldice Wetland Springs	s8, s9, s13	Water Level, Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1
	s8, s13	Logger Download	1	1	1	1	1	1	1	1	1	1	1	1
Shouldice Wetland – Beaver Dam Sinkhole	At dam, At sinkhole	Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1

Table 1: Water Monitoring Program (Continued)

Item	Station	Type of Monitoring	Number of Events											
			Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Niagara Escarpment Springs	Spring s1, s2, s3, s4(a, b, c), s5	Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1
Niagara Escarpment Ducks Unlimited Dam	Outflow weir	Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1
Niagara Escarpment Mud Creek	Channel A, Channel B	Flow, EC, temp	1	1	1	1	1	1	1	1	1	1	1	1
Ephemeral Pond	SG2	Water Level				4	4	4						
Precipitation	Precipitation gauge	Logger Download	1	1	1	1	1	1	1	1	1	1	1	1
Pumping Records	Flow meter	Totalizer Readings (if pumping)	31	28	31	30	31	30	31	31	30	31	30	31
Water Bearing Fractures	Active Quarry face	Inspect after each blast (photograph)			1	1	1	1	1	1	1	1	1	1

Table 2: Observation Wells – Groundwater Elevations - 2016

Monitoring Location	Groundwater Elevations (mAMSL)																				
	29-Jan-16	23-Feb-16	30-Mar-16	28-Apr-16	17-May-16	22-Jun-16	27-Jul-16	31-Aug-16	29-Sep-16	19-Oct-16	31-Oct-16	1-Nov-16	9-Nov-16	17-Nov-16	25-Nov-16	2-Dec-16	8-Dec-16	23-Dec-16	Min	Max	Avg
OW3	237.11	237.18	237.24	237.13		236.42	236.15	236.81	236.43	-	236.54	-	-	236.51	-	-	-	237.03	236.15	237.24	236.78
OW4	237.91	238.07	238.13	237.89	237.93	237.28	237.04	237.30	237.18	-	237.24	-	-	237.20	-	-	-	237.45	237.04	238.13	237.55
OW7s	247.82	247.87	247.98	247.76	247.78	247.39	246.68	247.37	247.29	-	247.27	-	247.13	246.97	246.99	247.73	247.76	247.53	246.68	247.98	247.46
OW7d	242.86	242.98	243.18	242.86	242.84	242.38	241.65	242.00	242.14	-	242.15	-	242.08	242.04	242.04	242.49	242.56	242.52	241.65	243.18	242.42
OW8s	244.21	244.51	245.41	244.07	244.15	243.83	243.68	243.75	243.74	-	243.78	-	-	243.79	-	-	-	244.01	243.68	245.41	244.08
OW8d	243.63	243.70	244.05	243.60	243.55	243.23	242.79	243.14	243.05	-	243.16	-	-	243.15	-	-	-	243.45	242.79	244.05	243.38
OW9s	243.57	243.47	243.98	243.63	243.32	242.85	242.54	242.91	242.87	-	242.92	-	242.92	242.92	242.90	243.35	243.35	243.14	242.54	243.98	243.17
OW9d	243.46	243.51	243.91	243.03	243.33	242.98	242.58	242.95	242.88	-	242.94	-	242.95	242.96	242.93	242.94	243.24	243.19	242.58	243.91	243.11
OW10s	246.33	246.49	246.86	246.30	246.30	245.97	245.42	245.74	245.58	-	246.13	-	246.10	246.09	246.12	246.48	246.60	246.59	245.42	246.86	246.19
OW10d	246.22	246.48	246.83	246.29	246.24	245.79	245.31	245.55	245.45	-	245.87	-	245.92	245.84	245.87	246.33	246.53	246.36	245.31	246.83	246.06
OW11s	Destroyed																		Destroyed		
OW11d	Destroyed																		Destroyed		
OW12s	244.33	244.50	-	243.93	244.22	243.76	243.63	243.70	243.63	-	243.69	-	-	243.71	-	-	-	-	243.63	244.50	243.91
OW12d	244.05	244.08	-	243.81	243.85	243.53	243.23	243.48	243.36	-	243.44	-	-	243.46	-	-	-	-	243.23	244.08	243.63
OW13s	245.10	245.13	245.56	244.98	245.09	244.70	244.35	244.65	244.45	-	244.53	-	-	244.42	-	-	-	244.73	244.35	245.56	244.81
OW13d	243.13	243.22	243.58	242.91	242.88	242.37	242.01	242.44	242.25	-	242.32	-	-	242.23	-	-	-	242.65	242.01	243.58	242.67
OW14s	246.96	247.02	247.42	246.90	246.86	245.86	245.70	245.81	245.71	-	245.64	-	-	245.60	245.61	245.89	245.96	245.85	245.60	247.42	246.19
OW14d	242.29	242.34	242.52	242.21	242.19	241.95	241.81	241.92	241.78	-	241.50	-	-	241.44	241.48	241.73	241.76	241.93	241.44	242.52	241.92
OW15s	244.29	244.49	245.37	243.98	244.06	243.77	243.62	243.74	243.72	-	243.75	-	-	243.72	-	-	-	243.92	243.62	245.37	244.04
OW15d	244.03	244.39	245.05	244.08	244.14	243.73	243.26	243.70	243.63	-	243.73	-	-	243.69	-	-	-	243.99	243.26	245.05	243.95
OW16s	Destroyed																		Destroyed		
OW16d	Destroyed																		Destroyed		
OW24	-	-	240.65	240.45	240.36	240.13	240.02	239.97	240.01	-	240.06	-	-	240.07	-	-	-	240.23	239.97	240.65	240.20
OW25s	240.20	240.18	240.51	240.32	240.33	240.10	239.56	239.72	239.65	-	239.76	-	-	239.73	-	-	-	239.92	239.56	240.51	240.00
OW25d	240.21	240.20	240.47	239.89	239.88	239.64	239.67	239.82	239.73	-	239.86	-	-	239.84	-	-	-	240.00	239.64	240.47	239.93
OW26	241.95	242.02	242.55	241.83	241.62	241.15	240.41	240.61	240.45	-	240.80	-	-	240.86	-	-	-	241.00	240.41	242.55	241.27
OW27s	241.58	241.56	241.97	241.42	241.15	240.83	240.57	240.72	240.56	-	240.82	-	240.70	240.71	240.74	240.96	241.04	240.92	240.56	241.97	241.02
OW27d	241.27	241.28	241.51	241.23	241.32	240.62	240.32	240.42	239.98	-	240.56	-	240.20	240.21	240.23	240.49	240.60	240.51	239.98	241.51	240.67
OW28s	244.51	245.07	246.33	245.15	243.90	242.98	242.62	242.73	242.73	-	242.77	-	-	242.64	242.65	242.92	243.20	243.04	242.62	246.33	243.55
OW28d	241.58	242.41	245.16	242.25	240.31	238.50	238.27	238.42	238.35	-	238.35	-	-	238.30	238.32	238.72	238.98	238.96	238.27	245.16	239.79
OW29s	246.56	246.64	-	246.48	246.45	245.69	245.04	245.88	245.84	-	245.91	-	-	245.89	-	-	-	246.13	245.04	246.64	246.05
OW29d	246.52	246.58	-	246.43	246.39	245.63	244.98	245.80	245.77	-	245.78	-	-	245.77	-	-	-	246.07	244.98	246.58	245.98
OW30s	247.43	247.48	-	247.35	247.38	246.92	246.06	246.59	246.35	-	246.59	-	246.38	246.53	246.54	246.74	246.88	247.01	246.06	247.48	246.81
OW30d	-	239.28	-	239.12	239.10	238.83	238.48	238.72	238.52	-	238.52	-	238.45	238.47	238.48	239.43	240.03	238.87	238.45	240.03	238.87
OW31s	245.81	246.07	246.59	245.37	245.46	244.60	244.30	244.72	244.56	-	244.62	-	-	244.48	-	-	-	244.91	244.30	246.59	245.12
OW31d	242.09	242.30	242.65	241.76	241.59	240.44	240.02	240.46	240.35	-	240.45	-	-	240.23	-	-	-	240.64	240.02	242.65	241.08
OW32s	245.68	245.98	246.61	245.02	245.16	244.36	244.15	244.27	244.38	-	244.44	-	-	244.39	244.41	244.81	245.21	244.98	244.15	246.61	244.92
OW32d	241.10	241.29	241.56	240.83	240.65	239.66	239.23	239.50	239.48	-	239.57	-	-	239.52	239.52	240.07	240.48	240.16	239.23	241.56	240.17
OW33s	244.52	245.08	246.30	244.06	244.10	243.36	243.16	243.55	243.32	-	243.40	-	-	243.30	243.35	243.65	244.24	244.07	243.16	246.30	243.97
OW33d	240.95	240.87	241.94	240.77	240.78	239.17	239.06	239.47	239.44	-	239.61	-	-	239.13	239.16	239.48	241.01	239.92	239.06	241.94	240.05
OW34	235.05	234.99	235.10	234.77	234.78	234.65	234.59	234.57	234.60	-	Destroyed								234.57	235.10	234.78
OW35	235.20	235.15	235.26	235.00	235.16	234.84	234.82	234.70	234.73	-	234.68	Destroyed							234.68	235.26	234.95
OW36	-	-	-	235.73	235.80	235.78	235.72	235.35	235.28	-	235.48	-	-	235.41	235.42	236.22	236.30	-	235.28	236.30	235.68
OW37	237.11	236.90	237.60	236.26	236.32	235.81	235.68	235.60	235.57	-	235.68	-	-	235.66	235.68	236.48	236.83	-	235.57	237.60	236.22
OW38	238.67	238.88	239.24	238.45	238.30	237.60	237.29	237.40	237.34	-	237.34	-	-	237.28	-	-	-	-	237.28	239.24	237.98
OW39	242.45	241.96	242.27	241.99	242.08	241.85	241.17	241.15	241.38	-	241.32	-	241.26	241.25	241.26	241.79	242.03	241.70	241.15	242.45	241.68
OW40	Destroyed																		Destroyed		
OW41s	246.12	-	246.28	245.60	246.10	245.89	245.64	245.70	245.68	-	245.76	-	-	245.72	-	-	-	245.94	245.60	246.28	245.86

Table 2: Observation Wells – Groundwater Elevations - 2016

Monitoring Location	Groundwater Elevations (mAMSL)																				
	29-Jan-16	23-Feb-16	30-Mar-16	28-Apr-16	17-May-16	22-Jun-16	27-Jul-16	31-Aug-16	29-Sep-16	19-Oct-16	31-Oct-16	1-Nov-16	9-Nov-16	17-Nov-16	25-Nov-16	2-Dec-16	8-Dec-16	23-Dec-16	**Min**	**Max**	**Avg**
OW41d	245.28	-	245.46	245.23	245.27	245.05	244.84	244.89	244.87	-	244.96	-	-	244.89	-	-	-	245.13	244.84	245.46	245.08
OW42s	-	-	246.89	246.20	246.26	245.54	245.29	245.50	245.72	-	245.71	-	-	245.61	-	-	-	245.82	245.29	246.89	245.86
OW42d	-	-	245.27	244.84	244.85	244.40	243.80	243.92	244.23	-	244.24	-	-	244.14	-	-	-	244.29	243.80	245.27	244.39
OW43s	246.67	-	247.34	246.83	246.63	246.13	245.80	245.88	245.84	-	245.88	-	245.89	245.87	245.88	246.29	246.54	246.20	245.80	247.34	246.25
OW43d	246.12	-	246.60	246.13	243.05	245.46	245.10	245.16	245.21	-	245.31	-	245.32	245.29	245.32	245.66	245.90	245.60	243.05	246.60	245.42
OW44s	244.89	245.12	246.33	244.66	244.72	244.45	244.33	244.52	244.44	-	244.46	-	244.45	244.43	244.43	244.91	245.19	244.62	244.33	246.33	244.74
OW44d	244.70	245.19	246.21	244.82	244.85	244.40	244.12	244.48	244.32	-	244.32	-	244.34	244.32	244.33	244.80	245.07	244.64	244.12	246.21	244.68
OW45	244.24	245.18	246.44	244.52	244.67	243.73	243.32	243.92	243.65	-	243.61	-	243.60	243.59	243.58	243.71	243.79	244.21	243.32	246.44	244.11
OW46k	243.98	244.00	244.53	243.67	243.78	243.25	242.64	243.33	243.22	-	243.25	-	243.26	243.21	243.22	243.62	243.72	243.53	242.64	244.53	243.52
OW46s	244.08	244.08	244.60	243.72	243.50	243.30	242.69	243.39	243.24	-	243.28	-	243.29	243.23	243.23	243.60	243.77	243.61	242.69	244.60	243.53
OW46d	243.79	243.76	244.46	243.53	244.07	243.18	242.82	243.13	243.17	-	243.13	-	243.24	243.20	243.23	243.76	243.88	243.38	242.82	244.46	243.49
OW47s	243.72	243.73	244.56	243.56	243.63	243.44	243.15	243.46	243.39	-	243.38	-	243.40	243.39	243.42	243.80	243.89	243.49	243.15	244.56	243.59
OW47d	243.75	243.81	244.42	243.58	243.62	243.27	242.84	243.30	243.23	-	243.22	-	243.26	243.23	243.26	243.73	243.90	243.47	242.84	244.42	243.49
OW48	243.31	243.45	244.42	243.55	243.12	242.74	242.64	242.81	242.70	-	242.80	-	242.82	242.74	242.76	243.19	243.41	242.97	242.64	244.42	243.09
OW49	238.97	239.93	241.47	239.04	238.98	237.34	237.02	237.02	236.98	-	237.01	-	-	236.94	236.93	237.28	237.73	-	236.93	241.47	238.04
OW50	244.16	245.56	248.45	243.62	242.70	237.91	237.26	237.20	237.14	-	237.21	-	-	237.09	237.09	237.36	237.63	-	237.09	248.45	240.02
OW51	241.25	242.18	243.85	241.02	241.33	239.41	239.08	239.09	239.02	-	239.10	-	-	239.03	239.10	239.40	239.64	-	239.02	243.85	240.18
OW52	241.98	242.11	243.16	241.23	241.63	239.48	239.21	239.20	239.15	-	239.23	-	-	239.18	239.19	239.77	240.16	-	239.15	243.16	240.33
OW53	242.99	243.19	243.36	242.93		243.15	242.89	242.77	242.51	-	242.70	-	-	242.51	-	-	-	-	242.51	243.36	242.90
OW58s	-	-	240.18	240.06	239.97	239.81	239.61	239.61	239.58	-	239.75	-	-	239.73	-	-	-	-	239.58	240.18	239.81
OW58d	-	-	240.39	240.22	240.24	240.10	240.03	240.02	240.01	-	240.03	-	-	240.01	-	-	-	-	240.01	240.39	240.12
OW59s	-	-	240.16	240.03	239.98	239.70	239.63	239.61	239.63	-	239.65	-	-	239.62	-	-	-	-	239.61	240.16	239.77
OW59d	-		240.26	240.12	240.09	239.91	239.83	239.82	239.79	-	239.87	-	-	239.84	-	-	-	-	239.79	240.26	239.95
OW60s	-	240.11	240.34	240.07	240.04	239.80	239.77	239.70	239.71	-	239.76	-	-	239.73	-	-	-	239.82	239.70	240.34	239.90
OW60d	-	-	240.26	240.05	240.00	239.81	239.74	239.72	239.69	-	239.76	-	-	239.75	-	-	-	239.79	239.69	240.26	239.85
OW62k	245.20	-	-	245.13	244.66	244.23	244.09	244.21	244.17	-	244.19	-	244.20	244.19	244.21	244.37	244.41	244.30	244.09	245.20	244.40
OW62s	244.18	-	-	244.08	244.55	244.17	243.87	243.92	243.87	-	243.96	-	243.95	243.95	243.96	244.07	244.10	244.07	243.87	244.55	244.05
OW62d	244.61	-	-	244.44	244.62	244.18	243.93	244.06	243.88	-	244.01	-	244.01	243.99	243.96	244.08	244.12	244.09	243.88	244.62	244.14
OW63s	245.93	246.04	246.32	245.85	245.86	245.22	244.93	245.01	244.97	-	245.31	-	-	245.29	-	-	-	245.50	244.93	246.32	245.52
OW63d	245.12	245.23	245.67	245.06	245.09	244.59	244.08	244.28	244.22	-	244.59	-	-	244.52	-	-	-	244.75	244.08	245.67	244.76
OW64s	244.92	245.00	245.59	244.84	244.88	244.52	244.04	244.39	244.34	-	244.48	-	-	244.45	-	-	-	244.74	244.04	245.59	244.68
OW64d	244.84	244.96	245.59	244.77	244.82	244.45	244.03	244.37	244.31	-	244.42	-	-	244.40	-	-	-	244.68	244.03	245.59	244.64
OW65s	247.55	247.64	247.94	247.62	247.45	246.89	246.35	247.91	246.96	-	246.97	-	-	246.93	-	-	-	-	246.35	247.94	247.29
OW65d	245.72	245.84	246.30	245.70	245.48	245.12	244.59	247.48	244.99	-	244.96	-	-	244.95	-	-	-	-	244.59	247.48	245.55
OW71k	243.33	243.22	243.65	243.04	243.08	242.62	242.29	242.69	242.64	242.72	242.70	242.72	242.70	242.66	242.67	242.93	242.99	242.92	242.29	243.65	242.86
OW71s	243.44	243.38	243.75	243.16	243.22	242.82	242.31	242.86	242.80	242.89	242.87	242.89	242.85	242.82	242.82	243.02	243.07	243.05	242.31	243.75	243.00
OW71d	243.53	243.45	243.93	243.21	243.25	242.83	242.41	242.85	242.79	242.86	242.86	242.86	242.85	242.84	242.83	243.06	243.14	243.08	242.41	243.93	243.04
OW72s	Not Installed					243.74	243.72	243.72	243.71	-	243.73	-	243.72	243.71	243.73	243.74	243.74	243.75	243.71	243.75	243.73

Notes:

mAMSL = Metres Above Mean Sea Level

\- = not measured

Table 3: Observation Wells – Groundwater Elevation Summary - Historical vs. 2016

Monitoring Location	Historical Elevations (mAMSL)				2016 Groundwater Elevations (mAMSL)			
	Minimum	Maximum	Range	Average	Minimum	Maximum	Range	Average
OW3	236.28	237.19	0.91	236.49	236.15	237.24	1.09	236.78
OW4	237.17	247.93	10.76	239.74	237.04	238.13	1.09	237.55
OW7s	246.18	248.32	2.13	247.47	246.68	247.98	1.30	247.46
OW7d	241.73	244.41	2.68	243.01	241.65	243.18	1.53	242.42
OW8s	242.75	245.29	2.54	243.89	243.68	245.41	1.73	244.08
OW8d	242.31	244.38	2.07	243.25	242.79	244.05	1.26	243.38
OW9s	242.20	244.07	1.87	242.99	242.54	243.98	1.44	243.17
OW9d	241.99	243.99	2.00	243.05	242.58	243.91	1.33	243.11
OW10s	245.18	247.29	2.11	246.13	245.42	246.86	1.44	246.19
OW10d	245.07	247.03	1.96	245.99	245.31	246.83	1.52	246.06
OW11s	243.30	245.94	2.64	243.69	Destroyed			
OW11d	243.32	245.37	2.05	244.02	Destroyed			
OW12s	243.30	245.23	1.93	243.80	243.63	244.50	0.87	243.91
OW12d	242.76	244.78	2.02	243.53	243.23	244.08	0.85	243.63
OW13s	243.40	245.39	1.99	244.57	244.35	245.56	1.21	244.81
OW13d	241.32	243.46	2.14	242.32	242.01	243.58	1.57	242.67
OW14s	244.26	247.29	3.03	246.07	245.60	247.42	1.82	246.19
OW14d	240.87	242.96	2.09	241.88	241.44	242.52	1.08	241.92
OW15s	243.18	245.86	2.68	243.93	243.62	245.37	1.75	244.04
OW15d	239.90	245.99	6.09	243.75	243.26	245.05	1.79	243.95
OW16s	242.46	247.79	5.33	246.15	Destroyed			
OW16d	235.10	247.05	11.95	243.01	Destroyed			
OW24	239.06	240.54	1.48	240.12	239.97	240.65	0.43	240.20
OW25s	239.10	240.41	1.31	239.86	239.56	240.51	0.95	240.00
OW25d	239.42	240.25	0.83	239.94	239.64	240.47	0.83	239.93
OW26	237.68	242.34	4.66	241.28	240.41	242.55	2.14	241.27
OW27s	239.09	241.78	2.69	240.96	240.56	241.97	1.41	241.02
OW27d	239.24	241.49	2.24	240.84	239.98	241.51	1.53	240.67
OW28s	242.68	245.55	2.87	243.23	242.62	246.33	3.71	243.55
OW28d	238.21	244.46	6.25	239.90	238.27	245.16	6.89	239.79
OW29s	245.09	246.93	1.84	246.23	245.04	246.64	1.60	246.05
OW29d	244.97	247.17	2.20	246.18	244.98	246.58	1.60	245.98
OW30s	245.55	247.64	2.09	247.07	246.06	247.48	1.42	246.81
OW30d	238.49	240.38	1.89	239.37	238.45	240.03	1.58	238.87
OW31s	244.21	247.13	2.92	245.14	244.30	246.59	2.29	245.12
OW31d	239.95	242.65	2.70	241.17	240.02	242.65	2.63	241.08
OW32s	244.06	246.41	2.35	244.87	244.15	246.61	2.46	244.92
OW32d	239.12	241.87	2.75	240.36	239.23	241.56	2.33	240.17
OW33s	242.09	246.24	4.15	243.88	243.16	246.30	3.14	243.97
OW33d	238.59	241.52	2.93	239.89	239.06	241.94	2.88	240.05
OW34	233.97	236.28	2.31	234.90	234.57	235.10	0.53	234.78
OW35	234.79	236.22	1.43	235.09	234.68	235.26	0.58	234.95
OW36	235.38	236.56	1.18	235.62	235.28	236.30	1.02	235.68
OW37	235.73	237.95	2.22	236.32	235.57	237.60	2.03	236.22
OW38	237.31	239.51	2.20	238.19	237.28	239.24	1.96	237.98
OW39	241.06	243.20	2.14	242.28	241.15	242.45	1.30	241.68
OW40	241.58	243.63	2.05	242.99	Destroyed			
OW41s	244.44	246.31	1.87	245.90	245.60	246.28	0.68	245.86
OW41d	243.66	245.58	1.92	244.95	244.84	245.46	0.62	245.08
OW42s	244.78	248.27	3.49	246.00	245.29	246.89	1.60	245.86
OW42d	243.73	245.28	1.55	244.62	243.80	245.27	1.47	244.39
OW43s	245.67	247.09	1.42	246.45	245.80	247.34	1.54	246.25
OW43d	244.81	246.52	1.71	245.81	243.05	246.60	3.55	245.42
OW44s	244.25	246.23	1.98	244.69	244.33	246.33	2.00	244.74
OW44d	244.01	246.39	2.38	244.70	244.12	246.21	2.09	244.68
OW45	243.22	246.40	3.19	244.27	243.32	246.44	3.12	244.11
OW46k	242.99	244.52	1.53	243.50	242.64	244.53	1.89	243.52
OW46s	242.63	244.58	1.95	243.57	242.69	244.60	1.91	243.53
OW46d	242.53	244.38	1.85	243.44	242.82	244.46	1.64	243.49
OW47s	243.00	244.52	1.52	243.53	243.15	244.56	1.41	243.59
OW47d	240.56	244.45	3.89	243.33	242.84	244.42	1.58	243.49
OW48	242.67	244.39	1.72	242.99	242.64	244.42	1.78	243.09
OW49	236.86	240.86	4.00	238.22	236.93	241.47	4.54	238.04
OW50	236.82	246.69	9.87	240.51	237.09	248.45	11.36	240.02
OW51	238.94	243.13	4.19	240.36	239.02	243.85	4.83	240.18
OW52	239.11	246.11	7.00	240.44	239.15	243.16	4.01	240.33
OW53	241.65	246.39	4.74	243.96	242.51	243.36	0.85	242.90
OW58s	239.51	240.08	0.57	239.85	239.58	240.18	0.60	239.81
OW58d	239.81	240.35	0.54	240.12	240.01	240.39	0.38	240.12
OW59s	239.40	240.18	0.78	239.79	239.61	240.16	0.55	239.77
OW59d	239.63	240.35	0.72	239.96	239.79	240.26	0.47	239.95
OW60s	239.54	240.17	0.63	239.89	239.70	240.34	0.64	239.90
OW60d	239.54	240.13	0.58	239.86	239.69	240.26	0.57	239.85
OW62k	243.55	245.29	1.74	244.46	244.09	245.20	1.11	244.40
OW62s	243.67	245.36	1.69	244.38	243.87	244.55	0.68	244.05
OW62d	243.65	245.26	1.61	244.38	243.88	244.62	0.74	244.14
OW63s	244.85	246.07	1.22	245.46	244.93	246.32	1.39	245.52
OW63d	244.29	245.19	0.90	244.75	244.08	245.67	1.59	244.76
OW64s	244.21	244.95	0.74	244.60	244.04	245.59	1.55	244.68
OW64d	244.18	244.90	0.72	244.57	244.03	245.59	1.56	244.64
OW65s	246.64	247.58	0.94	247.13	246.35	247.94	1.59	247.29
OW65d	244.95	245.73	0.78	245.40	244.59	247.48	2.89	245.55
OW71k	242.45	243.56	1.11	242.85	242.29	243.65	1.36	242.86
OW71s	242.62	243.85	1.23	243.02	242.31	243.75	1.44	243.00
OW71d	242.65	243.77	1.12	243.05	242.41	243.93	1.52	243.04
OW72s	Installed in May 2016				243.71	243.75	0.04	243.73

Notes:

mAMSL = Metres Above Mean Sea Level

Table 4: Observation Wells – Groundwater Vertical Hydraulic Gradients - 2016

Monitoring Location	29-Jan-16	23-Feb-16	30-Mar-16	28-Apr-16	17-May-16	22-Jun-16	27-Jul-16	31-Aug-16	29-Sep-16	19-Oct-16	31-Oct-16	1-Nov-16	9-Nov-16	17-Nov-16	25-Nov-16	2-Dec-16	8-Dec-16	23-Dec-16	**Min**	**Max**	**Avg**
OW7	-0.33	-0.33	-0.32	-0.33	-0.33	-0.34	-0.34	-0.36	-0.35	-	-0.34	-	-0.34	-0.33	-0.33	-0.35	-0.35	-0.34	-0.36	-0.32	-0.34
OW8	-0.04	-0.06	-0.10	-0.03	-0.04	-0.04	-0.06	-0.04	-0.05	-	-0.04	-	-	-0.05	-	-	-	-0.04	-0.10	-0.03	-0.05
OW9	-0.01	0.00	-0.01	-0.05	0.00	0.01	0.00	0.00	0.00	-	0.00	-	0.00	0.00	0.00	-0.03	-0.01	0.00	-0.05	0.01	0.00
OW10	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.01	-	-0.02	-	-0.01	-0.02	-0.02	-0.01	-0.01	-0.02	-0.02	0.00	-0.01
OW11	Destroyed																		Destroyed		
OW12	-0.02	-0.04	-	-0.01	-0.03	-0.02	-0.03	-0.02	-0.02	-	-0.02	-	-	-0.02	-	-	-	-	-0.04	-0.01	-0.02
OW13	-0.16	-0.16	-0.17	-0.17	-0.18	-0.19	-0.20	-0.18	-0.18	-	-0.18	-	-	-0.18	-	-	-	-0.17	-0.20	-0.16	-0.18
OW14	-0.38	-0.38	-0.40	-0.38	-0.38	-0.32	-0.32	-0.32	-0.32	-	-0.34	-	-	-0.34	-0.34	-0.34	-0.34	-0.32	-0.40	-0.32	-0.35
OW15	-0.02	-0.01	-0.02	0.01	0.01	0.00	-0.03	0.00	-0.01	-	0.00	-	-	0.00	-	-	-	0.01	-0.03	0.01	-0.01
OW16	Destroyed																		Destroyed		
OW25	0.00	0.00	0.00	-0.04	-0.04	-0.04	0.01	0.01	0.01	-	0.01	-	-	0.01	-	-	-	0.01	-0.04	0.01	-0.01
OW27	-0.03	-0.02	-0.04	-0.02	0.01	-0.02	-0.02	-0.03	-0.05	-	-0.02	-	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	0.01	-0.03
OW28	-0.43	-0.39	-0.17	-0.43	-0.53	-0.66	-0.64	-0.64	-0.65	-	-0.65	-	-	-0.64	-0.64	-0.62	-0.63	-0.60	-0.66	-0.17	-0.56
OW29	0.00	-0.01	-	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-	-0.01	-	-	-0.01	-	-	-	-0.01	-0.01	0.00	-0.01
OW30	-	-0.66	-	-0.66	-0.66	-0.65	-0.61	-0.63	-0.63	-	-0.65	-	-0.63	-0.64	-0.64	-0.58	-0.55	-0.65	-0.66	-0.55	-0.63
OW31	-0.29	-0.30	-0.31	-0.29	-0.31	-0.33	-0.34	-0.34	-0.33	-	-0.33	-	-	-0.34	-	-	-	-0.34	-0.34	-0.29	-0.32
OW32	-0.40	-0.40	-0.44	-0.36	-0.39	-0.41	-0.42	-0.41	-0.42	-	-0.42	-	-	-0.42	-0.42	-0.41	-0.41	-0.42	-0.44	-0.36	-0.41
OW33	-0.40	-0.48	-0.49	-0.37	-0.38	-0.47	-0.46	-0.46	-0.44	-	-0.43	-	-	-0.47	-0.47	-0.47	-0.37	-0.47	-0.49	-0.37	-0.44
OW41	-0.09	-	-0.09	-0.04	-0.09	-0.09	-0.08	-0.09	-0.09	-	-0.08	-	-	-0.09	-	-	-	-0.09	-0.09	-0.04	-0.08
OW42	-	-	-0.18	-0.15	-0.16	-0.13	-0.17	-0.18	-0.17	-	-0.16	-	-	-0.16	-	-	-	-0.17	-0.18	-0.13	-0.16
OW43	-0.05	-	-0.07	-0.07	-0.35	-0.07	-0.07	-0.07	-0.06	-	-0.06	-	-0.06	-0.06	-0.05	-0.06	-0.06	-0.06	-0.35	-0.05	-0.08
OW44	-0.02	0.01	-0.01	0.02	0.01	0.00	-0.02	0.00	-0.01	-	-0.01	-	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.02	0.02	-0.01
OW46	-0.03	-0.03	-0.01	-0.02	0.06	-0.01	0.01	-0.02	-0.01	-	-0.01	-	0.00	0.00	0.00	0.02	0.01	-0.02	-0.03	0.06	0.00
OW47	0.00	0.01	-0.01	0.00	0.00	-0.02	-0.03	-0.01	-0.01	-	-0.01	-	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.03	0.01	-0.01
OW58	-	-	0.02	0.02	0.03	0.03	0.05	0.04	0.05	-	0.03	-	-	0.03	-	-	-	-	0.02	0.05	0.03
OW59	-	-	0.02	0.02	0.02	0.04	0.03	0.04	0.03	-	0.04	-	-	0.04	-	-	-	-	0.02	0.04	0.03
OW60	-	-	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	-	0.00	-	-	0.00	-	-	-	0.00	-0.01	0.00	0.00
OW62 S&K	0.21	-	-	0.22	0.02	0.01	0.05	0.06	0.06	-	0.05	-	0.05	0.05	0.05	0.06	0.06	0.05	0.01	0.22	0.07
OW62 S&D	0.06	-	-	0.05	0.01	0.00	0.01	0.02	0.00	-	0.01	-	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06	0.01
OW63	-0.10	-0.10	-0.08	-0.10	-0.09	-0.08	-0.10	-0.09	-0.09	-	-0.09	-	-	-0.09	-	-	-	-0.09	-0.10	-0.08	-0.09
OW64	-0.02	-0.01	0.00	-0.02	-0.02	-0.02	0.00	0.00	-0.01	-	-0.02	-	-	-0.01	-	-	-	-0.02	-0.02	0.00	-0.01
OW65	-0.19	-0.19	-0.17	-0.20	-0.21	-0.19	-0.18	-0.05	-0.21	-	-0.21	-	-	-0.21	-	-	-	-	-0.21	-0.05	-0.18
OW71 S&K	-0.04	-0.05	-0.03	-0.04	-0.04	-0.06	-0.01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.03	-0.03	-0.04	-0.06	-0.01	-0.04
OW71 S&D	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00

Notes:

- = not measured

Table 5: Observation Wells - Groundwater Vertical Hydraulic Gradients Summary – Historical vs. 2016

Monitoring Location	Historical Gradients				2016 Groundwater Gradients			
	Minimum	Maximum	Range	Average	Minimum	Maximum	Range	Average
OW7	-0.36	-0.24	0.12	-0.30	-0.36	-0.32	0.04	-0.34
OW8	-0.10	-0.01	0.10	-0.05	-0.10	-0.03	0.06	-0.05
OW9	-0.05	0.03	0.08	0.00	-0.05	0.01	0.06	0.00
OW10	-0.05	0.02	0.07	-0.01	-0.02	0.00	0.02	-0.01
OW11	-0.04	0.09	0.13	0.02	Destroyed			
OW12	-0.08	0.01	0.09	-0.02	-0.04	-0.01	0.03	-0.02
OW13	-0.22	-0.07	0.15	-0.19	-0.20	-0.16	0.04	-0.18
OW14	-0.45	-0.26	0.19	-0.34	-0.40	-0.32	0.08	-0.35
OW15	-0.26	0.01	0.28	-0.01	-0.03	0.01	0.04	-0.01
OW16	-0.67	-0.01	0.67	-0.23	Destroyed			
OW25	-0.05	0.09	0.14	0.01	-0.04	0.01	0.06	-0.01
OW27	-0.05	0.05	0.10	-0.01	-0.05	0.01	0.06	-0.03
OW28	-0.71	-0.01	0.69	-0.49	-0.66	-0.17	0.49	-0.56
OW29	-0.02	0.03	0.05	-0.01	-0.01	0.00	0.01	-0.01
OW30	-0.66	-0.52	0.14	-0.62	-0.66	-0.55	0.11	-0.63
OW31	-0.41	-0.25	0.15	-0.31	-0.34	-0.29	0.05	-0.32
OW32	-0.46	-0.32	0.14	-0.39	-0.44	-0.36	0.07	-0.41
OW33	-0.59	-0.36	0.23	-0.45	-0.49	-0.37	0.13	-0.44
OW41	-0.12	-0.06	0.06	-0.10	-0.09	-0.04	0.05	-0.08
OW42	-0.36	-0.03	0.33	-0.15	-0.18	-0.13	0.05	-0.16
OW43	-0.13	-0.05	0.09	-0.06	-0.35	-0.05	0.30	-0.08
OW44	-0.03	0.04	0.08	0.00	-0.02	0.02	0.03	-0.01
OW46	-0.05	0.01	0.06	-0.01	-0.03	0.06	0.09	0.00
OW47	-0.25	0.04	0.29	-0.02	-0.03	0.01	0.03	-0.01
OW58	0.02	0.07	0.04	0.03	0.02	0.05	0.03	0.03
OW59	0.00	0.05	0.05	0.03	0.02	0.04	0.02	0.03
OW60	-0.03	0.00	0.04	0.00	-0.01	0.00	0.01	0.00
OW62 S&K	-0.02	0.04	0.06	0.02	0.01	0.22	0.21	0.07
OW62 S&D	-0.02	0.02	0.05	0.00	0.00	0.06	0.06	0.01
OW63	-0.11	-0.07	0.04	-0.09	-0.10	-0.08	0.03	-0.09
OW64	-0.02	0.05	0.07	-0.01	-0.02	0.00	0.02	-0.01
OW65	-0.20	-0.17	0.03	-0.18	-0.21	-0.05	0.17	-0.18
OW71 S&K	-0.09	0.04	0.14	-0.05	-0.06	-0.01	0.06	-0.04
OW71 S&D	-0.01	0.05	0.06	0.00	0.00	0.02	0.03	0.00

Notes:

mAMSL = Metres Above Mean Sea Level

Table 6: Pumping Records (L) – 2016

Date	January	February	March	April	May	June	July	August	September	October	November	December	Total
1		2,157,691	2,157,570	2,157,166		1,687,122						1,311,592	
2		2,157,983	2,157,215		1,496,370	704,834					1,418,883	1,046,864	
3		2,156,007	2,158,010		1,499,000					1,448,158			
4	2,156,441	2,155,502	2,158,107	2,156,212	1,014,270			1,919,585			681,824		
5	2,157,971	2,158,651		2,156,126								2,156,992	
6	2,157,965	2,156,036		2,156,165	1,801,608	1,711,048			1,291,721	473,885		1,857,337	
7	2,158,757	2,157,172	2,157,881	2,157,616		1,749,217				412,969	829,532	1,656,031	
8	2,158,201	2,156,902	2,157,875	2,157,775					1,617,712		331,016	1,046,800	
9		2,156,864	2,157,751						605,014			424,038	
10		2,155,416	2,157,787			1,751,129							
11	2,158,391	2,157,979	2,156,360	518,527	1,771,212			1,907,958		777,684			
12	2,157,953	2,156,579		518,602								1,197,796	
13	2,157,751			519,119	1,809,212	2,104,383				566,987			
14	2,156,820		2,156,910	519,227		1,119,940					1,226,394		
15	2,159,011	2,156,792	2,156,111	518,989		1,761,399							
16	2,157,903	2,157,098	2,157,019		1,068,111			1,258,709			360,784		
17	2,158,108	2,157,112	2,157,087			1,757,316		2,127,981		1,907,443		1,405,970	
18	2,156,999	2,157,209	2,156,612	519,981				2,131,078		984,770			
19	2,157,394	2,156,919		519,899				1,707,111	1,760,379			1,192,615	
20	2,158,899			520,019		1,762,438		1,826,921		438,761			
21	2,158,911		2,157,043	520,189		1,747,990				795,414		2,033,098	
22	2,159,009	2,153,881	2,157,130	520,272				1,741,310			619,732		
23	2,158,272	2,155,902	2,156,407						1,223,487			1,344,161	
24	2,158,521	2,156,412	2,156,165			1,595,921		1,053,322		904,154			
25	2,155,987	2,156,211	2,157,707	518,952							790,165		
26	2,156,272	2,156,118		254,014					1,557,661			696,846	
27	2,158,419					1,760,592						2,009,302	
28	2,158,249		2,156,665								1,193,145	2,156,119	
29	2,157,953	2,157,009	2,156,306	525,945							816,276	2,154,416	
30	2,159,002		2,157,036			1,029,129		1,413,396		1,429,817	572,734	2,153,890	
31	2,158,510											2,155,443	
Total	56,107,669	49,603,445	47,456,754	19,434,795	10,459,783	22,242,458	0	17,087,371	8,055,974	10,140,042	8,840,485	27,999,310	277,428,086

Table 7: Summary of 2016 Pumping Records – Takings vs. Limits

Parameter	Value
Maximum Amount Taken (L/day) Maximum Allowed Daily Taking (L/day)	2,159,011 2,160,000
Maximum Number of Hours Pumped per day Maximum Allowed Hours Pumped per day	12 12
Maximum Rate of Taking (L/min) Maximum Allowable Rate of Taking (L/min)	3,000 3,000
Actual Number of Days of Taking per Year Maximum Number of Days Allowed per Year	167 365
Total Pumped (Litres) Total Allowable (Litres)	277,428,086 788,400,000
Difference between Allowable and Actual Pumped	510,971,914

Table 8: Precipitation Data (mm) - Keppel Quarry - 2016

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1.0	1.4	0.8	0.0	0.2	0.6	0.2	0.4	0.0	0.0	0.8	0.2	6.0	
2.0	0.0	10.0	0.4	1.8	0.0	0.0	0.0	0.0	0.0	8.4	1.4	4.6	
3.0	4.0	7.2	0.8	0.4	0.6	0.0	0.0	0.0	0.0	0.0	2.2	0.0	
4.0	3.2	0.0	0.8	2.2	1.4	20.0	0.0	0.0	0.2	0.2	0.2	10.2	
5.0	0.0	1.0	1.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.2	7.2	
6.0	0.0	0.6	3.8	15.6	0.8	0.4	0.0	0.0	9.8	0.0	0.0	0.8	
7.0	0.0	0.4	0.0	3.2	0.8	0.2	0.0	0.0	20.2	1.4	0.0	0.4	
8.0	1.2	10.0	2.4	1.2	0.0	0.0	10.4	0.0	0.2	5.2	0.6	4.8	
9.0	4.8	9.6	0.0	0.2	0.0	0.0	1.2	0.0	4.8	0.2	0.2	0.0	
10.0	15.6	2.8	0.0	7.4	0.0	6.4	0.0	0.0	1.8	0.0	0.2	3.8	
11.0	22.4	2.5	0.2	0.6	0.0	0.0	0.0	2.2	0.0	0.0	0.0	6.2	
12.0	10.4	3.9	0.0	0.2	14.4	0.0	0.0	20.8	0.0	8.8	0.2	8.2	
13.0	7.8	1.2	3.6	0.0	17.4	0.0	0.2	1.4	0.4	0.0	0.0	1.7	
14.0	2.4	0.4	1.0	0.0	2.8	0.0	0.4	0.0	0.2	0.0	0.0	5.8	
15.0	6.6	2.6	6.0	0.0	0.6	1.2	0.0	62.0	0.0	13.2	0.4	10.8	
16.0	6.0	0.4	11.2	0.0	0.2	0.0	0.0	6.0	14.2	2.6	0.2	5.6	
17.0	5.6	1.8	2.6	0.0	0.0	0.0	0.8	4.4	1.6	0.0	0.0	12.2	
18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	5.2	
19.0	0.2	7.8	0.0	0.0	0.0	0.0	0.0	19.2	0.0	2.0	7.8	1.0	
20.0	1.2	2.2	0.2	0.0	0.0	0.0	0.0	4.4	0.0	0.8	0.4	0.0	
21.0	0.4	0.6	0.2	3.0	0.0	0.0	0.4	0.0	1.4	0.8	0.0	3.4	
22.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.6	0.2	0.0	0.2	
23.0	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
24.0	0.0	33.9	4.6	5.8	0.2	0.0	1.6	2.6	0.0	0.0	5.8	3.8	
25.0	0.2	4.4	10.6	12.8	1.0	0.0	0.0	0.0	9.8	0.0	1.0	0.0	
26.0	5.4	0.0	13.4	0.0	0.0	11.6	0.0	0.0	0.6	1.8	4.4	10.6	
27.0	0.2	0.0	23.2	0.0	0.0	0.0	1.4	1.0	2.4	7.6	6.2	0.4	
28.0	10.0	3.4	0.6	0.0	0.0	0.0	0.0	0.2	0.0	0.8	2.8	4.6	
29.0	1.2	1.6	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.6	5.8	10.8	
30.0	0.0		28.4	5.0	0.0	10.8	0.0	0.0	1.4	0.0	2.6	1.8	
31.0	11.4		11.4		0.0		8.8	0.4		0.8		19.4	
Total	**122.6**	**109.1**	**131.4**	**60.0**	**40.8**	**51.0**	**25.6**	**124.8**	**69.8**	**56.2**	**46.8**	**149.5**	**987.6**
Wiarton Climate Normals 1981-2010 Monthly	**99.5**	**74**	**67.4**	**73.1**	**83.5**	**76.4**	**65.8**	**77.7**	**103.1**	**101**	**115.7**	**110.6**	**1047.8**

Notes:
Precipitation data for January, February and November 17 to December 31 was taken from the Wiarton Airport weather station. Precipitation data from March to November was recorded using an on-Site rain gauge.

Table 9: Annual Precipitation vs. Climate Normals

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ecipitation (mm/ye	1088.4	979.1	1270.2	960.9	912.3	1281.9	985.8	1390.4	1126.4	831.5	987.6
te Normal (1981-	1047.9	1047.9	1047.9	1047.9	1047.9	1047.9	1047.9	1047.9	1047.9	1047.9	1047.9

Table 10: Testpits and Mini-Piezometers – Groundwater Elevations - 2016

Monitoring Location	Groundwater Elevations (mAMSL)											
	MP54(in)	MP54(out)	MP55(in)	MP55(out)	MP56(in)	MP56(out)	MP57(in)	MP57(out)	TP16	TP17	TP18	TP19
29-Jan-16	-	-	-	-	-	-	-	-	-	-	240.17	-
23-Feb-16	-	-	-	-	-	-	-	-	-	++	240.13	++
30-Mar-16	240.11	240.09	240.15	240.00	240.16	240.16	240.02	240.08	240.72	240.58	240.36	240.27
28-Apr-16	240.01	240.02	239.93	239.87	240.05	240.07	240.27	240.07	240.61	240.12	240.02	240.04
17-May-16	239.97	239.95	240.05	239.95	240.01	239.96	239.97	239.98	240.54	240.10	240.00	240.01
22-Jun-16	239.82	**	239.82	**	239.87	239.87	239.82	**	239.83	239.70	239.76	239.80
27-Jul-16	239.79	**	239.75	**	239.80	**	239.76	**	239.66	239.48	239.48	239.58
31-Aug-16	239.78	**	239.71	**	239.78	**	239.70	**	239.72	239.59	239.66	239.70
29-Sep-16	239.77	**	239.70	**	239.79	**	239.70	**	239.74	239.56	239.67	239.65
19-Oct-16	-	-	-	-	-	-	-	-	-	-	-	-
31-Oct-16	239.77	**	239.76	**	239.79	239.76	239.77	**	239.79	239.64	239.72	239.76
1-Nov-16	-	-	-	-	-	-	-	-	-	-	-	-
9-Nov-16	-	-	-	-	-	-	-	-	-	-	-	-
17-Nov-16	239.76	**	239.74	**	239.77	**	239.74	**	239.76	239.62	239.69	239.74
25-Nov-16	-	-	-	-	-	-	-	-	-	-	-	-
2-Dec-16	-	-	-	-	-	-	-	-	-	-	-	-
8-Dec-16	-	-	-	-	-	-	-	-	-	-	-	-
23-Dec-16	-	-	-	-	239.93	++	239.84	++	239.96	239.77	239.88	240.02
Min	239.76	239.95	239.70	239.87	239.77	239.76	239.70	239.98	239.66	239.48	239.48	239.58
Max	240.11	240.09	240.15	240.00	240.16	240.16	240.27	240.08	240.72	240.58	240.36	240.27
Avg	239.86	240.02	239.85	239.94	239.90	239.96	239.86	240.04	240.03	239.82	239.88	239.86

Notes:

*** = dry*

++ = frozen

- = not measured

Table 11: Testpits and Mini-Piezometers – Groundwater Elevation Summary - Historical vs. 2016

Location	Historical Elevations (mAMSL)				2016 Groundwater Elevations (mAMSL)			
	Minimum	Maximum	Range	Average	Minimum	Maximum	Range	Average
MP54(in)	239.52	240.29	0.77	239.83	239.76	240.11	0.35	239.86
MP54(out)	239.49	240.29	0.81	239.84	239.95	240.09	0.14	240.02
MP55(in)	239.52	240.19	0.67	239.85	239.70	240.15	0.45	239.85
MP55(out)	239.54	240.17	0.63	239.85	239.87	240.00	0.13	239.94
MP56(in)	239.60	240.13	0.53	239.88	239.77	240.16	0.39	239.90
MP56(out)	239.62	240.13	0.51	239.88	239.76	240.16	0.40	239.96
MP57(in)	239.62	240.08	0.46	239.85	239.70	240.27	0.57	239.86
MP57(out)	239.64	240.08	0.44	239.85	239.98	240.08	0.10	240.04
TP16	239.21	240.72	1.51	240.08	239.66	240.72	1.06	240.03
TP17	239.24	240.66	1.42	239.89	239.48	240.58	1.10	239.82
TP18	239.18	240.30	1.12	239.81	239.48	240.36	0.88	239.88
TP19	239.24	240.15	0.91	239.83	239.58	240.27	0.69	239.86

Notes:

mAMSL = Metres Above Mean Sea Level

Table 12: Mini-Piezometers – Groundwater Vertical Hydraulic Gradients - 2016

Location	MP54	MP55	MP56	MP57
29-Jan-16	-	-	-	-
23-Feb-16	-	-	-	-
30-Mar-16	0.01	0.07	0.00	-0.03
28-Apr-16	0.00	0.03	-0.01	0.09
17-May-16	0.01	0.05	0.02	0.00
22-Jun-16	**	**	0.00	-0.01
27-Jul-16	**	**	**	**
31-Aug-16	**	**	**	**
29-Sep-16	**	**	**	**
19-Oct-16	-	-	-	-
31-Oct-16	**	**	0.02	**
1-Nov-16	-	-	-	-
9-Nov-16	-	-	-	-
17-Nov-16	**	**	**	**
25-Nov-16	-	-	-	-
2-Dec-16	-	-	-	-
8-Dec-16	-	-	-	-
23-Dec-16	-	-	++	++
Min	0.00	0.03	-0.01	-0.03
Max	0.01	0.07	0.02	0.09
Avg	0.00	0.05	0.01	0.01

Notes:

*** = dry*

++ = frozen

- = not measured

Table 13: Shouldice Wetland – Water Elevations - 2016

Monitoring Location	Water Elevations (mAMSL)		
	SG1	S8	S13
29-Jan-16	-	-	-
23-Feb-16	-	240.02	243.33
30-Mar-16	-	-	-
28-Apr-16	243.27	239.57	243.30
17-May-16	243.30	239.95	243.32
22-Jun-16	243.12	239.41	243.13
27-Jul-16	**	239.56	**
31-Aug-16	**	239.72	**
29-Sep-16	243.12	239.48	243.17
19-Oct-16	-	-	-
31-Oct-16	243.10	239.76	243.17
1-Nov-16	-	-	-
9-Nov-16	243.12	239.75	243.17
17-Nov-16	243.08	239.74	243.14
25-Nov-16	243.09	239.76	243.16
2-Dec-16	243.18	239.89	243.22
8-Dec-16	243.19	239.96	243.23
23-Dec-16	243.27	-	243.30
Min	243.08	239.41	243.13
Max	243.30	240.02	243.33
Avg	243.17	239.74	243.22

Notes:

mAMSL = Metres Above Mean Sea Level

*** = dry*

++ = frozen

- = not measured

Table 14: Flow Data - 2016

	Shouldice Wetland												Glen Management Area					
Date	s8	s9	s13	Dugout Pond outflow	Culvert 4	Culvert 5	Culvert 5a	Culvert 6	Culvert 6a	Culvert 7	Beaver Dam	Sinkhole	s1	s2	s3	Channel A	Channel B	D.U. Dam
29-Jan-16	++	++	-	-	++	++	++	++	++	++	*	-	flowing	flowing	flowing	flowing	++	flowing
23-Feb-16	flowing	++	-	*	++	++	++	++	++	++	-	-	flowing	flowing	flowing	flowing	-	flowing
30-Mar-16	-	-	-	-	-	-	-	-	-	-	flowing	flowing	flowing	flowing	flowing	flowing	-	flowing
28-Apr-16	*	*	*	*	flowing	flowing	flowing	flowing	flowing	flowing	flowing	*	flowing	flowing	flowing	flowing	-	flowing
17-May-16	flowing	*	*	*	*	flowing	*	flowing	flowing	flowing	flowing	*	flowing	flowing	flowing	flowing	**	flowing
21-Jun-16	*	**	**	*	flowing	*	*	flowing	flowing	*	*	*	flowing	flowing	flowing	flowing	**	flowing
29-Jul-16	**	**	**	**	**	*	**	**	flowing	*	*	**	flowing	**	flowing	flowing	**	flowing
30-Aug-16	**	**	**	**	**	*	**	flowing	flowing	*	*	**	flowing	**	flowing	flowing	**	flowing
29-Sep-16	**	**	**	**	**	*	**	*	*	**	*	**	flowing	flowing	flowing	flowing	**	flowing
31-Oct-16	**	**	*	**	**	*	**	*	*	**	*	**	flowing	flowing	flowing	flowing	**	flowing
17-Nov-16	**	**	*	**	**	*	**	*	*	**	*	**	flowing	flowing	flowing	flowing	**	flowing
25-Nov-16	-	-	-	-	-	-	-	-	-	-	-	-	flowing	flowing	flowing	flowing	-	flowing
2-Dec-16	-	-	-	-	-	-	-	-	-	-	-	-	flowing	flowing	flowing	flowing	-	flowing
8-Dec-16	-	-	-	-	-	-	-	-	-	-	-	-	flowing	flowing	flowing	flowing	-	flowing
22-Dec-16	flowing	++	flowing	++	++	*	*	++	++	++	-	-	flowing	flowing	flowing	flowing	-	-

Notes:

D.U. Dam = Ducks Unlimited Dam

** = no flow observed*

*** = dry*

++ = frozen

- = not measured

Table 15: Electrical Conductivity Data - 2016

Shouldice Wetland													Glen Management Area					
Date	**s8**	**s9**	**s13**	**Dugout pond (SG1)**	**Culvert 4**	**Culvert 5**	**Culvert 5a**	**Culvert 6**	**Culvert 6a**	**Culvert 7**	**Beaver Dam**	**Sinkhole**	**s1**	**s2**	**s3**	**Channel A**	**Channel B**	**D.U. Dam**
29-Jan-16	++	++	-	++	++	++	++	++	++	++	514	-	518	525	520	508	++	541
23-Feb-16	496	N/A	453	470	++	++	++	++	++	++	-	-	458	466	469	467	N/A	477
30-Mar-16	-	-	-	-	-	-	-	-	-	-	392	385	361	366	382	375	N/A	397
28-Apr-16	501	505	456	472	423	421	410	415	421	422	415	422	426	426	430	445	N/A	410
17-May-16	509	511	499	531	525	466	447	404	403	401	456	460	502	484	485	513	N/A	463
21-Jun-16	604	**	761	795	612	633	551	498	499	514	419	485	605	598	600	614	**	397
29-Jul-16	**	**	**	**	**	652	**	**	526	547	415	**	643	**	639	614	N/A	589
30-Aug-16	**	**	**	**	**	522	**	428	489	446	462	**	596	**	602	584	N/A	552
29-Sep-16	**	**	**	**	675	642	**	477	-	**	569	**	662	642	651	624	N/A	589
31-Oct-16	**	**	1160	1174	660	654	**	502	-	**	582	**	665	661	672	640	N/A	592
17-Nov-16	**	**	1127	1202	690	677	**	547	-	**	600	**	623	677	668	669	N/A	601
25-Nov-16	**	+	1155	1178	-	-	-	-	-	-	-	-	637	667	682	632	N/A	615
2-Dec-16	**	+	956	1025	-	-	-	-	-	-	-	-	586	582	547	623	N/A	599
8-Dec-16	**	-	1012	1101	-	-	-	-	-	-	-	-	498	475	482	457	N/A	542
22-Dec-16	++	++	689	704	++	422	468	++	++	++	-	-	522	529	536	501	N/A	N/A
Max	604	511	1160	1202	690						600	485	682			669	-	615
Min	496	505	453	470	401						392	385	361			375	-	397
Avg	528	508	827	865	514						482	438	553			551	-	526

Notes:

D.U. Dam = Ducks Unlimited Dam

units = ųS/cm

values are compensated to 20 degrees Celsius

*** = dry*

++ = frozen

- = not measured

+ = not required

Table 16: Temperature Data – 2016

	Shouldice Wetland												Glen Management Area					
Date	**s8**	**s9**	**s13**	**Dugout Pong (SG1)**	**Culvert 4**	**Culvert 5**	**Culvert 5a**	**Culvert 6**	**Culvert 6a**	**Culvert 7**	**Beaver Dam**	**Sinkhole**	**s1**	**s2**	**s3**	**Channel A**	**Channel B**	**D.U. Dam**
29-Jan-16	++	++	-	++	++	++	++	++	++	++	2	-	2.2	2.2	2.4	2.5	++	3.0
23-Feb-16	7	++	6	7	++	++	++	++	++	++	-	-	1.5	1.6	2.1	2.6	-	4.9
30-Mar-16	-	-	-	-	-	-	-	-	-	-	6	6	4.5	4.5	4.6	6.0	-	5.9
28-Apr-16	7	7	6	6	7	7	7	7	7	7	6	7	8.1	8.4	8.2	9.9	-	8.9
17-May-16	7	7	7	11	12	13	13	13	13	12	18	17	9.3	9.6	9.8	11.0	**	14.2
21-Jun-16	12	**	15	15	22	21	22	22	23	19	20	17	9.4	10.5	10.5	13.8	**	27.2
29-Jul-16	**	**	**	**	**	22	**	**	21	23	21	**	9.6	**	10.4	13.8	**	22.2
30-Aug-16	**	**	**	**	**	20	**	19	18	18	19	**	12.3	**	12.5	14.4	**	19.5
29-Sep-16	**	**	**	**	15	15	**	15	N/A	**	16	**	12.5	12.3	12.4	12.2	**	14.9
31-Oct-16	**	**	10	14	11	11	**	12	N/A	**	13	**	12.7	12.1	12.0	11.4	**	12.2
17-Nov-16	**	**	11	12	8	8	**	8	N/A	**	12	**	11.0	10.7	10.8	10.7	**	10.2
25-Nov-16	**	-	9	10	-	-	-	-	-	-	-	-	10.8	10.6	10.8	10.7	**	10.0
2-Dec-16	**	-	8	8	-	-	-	-	-	-	-	-	9.6	9.7	9.6	9.2	**	10.2
8-Dec-16	**	-	7	7	-	-	-	-	-	-	-	-	7.2	7.3	7.0	7.6	**	7.1
22-Dec-16	++	++	4	5	++	4	5	++	++	++	-	-	3.1	3.3	3.0	3.6	**	-
Max	12	7	15	15	23						21	17	12.7			14.4	-	27.2
Min	7	7	4	5	4						2	6	1.5			2.5	-	3.0
Avg	8	7	8	9	14						13	11	8.2			9.3	-	12.2

Notes:

D.U. Dam = Ducks Unlimited Dam

values are compensated to 20 degrees Celsius

*** = dry*

++ = frozen

Table 17 : Approved Trigger Values (mAMSL)

Sentry Observation Wells	Green				Yellow				Red			
Season	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
OW8s	243.92	243.38	243.22	244.04	243.77	243.23	243.07	243.89	243.62	243.08	242.92	243.74
OW8d	243.34	242.60	242.46	243.61	243.19	242.45	242.31	243.46	243.04	242.30	242.16	243.31
OW9s	242.98	242.35	242.40	243.08	242.83	242.20	242.25	242.93	242.68	242.05	242.10	242.78
OW9d	243.16	242.14	242.38	243.38	243.01	241.99	242.23	243.23	242.86	241.84	242.08	243.08
OW12s	243.80	243.51	243.45	243.87	243.65	243.36	243.30	243.72	243.50	243.21	243.15	243.57
OW12d	243.62	243.04	242.91	243.83	243.47	242.89	242.76	243.68	243.32	242.74	242.61	243.53
OW13s	244.73	243.82	243.55	244.95	244.58	243.67	243.40	244.80	244.43	243.52	243.25	244.65
OW13d	242.14	241.57	241.47	242.63	241.99	241.42	241.32	242.48	241.84	241.27	241.17	242.33
OW33s	243.62	243.25	243.24	243.77	243.47	243.10	243.09	243.62	243.32	242.95	242.94	243.47
OW33d	239.40	238.74	238.88	240.07	239.25	238.59	238.73	239.92	239.10	238.44	238.58	239.77
OW45	244.08	243.37	243.98	244.28	243.93	243.22	243.83	244.13	243.78	243.07	243.68	243.98
OW47s	243.60	243.15	243.29	243.62	243.45	243.00	243.14	243.47	243.30	242.85	242.99	243.32
OW47d	243.51	242.86	243.42	243.57	243.36	242.71	243.27	243.42	243.21	242.56	243.12	243.27
OW51	239.90	239.15	239.12	240.23	239.75	239.00	238.97	240.08	239.60	238.85	238.82	239.93
OW53	241.80	242.54	243.60	244.53	241.65	242.39	243.45	244.38	241.50	242.24	243.30	244.23
s8	239.97	NA	239.78	240.04	239.82	NA	239.63	239.89	239.67	NA	239.48	244.23
s13	243.01	NA	242.50	243.08	242.86	NA	242.35	242.93	242.71	NA	242.20	244.23
(Dugout Pond) SG1	243.24	243.16	243.22	243.21	243.09	243.01	243.07	243.06	242.94	242.86	242.92	244.23

Notes:

NA= Not Applicable

Table 18: 2016 Trigger Values (mAMSL)

Sentry Observation Wells	Green				Yellow				Red			
Season	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
OW8s	243.92	242.90	243.22	243.94	243.77	242.75	243.07	243.79	243.62	242.60	242.92	243.64
OW8d	243.32	242.60	242.46	243.46	243.17	242.45	242.31	243.31	243.02	242.30	242.16	243.16
OW9s	242.98	242.35	242.40	243.08	242.83	242.20	242.25	242.93	242.68	242.05	242.10	242.78
OW9d	243.12	242.14	242.38	242.99	242.97	241.99	242.23	242.84	242.82	241.84	242.08	242.69
OW12s	243.80	243.51	243.45	243.74	243.65	243.36	243.30	243.59	243.50	243.21	243.15	243.44
OW12d	243.60	243.04	242.91	243.68	243.45	242.89	242.76	243.53	243.30	242.74	242.61	243.38
OW13s	244.28	243.82	243.55	243.97	244.13	243.67	243.40	243.82	243.98	243.52	243.25	243.67
OW13d	242.14	241.57	241.47	242.53	241.99	241.42	241.32	242.38	241.84	241.27	241.17	242.23
OW33s	243.49	242.24	243.24	243.53	243.34	242.09	243.09	243.38	243.19	241.94	242.94	243.23
OW33d	239.38	238.74	238.88	239.67	239.23	238.59	238.73	239.52	239.08	238.44	238.58	239.37
OW45	243.85	243.37	243.44	244.16	243.70	243.22	243.29	244.01	243.55	243.07	243.14	243.86
OW47s	243.56	243.15	243.25	243.60	243.41	243.00	243.10	243.45	243.26	242.85	242.95	243.30
OW47d	243.41	242.86	243.23	243.48	243.26	242.71	243.08	243.33	243.11	242.56	242.93	243.18
OW51	239.48	239.15	239.09	239.88	239.33	239.00	238.94	239.73	239.18	238.85	238.79	239.58
OW53	241.80	242.44	242.16	243.95	241.65	242.29	242.01	243.80	241.50	242.14	241.86	243.65
OW71k	242.75	242.60	242.69	242.90	242.60	242.45	242.54	242.75	242.45	242.30	242.39	242.60
OW71s	242.91	242.77	242.87	243.07	242.76	242.62	242.72	242.92	242.61	242.47	242.57	242.77
OW71d	242.96	242.80	242.86	243.09	242.81	242.65	242.71	242.94	242.66	242.50	242.56	242.79
s8	239.87	NA	239.59	239.98	239.72	NA	239.44	239.83	239.57	NA	239.29	239.68
s13	243.01	NA	242.48	243.08	242.86	NA	242.33	242.93	242.71	NA	242.18	242.78
(Dugout Pond) SG1	243.18	243.00	243.07	243.12	243.03	242.85	242.92	242.97	242.88	242.70	242.77	242.82

Notes:

NA= Not Applicable

Table 19: Summary of Exceeded Trigger Values - 2016

Well ID	Green Trigger Value Exceedance		Yellow Trigger Value Exceedance		Red Trigger Value Exceedance	
	From	To	From	To	From	To
OW8s	5-Jun-16	21-Jun-16	None	None	None	None
OW8d	10-Jun-16	22-Jun-16	None	None	None	None
	14-Aug-16	16-Aug-16	None	None	None	None
	21-Dec-16	26-Dec-16	None	None	None	None
OW9s	31-May-16	21-Jun-16	None	None	None	None
	8-Aug-16	16-Aug-16	None	None	None	None
OW9d	9-Jun-16	21-Jun-16	None	None	None	None
OW12s	31-May-16	21-Jun-16	None	None	None	None
	11-Aug-16	16-Aug-16	None	None	None	None
OW12d	12-Jun-16	21-Jun-16	None	None	None	None
	15-Aug-16	16-Aug-16	None	None	None	None
OW13s	None	None	None	None	None	None
OW13d	None	None	None	None	None	None
OW33s	12-Jun-16	21-Jun-16	None	None	None	None
OW33d	11-Jun-16	21-Jun-16	18-Jun-16	21-Jun-16	None	None
OW45	16-Jun-16	22-Jun-16	None	None	None	None
	28-Jul-16	17-Aug-16	8-Aug-16	16-Aug-16	None	None
OW47s	25-Apr-16	26-Apr-16	None	None	None	None
	1-May-16	15-May-16	None	None	None	None
	21-May-16	21-Jun-16	None	None	None	None
	30-Jul-16	16-Aug-16	10-Aug-16	16-Aug-16	None	None
	21-Dec-16	27-Dec-16	None	None	None	None
OW47d	9-Jun-16	21-Jun-16	None	None	None	None
	27-Jul-16	16-Aug-16	6-Aug-16	16-Aug-16	None	None
	2-Oct-16	3-Oct-16	None	None	None	None
	8-Oct-16	11-Oct-16	None	None	None	None
	13-Oct-16	16-Oct-16	None	None	None	None
	22-Nov-16	25-Nov-16	None	None	None	None
OW51	14-Jun-16	21-Jun-16	None	None	None	None
	28-Jul-16	16-Aug-16	None	None	None	None
	1-Sep-16	27-Nov-16	None	None	None	None
	21-Dec-16	24-Dec-16	None	None	None	None
OW71k	12-Jun-16	21-Jun-16	None	None	None	None
	24-Jun-16	16-Aug-16	18-Jul-16	16-Aug-16	28-Jul-16	16-Aug-16
	21-Sep-16	17-Oct-16	None	None	None	None
	17-Nov-16	26-Nov-16	None	None	None	None
OW71s	3-Jun-16	5-Jun-16	None	None	None	None
	9-Jun-16	21-Jun-16	None	None	None	None
	23-Jun-16	16-Aug-16	15-Jul-16	16-Aug-16	21-Jul-16	16-Aug-16
	21-Sep-16	18-Oct-16	None	None	None	None
	20-Oct-16	28-Nov-16	None	None	None	None
	21-Dec-16	26-Dec-16	None	None	None	None
OW71d	3-Jun-16	5-Jun-16	None	None	None	None
	8-Jun-16	21-Jun-16	None	None	None	None
	23-Jun-16	17-Aug-16	15-Jul-16	17-Aug-16	23-Jul-16	16-Aug-16
	21-Sep-16	17-Oct-16	None	None	None	None
	14-Nov-16	26-Nov-16	None	None	None	None
SG1	8-May-16	13-May-16	None	None	None	None
	23-May-16	21-Jun-16	None	None	None	None
	1-Jul-16	16-Aug-16	19-Jul-16	16-Aug-16	None	None
	21-Sep-16	17-Oct-16	None	None	None	None
	24-Oct-16	25-Nov-16	None	None	None	None
s8	2-Jun-16	21-Jun-16	None	None	None	None
s13	None	None	None	None	None	None

Table 20: 2017 Trigger Values (mAMSL)

Sentry Observation Wells	Green				Yellow				Red			
Season	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
OW8s	243.92	242.90	243.22	243.94	243.77	242.75	243.07	243.79	243.62	242.60	242.92	243.64
OW8d	243.32	242.60	242.46	243.46	243.17	242.45	242.31	243.31	243.02	242.30	242.16	243.16
OW9s	242.98	242.35	242.40	243.08	242.83	242.20	242.25	242.93	242.68	242.05	242.10	242.78
OW9d	243.12	242.14	242.38	242.99	242.97	241.99	242.23	242.84	242.82	241.84	242.08	242.69
OW12s	243.80	243.51	243.45	243.74	243.65	243.36	243.30	243.59	243.50	243.21	243.15	243.44
OW12d	243.60	243.04	242.91	243.68	243.45	242.89	242.76	243.53	243.30	242.74	242.61	243.38
OW13s	244.28	243.82	243.55	243.97	244.13	243.67	243.40	243.82	243.98	243.52	243.25	243.67
OW13d	242.14	241.57	241.47	242.53	241.99	241.42	241.32	242.38	241.84	241.27	241.17	242.23
OW33s	243.49	242.24	243.24	243.53	243.34	242.09	243.09	243.38	243.19	241.94	242.94	243.23
OW33d	239.04	238.74	238.88	239.67	238.89	238.59	238.73	239.52	238.74	238.44	238.58	239.37
OW45	243.85	243.27	243.44	244.16	243.70	243.12	243.29	244.01	243.55	242.97	243.14	243.86
OW47s	243.56	243.07	243.25	243.60	243.41	242.92	243.10	243.45	243.26	242.77	242.95	243.30
OW47d	243.41	242.74	243.23	243.48	243.26	242.59	243.08	243.33	243.11	242.44	242.93	243.18
OW51	239.48	239.15	239.09	239.87	239.33	239.00	238.94	239.72	239.18	238.85	238.79	239.57
OW71k	242.75	242.08	242.69	242.90	242.60	241.93	242.54	242.75	242.45	241.78	242.39	242.60
OW71s	242.91	242.04	242.87	243.07	242.76	241.89	242.72	242.92	242.61	241.74	242.57	242.77
OW71d	242.96	242.24	242.86	243.09	242.81	242.09	242.71	242.94	242.66	241.94	242.56	242.79
s8	239.87	NA	239.59	239.94	239.72	NA	239.44	239.79	239.57	NA	239.29	239.64
s13	243.00	NA	242.48	243.08	242.85	NA	242.33	242.93	242.70	NA	242.18	242.78
(Dugout Pond) SG1	243.18	NA	243.07	243.12	243.03	NA	242.92	242.97	242.88	NA	242.77	242.82

Notes:

NA= Not Applicable

Table 21: Ephemeral Pond – Water Levels - 2016

Monitoring Location	Groundwater Levels
Reference	**Top of PVC**
28-Apr-16	0.50
17-May-16	0.49
22-Jun-16	0.20

Table 22: Private Wells – Water Elevations - 2016

Category	Location	ID	Water Elevations (mAMSL)														
			29-Jan-16	23-Feb-16	30-Mar-16	28-Apr-16	17-May-16	21-Jun-16	21-Jul-16	31-Aug-16	29-Sep-16	31-Oct-16	17-Nov-16	23-Dec-16	Max	Min	Avg
A	Ritchie	3345	Asked to be Removed from Porgram in 2016												Removed for Program		
	Cramp	7253	-	-	-	-	-	-	-	-	-	-	-	-	Only Measured via Data Logger		
	S.Ruthven	5197	-	-	-	-	-	-	-	-	-	-	-	-	Only Measured via Data Logger		
	Sutherland	3447	-	-		-	246.96	246.38	246.76	246.88	246.78	246.83	246.78	247.05	246.96	246.38	246.77
B	Jenks	PW1	-	-	250.56	-	-	244.15	-	-	-	244.41	-	-	250.56	244.15	246.37
	Thompson	PW2	-	-	252.12	-	-	244.45	-	-	-	244.66	-	-	252.12	244.45	247.08
	Porter	PW3	-	-	249.54	-	-	242.76	-	-	-	242.92	-	-	249.54	242.76	245.07

Notes:

- = not measured

Table 23: Noise and Vibration Data Summary

Date	Receptor	Resident	Adress	Vibration (mm/s)	Noise - Overpressure (dB)
19-May-16	BR1	Cramp	178717 Grey Rd 17	1.8	**139.6**
	BR2	Ritchie	178841 Grey Rd 17	4.8	117.8
14-Jun-16	BR2	Ritchie	178841 Grey Rd 17	3.4	119.0
	BR3	McGregor	178706 Grey Rd 17	nt	120.0
	BR4	Ruthven	283197 Conc Rd 10	nt	bt
21-Jul-16	BR1	Cramp	178717 Grey Rd 17	0.2	123.0
	BR2	Ritchie	178841 Grey Rd 17	7.8	120.0
	BR3	McGregor	178706 Grey Rd 17	0.2	121.0
18-Aug-16	BR1	Cramp	178717 Grey Rd 17	nt	128.0
	BR2	Ritchie	178841 Grey Rd 17	5.5	121.0
	BR4	Ruthven	283197 Conc Rd 10	nt	127.0
	BR5	Wilde	302377 Grey Rd 170	3.5	98.8
22-Sep-16	BR1	Cramp	178717 Grey Rd 17	0.3	123.0
	BR2	Ritchie	178841 Grey Rd 17	7.1	119.0
	BR3	McGregor	178706 Grey Rd 17	0.2	122.0
14-Oct-16	BR1	Cramp	178717 Grey Rd 17	0.3	125.0
	BR2	Ritchie	178841 Grey Rd 17	6.2	119.0
	BR3	McGregor	178706 Grey Rd 17	0.2	123.0
	BR5	Wilde	302377 Grey Rd 170	11.2	<88
10-Nov-16	BR1	Cramp	178717 Grey Rd 17	1.4	121.0
	BR2	Ritchie	178841 Grey Rd 17	6.7	119.0
	BR3	McGregor	178706 Grey Rd 17	1.3	119.0
	BR5	Wilde	302377 Grey Rd 170	2.4	94.0
8-Dec-16	BR1	Cramp	178717 Grey Rd 17	0.4	**133.6**
	BR2	Ritchie	178841 Grey Rd 17	7.9	118.5
	BR3	McGregor	178706 Grey Rd 17	0.4	**131.7**
	BR4	Ruthven	283197 Conc Rd 10	0.4	**128.3**
Max				11.2	139.6
Min				0.2	94.0
Average				3.2	121.3

Notes:

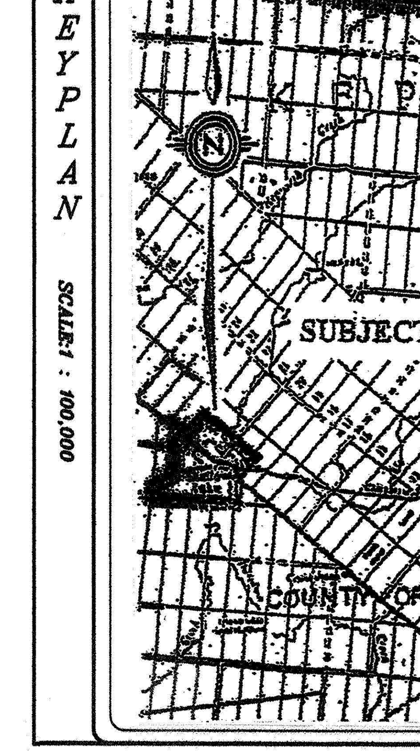
The MOECC recommended limit for Vibration is 12.5 mm/sec

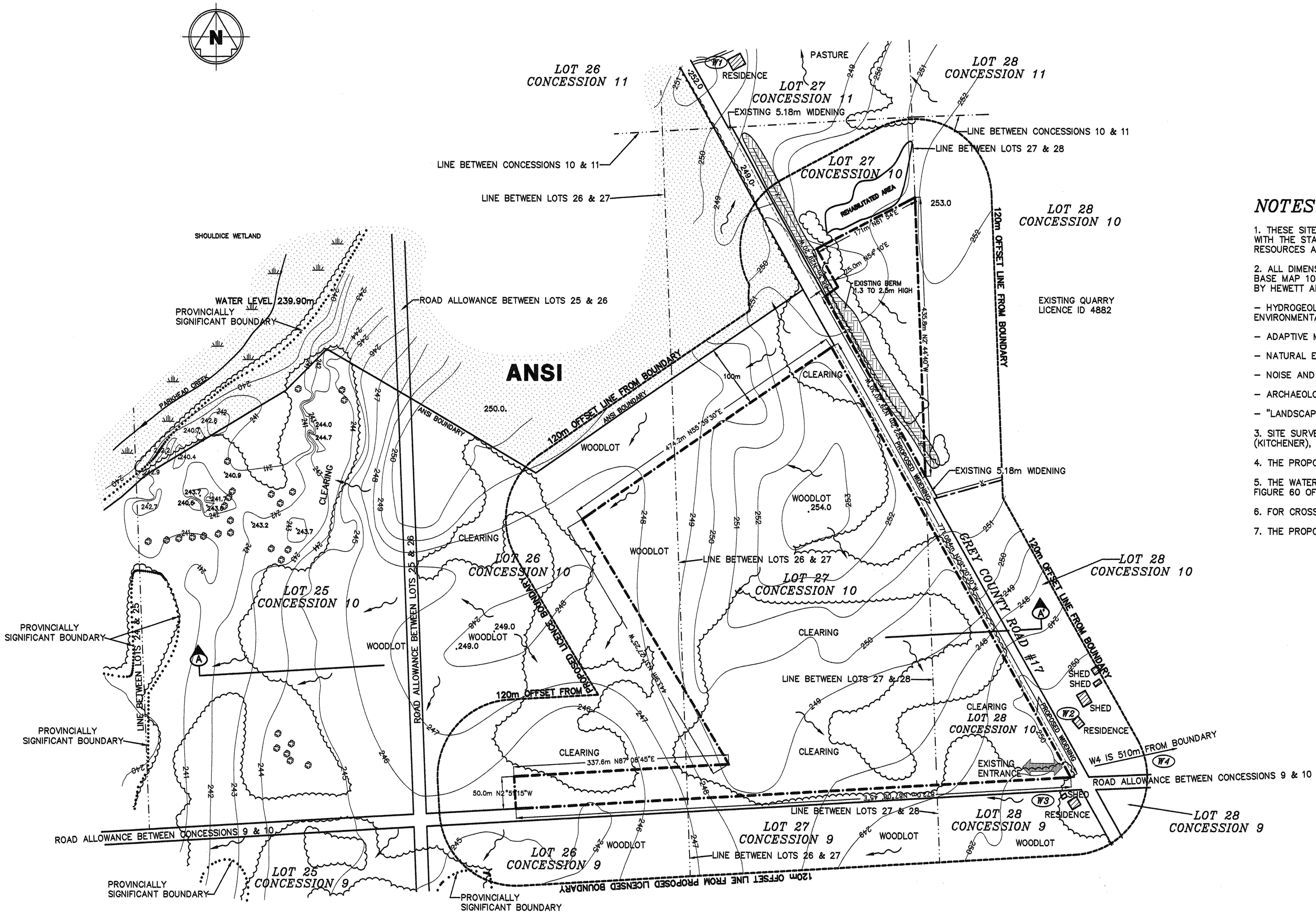
The MOECC recommended limit for Overpressure is 128 dB

nt = no trigger

APPENDIX A

AGGREGATE RESOURCES ACT (ARA)
SITE PLANS





NOTES:

1. THESE SITE PLANS ARE PREPARED FOR SUBMISSION TO THE MINISTRY OF NATURAL RESOURCES TO COMPLY WITH THE STANDARDS FOR A CATEGORY 2, CLASS A (QUARRY BELOW WATER) LICENCE UNDER THE AGGREGATE RESOURCES ACT AND REGULATIONS.

2. ALL DIMENSIONS ARE IN METRIC UNITS. ELEVATIONS ARE GEODETIC, ASL. REFERENCE WAS MADE TO ONTARIO BASE MAP 10 17 4950 49400 & 10 17 5000 49400, REGISTERED PLAN 16R-3903, A DRAFT PLAN OF SURVEY BY HEWETT AND MILNE LIMITED, ONTARIO LAND SURVEYORS AND THE FOLLOWING REPORTS:

- HYDROGEOLOGICAL REPORTS, ADDENDUMS, RESPONSES BY WATERLOO GEOSCIENCE LIMITED, NOVATERRA ENVIRONMENTAL LIMITED, MTE CONSULTANTS INC.
- ADAPTIVE MANAGEMENT PLAN BY MTE CONSULTANTS INC.
- NATURAL ENVIRONMENT STUDIES, ADDENDUMS AND RESPONSES BY AQUATIC WILDLIFE SERVICES
- NOISE AND BLASTING STUDIES BY AERCOUSTICS ENGINEERING LTD. AND DST CONSULTING ENGINEERS INC.
- ARCHAEOLOGICAL STUDIES BY SCARLETT JANUSAS
- "LANDSCAPING DETAILS" & "VEGETATION INVENTORY & PRESERVATION PLAN" BY L. PORTER.

3. SITE SURVEYS AND INSPECTION BY WM. BRADSHAW, P.ENG. (OCTOBER, 2003) & ACI SURVEYS LTD. (KITCHENER), OCTOBER, 2006.

4. THE PROPOSED LICENSED AREA IS LOCATED IN THE NIAGARA ESCARPMENT AREA.

5. THE WATER TABLE ELEVATION VARIES FROM APPROXIMATELY 240m TO 247m AND WAS DETERMINED FROM FIGURE 60 OF THE HYDROGEOLOGICAL INVESTIGATION BY MTE CONSULTANTS (OCT. 14, 2009).

6. FOR CROSS-SECTION INFORMATION, SEE DRAWING 7, CROSS-SECTIONS & DETAILS.

7. THE PROPOSED LICENSED AREA IS 35.0 HECTARES.

LEGEND:

- ANSI–Area of Natural & Scientific Interest
- BUILDING
- DOMESTIC WATER WELL
- DRAINAGE DIRECTION
- PROPOSED LICENSED BOUNDARY
- PROVINCIALLY SIGNIFICANT BOUNDARY
- ENTRANCE/EXIT
- 1.2m HIGH POST & WIRE FENCE
- 120m OFFSET LINE FROM
- LOT LINE
- EXISTING BERM
- .462.5 SPOT ELEVATION
- 464 1m CONTOUR
- 465 5m CONTOUR
- DECIDUOUS TREE
- CONIFEROUS TREE
- WET AREA

HAROLD SUTHERLAND CONSTRUCTION LTD.
R.R. #2, KEMBLE, ONTARIO, N0H1S0

NEW KEPPEL QUARRY

PARTS LOTS 26, 27 & 28, CONCESSION 10
TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppel Twp)
COUNTY OF GREY

EXISTING FEATURES

DRAWING 1 of 9

SCALE: 1:4000
100 50 0 100 200 300

LICENSED PROFESSIONAL ENGINEER
W.L. BRADSHAW
PROVINCE OF ONTARIO

Wm. Bradshaw, P.Eng.
Kitchener, Ontario

No.	AMENDMENT	DATE

December 11, 2014