Memo

To	**Dave Simms, Simon Gautrey**	File no	**TC81525**
From	**Jacob Zaidel**	cc	**Dave Bucar, Peter Andrews (Goldcorp)**
Tel			
Fax			
Date	**September 2010**		

Subject **Estimating Pumping Rates Required for the Dewatering of Mine Workings at the Hollinger-McIntire Mine Sites in Support of the Hollinger PTTW Application**

Introduction

The following memo describes the approach used to estimate pumping rates required to dewater the Hollinger-McIntire mine workings. The following two water inflow components were taken into account in these estimates: (1) water released from storage in the existing mine workings; and (2) groundwater seepage into the workings. Computation of both components is discussed below. Note that potential water inflows into the mine workings associated with short term surface run-off and direct precipitation events were not taken into account in these calculations. Groundwater seepage rates do, however, take into account average annual precipitation rates as input into the groundwater regime.

Water Released from Storage

The amount of water released from storage in the existing mine workings due to their dewatering was calculated based on stage-storage curves (Figure 1). These curves were developed using the 3D block model data provided by Goldcorp to AMEC in 2007. This block model includes information on the spatial distribution and volume of the existing mine workings from an elevation of 350 mASL down to the -248 mASL level. According to these data the total void space of the mine workings (excluding backfill) located within this elevation interval is 40,573,862 m^3. The following additional assumptions were utilized in the calculations:

- Total backfill volume was assumed to be 673,946,364 ft^3 (18,870,498 m^3) based on the information provided by Golder (1997). Backfill material was assumed to be uniformly distributed within the existing mine workings;
- Spatial variations of the water levels in the mine workings were neglected, i.e., increased pumping from the McIntyre #11 Shaft is assumed to result in the instantaneous reduction of water levels throughout the entire network of the interconnected mine workings; and,
- Current water level in the mine workings was assumed to be about 304 mASL, based on the water levels recorded in the McIntyre #11 Shaft.

According to the curve, representing the mine void volume corrected for backfill (Figure 1) the net volume of water in the mine, corresponding to the current elevation of 304 mASL is about 20,525,900 m^3. Similar net volumes, corresponding to other elevations, calculated as 304 mASL minus the prescribed change in the water levels due to the mine dewatering, can be obtained from the same curve. Pumping rates associated with water released from storage are calculated as a change in net void volume corresponding to two different water levels divided by a time-period over which the prescribed water level decline is expected to occur.

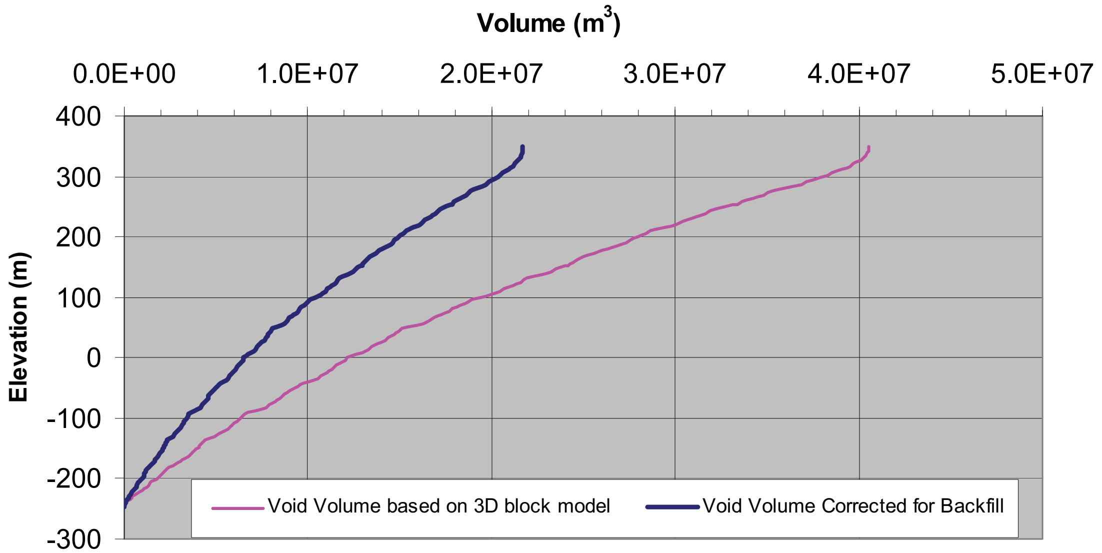

Figure 1: Mine Workings' Volume vs. Elevation

Groundwater Seepage into the Mine

Groundwater seepage rates into the existing mine workings and proposed open pits (Central Pit, Millerton Pit and 92 Pit) were estimates using a numerical (MODFLOW) three-dimensional groundwater flow model. Prior to using this model as a predictive tool it was calibrated to the following targets:

- Water levels in 32 observation wells screened in the overburden and bedrock;
- Observed water level in Gillies, Clearwater and Charlebois Lakes;
- Reported daily average pumping rate of 1,200 to 1,900 m^3/d from the McIntyre #11 Shaft, required to maintain its water level at the elevation of about 304 mASL; and,
- The reported historic pumping rate of about 3,800 to 7,600 m^3/d (1,000,000 to 2,000,000 US gallons per day) from the Hollinger and McIntyre mine workings (Golder, 1997).

The details of the Hollinger groundwater flow model development and calibration are presented in the attached AMEC (2009) report. Two predictive variants were simulated by the model: (1) the base case scenario, corresponding to the “best-fit” combination of the model input parameters and (2) a more conservative variant with the increased hydraulic conductivity of rock a depth of 140 to180 m (AMEC, 2009). Simulating both variants in a transient mode over a period of seven years, corresponding to the various stages of excavation, it was assumed that the water level in the underground openings is maintained at the elevation of the pit bottom minus 20 m. Figure 2 shows model predicted seepage rates into the proposed pits, main access ramp and the remaining mine workings (i.e., mine workings located outside of the proposed pits' perimeters and below their bottoms).

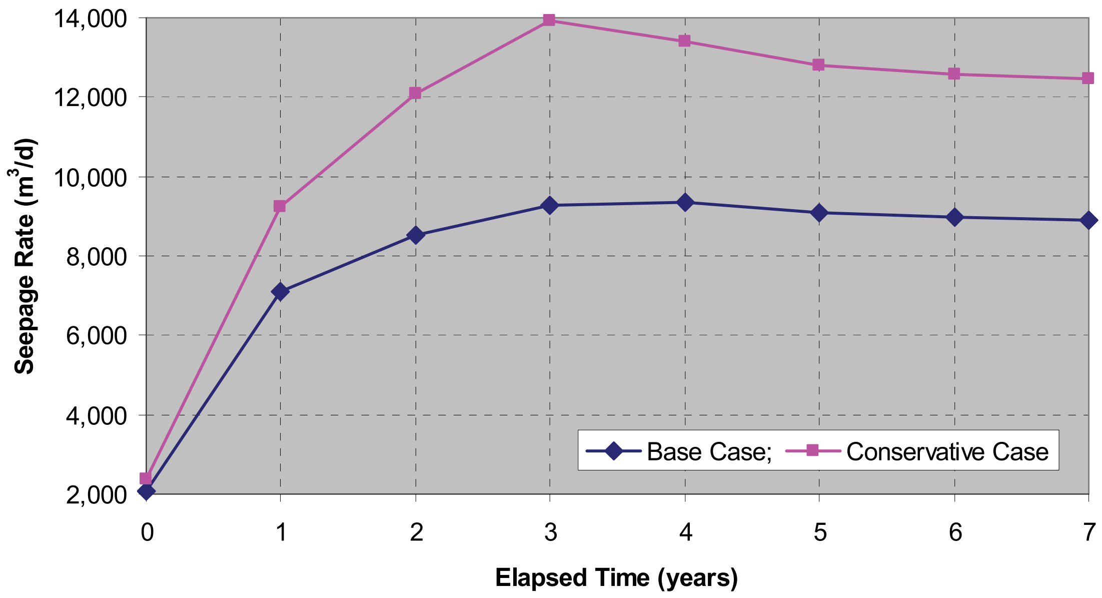

Figure 2: Hollinger Model Predicted Groundwater Seepage Rates

According to the simulated base case scenario, the total groundwater seepage is expected to reach a maximum of about 9,400 m^3/d after the third year of excavation and then gradually to decline to about 8,900 m^3/d at the end of the seventh year. The simulated conservative scenario shows significantly higher seepage rates, compared with the base case scenario. For example, the total seepage rate the end of year seven is predicted to reach 12,400 m^3/d compared with the rate 8,900 m^3/d for the Base Case Scenario (Figure 2).

References

AMEC Earth & Environmental Limited, 2009. Hydrogeological Assessment in Support of PTTW and C. of A. Application for the Hollinger Project.

Golder Associated Ltd., 1997. Report on Timmins Mine Water Study, 97-1201.

GOLDCORP CANADA LTD.
HOLLINGER PROJECT

HYDROGEOLOGICAL ASSESSMENT IN

SUPPORT OF PTTW AND C. of A. APPLICATION FOR THE HOLLINGER PROJECT

Submitted to:

Goldcorp Canada Ltd. – Porcupine Gold Mines
4315 Gold Mine Road, P.O. Box 70
South Porcupine, Ontario
P0N 1H0

Submitted by:

AMEC Earth & Environmental
a Division of AMEC Americas Limited
160 Traders Blvd. E., Suite 110
Mississauga, Ontario
L4Z 3K7

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Porcupine Gold Mines (PGM), a joint venture between Goldcorp Canada Ltd. (51%) and Goldcorp Inc. (49%), (Goldcorp), is planning to redevelop the former Hollinger and McIntyre Mine area, in Timmins, as a new open pit and underground (UG) mining complex (Figure 1). The open pit complex would involve the sequential development of four staged phases that would be used to access shallow ore zones within 200 to 250 metres (m) of the ground surface. The UG portion of the mine complex would involve the development of two new UG ramps and associated future shafts that would be used to access deeper ore zones.

The four staged pit phases are generally referenced as the 92 Pit, the Millerton Pit, the Central Pit, and the Vipond Pit (Figures 1 and 2). The UG operations would consist of the Millerton and Central Porphyry Zone (CPZ) operations. Ramps developed at the Millerton and CPZ locations would be developed to approximately 400 m below grade. Mining beyond that point would likely involve shaft mining, potentially using the existing Hollinger No. 26 Shaft to develop the Millerton UG, and the McIntyre No. 11 Shaft to develop the CPZ UG. Ramp development and associated UG exploration would be used to confirm UG ore resources, and the viability of UG mining.

The former Hollinger and McIntyre Mines both support extensive historic and interconnected UG workings that extend to a maximum depth of more than 2,000 m below surface, and both mine sites are currently in a state of closure. To manage mine water levels in the area, Goldcorp currently pumps water from the McIntyre No. 11 Shaft to Little Pearl Tailings Pond (LPTP). Pumping generally occurs at a rate sufficient to maintain the water table in the McIntyre site UG workings at a position approximately 25 m below grade, and at more distant southern locations, near the Shania Twain Centre, at a level of about 10 m below grade. Pumping in this manner prevents groundwater from the UG workings, from breaking surface in an uncontrolled fashion, and allows the groundwater to be managed at one location – LPTP.

Water management at the sites is carried out in accordance with the terms and conditions specified in Amended Permit to Take Water (PTTW) 0248-6UJMBL, dated October 13, 2006; and in Amended Certificate of Approval (C. of A.) 8572-4L8GYF, dated July 6, 2000, as amended by Notice No. 1, dated October 13, 2000, and Notice No. 2, dated April 4, 2001.

PTTW 0248-6UJMBL allows pumping at a maximum rate of 13,402 cubic metres per day (m^3/d) from the McIntyre No. 11 Shaft, and 1,000 m^3/d from the Hollinger No. 26 Shaft. C. of A. 8572-4L8GYF provides for pumping groundwater from the McIntyre No. 11 Shaft to a silt-curtain enclosed area on the north side of LPTP.

To manage groundwater associated with future, planned mining operations, mine water from the McIntyre No. 11 Shaft would initially be pumped at a greater rate of up to 40,000 m^3/d for approximately the first 2 years of operations, and at a lesser rate of up to approximately 25,000 m^3/d thereafter, until mining operations are completed over a period of up to approximately 15 years, depending on whether or not UG operations proceed. Water pumped from the McIntyre No. 11 Shaft will contain suspended solids, residual ammonia from the use of ammonium-nitrate based blasting agents, reduced iron (Fe^{2+} state), and lesser quantities of other heavy metals.

To better manage the mine water discharge, the current point of discharge into LPTP would be shifted from the north side to the northwest end of the pond. The entire pond would then be used for mine water treatment. Water treatment in the LPTP would be assisted through the use of flocculants and silt curtains (or rock fill berms), as required to promote the settlement of total suspended solids (TSS). Residual ammonia would be managed through the use of emulsion, or emulsion blend explosives, as required to control soluble ammonia residuals at source.

The outflow from LPTP would be reconfigured from its current condition of a single 36-inch diameter culvert without controls, to the use of a thin-plate, concrete weir, connecting to a single larger concrete box culvert, sufficient to provide for the continuous measurement of flows from the treatment works to an accuracy of ±15% in accordance with Ontario Regulation (O. Reg.) 560/94.

The purpose of this submission is to support application for amendments to PTTW 0248-6UJMBL and C. of A. 8572-4L8GYF, to allow for increased mine water pumping rates, and the treatment of such water, as described above. Copies of the current PTTW and C. of A. are included as Appendix A.

1.1 Site History

The Hollinger gold deposit was discovered in 1909, as one of the three original major Timmins properties, along with that of the Dome and McIntyre Mines. The main Hollinger Mine operated from 1910 to 1968 and further mining took place in the 1970's and 1980's. The Hollinger, McIntyre and Coniaurum underground mine workings are all interconnected, along with those of a number of other smaller mines in the area.

Because of their connection to the McIntyre Mine, the Hollinger underground workings were kept dry while McIntyre operations continued until 1988, when the McIntyre Mine was shut down. The pumps at Hollinger and McIntyre Mines were shut down in 1991, and the underground working allowed to flood. A surface pump was installed in the McIntyre No 11 Shaft in 2000 and currently the upper mine levels are dewatered to a level ranging between 24 to 34 m below ground surface (mbgs), to help manage near-surface groundwater levels in the area. Mine water from the Hollinger, McIntyre and Coniaurum Mines is managed through the McIntyre No. 11 Shaft, with discharge to Little Pearl Tailings Pond. The McIntyre Mine operated from 1911 to 1988.

1.2 Project Overview

Goldcorp, through PGM, is planning to develop the Hollinger Project by redeveloping the former Hollinger and McIntyre Mines area as a new open pit and UG mining complex. The open pit complex would involve the sequential development of an open pit, through a series of phased pushbacks that would be used to access shallow ore zones within 200 to 250 mbgs. The UG portion of the mine complex would involve the potential development of two new UG ramps and associated ventilation raises that would be used to access deeper ore zones (Figure 1.2).

Development of the new Hollinger Project would require comparatively limited new infrastructure, as ore from the Project Site would be hauled to and processed at the existing Dome Mill, with tailings from ore processing to be discharged to the existing Dome Mine tailings deposition area.

The UG operations would consist of the Millerton and Central Porphyry Zone (CPZ) UG operations. Ramps developed at the Millerton and CPZ locations would be developed to approximately 400 mbgs. Mining beyond that point would likely involve shaft hoisting. Opportunities to use existing infrastructure for the deeper mining could potentially involve using the existing Hollinger No. 26 Shaft to develop the Millerton UG, and the McIntyre No. 11 Shaft to develop the CPZ UG. Ramp development and associated UG exploration would be used to confirm UG ore resources, and the viability of UG mining.

Under the current open pit design, there would be a requirement for the disposal of approximately 37,000,000 m^3 of mine rock. The majority of the mine rock (estimated at 20,000,000 to 30,000,000 m^3) would be retained on the Hollinger Project Site and would be used to backfill and overfill the initially excavated phased mine pits. Rock will also be used to build the Environmental Control Berm and the Transportation Corridor with the remainder being stored at the Dome Mine site.

Infrastructure used and/or developed to support the Hollinger Project would include:

- At the Hollinger Project Site:
  - permanent mine rock and overburden stockpiles;
  - site water collection and drainage systems (if required);
  - potentially some small fuel and petroleum product storage facilities (if required);
  - electrical connections from nearby, currently in place, Hydro One infrastructure; and,
  - natural gas (if required) from nearby, currently in place, Union Gas infrastructure.

- Off the Hollinger Project Site:
  - the approximately 4.8 km long Transportation Corridor linking the Hollinger Project Site with the Dome Mill;
  - potentially additional mine rock stockpiles (at the Dome site) (if required); and,
  - mine dewatering system from McIntyre No. 11 Shaft to Little Pearl Tailings Pond.

In addition, the Project would include the construction of an Environmental Control Berm around the Hollinger Project Site. This is a key feature of the Project with the main purpose of the Environmental Control Berm being to manage noise and other effects on nearby receptors.

Throughout the operations phase, mine rock material would be used to progressively backfill the phased mined pits. At closure, the remaining pit will be allowed to flood, and the pit discharge will likely be routed by gravity flow south to either the Skynner Creek or Perch Lake systems, both of which drain to the Mountjoy River. All remaining Project infrastructure would be removed at closure, and the Project Site would be rehabilitated in accordance with established mine closure protocols. In addition, closure will be carried out such that existing safety hazards would be removed. Part of the Closure Plan would be to ensure, through stakeholder input and working collaboration with the

City of Timmins' Planning Department, that the Project Site would be landscaped in an aesthetically pleasing manner.

1.3 General Setting

The Timmins area is characterized by a mix of urban and industrial development superimposed on a background of coniferous and mixed deciduous coniferous boreal forest. The City of Timmins consists of a major downtown urban area, as well as a number of other smaller urban centres scattered throughout the area, with Schumacher, South Porcupine, and Connaught Hill being the more prominent of these smaller centres. Various other smaller hamlets also occur throughout the area, such as Gold Centre, the Aunor, Buffalo-Ankerite and Delnite areas, and several other small clusters of residences. Many or most of these communities have grown up around former mine sites. All of these areas, together with a much larger surrounding region, were amalgamated in 1973 to form the City of Timmins.

The City of Timmins provides municipal water to area residents within the city, and only a few residents in outlying areas rely on private wells for their water supply.

South Porcupine and other communities to the east are linked to Timmins by Highway 101, with a commercial strip occurring along this highway between downtown Timmins and Schumacher. Highway 655 extends north from Highway 101, with linkages to the Timmins airport via Airport Road, and linkages further north to Xstrata Copper's Kidd Mine site and Highway 11. Several major transmission, gas, water, and sewer lines pass through the area, as well as local services.

Timmins was founded as a mining centre, with the three prominent original mines being the Hollinger Mine, the McIntyre Mine, and the Dome Mine. Of these, only the Dome Mine is still in operation within the study area. Numerous other smaller mines also operated in the local area; many of which were or became linked to the three major mines at one time or another. None of these smaller mines are currently active. Above and below grade tailings, associated with these active and former mine sites, are widespread throughout the study area (Figure 1.1). Prominent waste rock stockpiles are associated with the Dome Mine. There is little evidence of waste rock stockpiles associated with the other mining operations, because all the mines, except for the Dome open pit operation, were underground mines. Waste rock produced by these underground mines was typically used as material for construction and backfill operations.

Topography in the Timmins area is dominated by its location at the transition of Precambrian Shield terrain to flat-lying glaciolacustrine silt and clay plains. An extensive glaciolacustrine sand plain area lies to the south of Timmins, including dune formations, and extends into the lower, southwest portion of the study area (Figure 1.3). A prominent esker system extends immediately adjacent and parallel to the east side of Highway 655, north from Highway 101. The local topography reaches a maximum elevation of about 365 m above mean sea level (amsl) in the area just southeast of the Hollinger site and north of Gold Mine Road. Further east towards South Porcupine, and within the glaciolacustrine silt and clay plains, the local topography decreases to as little as 280 m elevation.

The bedrock geology of the Timmins area is structurally complex, and includes several major fault zones, and anticline / syncline systems, many of which control surface topographic expressions. The Pearl Lake / Little Pearl Tailings Pond, and the Gillies Lake area are controlled by these features, and as a result are the site of deeper sediment accumulations. Bedrock exposures are widespread and frequent throughout the major portion of the study area, but with much reduced expression in the areas dominated by glaciolacustrine silt, clay and sand plains.

Several small lakes and numerous ponds are scattered throughout the area, with larger numbers of ponds having formed along low gradient creek valleys as a result of beaver activity. Most of the area’s drainage is captured by the Porcupine and South Porcupine Rivers, which flow east, converging just upstream of Porcupine Lake, northeast of the Dome Mine site. The Porcupine River is a low gradient system that has its headwaters in the area just north and east of the Hollinger site. The Porcupine River drains into Night Hawk Lake and the Frederick House River system. Areas south and west of the Hollinger site drain to either the Skynner Creek or Perch Lake systems, both of which drain to the Mountjoy River, which flows into the Mattagami River. Areas north and west of the Hollinger site drain to Gillies Lake and the Town Creek system, which drains to the Mattagami River; or slightly further north there are a number of smaller drainages that drain directly west to the Mattagami River.

Virtually all drainages in the area have been affected by existing or past mining activities, which have affected water quality, and to a lesser extent drainage patterns themselves.

The majority of the landscape that has not been developed for urbanization or mining remains in forest cover, with the exception of principal agricultural areas to the north and south of Timmins, near to the Mattagami River, and a number of smaller parcels of land in and around the Porcupine Lake area. Forest communities in the area are virtually all second growth as a result of past logging activities, and fires. Throughout the generally lower-lying, eastern portion of the study area, forest communities are dominated by varying mixtures of black spruce and poplar (trembling aspen and balsam poplar), with white spruce, jack pine, balsam fir, larch and white birch as common associates. Central portions of the study area, where rock outcroppings are common, show similar forest community types, but with a somewhat stronger representation of jack pine. Sandy areas north of Gillies Lake bordering Highway 655, and south and west of the Kayorum (Hollinger) tailings stack, show a dominance of jack pine, or jack pine with poplar. The abundance of poplar in the area is indicative of the level of past disturbance, as poplar species are typically successional and not characteristic of mature forest communities. Virtually all major forest blocks are transected by roads, transmission lines, trails, or other such linear features.

1.4 Spatial and Temporal Boundaries

To encompass potential development areas and immediate drainages there from, including potential developments associated with earlier, more aggressive mine development scenarios which are no longer contemplated, Local Study Area (LSA) boundaries for natural environment investigations were focused on watershed and riverine boundaries, with the exception of the northwest study area boundary, which was defined by Laforest Road and a narrow strip of land bordering the east side of Highway 655 (Figure 1.1).

1.5 Study Objectives

The main objectives of this study were to provide:

- A characterization of the existing groundwater conditions (flow direction, velocities and ultimate discharge points [i.e., receivers]);
- A conceptual and numerical model of the proposed mine;
- A prediction of potential effects of dewatering on the local groundwater flow system as a result of pit expansion;
- Identify conceptual mitigation plans and strategies; and,
- Support for the application for a PTTW and C. of A. for dewatering.

2.0 METHODS

This hydrogeological assessment builds upon both historical hydrogeology studies and work undertaken by AMEC in 2007 and 2008 to infill data gaps identified in the pre-feasibility studies. The above information was used to develop a numerical groundwater model. The model was correlated to historical dewatering data from the historical mine and to current conditions, and then used to predict groundwater inflows into the proposed mine.

2.1 Existing Data Sources

Existing data sources which can be used to characterize Timmins area hydrogeological conditions include:

- Detailed topographic mapping (Lidar imaging) conducted for the Timmins area for Goldcorp during 2006, with contour intervals at 0.3 m elevation;
- Historic pumping records – McIntyre Porcupine Mines Limited (1967);
- Historic Pumping records for the Dome Mine;
- A summary of a geological interpretation developed by Panterra Geoservices Inc.;
- A Gillies Lake Geotechnical Report prepared by Golder Associates (1988) for the Timmins Gold Tailings Project;
- Exploration borehole data provided by Goldcorp including bedrock surfaces;
- Three dimensional data on the location of historical workings in a VULCAN model database;
- Water Well Records in the MOE database;
- Climatic statistics available from the Timmins airport;
- Timmins Mine Water Study (Golder, 1997);
- Timmins Mine Water Management Plan (Aquafor Beech Limited, June 2000); and,
- Storm Water Management Plan – Mine Water Discharge to Gillies Lake (Aquafor Beech Limited, September 2000).

The Lidar imaging was extremely valuable for delineating local watershed boundaries and conditions because of its digital format; high resolution coloured air photo background; and detailed contour mapping that can be manipulated to contour sets with detail down to 0.3 m.

The historic pumping records are useful as this information provides real data with respect to the volume of water that the bedrock aquifer produces under activity mining operations. These data were used to assist in model calibration in that these volumes have been extracted (historically) from underground without producing large scale dewatering of the numerous adjacent surface water features.

Existing geological and geotechnical data were used to help in characterizing the geological setting in the immediate vicinity of the proposed project and allow interpolation and extrapolation of the conditions observed during AMEC’s field studies. This information was supplemented with information from water wells in the area obtained from the MOE Water Well Information System database. Goldcorp also provided a three dimensional interpretation of the local geology developed from an extensive data base of exploration holes and maps of the underground workings in a VULCAN geologic model format. This model was used to map the locations of the underground workings that are part of the former McIntyre and Hollinger Mines and provided a bedrock surface map.

The Timmins airport climatic station meets World Meteorological Organization (WMO) standards for temperature and precipitation, and includes a nearly complete set of climatic parameters necessary for inputs required for the hydrogeological modeling, and is therefore regarded as a quality climate station.

The Timmins Mine Water Study, Water Management Plan and Storm Water Management Plan provide an understanding of the interaction between the existing mine workings, the watersheds and the current dewatering efforts.

2.2 Identified Data Gaps

In 2007, AMEC conducted an initial review of existing information to identify potential data gaps. Historically, a number of monitoring wells were installed in various locations around the Hollinger site as part of different projects. These wells were installed near the west end of the proposed pit complex to assist in the investigation of a series of near surface mine workings, and to the north of the east end of the proposed works associated with McIntyre Mine site and tailings impoundments. The logs of these wells were reviewed to assist in development of the hydrogeological model for the site and surrounding area. The majority of these wells were installed in the overburden deposits and presented a data gap as to the bedrock conditions.

In addition to available borehole logs, Water Well Records in the MOE database were also reviewed (Appendix C). Most of these wells were completed in either the overburden or the shallow bedrock and provided little information on the deep bedrock.

Based on the data requirements to assess hydrogeological conditions at the site, AMEC developed an initial work program in 2007 to address the following data gaps:

- Deep bedrock conditions in the vicinity of the proposed workings (limited borehole and monitoring well data);

- Potential for fault/shear zone controlled features in the bedrock;
- Hydraulic conductivity of rock formations;
- Horizontal and vertical extent of overburden deposits (limited borehole and stratigraphic data);
- The existing Zone of Influence related to the current, ongoing dewatering efforts associated with the existing mine workings and the mine water management plan; and,
- Potential for significant hydraulic connection with surface water features in close proximity to proposed mine workings.

In order to address these data gaps AMEC worked with Goldcorp personnel to select accessible, representative locations for intrusive investigations of each of the overburden, shallow bedrock and deep bedrock aquifers. Special consideration with respect to the location of the existing underground workings was made during location of the deep bedrock aquifer instrumentation to ensure that these voids were not intercepted.

2.3 2007 Drilling and Monitoring Well Installation Program

Based on a review of the available information, AMEC prepared a drilling and monitoring well installation program that included drilling at a total of 13 locations around the proposed pit complex area in 2007 (Figure 2.1). The 2007 program included packer testing and the installation of multi-level monitoring wells in order to:

- Determine the composition and extent of the overburden and bedrock deposits;
- Characterize aquifer conditions and properties; and,
- Provide information as to the existing or potential for interference with surrounding land use and/or surface water features.

The overburden and shallow bedrock aquifers were investigated through the use of a track-mounted, standard soils auger drilling rig, equipped with split-spoon sampling and NQ bedrock coring equipment and capabilities provided by Marathon Drilling Limited. Soil samples were collected via the split-spoon sampling equipment throughout the overburden deposits on 0.76 m intervals and bedrock coring and samples were completed continuously throughout shallow bedrock in 1.5 m runs. The four deep bedrock aquifer boreholes were completed using a truck mounted water well drilling rig, supplied by Davidson Well Drilling, using 150 mm diameter dual rotary drilling technology, to depths between 134 and 183 m below.

In accordance with O. Reg. 903, AMEC retained licensed water well drillers to complete the installation of all monitoring wells. Following drilling and sampling, the boreholes were instrumented with 50 mm ID PVC monitoring wells complete with 3 m screened interval (#10 slot screen) set at the borehole base. The monitoring wells were completed with a solid PVC riser casing, including an above ground allowance of approximately 1 m, and the casing annulus was sealed using a granular bentonite and drill cuttings backfill mix. A lockable steel protective post was installed over the PVC casing and grouted into place to ensure secured access and that these wells could serve as long-term monitoring stations.

Well construction details for the monitoring wells are included in the borehole logs provided in Appendix B. The locations of these monitoring wells are provided in Figure 2.1.

In order to characterize the hydraulic properties of the bedrock aquifer in the vicinity of the proposed mine development AMEC conducted packer testing and slug testing of the bedrock holes located around the perimeter of the proposed open pit complex. The packer testing program involved the testing of bulk hydraulic conductivities of the entire open borehole for the shallow bedrock holes (Marathon Drilling Limited), as well as targeting discrete fractured intervals and other zones of hydraulic significance (i.e., weathered versus unweathered zones, etc). A number of other bulk tests covering certain intervals of the holes were also completed. The deep bedrock holes were subjected to continuous packer testing on 20 m wide intervals over the entire depth of the hole (Davidson Well Drilling). The data were used assist in the development of a representative computer model.

2.4 2008 Pearl Lake Drilling Program

A preliminary groundwater numerical model was constructed using information from historical sources and the 2007 field program. Because of the proximity of the proposed pit complex to LPTP and Pearl Lake, the model was determined to be sensitive to the type of geologic materials assumed to be present under the lake. To reduce the uncertainty in the model, additional drilling was completed on Pearl Lake in March 2008 using a drill rig driven onto the frozen lake.

The 2008 Pearl Lake drilling was conducted by Marathon Drilling Limited under AMEC supervision following a methodology similar to that of the 2007 drilling program, although in this case, no monitoring wells were installed. The 2008 program included three boreholes drilled to depths of 4.3 to 6.4 m below the lake bottom. For each borehole, the geologic material below the organic lake bed was continuously split spoon sampled to obtain a continuous log of the lake bed material. The logs of these boreholes are included in Appendix B.

2.5 2008 Stream Flow Measurement Program

Stream flow measurements were begun in 2008 at three stations with the Local Study Area, with the aim of establishing rating curves for subsequent stream flow monitoring. The locations of the stream flow measurement stations are shown in Figure 3.1. Stream flow measurements have been taken in the early winter of 2009, in the spring of 2009 and early summer of 2009. The results of the stream flow monitoring are described in Section 3.1.

3.0 SITE CHARACTERISTICS

3.1 Surface Water and Drainage

Watersheds that could potentially be affected by project related developments are shown in Figure 3.1. Potentially affected watersheds are defined to include those that could be affected by mine water discharge, runoff from possible waste rock stockpile areas, and Hollinger pit discharge at closure. The Hollinger site itself is located at the apex of three watersheds, namely those of the Porcupine River to the east, Skynner Creek to the southwest, and the Gillies Lake / Town Creek system to the northwest. The precise delineation of watershed boundaries in the immediate Hollinger site area is difficult, even with the benefit of 0.3 m Lidar contour intervals, because of extensive open-pitting and underground stope breakthroughs in this area. Gillies Lake is connected to Town Creek by way of a buried pipeline outfall that flows north from the lake.

Boundaries of a number of other LSA watersheds have also been influenced by past mining operations. This is especially true of areas in the vicinity of the Kayorum, McIntyre, ERG, Delnite and Dome tailings areas, as well as areas affected by the Dome open pit and waste rock stockpiles.

Porcupine River System

The dominant watersheds draining the area surrounding the Hollinger site area are those of the Porcupine and South Porcupine Rivers, which to the point of their confluence just west of Porcupine Lake, measure 32.0 km^2 and 42.7 km^2, respectively (Figure 3.1). Beyond their confluence, these two systems pass into the southwest end Porcupine Lake. From Porcupine Lake, the Porcupine River flows in a north-northeasterly direction, looping around the Kidd Metsite tailings areas, before turning south to Night Hawk Lake, and the Frederick House River system. The North Porcupine River, which drains the northern portion of the ERG tailings area and adjacent areas north of the Porcupine watershed boundary shown in Figure 3.1, enters the main branch of the Porcupine River near the northwest margin of the Kidd Metsite tailings. Near where the Porcupine River crosses Highway 101, at Hoyle, just upstream of its confluence with Night Hawk Lake, Environment Canada maintained the Porcupine River WSC flow gauging station (04MD004) from January 1977 to September 1994. The station was re-established in 2008.

Headwaters of the Porcupine River drain LPTP, Pearl Lake, Clearwater Lake, and the southern portion of the ERG tailings area. Current underground pumping at the McIntyre #11 Shaft headframe discharges to LPTP, and hence to the Porcupine River. Water quality within the Porcupine River is influenced by past mining activities, as is the water quality of virtually all other watersheds shown in Figure 3.1, except those of the Perch Lake system and the series of smaller creeks shown in the northwest portion of the figure.

The Porcupine River is a low gradient system, with the river mainstem, downstream of Pearl Lake exhibiting a gradient of 0.44 % (i.e., a drop of 4.4 m vertical per 1,000 m horizontal). The river flow and that of its tributaries is interrupted by numerous beaver dams, both active and historic. The elevations of LPTP (313.2 m amsl) and Pearl Lake (313.0 m amsl) are important to future considerations involving the re-flooding of the Hollinger open pit, at mine closure, because both of these water bodies exhibit elevations which may, or may not be above any future pit lake water level.

The South Porcupine headwaters drain McDonald and Simpson Lakes, as well as the existing Dome tailings containment facility, and the Dome waste rock storage area (Figure 3.1). South Porcupine River characteristics are similar to those of the Porcupine River, being characterized by a mainstem gradient of 0.33 % (3.3 m vertical drop per 1,000 m horizontal), and numerous beaver dams.

Skynner Creek and Perch Lake System Watersheds

Skynner Creek originates at Skynner Lake in the extreme southeast of the watershed, but also drains the southern portion of the City of Timmins proper and the Kayorum tailings area. Its watershed measures approximately 13.4 km^2 (Figure 3.1). The northeastern portion of the watershed has been strongly altered by the Kayorum tailings area, and by headwater channelling to the north in the vicinity of the Hollinger Golf Club. Skynner Creek drains to the Mountjoy River, which flows into the Mattagami River. This creek is also a low gradient system, being characterized by a mainstem gradient of 0.54 % (5.4 m vertical drop per 1,000 m horizontal), and numerous beaver dams.

Skynner Creek is of interest to the Hollinger project from three perspectives. First, the southernmost portion of the Hollinger site drains south to the Skynner Creek system. Second, much of the Skynner Creek drainage system passes through terrain dominated by glaciofluvial sand deposits. Hence, there is the potential for stronger surface water / groundwater interconnections in this area. And third, because of its lower elevation, it would be possible to induce gravity flow from a future flooded Hollinger pit (following mine closure) to the Skynner Creek system.

The Perch Lake system is a smaller drainage system, located adjacent to the Skynner Creek watershed, which also flows to the Mountjoy River. Similar to the Skynner Creek system, much of the Perch Lake watershed is founded on glaciofluvial sand deposits, and therefore potentially exhibits a strong surface water / groundwater interconnection. Similar to the Skynner Creek system, the Perch Lake system is positioned at a lower elevation such that it would also be possible to induce gravity flow from a future flooded Hollinger pit (following mine closure) to the Skynner Creek or Perch Lake systems.

Town Creek and Smaller North Mattagami River Watersheds

The Town Creek system drains Gillies Lake, low gradient tailings areas to the east of Highway 655, and significant portions of the City of Timmins proper (Figure 3.1). The connection between Gillies Lake and Town Creek is subsurface, by way of a buried pipeline that exits to the Town Creek drainage system in the area of Murray Street Park. The low gradient tailings to the east of Highway 655 (the Hollinger tailings) were reportedly deposited in the former northeastward extension of Gillies Lake during the 1920's and 1930's (Kees Pols per. comm., Mattagami Region Conservation Authority, October 5, 2007). A small portion of these tailings are partially sulphide concentrate tailings and are therefore potentially acid generating. Management of these tailings is being addressed through a separate closure plan.

Past consideration has been given to draining Hollinger Mine workings to the Gillies Lake / Town Creek system. However, concerns over the potential flooding of portions of the City adjacent to lower reaches of the Town Creek system argue against this proposal, and against directing passive drainage from any future flooded Hollinger pit lake (after mine closure) to the Town Creek system.

In addition to Town Creek, there are four other smaller watersheds that drain the area west of Highway 655 and north of the Town Creek system. All of these smaller watersheds drain directly or indirectly (through Craft Creek) to the Mattagami River. These smaller watersheds are included in the LSA for the sole reason that consideration was given to stockpiling waste rock in the area west of Highway 655 and north of the Timmins hospital. Further considerations argued against using this area for waste rock storage, hence no specific efforts have been directed at characterizing these smaller watersheds, other than to define their boundaries.

Stream Flow Monitoring

AMEC began conducting stream flow monitoring at three of the watersheds in 2008 as part of the long term strategy to develop rating curves for the local streams. The locations of the stream flow monitoring stations are shown in Figure 3.1. To date there have been up to four stream measurements at these locations (Table 3.1). Additional stream flow measurements will be required to develop a rating curve for each station. While all the stream flow measurements have generally occurred in periods of higher flow, they are listed here to provide an indication of the range of flows that might be expected in the watersheds.

Flows for the different systems were sometimes carried out at different days within the same approximate time periods, under sometimes differing hydrological conditions (e.g., rain events). It is therefore premature to draw any conclusions from this limited data set regarding comparative watershed yields.

3.2 Overburden

As described in Section 2.2, gaps in the existing overburden data set were addressed through the advancement of 13 multi-level monitoring wells, surrounding the proposed pits and three boreholes into the bed of Pearl Lake.

The overburden geology generally consists of glacial deposits, overlain in places by thin peat deposits and fill (mostly mine tailings).

Generally, the oldest overburden unit in the area is the Matheson boulder-sand-silt till, which is typically found overlying the bedrock surface in depressions in the bedrock surface. The deposition of the till took place beneath the Wisconsin ice sheet, along with sand and gravel esker deposits. A significant esker deposit is located in the northern part of the study area running parallel to Highway 655.

The Wisconsin ice front retreated to the north approximately 10,000 years ago. As the glacial front receded, pro-glacial lake Barlow-Ojibway formed in front of glaciers. Meltwaters from the glacier carried significant quantities of material into the glacial lake. Silty sands and gravels were deposited in ice contact and outwash deposits in front of the receded glacier at locations where the meltwater discharged to the lake creating a variable distribution of coarse grained material.

Away from the meltwater discharge points, significant quantities of silt and clay were deposited as a blanket across the region in low-lying areas as either varved or massive silt and clay deposits. This includes the lake bed sediments of Gilles Lake, which is located within the mapped lacustrine plain, and which is reported to be composed of clay and silt (Klohn-Crippen, 1998 and SENES, 2007).

In general, the esker complex formed before the silts and clays were deposited, and consequently the silts and clays tend to overlie portions of the esker sands and gravels. However, deposits of sand can be found over the clay as a result of erosion and reworking of the esker and ice-contact deltas. This may have occurred beneath Pearl Lake. Finally, with time, peat and organic soils have formed in shallow wet areas.

In historical times, significant thickness of fill material, mostly in the form of mine tailings and waste rock has been placed in the area (Figure 1.1). The LPTP and to a lesser extent, Pearl Lake are reported to have tailings as bottom sediments in some areas (Golder, 1985).

The horizontal extent of these deposits is presented in plan view in Figure 3.2 and an overburden thickness map was derived from exploration borehole data along transects shown in Figure 3.3. In general, the overburden sediments are thin in the area of the proposed pits and areas east of the pits, where the overburden generally occurs as a thin veneer of till across and between areas dominated by bedrock highs. The overburden thicknesses increases to the west of the site into areas mapped as lacustrine plain sediments, which are likely underlain by older till and outwash sediments.

The thickest overburden sediments occur beneath the local lakes with overburden thickness reaching greater than 20 m beneath Gilles Lake and more than 60 m beneath Pearl Lake. The overburden geology in cross-section is illustrated Figures 3.4 and 3.5. The thick overburden sediments beneath Pearl Lake are interpreted to include a thin silt layer beneath the Lake, and thicker deeper silt layer at depth. The silt layers are interpreted to be separated and underlain by sand layers. The interpreted overburden sediments beneath Gilles Lake are also interpreted to include a significant silt layer based on surficial geologic mapping (Figure 3.5) and a reports by Klohn-Crippen (1998) and SENES (2007).

In the area of the proposed pits, the cross-sections show the overburden to be thin to absent. Thicker overburden sediments on the order of 3 to 8 m thick occur to the southwest of the proposed pits. Borehole logs and water well records from this area indicate that the overburden is primarily sand or gravel with silt at surface in some locations.

3.3 Bedrock

The Hollinger-McIntyre deposit is hosted by mafic volcanic rocks of the central and upper Tisdale assemblages that are intruded by porphyritic intrusions. Mafic volcanic rocks in the deposit have generally been divided into three units: the Northern, Central and Vipond Formations (Figure 3.6).

The Hollinger Mine historically was developed on gold bearing veins which are structurally controlled by lithologic contacts and deformation zones associated with altered Central and Vipond Formation volcanics. These units strike N55E and 70 SE, and are folded into an anticline. The Northern formation occurs in the core of Central Tisdale Anticline. The Central Formation hosts most of the major veins systems in the Hollinger and McIntyre mines. It is comprised of a heterogeneous sequence and the basal units in the Central Formation are the most important ore hosts in the deposit. The Vipond Formation is the youngest volcanic package in the deposit area (J. Floyd, email, Goldcorp Canada Ltd., September 24, 2007).

The lavas have been intruded by a group of porphyry stocks, the largest of which is the Pearl Lake Porphyry. The porphyries are generally conformable to the folds within enclosed rocks and plunge at 45 to 50 degrees E. The porphyry deposits occur in areas of bedrock depressions beneath the lakes, suggesting that they are softer and more prone to erosion than the mafic volcanic rock units that they intrude into.

The core of the Hollinger-McIntyre deposits is an elliptical area of high strain developed along the south limb of the Central Tisdale anticline which surrounds the Pearl Lake porphyry and is approximately 450 to 600 m wide by more than 3 km in length. The elliptical fold of Central Tisdale anticline contains a series of subsidiary folds including the Northern anticline, Hollinger syncline and the Hollinger anticline. The elliptical nature of this structure in plan is due to the non-cylindrical, doubly plunging properties that closes the structure to both the east and west.

3.4 Hydrostratigraphic Layers

Previous studies, as well as the current intrusive investigations characterized the Hollinger Mine site into six hydrostratigraphic units as outlined in Table 3.2.

This table summarizes the general stratigraphy in the study area; however, Units 1, 2 and 3 are not present or continuous across the entire site, and are absent in areas with bedrock highs, while Unit 2 occurs less frequently to the north.

3.5 Private Water Wells

The City of Timmins provides municipal water to local residents and businesses and there are few private water wells in the area. A search of the MOE Water Well Record database identified severl records within a kilometre of the site (Figure 3.7). Of these, two are likely geotechnical boreholes, two are likely pvc monitoring wells, and only three are listed a water supplies. Two of the water supply wells are large diameter, likely dug wells that are completed in the overburden at depths of 10 to 20 m (MOE 165673 to the north and MOE 1605674 to the southwest). The third is a 73 m deep drilled well completed in bedrock to the southwest of the site.

The static water level is only recorded for the deep bedrock hole which was completed in 1980 at a time when the historical Hollinger Mine was in operation. At this time, the static water level was approximately 12 m below ground level, which is similar the water levels collected in 2007 from monitoring wells installed as part of this program (Section 3.4) suggesting that the historical mine workings had little effect on the water level in this well.

3.6 Hydraulic Conductivity Test Results

In order to characterize the hydraulic properties of the bedrock aquifer in the vicinity of the proposed mine development AMEC conducted constant head packer testing in the four deep bedrock holes located around the perimeter of the proposed open pit in 2007 (BH07HO-03, BH07HO-05, BH07HO-09 and BH07HO-13), as well as in 10 of the shallow bedrock holes. Several monitoring wells subsequently constructed in the boreholes were also slug tested to provide additional information on the permeability of the bedrock.

The packer testing program involved testing of bulk hydraulic conductivities of the entire open borehole (for the shallow holes), as well as targeting discrete fractured intervals and other zones of potential hydraulic significance (i.e., weathered versus unweathered zones, etc). The packer tests in the shallow bedrock holes were completed using both single and double packer techniques with the test interval ranging from 3 to 9 m. The deep bedrock holes were subject to continuous packer testing, using the double packer technique for the open hole (uncased) interval with a 20 m interval. A summary of these estimations is provided in Table 3.3. Where similar intervals in the shallow bedrock were tested using both constant head and falling head methodologies, the results were generally similar.

Generally the results of hydraulic conductivity testing showed that the hydraulic conductivity of the rock was between 10^{-4} and 10^{-8} cm/s, with higher hydraulic conductivities (10^{-4} to 10^{-5} cm/s) reported in the shallow bedrock at most locations, presumably due to weathering or fracturing of the shallow bedrock. The presence of higher permeabilities near the surface of the bedrock also applied in areas with thick overburden conditions, such as BH-07-05 near Pearl Lake.

Testing in the deeper bedrock indicates that the hydraulic conductivity decreased by approximately two orders of magnitude within 10 to 20 m of surface, and generally displayed tight rock properties with hydraulic conductivities on the order of 10^{-8} cm/s until depths of approximately 100 m, but increased below this depth. The increase in hydraulic conductivity results at depths below 100 m was unexpected given that bedrock generally becomes tighter with depth and no drilling fluid losses or fractures were identified during drilling. Subsequent to the field program, it was determined that the packers were likely not sufficiently inflated to overcome the hydrostatic pressures, and therefore had an inadequate seal against the bedrock at depths of 100 m or more. As a result, these results of the packer tests were not considered representative of the bedrock at depth.

3.7 Monitoring Well Installations in 2007

Following completion of the packer tests, a monitoring well was installed in each of the boreholes completed in bedrock. In addition, a number of these instruments were twinned with shallower multi-level installations in either bedrock or overburden (if adequate depth of such materials permitted).

AMEC staff obtained water level data during the weeks of July 19, September 25, and November 12, 2007. A table of water level depths is provided along with the well screen installation depths (below existing grade) in Table 3.4. The seasonal groundwater fluctuations observed between the monitoring events is apparent in Table 3.4 and is on the order of 0.5 to 1.5 m for the monitoring period.

A map of the groundwater potentiometric surface was generated using groundwater levels from the shallow bedrock monitoring wells, the lake elevations and the water level elevation in the existing mine workings (Figure 3.8). The shallow groundwater table was generally found to be relatively shallow (i.e., within a few metres at most locations), indicating that the water table surface will closely follow the surface topography. The results indicate that there is a groundwater high in the area to the southwest of the proposed mine site and between Gillies Lake and Pearl Lake, with groundwater discharge to the lakes and Skyner Creek. There may also be one or more very localised cones of depression around the former open pits at the Hollinger mine that are presently being dewatered from the McIntyre Mine Shaft 11 to allow access to the upper part of the mine for tours.

The water level data in Table 3.4 also indicate that downward gradients were measured in the multi-level wells BH07HG03, BH07HG05, BH07HG09 and BH07HG13. The downward gradients are significantly stronger for the sites completed on high ground (BH07HG03 and BH07HG13) suggesting that much of the downward gradient at these locations can be explained by a “perched” water table forming in the upper weathered bedrock aquifer. However, small downward gradients were also measured in relatively low-lying areas (BH07HG05 and BH07HG09) that are close to surface water features (Pearl Lake and Skyner Creek) where upward gradients would be expected. The presence of downward gradients at these two wells might reflect a deep cone of depression associated with the existing mine workings that are partially dewatered.

Alternatively, the water levels in some deep groundwater monitors, which were completed in relatively tight bedrock material, may not be in equilibrium. As such the apparent downward gradients may change with additional measurements.

3.8 Groundwater Chemistry

As part of the November monitoring event, AMEC collected representative groundwater samples from 16 of the 18 monitoring wells installed on-site (two of the monitoring wells were dry). The groundwater monitoring wells were instrumented with dedicated Waterra tubing and foot valves to facilitate well development, purging and sampling requirements. The portion of the sample collected for metals analysis was field filtered using 0.45 micron inline Waterra filter, prior to preservation in the laboratory prepared bottles. In order to increase efficiency and for ease of labelling the laboratory prepared bottles AMEC shortened the boreholes names BH07HG-## to MW-## during the groundwater sampling program.

Samples were submitted under chain of custody, in a temperature-controlled setting (i.e., cooler on ice) to a CAEAL accredited laboratory sub-contractor, Maxxam Analytics (Maxxam), in Mississauga, Ontario for analysis. The analytical results were then forwarded to AMEC. Laboratory Certificates of Analysis are provided in Appendix C. As a quality assurance measure, laboratory blanks as well as two field duplicates (Dup-1 and Dup-2) were used to ensure sample integrity. Dup-1 is a field duplicate of MW-12 and Dup-2 is a field duplicate of MW-6. In general these sample show good correlation between samples and suggest that any errors or anomalous data is not likely attributed to field sampling or laboratory protocols.

A discussion of the various groupings of groundwater data is discussed in the sections below. Groundwater quality data are compared to Ontario Drinking Water Standards (ODWS), however, these guidelines are based on a potable water supply and thus do not directly apply to the baseline groundwater data. There are no groundwater users in the vicinity of these monitoring wells. The lab results for the groundwater samples are summarized in Table 3.4.

In general, the groundwater quality in the vicinity of the proposed Hollinger project is characterized by elevated concentrations of alkalinity, conductivity, hardness, sulphate, TDS and various metals including iron and manganese. Hardness and manganese exceed the ODWS for every monitoring well sampled during the fall 2007 monitoring event and are considered representative of background conditions for the area.

The lowest quality groundwater is quantified for monitoring wells locations MW-4, located near the LPTP. ODWS exceedences at MW-4 include alkalinity, dissolved organic carbon (DOC), hardness (10 times the average of the remainder of the samples), pH, sulphate (20 times the average of the remainder of the samples), total dissolved solids (TDS), cadmium, copper, iron, lead, manganese and zinc. These elevated concentrations are likely associated with previous mining activities on the subject site (i.e., a large amount of waste rock present on surface).

3.9 2008 drilling results from Pearl Lake

In March 2008, three boreholes were drilled into the lake bed at Pearl Lake to investigate the nature of the lake bed sediments in this area (Figures 3.3 and 3.4). Previously, exploration drilling indicated that the overburden in the area of Pearl Lake was up to 70m thick, and drilling results from BH07-HO05 drilled adjacent to the lake indicated that the deeper overburden sediments were sandy material potentially forming a significant local aquifer.

The three boreholes were drilled in the lake bed sediments to depths of up to 6.4 m below the organic lake bed sediments, and therefore only intercepted the top 10% of the overburden sediments beneath the lake. The drilling results showed that the organic sediments were underlain by one to 3 m of very soft clay and silt (>85% silt and clay material) that were in turn underlain by silty sand to sandy silt material, displaying a fining upwards sequence. The presence of the clay and silt material indicates that the lake bottom is underlain by an aquitard.

For comparison, the borehole log for BH07-HO05 that was drilled on the spit of land that divides the LPTP from Pearl Lake at a slightly higher elevation than the lake, reported sand material underlying a 7.7 m thick silt deposit that was present from 9.1 to 16.8 m below ground level, with a second, 0.5 m thick soft silt layer at a depth of 4.6 m. The spit of land with BH07-HO05 is thought to be composed partly of fill and the upper 4.6 m of the log of BH07-HO05 is likely fill material. As such, the clay and silt deposits on the lake floor may correlate to the upper 0.5 m thick silt layer in BH07-HO05. The deeper 7.7 m thick silt layer at BH07-HO05 may also extend under the lake but present at depth and not encountered by the lake bed drilling program. The deeper silt layer, if present, would form a second aquitard beneath the lake (Figure 3-4).

3.10 Numerical Groundwater Flow Model

A numerical three-dimensional steady-state groundwater flow model was developed and used to estimate the seepage rate into the proposed Hollinger pits and to assess the likely effect of its dewatering on the groundwater flow system.

The Modular Finite-Difference Groundwater Flow Model (MODFLOW) developed by McDonald and Harbaugh (1988) for the United States Geological Survey (USGS) was used to simulate groundwater flow in the study area. MODFLOW is a groundwater flow simulator that has been accepted by regulatory agencies and used extensively for a variety of applications. It allows the simulation of steady state and transient flow regimes in both two and three dimensions. A detailed description of MODFLOW is provided in the software package manual (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996; Harbaugh et al., 2000). Prior to the model application as a predictive tool for the proposed pit, the model was calibrated to the following data:

- Static water levels in 18 monitoring wells, 13 local private wells and 1 municipal well (Winding Woods Subdivision);
- Static water levels in Gillies, Clearwater and Charlebois Lakes;
- The reported daily average pumping rate of 1,200 m^3/d – 1,900 m^3/d from the McIntyre #11 Shaft, required to maintain the water levels in the flooded mine workings at the elevation of 300 masl – 309 masl; and
- The reported historic pumping rate of about 3,800 m^3/d to 7,600 m^3/d (1,000,000 to 2,000,000 US gallons per day) out of the existing underground mine workings, corresponding to the mine operation period (Golder, 1997; Kaczmarek, 2009).

The developed model was used to simulate groundwater flow in both the overburden and bedrock aquifer zones. Although MODFLOW was primarily developed to simulate flow in porous media it is often used for groundwater flow modelling in fractured rocks if they behave as equivalent porous media at the scale of study. This assumption was utilized in the presented study.

A fully integrated pre- and post-processor - Visual MODFLOW (Version 4.2) developed by Waterloo Hydrogeologic Software, Inc. (Guiguer and Franz, 2006) - was used to assemble the input data for the Hollinger groundwater flow model and post-process the MODFLOW simulated results.

3.10.1 Model Domain Geologic Setting

The developed conceptual model is based on the hydrogeological conditions for the study area described earlier in this section 3.

According to the regional scale geology map (Lee, 1979) the Hollinger mine site is located within a glaciolacustrine sand and clay plain surrounded by bedrock outcrops (Figure 2.1). Field studies conducted by AMEC in 2007 show that the overburden encountered on site consists primarily of silty sand, till, silty clay, organics and tailings. Along the boundary of the proposed pit overburden thickness varies from almost 0 to about 20 m (Klohn-Crippen 1998). Thick overburden sediments (up to 70 m) were reported in exploration borehole data between LPTP and Pearl Lake. These water bodies overly a depression in the bedrock surface, which is likely filled with sand and silt deposits. Silty clay/clayey silt deposits were reported to be present underneath Gillies Lake and Gillies Pond (Klohn-Crippen, 1998; SENES, 2007) and were recently found underneath Pearl Lake (Section 3.9).

Thin overburden or bedrock dominated terrain (outcrops) is located to the southeast of the mine site. Thick esker/outwash deposits (10 to 30 m) exist to the north and southwest from the Hollinger mine site. Coarse sand and gravel material appears to be replaced by the finer sand and till deposits further away from the esker/outwash area. The thickness of the silty clay unit varies from a few metres to 20 m and more between the esker and the Mattagami River. The average clay thickness in the area outside of the esker is about 10 m. In the areas covered by surficial clay, a basal sand unit occurs at the overburden-rock interface (AMEC, 2006).

The overburden material at the site is underlain by Precambrian rock. The shallow rock is known to be weathered and relatively pervious with the bulk K-value estimated to be in the order of 10^{-4} cm/s (Section 3.1.3; Klohn-Crippen, 1998).

3.10.2 Adjacent Surface Water Body Bathymetry

Little Pearl Tailings Pond

Bathymetry of the LPTP indicated a water column of up to 11 m deep. Lakebed sediments are comprised primarily of tailings and silty sand (Golder, 1985).

Pearl Lake

The bathymetry of Pearl Lake indicated a water column of up to 13 m deep. Based on information collected to date, lakebed sediments are comprised primarily of silty sand, however, some tailings may be expected due to spill over from LPTP. Recent drilling conducted by AMEC in the winter of

2008 also encountered a 1 to 3 m thick silty clay layer underneath Pearl Lake at a depth of 10 to 12 m.

Gillies Lake

Gillies Lake has a mean depth of about 2 m with a maximum depth of about 5 m. Lakebed sediments are comprised primarily of clay/silt (Klohn-Crippen, 1998; SENES, 2007).

3.10.3 Recharge and Discharge Zones

Groundwater recharge in the study area is assumed to be primarily from precipitation. Most significant recharge is expected to occur in the esker/outwash areas. Relatively small recharge is expected to occur through the surficial silty clay unit and in the bedrock dominated terrain. LPTP and Pearl Lake most likely acted as recharge zones during the mine operation period since water pumped out of the mine workings was discharged into these water bodies (Golder, 1985, 1997).

Under the non-pumping condition, groundwater in the vicinity of the mine site is expected to discharge into LPTP, and to Pearl and Gillies Lakes. West of the Hollinger Mine site groundwater is expected to discharge primarily into Mattagami River. South of the mine site groundwater is expected to discharge primarily into Skynner Creek and the Mountjoy River. East of the Mine site groundwater is expected to discharge primarily into Porcupine River. Some groundwater in this area is also discharging into the Dome Mine represented by an open pit and underground mine workings. Current groundwater pumping at the Dome Mine is at a rate of about 4,000 m^3/d (average daily pumping rate in 2006, according to the data presented by Goldcorp).

During the historic mine operation period, a discharge rate of up to about 7,600 m^3/d was reported to occur into the existing dewatered mine workings (Golder, 1997). Currently, due to the pumping from the McIntyre Mine, some groundwater discharges into the existing flooded mine workings, as a result of the induced head differential from this pumping.

3.10.4 Mine Workings

Extensive mine workings, associated with the Hollinger and McIntyre Mines exist in the study area. Goldcorp provided AMEC with the digital information from a VULCAN model showing a 3D distribution of the existing mine workings down to the elevation of -246 masl. Their locations in plan view are shown in Figure 3.9. The total volume of voids, associated with these workings is about 41,500,000 m^3. The mine workings are currently flooded and for the most part are not backfilled.

According to the Goldcorp data, pumping from the McIntyre mine workings occurs at a rate of about 4,500 m^3/d in order to control groundwater levels to accommodate the Timmins Gold Mine Tour and to maintain water levels below a number of openings to surface which would otherwise discharge to the environment if not controlled. It should be noted that this rate corresponds to the pumping periods only, i.e., when the pumps were actually turned on. According to the same data, the average daily pumping rate (including both pumping and non-pumping periods) was estimated to be in the order of 1,200 m^3/d – 1,900 m^3/d.

The McIntyre headframe is located about 200 m from LPTP (and also from Pearl Lake) into which the mine water is currently discharged. Given the sand around LPTP and Pearl Lake, these water bodies are expected to be the source of much of the groundwater seeping into the mine.

3.11 MODFLOW Models

The model domain for the developed Hollinger groundwater flow model is shown in Figure 3.10. In order to avoid potential interaction of the model boundaries with the estimated effect of groundwater extraction from the proposed pit and the existing Hollinger and McIntyre mine workings, the model domain extends over a significant distance in all directions from the mine site.

The model domain extends over about 9 km to the south (Mountjoy River), 9 km to the east (Porcupine River and Lake), about 3 km to the west (Mattagami River) and 20 km to the north, to the outflow of Bigwater Lake into North Porcupine River. In the vertical direction the model extends from the ground surface down to a depth of about 500 to 600 m. Groundwater flow below this depth and beyond the boundaries of the model domain is expected to provide negligible contribution to the simulated seepage into the proposed pit and existing underground mine workings.

The total number of model layers equals 41. Model layer 1 corresponds primarily to the overburden unit. Model layers 2 to 10 (total thickness of about 30 m) correspond to the shallow rock, except for the areas underneath LPTP and Pearl Lake, where deep overburden sediments were encountered. Model layers 11 to 24 represent intermediate rock (total thickness of about 120 m), and model layers 25 to 41 represent deep bedrock (total thickness of about 400 m). Within each model layer the numerical finite-difference grid consisted of 186 rows and 258 columns. The horizontal sizes of the numerical cells varied from 15 m at the mine site, to about 100 m close to the model domain boundary. A finer grid spacing of 3 m was utilized to calculate the relatively coarse grid drain conductances associated with the underground mine workings (Section 3.6.3).

3.11.1 Boundary Conditions

Constant head values of 270 masl to 273 masl, corresponding to the water levels of the Mattagami and Mountjoy Rivers, were specified along the western boundary of the model domain. Constant head values of 277 masl to 278 masl, corresponding to the water levels in Porcupine River and Lake were specified along the eastern boundary of the model domain. This boundary condition reflects shallow groundwater water discharge into the rivers and potential for the deep groundwater flow across these boundaries. To simulate currently existing conditions constant head values of 313.5 masl and 313 masl were specified in LPTP and Pearl Lake, respectively.

Streams (creeks), located within the model domain, were represented by the so-called drain nodes in the uppermost model layer 1. The drain nodes were also used to simulate the historical pumping from the existing mine workings. Their locations were imported into the MODFLOW model from the output generated by the Goldcorp VULCAN model.

A series of groundwater extraction wells located along the perimeter of the Dome Pit were used to simulate groundwater extraction from this mine, reported to be about 4,000 m^3/d. This simplifying assumption on the location of the imaginary extraction wells with the prescribed total pumping rate is not expected to affect noticeably the Hollinger model results since (a) there are no calibration targets associated with the Dome Mine site (i.e., observed water levels and/or flows) and (b) no significant interference the Hollinger and the Dome mine sites, located at a distance of about 5,000 m from each other, is expected to occur.

3.11.2 Input Parameters

Due to the limited information available over a large model domain a simplified approach was utilized in this study, as per the following:

- Overburden was simulated as a single model layer over the majority of the model domain with horizontal and vertical hydraulic conductivities representing an average over the layer thickness values of these parameters.

- Uniform horizontal hydraulic conductivity of the overburden was applied everywhere outside eskers/outwash sand, till and alluvial deposits area. This bulk hydraulic conductivity value, expected to be in the order of 10^{-4} cm/s, represents silty sand, tailings and an average horizontal hydraulic conductivity value of the overburden material comprised of surficial silty clays and basal sand unit.

- Vertical hydraulic conductivity of the overburden was assumed to be equal to the horizontal one (isotropic conditions) in the areas with no consistent clay/silt layer. Vertical hydraulic conductivity of the overburden was assumed to be significantly lower than the horizontal one in the areas where a clay/silt layer was known to be present (e.g., glaciolacustrine plain with surficial clay/silts at surface).

- Under the simulated base case scenario hydraulic conductivity of rock was assumed to vary only with respect to depth. Three bedrock aquifer zones were simulated: shallow, intermediate and deep, with progressively decreasing hydraulic conductivity with depth. An additional variant with high K-zone in rock at a depth of about 140 to 180 m, consistent with the packer test results (Section 3.2) was also simulated. Rock was simulated to be isotropic.

- Recharge rates were assigned in accordance with the dominant surficial material zone, identified based on the existing quaternary geology maps and site specific data.

Input parameters (hydraulic conductivities and recharge rates) initially assigned to the various overburden and bedrock aquifer zones are summarized in Table 3.6. These parameters were modified through the process of model calibration.

An artificially high hydraulic conductivity value of 1 cm/s was assigned in the numerical cells coinciding with Gillies, Clearwater and Charlebois Lakes. This approach represents the so-called "high K" technique often used for simulating lake-aquifer interactions using MODFLOW (Lee, 1996). According to this technique, the lake stage is computed for lake cells with the same equations used to compute aquifer heads. Because the hydraulic conductivity is high, little or no spatial variation in head (stage) will occur in numerical cells representing a lake.

Figures 3.11 and 3.12 show distributions of the various model simulated hydraulic conductivity zones in model layer 1, and in the south-north cross-section, drawn through the area of the proposed pits.

3.11.3 Model Calibration

The calibration of a groundwater flow model is a demonstration that the model is capable of reproducing field measured heads and flows: the so-called calibration values (Anderson and Woessner, 1992). Calibration of the model is achieved by adjusting the physical and hydraulic parameters that are associated with highest degree of uncertainty in order to obtain a reasonable match between computed and observed (measured) data.

Simulating the existing conditions the developed groundwater flow model was calibrated to the following targets:

- Water levels in 18 monitoring wells, 13 local private wells and 1 municipal well (Winding Woods Subdivision) screened in the overburden and bedrock aquifer zones (note private wells near the pit were not used as calibration targets as they either lacked water level data or were drilled during periods of active mining and could not therefore be calibrated to pre-mining conditions);

- Water level (elevation of 308 masl) in Gillies Lake;

- Water level (elevation of 312 masl) in Clearwater Lake;

- Water level (elevation of 306 masl) in Charlebois Lake;

- Reported daily average pumping rate of 1,200 to 1,900 m^3/d from the McIntyre #11 Shaft, required to maintain its water level at the elevation of 300 to 309 masl; and,

- Simulating the mine operational period (prior to 1988), the developed groundwater flow model was calibrated to the reported historic pumping rate of about 3,800 to 7,600 m^3/d (1,000,000 to 2,000,000 US gallons per day) from the Hollinger and McIntyre mine workings, (Golder, 1997; Kaczmarek, 2009).

Utilizing numerical cells that are several times larger than mine shafts and drifts (15 m versus 3 m) required special calculation of the drain conductances, associated with these workings. The reason for this is that the application of 3 m grid spacing, consistent with the characteristic diameter of the shafts and drifts is not practical given the very extensive network of mine workings at the site. Such detail would result in the model that is impossible to operate and run using the currently available software and hardware tools. Drain conductances for a relatively coarse grid were calculated using an approach developed for the petroleum reservoir simulation of unconventional wells (Wolfsteiner, Durlofsky and Aziz, 2003). According to this approach, first, the simplified steady-state flow problem is solved either using a semi-analytical or numerical method with a fine enough grid. At the second stage, this reference solution is used to calculate flows into each well (or drain) segment and then mapped onto the target coarser grid model. At the third stage, the coarser grid model is run with sinks being defined at the previous stages. At the final fourth stage, the upscaled drain conductance (Cond) for each drain node is calculated using the following formula (Wolfsteiner, Durlofsky and Aziz, 2003):

$$\text{Cond} = q/(H-h)$$

where q is the seepage rate into the drain node obtained from the reference (fine grid) solution; H is the model simulated hydraulic head, corresponding to a coarse grid solution with specified q values, and h is a drain elevation. Details of the well index upscaling technique are provided by Wolfsteiner, Durlofsky and Aziz (2003).

Drain conductances associated with 15 x15 m cells of the Hollinger groundwater flow model were originally computed using a uniform bulk rock hydraulic conductivity value of 10^{-5} cm/s. Resultant conductances varied from $2\text{x}10^{-9}$ m^2/d (dewatered cells located primarily inside simulated stopes) to 0.69 m^2/d (individual shafts or drifts). According to the 'well index' theory, drain conductance is directly proportional to the hydraulic conductivity of isotropic rock (Peaceman, 1983). Therefore, the drain conductances originally computed for the hydraulic conductivity value of 10^{-5} cm/s, were increased or decreased proportionally to the modified hydraulic conductivity of rock. Applicability of this approach for predicting groundwater seepage with a relatively coarse numerical grid was verified by simulating seepage into the underground mine workings at the Pamour Mine site using 5 and 25 m cell sizes. Seepage rates simulated by the coarse grid model (25 x 25 m cells) with the drain conductances computed as outlined above, appeared to deviate from the fine grid model (5 x 5 m cells) results by only about 2 to 5%.

The simulated groundwater flow system obtained at the end of model calibration to the existing conditions is shown in Figure 3.13 (model layer 3). Despite some noticeable local discrepancies between computed and observed hydraulic heads (Table 3.7) the model replicates properly the overall water levels and expected groundwater flow system. The correlation between computed and observed hydraulic heads is shown in Figure 3.14. The results presented in this figure demonstrate a relatively good agreement between computed and observed data: mean, mean absolute and root mean squared errors (discrepancies between computed and observed heads) are -0.2 m, 2.8 m, and 3.7 m, respectively. The ratio of the root mean squared error to the total head loss (or water table relief) in the area of interest is approximately 7.8%. Therefore, the errors represent only a small portion of the overall model response (Anderson and Woessner, 1992).

Assuming that water level in the flooded mine workings is currently at the average elevation of 304 masl, resulted in the model predicted seepage rate of about 2,000 m^3/d into the existing workings – a conservative approximation of the reported daily average pumping rate (1,200 to 1,900 m^3/d) from the McIntyre #11 Shaft. Note that some overestimation of the seepage rate by the model was expected since in reality water levels in the backfilled mine workings should be somewhat higher than in the McIntyre #11 Shaft. However, the developed MODFLOW model conservatively ignores the spatial variation in water levels/hydraulic heads within the flooded underground workings.

In simulating groundwater flow for the past mine operational condition, only the water level in Pearl Lake was specified at 313 masl since water pumped out of the mine workings was discharged back into this lake while there was very little water in LPTP at that time (Golder, 1985;1997). The water level in Gillies Lake was also fixed at 308 masl since: (a) it is known that this lake had a configuration which is comparable to the current condition (based on historic aerial photographs), most likely due to the presence of the 2 to 5 m thick layer of the fine-textured sediments (clay/silt) underlying fine tailings deposited at the bottom of the lake (Klohn-Crippen, 1998; SENES, 2007); and (b) numerical problems associated with a MODFLOW simulation of a perched water condition.

The groundwater seepage rate into the fully dewatered existing underground mine workings was computed to be about 5,700 m^3/d, i.e., within the reported range of pumping rates from 3,800 m^3/d to 7,600 m^3/d, corresponding to the mine operational period. Note that the developed model was not expected to match exactly the upper limit of the reported daily average pumping rate, i.e., 7,600 m^3/d or 2 million US gpd, for the following two major reasons:

- Not all of the existing mine workings were simulated by the model. The mine workings included in the Goldcorp VULCAN model and incorporated into the AMEC groundwater flow model extend down to a maximum depth of about 600 m. However, in reality, the mine workings are known to extend deeper, down to the mine level of 5,450 ft, i.e., 1,662 m. Furthermore, while the VULCAN model is likely the most complete map available, it may not include some undocumented or poorly documented underground workings; and,

- The reported pumping rate may actually include some surface runoff component in addition to the groundwater seepage. Comparing the estimated time required to flood the existing underground mine workings with the actual one, Golder (1997) concluded that the reported rate of 7,600 m^3/d for the mine water inflow may be an overestimation of the actual rate.

The model predicted seepage rate of about 5,700 m^3/d also appears to be consistent with the reported dewatering rate of about 4,000 m^3/d for the somewhat smaller Dome mine. Based on the above, model predicted seepage rate of 5,700 m^3/d was considered to provide an acceptable match to the reported inflow rate observed during the mine operational period.

The calibrated model was then used to estimate seepage rates into the proposed pits, main access ramps and the remaining mine workings as well as to assess the potential zone of influence likely to be caused by the dewatering of the proposed excavations.

3.11.4 Predictive Simulations – Zone of Influence of Proposed Open Pits

The groundwater flow model described above in Sections 3.6.1 to 3.6.3 corresponds to the current and historical mine operation conditions. After being calibrated, this model was modified in order to simulate the transient groundwater flow regime associated with the proposed excavation of three open pits and their Zone of Influence. According to the information provided by Goldcorp to AMEC, the pits are supposed to be mined in overlapping sequence. The mining rate is expected to be close to 48 vertical metres per year. The life-span of the open pit mining is expected to be approximately 7 years, potentially followed by UG development. During the excavation of the proposed pits water levels in the existing underground mine workings is expected to be maintained about 20 m below the bottom of the excavation(s).

Outlines of the simulated excavations at the end of year seven (ultimate pits) are shown in Figure 3.9. To simulate gradual excavation and dewatering of the proposed pits over a period of seven years, the following modifications were made to the developed and calibrated groundwater flow model:

- The steady-state groundwater flow model was converted to a series of seven transient models, corresponding to years 1 to 7 of the proposed excavation, i.e., for each year of the excavation a separate transient flow model was constructed;

- Each of the seven transient models was constructed in accordance with the mine plan provided to AMEC by Goldcorp;

- For each of the seven models, representing various stages of excavation, inactive cells were specified within the excavation, with the exception of the relatively thin band of cells along the pits' walls and immediately above their bottoms;

- Additional drain nodes were specified along the face of the simulated excavations and at their bottoms. These drain nodes were used to simulate the potential seepage face along the proposed open pits' walls and groundwater inflow through their bottoms;

- Underground mine workings remaining outside of the excavation were simulated as drain nodes with head values being equal either to the local elevation of the mine workings (potential seepage face in the dewatered underground openings located above the lowest pit bottom) or to the elevation of the pit bottom minus 20 m (flooded portion of workings below the excavation); and,

- Water levels in LPTP and Pearl Lake were specified at the projected elevations of 312.85 masl and 312.7 masl, respectively.

Each transient period of one year was subdivided into 12 stress-periods and 36 time-steps to ensure gradual transition between hydraulic heads corresponding to the beginning and to the end of simulated period.

In addition to the hydraulic conductivities and recharge rates transient model runs required specification of storage input parameters. Storage parameters (specific storage and specific yield), specified based the available literature data are shown in Table 3.8.

Two predictive variants were simulated: first, the base case scenario corresponding to the “best-fit” combination of the model input parameters shown in Table 3.6; and second, a more conservative variant with an increased hydraulic conductivity of rock at a depth of 140 to180 m. The latter variant was more consistent with the packer test results showing a noticeably more pervious rock zone at depth in boreholes BH 07-03, BH 07-05 and BH 07-09 (Table 3.3).

Base Case Scenario

According to the simulated base case scenario, the total groundwater seepage into the proposed pits and mine workings located outside of the proposed pits’ perimeters and below their bottom (flooded mine workings) is expected to reach a maximum of about 9,400 m^3/d after the third year of excavation and then gradually to decline to about 8,900 m^3/d at the end of the seventh year (Figure 3.15). This represents a 56% increase in the seepage rate compared with the model predicted steady-state inflow into the existing workings occurring during the mine operational period. Note that: (a) about 1,000 m^3/d out of 8,900 m^3/d is predicted to be coming out of storage in the overburden and shallow rock, suggesting that the system will not have reached the steady-state condition at the end of the excavation period of seven years; and (b) about 2,500 m^3/d out of 8,900 m^3/d is predicted to be coming out of LPTP and Pearl Lake, resulting in some short-circuiting of water that will be pumped back into this pond. The remaining pumping rate of 5,400 m^3/d (i.e., 8,900 m^3/d minus 1,000 m^3/d and minus 2,500 m^3/d) appears to be close to the model predicted steady-state seepage rate of about 5,700 m^3/d into the existing workings, that occurred during the mine operational period (Section 3.6.3). As a result, the model predicted zone-of-influence, defined as a simulated 1 m drawdown in shallow rock, corresponding to the pumping from the proposed Hollinger pits, main access ramp and remaining mine workings at the end of year seven, appears to be similar to the zone-of-influence, corresponding to the historical pumping from the mine workings (Figure 3.16).

Figure 3.17 shows the model simulated cone of depression associated with groundwater extraction from the proposed pits, main access ramp and the remaining mine workings. There may also be some localised drawdown in areas where unknown or poorly mapped underground workings that are not included in the model, but connected to the Hollinger Mine approach the ground surface.

Additional Conservative Scenario

According to the packer test results presented in Section 3.2, higher K-values were reported in the bottom of boreholes BH 07-03, BH 07-05 and BH 07-09 (Table 3.3). While these higher K-values are likely attributed to equipment limitations, an additional conservative scenario that assumes a deeper zone of more permeable rock, possibly associated with the existing mine workings, was modelled to assess the effect of a deep high K zone scenario. For this scenario, a geometric mean K-value of rock within the lower 40 m to 60 m thick zone was estimated to be about 2x10^{-4} cm/s, i.e., similar to the typical hydraulic conductivity of the shallow weathered rock. Based on the above an additional predictive variant was simulated by the model incorporating a more permeable zone at the contact between intermediate and deep bedrock. The extent of such a permeable zone is unknown, and assumed to be present at both Hollinger and McIntyre mine sites including a 500 m buffer surrounding the existing mine workings. The zone was assumed to be 40 m thick. Making the zone significantly greater than 40 m thick would have lead to unrealistic historical inflow rates and was not considered.

The groundwater flow model results for this scenario show a noticeably higher total seepage rate into the proposed pits, main access ramp and the remaining mine workings at the end of year seven (12,400 m^3/d), compared with the Base Case Scenario (8,900 m^3/d), described above (Figure 3.16). Therefore, the additionally simulated variant with the high K-zone at a depth of 140 to 180 m should be considered as a conservative scenario. Figure 3.18 shows the model predicted zone-of-influence (defined as a simulated 1 m drawdown in shallow rock) corresponding to the pumping from the proposed Hollinger pits, main access ramp and remaining mine workings at the end of year seven for this scenario. This zone-of-influence (ZOI) is predicted to be larger than the similar ZOI corresponding to the Base Case scenario (Figure 3.15). However, the ZOI computed at the end of the simulated excavation period (year seven) and the ZOI corresponding to the long-term historical pumping from the mine workings appear to be close to each other, similar to Base Case scenario.

Therefore, according to both the Base Case and Conservative Scenarios, the overall impact of the dewatering of the proposed Hollinger pits, main access ramp and remaining workings on the groundwater flow system is expected to be similar to the historical impacts observed during the mine operational period, i.e., to pre-1988 conditions.

4.0 DISCUSSION

During the study, a single numerical groundwater flow model, with two hydraulic conductivity variants, was developed and calibrated in order to estimate distinct groundwater related objectives. The first objective was to provide an estimate of the long-term seepage rate into the proposed open pit and existing underground workings; and the second objective was to determine if such a seepage rate and corresponding groundwater extraction rate would be likely to result in effects on adjacent surface water features or nearby groundwater users.

4.1 Groundwater – Surface Water Interactions

Of particular importance to the Hollinger Project is the linkage between groundwater and surface water systems. Groundwater recharge is a special case of runoff storage, but on a longer time scale. Groundwater systems are important to the maintenance of vegetation communities, including wetlands, as well as to the maintenance of creek and river baseflows, when available precipitation is lacking, such as during periods of drought; and in the case of creek and river baseflow in winter when precipitation is largely locked up in the form of ice and snow. Groundwater systems are replenished through the infiltration of precipitation (and runoff) into the subsurface, the rate of which is a function of soil porosity and runoff storage potential. Groundwater release is similarly a function of soil porosity and other factors such as the expression of drainage networks and the presence of aquitards.

Mine dewatering has the potential to affect surface water systems through the reduction of baseflow or groundwater discharge to lakes. More specifically, by drawing down the local groundwater table, groundwater discharge sources that normally serve to maintain creek and river baseflow, and wetland environments, can potentially become diminished or depleted. There is also the potential for enhanced direct leakage from surface water systems, such as lakes and ponds, to depressurized groundwater systems. To evaluate these potentials, it is important to determine the extent of expected groundwater removal, and subsurface soil conditions associated with local aquatic systems and wetlands.

Zones of porous soil are most problematic, where these exhibit a direct connection to bedrock. The Pearl Lake system - is characterized by extensive sandy terrain. If these permeable deposits are in direct contact with the bedrock, and if the bedrock becomes depressurized as a result of mine dewatering activities, these surface hydrological systems could be adversely affected. Sediments beneath Pearl Lake also appear to be comprised principally of sandy materials interbedded with layers of silt. Any such potential adverse effects would have to be assessed through ongoing monitoring of potential groundwater/ surface water interactions.

The Zone of Influence is estimated to extend from the mine out to distances of two km in the seven years of proposed mining. In comparison to historical activities at the site, which was actively mined for a period of approximately 80 years until 1988, the Zone of Influence is expected to smaller than the one created by historical activities as the proposed mine will have significantly less than 80 years to remove water from storage than the historical mine, and the removal of water from storage will attenuate the growth of the Zone of Influence. As there are no known reports of creeks going dry during the historical mining period, and no creeks are predicted to be affected by the numerical model, no significant environmental effects on local surface water features are expected, assuming similar dewatering practices are followed for the new and historical mine. Historic air photo coverage of the Timmins area from 1969, when both the Hollinger and McIntyre Mines were fully dewatered (or nearly so – the Hollinger Mine was just beginning to flood, having been closed in 1968), shows lake forms and margins consistent with those of today (Figure 4.1).

Of the 8,900 m^3/d of seepage expected to report to the proposed pit towards the end of mining in the base case scenario, the single biggest source of water was the LPTP that is located close to the pit and was modelled without a clay bottom. The largest source of water from a natural surface water feature is approximately 2,500 m^3/d predicted to be recycled from the Pearl Lake system, which is also likely underdrained by ongoing dewatering at the McIntyre head frame to allow the upper part of the mine to stay open for the Timmins gold mine tour. The remaining water includes 1,000 m^3/d taken from storage, and 5,400 m^3/d that is mostly captured precipitation.

For comparison, stream flow measurements collected in nearby water courses during 2008 indicate that flows in local creeks have flows on the order of at least 10,000 m^3/d suggesting that small declines in groundwater discharge to these features anticipated, with the possible exception of the Pearl Lake system are not significant.

These estimates suggest that mitigative measures will be required to maintain the current water levels in Pearl Lake. Presently water levels in Pearl Lake are supplemented by discharge from the McIntyre Mine, and it is proposed to continue this practice for the proposed mine.

4.2 Private Wells

The City of Timmins provides municipal water to residents and businesses within the urban area, and it is expected that there are no private wells that would effected by mine dewatering close to the mine. Municipal water is not available in the rural areas, further to the southwest of the proposed mine, and a search of the water well records and local maps indicates that there are a few residents in this area that likely rely water wells for their water supply. However, the closest of these is more than 1 km from the mine near the edge of the Zone of Influence. At this distance, it is not anticipated that the operation of these wells will be affected by mine dewatering. However, any active wells in this area should be monitored to confirm expected conditions.

4.3 Other Pumping Requirements in Addition to Groundwater Seepage

In addition to the removal of 8,900 to 9,400 m^3/d of groundwater seepage from the mine, a PTTW must include an allowance for the removal of surface water runoff into the open pit and down the access ramp, and for the removal of water already in the flooded existing mine workings.

Estimation of Surface Water Runoff into the Mine

Surface water runoff into the mine was estimated by looking at the detailed topography of the site and historical climate data. The area around the mine through which surface water may runoff into the mine workings was estimated using the Lidar mapping and the proposed mine design. A series of ditches and berms will be used to minimise surface water runoff into the mine entrances; however these are unlikely to be completely effective in preventing seasonal flooding or rapid transmission of water through fractures in the unsaturated zone not included in the groundwater model.

The Lidar map and diagrams provided by Goldcorp indicate that the area over which runoff may be directed to the mine is approximately 95.9 ha. A review of past historical rain events, indicates that the Timmins area may reasonably expect to receive up to 116 mm of rain in a single day, corresponding to the 24-hr, 100-year rainfall storm event. If all the rainfall landing in the area was directed towards the mine, the resulting volume of water would be approximately 103,600 m^3, based on a model simulated runoff depth of 108 mm. The underground working within 20 m of the pit flow occupies an average volume of approximately 500,000 m^3, which is sufficient to contain the storm event volume.

A more common scenario would involve the rapid melting of snow accumulation from the winter in the spring combined with a spring melt. Such an event could create a similar surface water inflow into the mine as a single large storm event, requiring a similar pumping allowance.

There would also be a small volume of process water introduced into the mine for drill rig cooling and dust suppression, but the volume is small enough to be adequately covered by the above estimate of captured surface water runoff.

Removal of Water in the Former Open Pits and Underground Workings

There is a large volume of water presently contained within the former open pits and underground workings that would need to be removed. The volume of combined former open pits and underground workings was estimated using the VULCAN three dimensional model provided by Goldcorp as 40.5 million m^3, of which approximately 19 million m^3 was reported to be back filled (Golder 2007). This information was used to develop a storage stage curve assuming the back fill material was evenly distributed through every level in the mine.

As the upper part of the former underground mine and open pits are dewatered via the McIntrye headframe to allow access for the Timmins Gold Mine Tour, this part of the mine does not need to be dewatered. Based on the storage stage curve, approximately 21 million m^3 of water remain in the voids of the former mine. The water needs to be removed to below the working level of the mine before mining can begin. Removal of this storage water is also required to induce increased groundwater inflow into the mine above current volumes.

The volume of the voids decreases rapidly with depth once the base of the former open pits is reached, and the volume of water to be removed per metre of water level lowering is much higher in the upper part of the mine compared to the lower parts of the mine where there are only underground workings. The volume of water in the upper part of the mine is estimated to be 11 million m^3. To remove this water in approximately one year would require a dewatering rate of approximately 30,000 m^3/d.

Summary of Requested PTTW Volumes

The long term groundwater withdrawal from the bedrock is estimated to be approximately 10,000 m^3/day; however, a pumping rate of 30,000 m^3/day is requested to remove water from the flooded historical open pits during the initial phase of mining. Once the flooded open pits are dewatered to 200m, the amount of water released from the former mines will decrease as the former pits are smaller at depth and the volume of water in the former underground workings is relatively small. During the later periods, however, it will be important to have pumping capacity to remove runoff entering the mine through the open pits and access ramps, as this can cause rapid flooding of the mine when it is deeper and operating as an underground mine with only a small volume of active tunnels which may flood quickly. Therefore maintaining the permit allowance of 30,000 m^3/day is requested throughout the mine life to allow rapid removal of surface water runoff, in addition to small volumes of groundwater inflow.

4.4 Mine Closure

At mine closure, the most likely method of open pit rehabilitation will be to flood the pit. An inspection of the local topography indicates that it would not be possible to affect passive drainage north to the Porcupine River system. The only other options for passive outflow are therefore development of a constructed drainage way (or partially buried pipeline) leading to the Skynner Creek or Perch Lake systems.

4.5 Monitoring Recommendations

Work undertaken during this study, has indicated that with the exception of the LPTP facility and Pearl Lake, there will be no significant affect on local surface water features or the use of local water wells. To confirm that the Zone of Influence expands at a rate consistent with the predictions made using the numerical groundwater flow model and that there are no significant effects on local surface water systems the following monitoring activities are proposed.

- Groundwater levels in the existing monitoring wells installed as part of the 2007 drilling program be collected on a monthly basis for two years and then on a quarterly basis thereafter to assess the growth of the drawdown cone.

- Water levels within the mine and pumping from the mine be measured on a daily basis to identify periods when high levels of pumping are associated with dewatering of the existing flooded workings and when low levels of pumping are representative of groundwater seepage into the mine.

- Rating curves be fully developed for the three stream flow measurement stations and that continuous stream flow (water level) monitoring data loggers continue to be downloaded on a quarterly basis to that confirm impacts to stream flows are minimal.

- Surface water levels continue to be recorded on a daily basis using pressure transducers from each of Pearl Lake, Gillies Lake and LPTP.

- A report describing the monitoring data collected above and comparing the above information to climate data, be prepared on an annual basis and submitted to the MOE, until five years after mine closure.

Sincerely yours,

AMEC Earth & Environmental Limited

a division of AMEC Americas Limited

Prepared by:

Simon Gautrey, M.Sc., P.Geo.
Senior Hydrogeologist

PROFESSIONAL GEOSCIENTISTS
SIMON J. GAUTREY
PRACTISING MEMBER
0461
ONTARIO
Sept 27 2010

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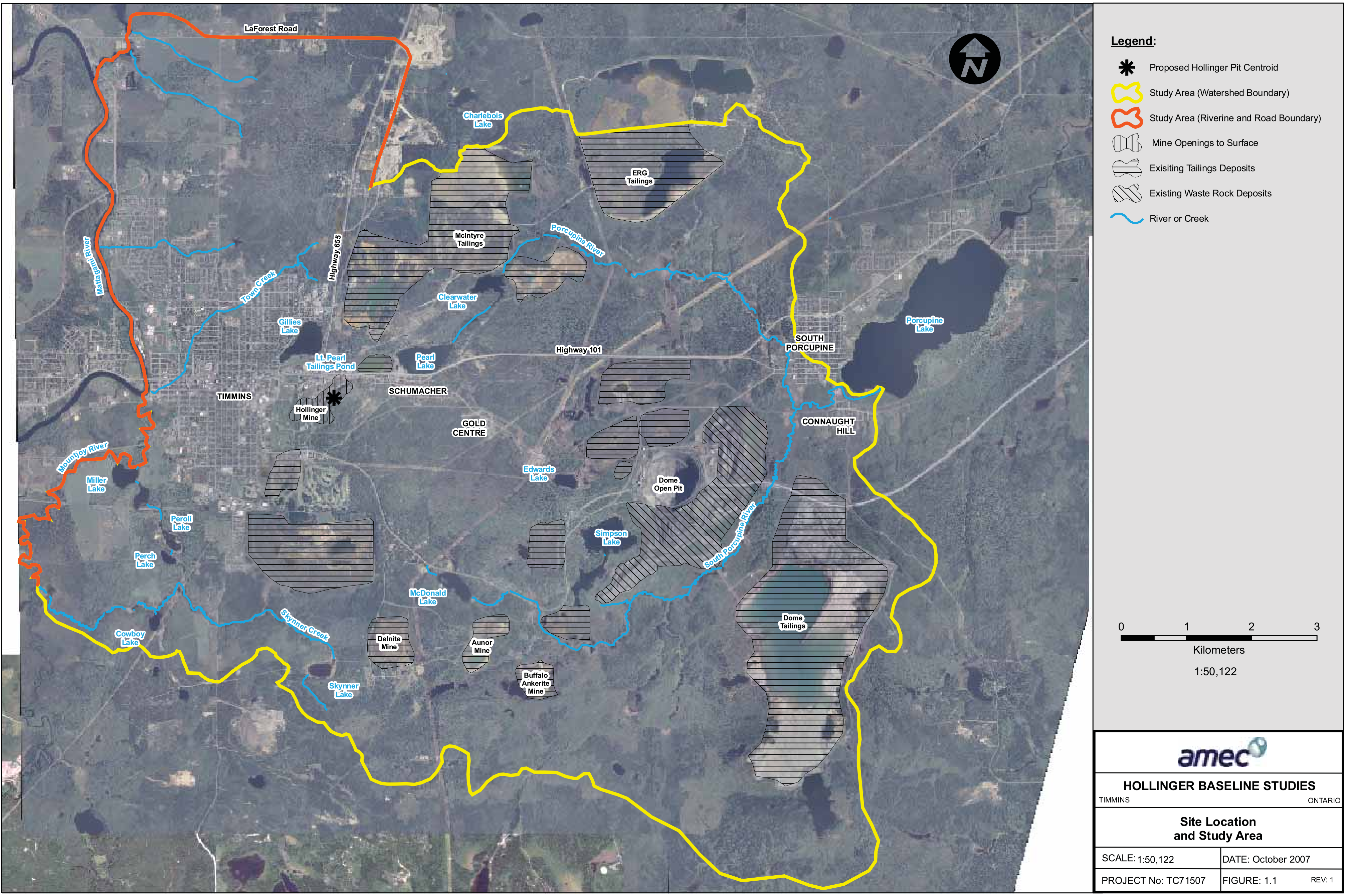

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HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

**Site Location
and Study Area**

SCALE: 1:50,122	DATE: October 2007
PROJECT No: TC71507	FIGURE: 1.1 REV: 1

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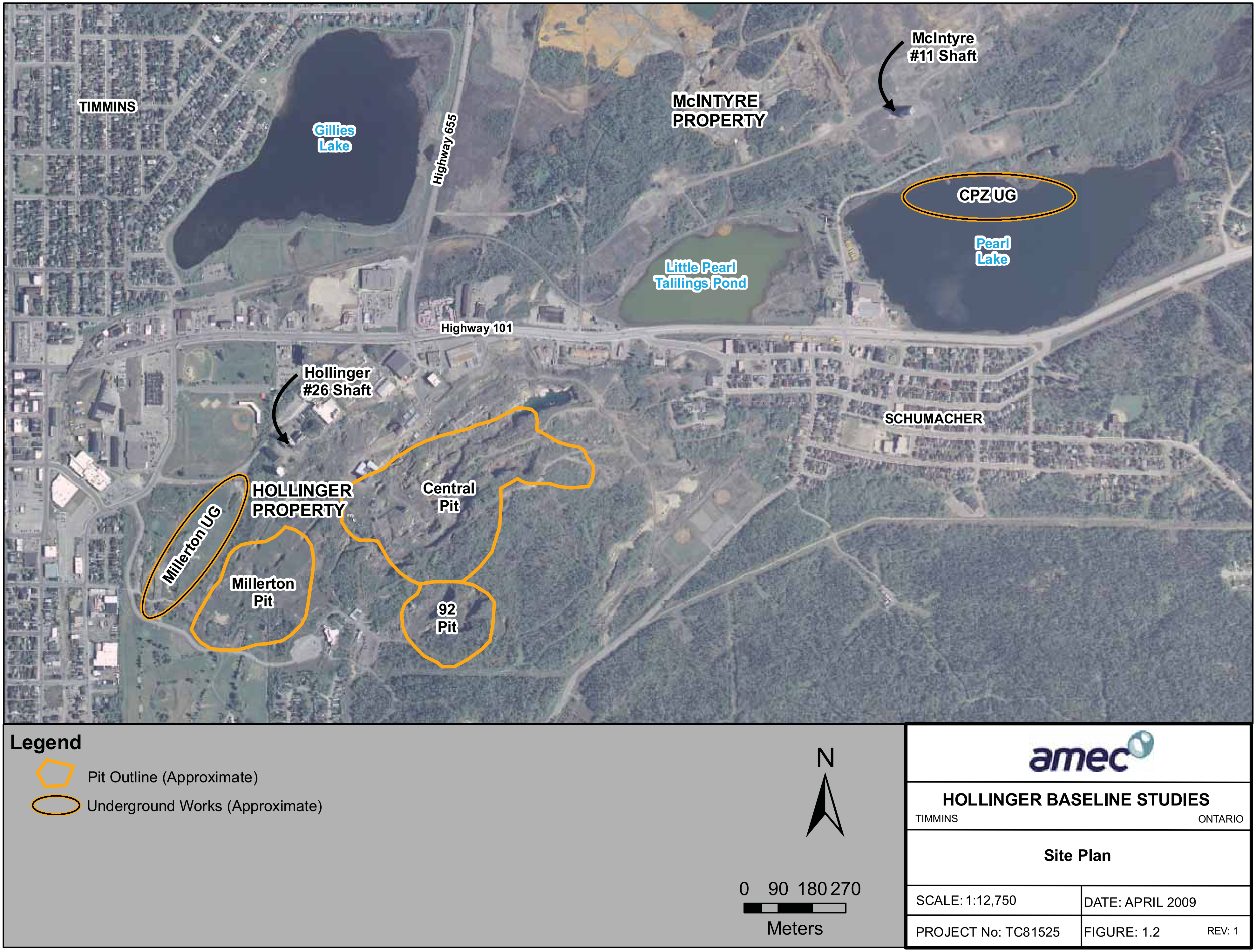

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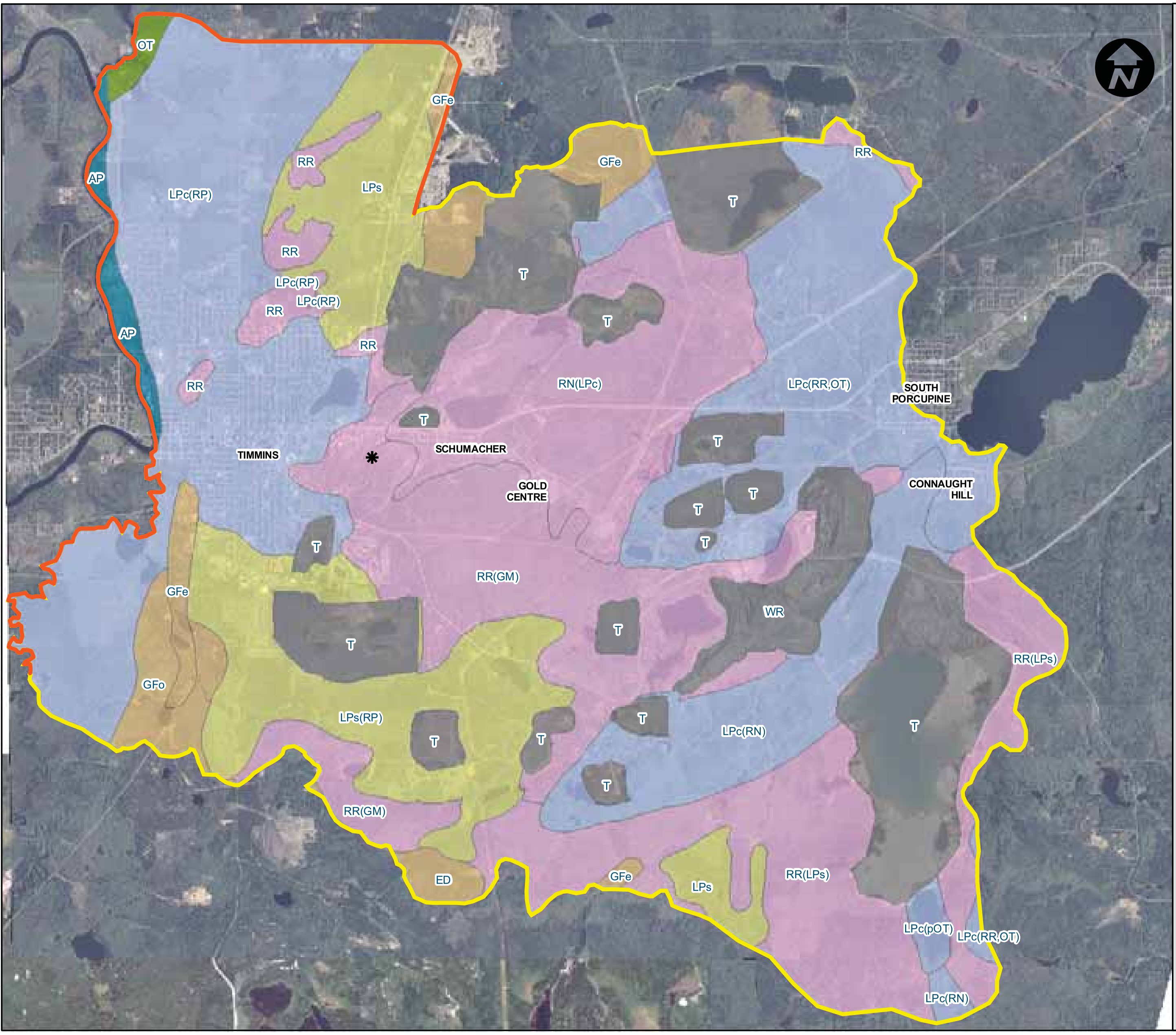
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Site Plan

SCALE: 1:12,750	DATE: APRIL 2009
PROJECT No: TC81525	FIGURE: 1.2 REV: 1

P:\EM\Projects\2008\TC81525 Hollinger Permitting\GIS_Data\PTTW_Investigation_Dec2008\Site_Plan.mxd



Legend:

- ✱ Proposed Hollinger Pit Centroid
- Study Area (Watershed Boundary)
- Study Area (Riverine and Road Boundary)

Surficial Geology Types

- 1, RR - Rock ridge
- 2, RR(GM) - Rock ridge (ground moraine)
  (subordinate landform types are shown in brackets)
- 3, RN(LPc) - Rock knob (lacustrine plain - clay/silt)
- 4, RR(LPs) - Rock ridge (lacustrine plain - sand)
- 5, LPc(RR,OT) - Lacustrine plain - clay/silt (rock ridge/organic terrain)
- 6, LPc(RN) - Lacustrine plain - clay/silt (rock knob)
- 7, LPc(RP) - Lacustrine plain - clay/silt (rock plain)
- 8, LPs(RP) - Lacustrine plain - sand (rock plain)
- 9, LPs - Lacustrine plain - sand
- 10, LPc(OT) - Lacustrine plain - clay/silt (organic terrain)
- 11, GFo - Glacial-fluvial outwash - sand
- 12, GFe - Glacial-fluvial esker - sand
- 13, ED - Dunes - sand
- 14, AP - Alluvial plain
- 15, OT - Organic terrain
- 16, T - Tailings
- 17, WR - Waste rock

SOURCE: Northern Ontario Engineering Geology Terrain Study
Base Maps - Timmins (Map 5029) and pamour (Map 5026)

0 1 2 3
Kilometers
1:53,000

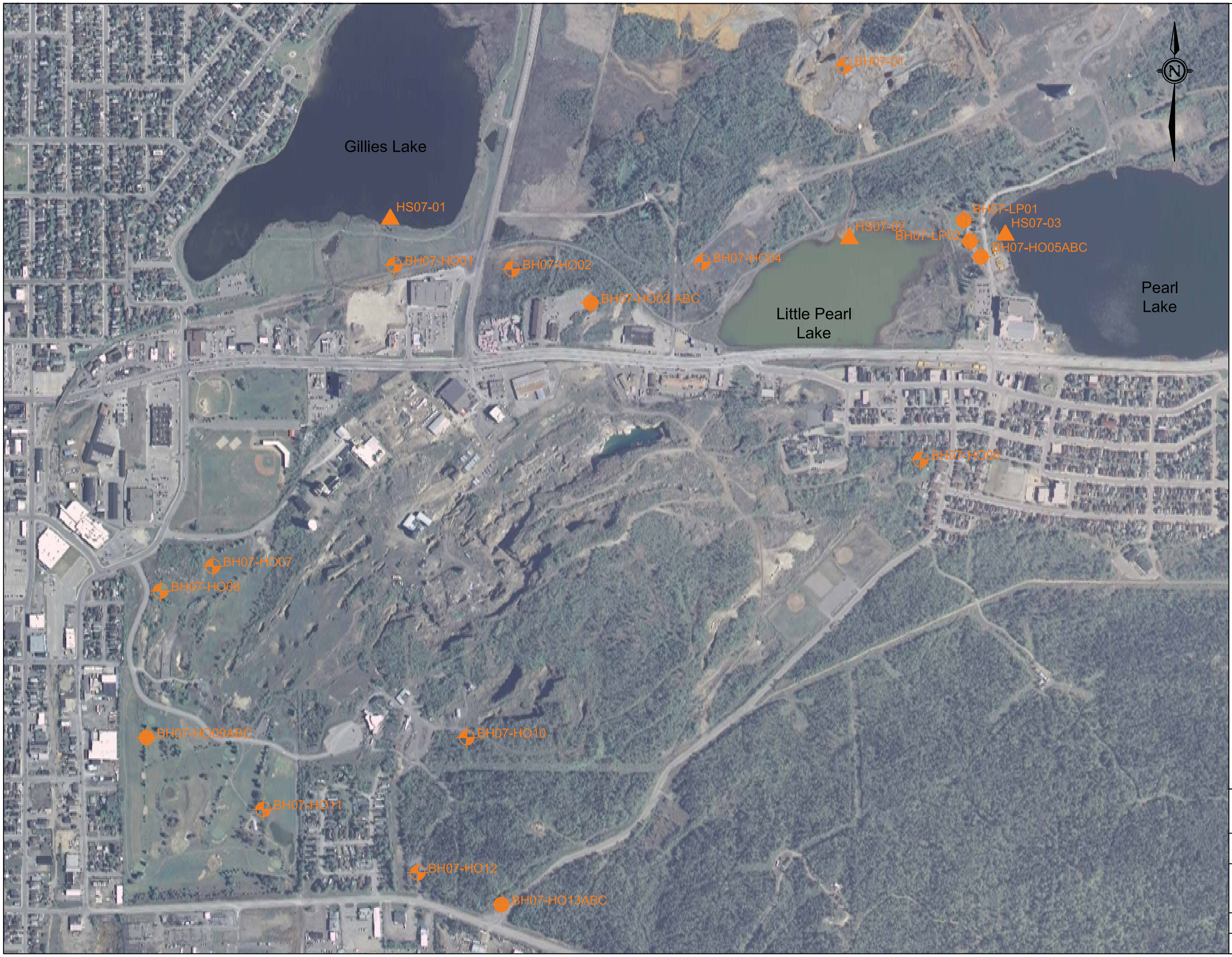
amec

HOLLINGER BASELINE STUDIES
TIMMINS ONTARIO

Surficial Geology

SCALE: 1:53,000	DATE: APRIL 2009
PROJECT No: TC81525	FIGURE: 1.3 REV: 1

P:\EM\Projects\2008\TC81525 Hollinger Permitting\GIS_Data\PTTW_CofA_April2009\Figure 15 - Geology.mxd



Legend:

▲	Hand Sample
●	Borehole Multi-Level (200 m max)
⊕	Borehole Shallow (12 m max)

0 100 200 300 400 500

Approximate Scale (m)

HOLLINGER BASELINE STUDIES
HYDROGEOLOGY STUDY

Monitoring Well Location Plan

Scale: 1:10000	Date: November 2007
Project No: TC71507	Figure No: 2.1

Legend:

- ✱ Proposed Hollinger Pit Centroid
- Study Area (Riverine and Road Boundary)
- Study Area (Watershed Boundary)
- Watersheds
- River or Creek
- Intermittent Watercourse

Flow Monitoring Locations

① Porcupine River near Highway 101

② South Porcupine River near Pamour pit haul road

③ Skynner Creek near the Pine Street south crossing

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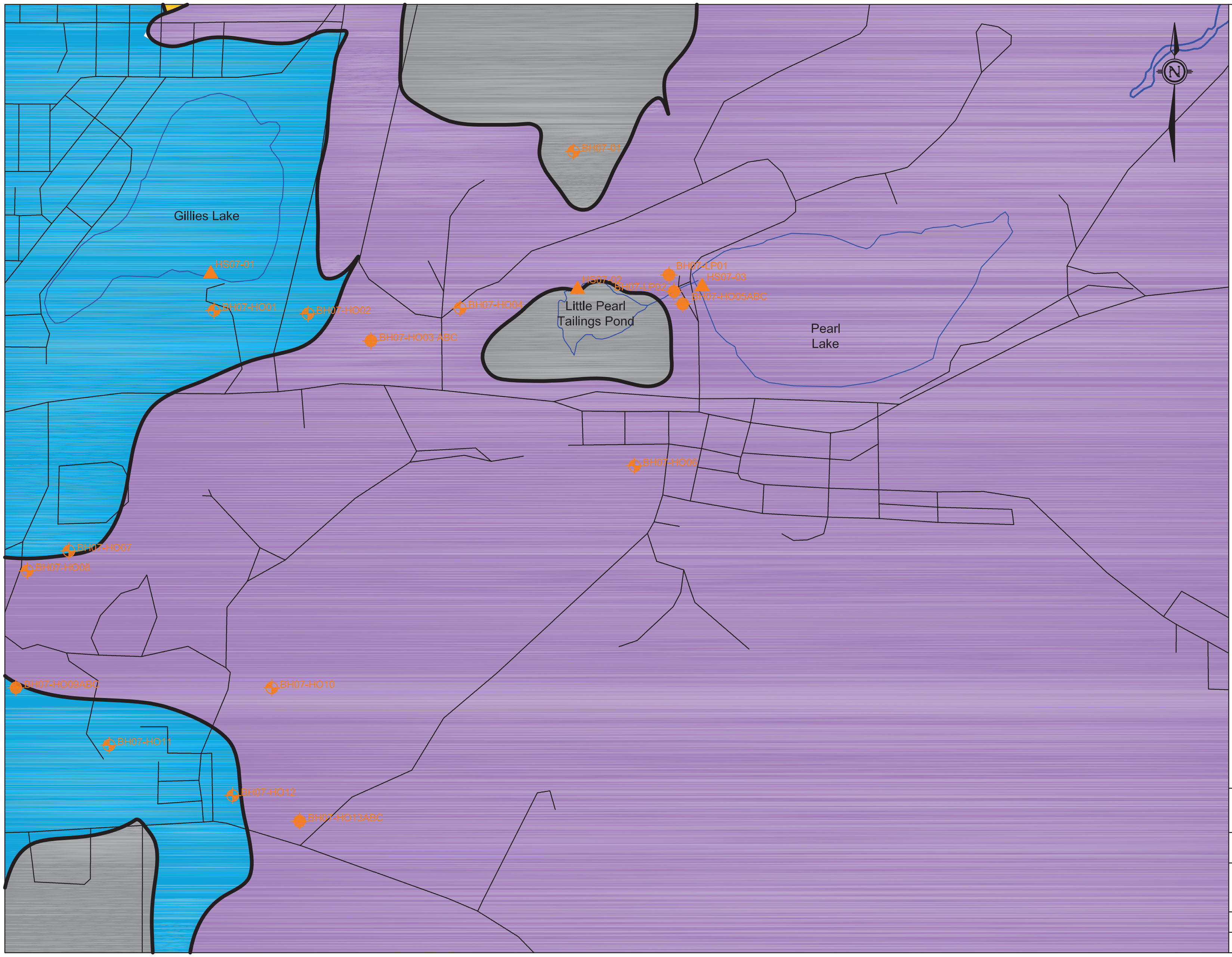
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Watersheds and Flow Monitoring Locations

SCALE: 1:53,000	DATE: October 2007
PROJECT No: TC71507	FIGURE: 3.1 REV: 1

C:\TC71507 Hollinger Baseline Studies\GIS data\Quaternary Geology\Appendix_C_Figure 4 - Watersheds.mxd



Legend:

▲ Hand Sample

● Borehole Multi-Level (200 m max)

⌖ Borehole Shallow (12 m max)

🟪 Rock Ridge (lacustrine plain - clay/silt)

🟦 Lacustrine plain

⬛ Tailings

0 100 200 300 400 500
Approximate Scale (m)

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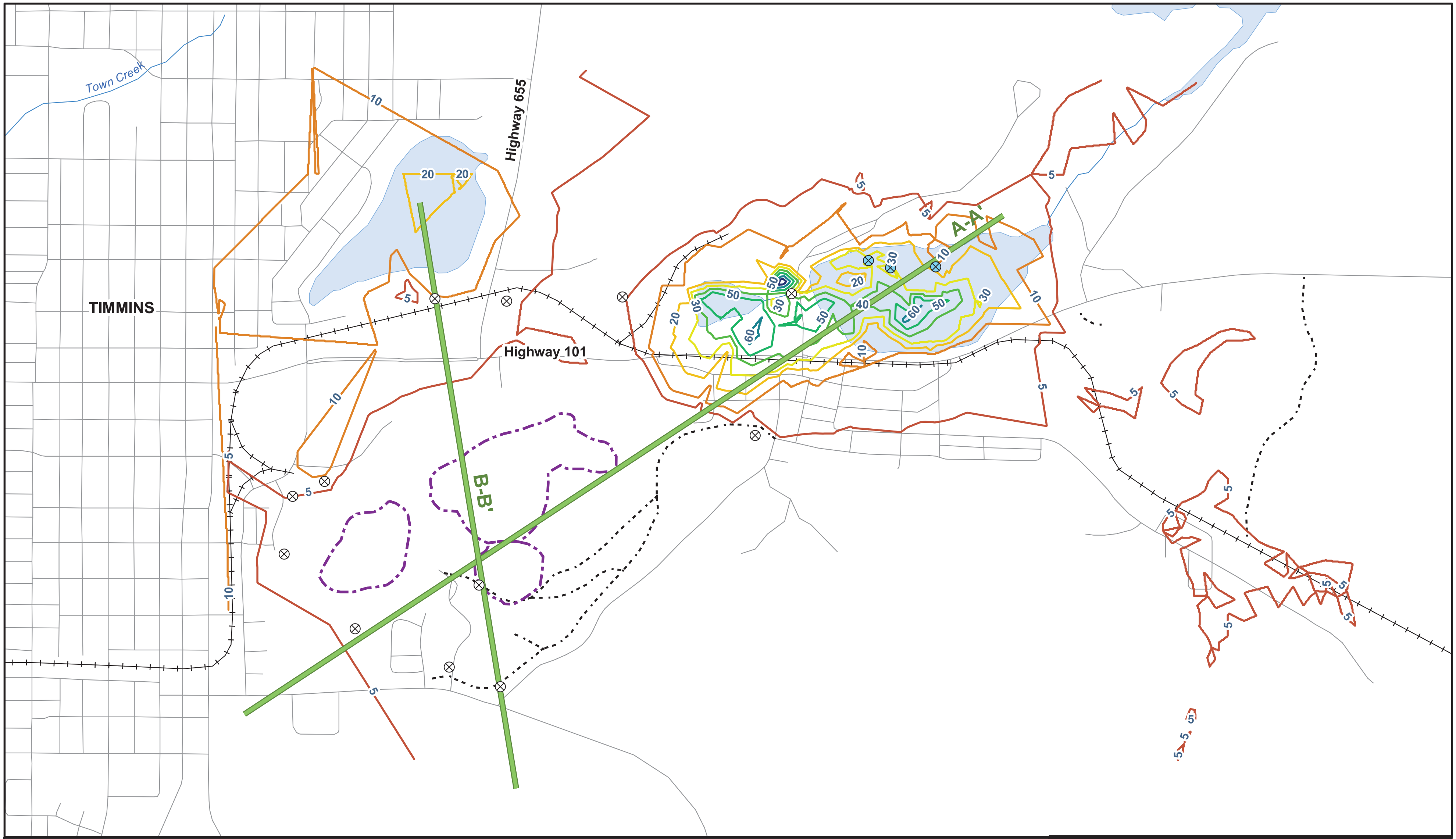
HOLLINGER BASELINE STUDIES
HYDROGEOLOGY STUDY

Overburden Geology

Scale: 1:10000	Date: November 2007
Project No: TC71507	Figure No: 3.2



Legend

- ⊗ AMEC Monitoring well
- ⊗ AMEC Borehole (drilled through lake ice)
- ⬠ Municipal Pumping well
- Cross Section Locations
- Pit Outlines

N

0 140 280 420
Meters

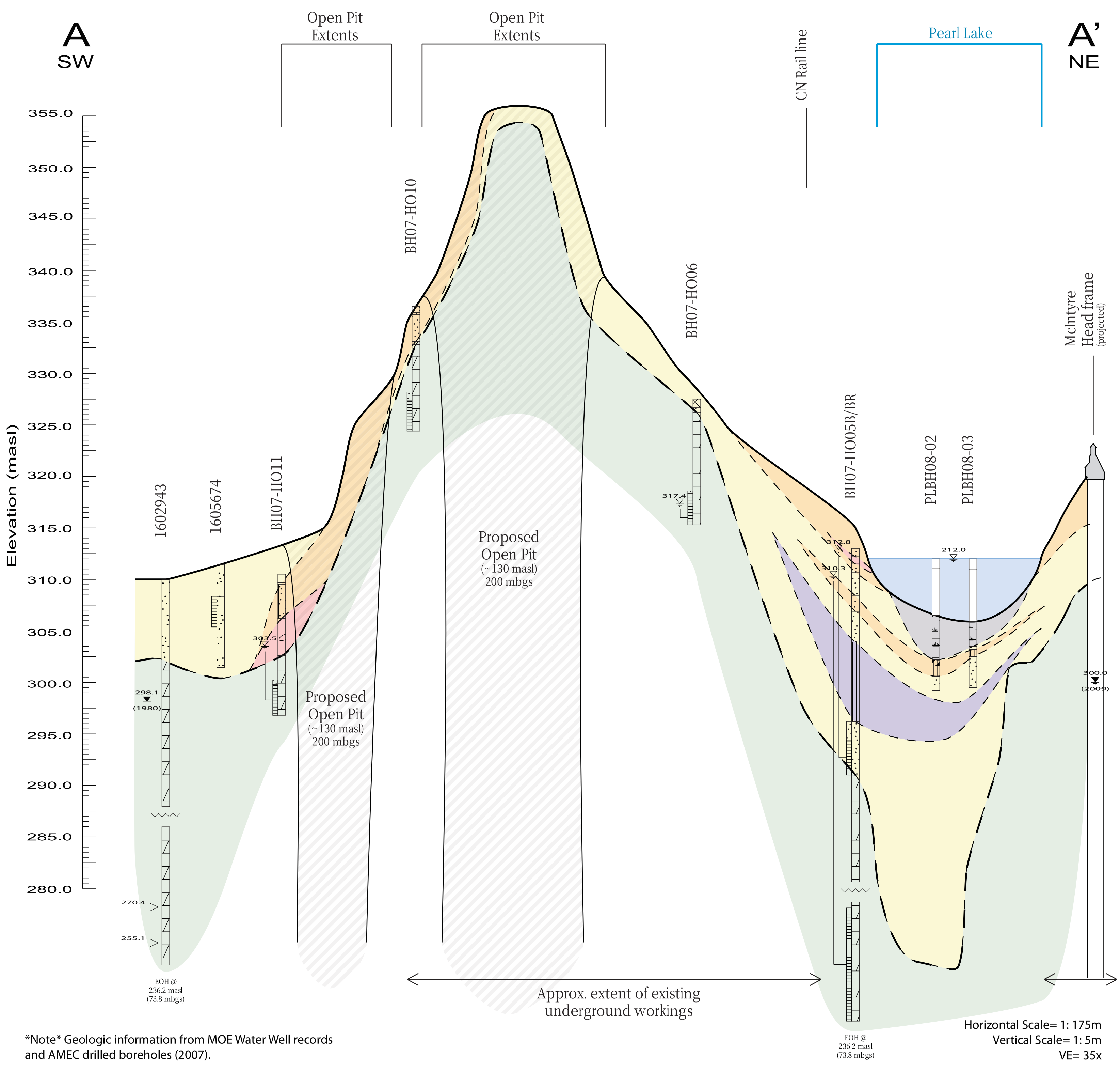
amec

HOLLINGER BASELINE STUDIES
TIMMINS ONTARIO

Overburden Thickness and Cross Section Locations

SCALE: 1:20,000	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.3 REV: 1

P:\EM\Projects\2008\TC81525 Hollinger Permitting\GIS_Data\PTTW_Investigation_Dec2008\Site_Plan.mxd



Note Geologic information from MOE Water Well records and AMEC drilled boreholes (2007).

Horizontal Scale= 1: 175m
Vertical Scale= 1: 5m
VE= 35x

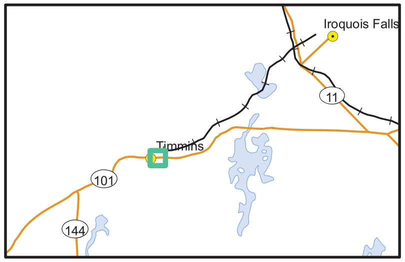
HYDROGEOLOGICAL ASSESSMENT
HOLLINGER MINE

Figure 3.4

Regional Hydrostratigraphic
Cross Section A-A'

Legend

▨	Organics
▨	Clay
▨	Silt
▨	Sand
▨	Silty Sand to Sandy Silt
▨	Gravel
▨	Bedrock
271.7	Monitoring well screened interval and sand pack
150.2	Static Water level from other sources (year)
271	Water Found interval



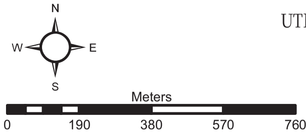
Source: National Topographic Database (Canvec) base map shapefiles, 1:10 000 nominal scale.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

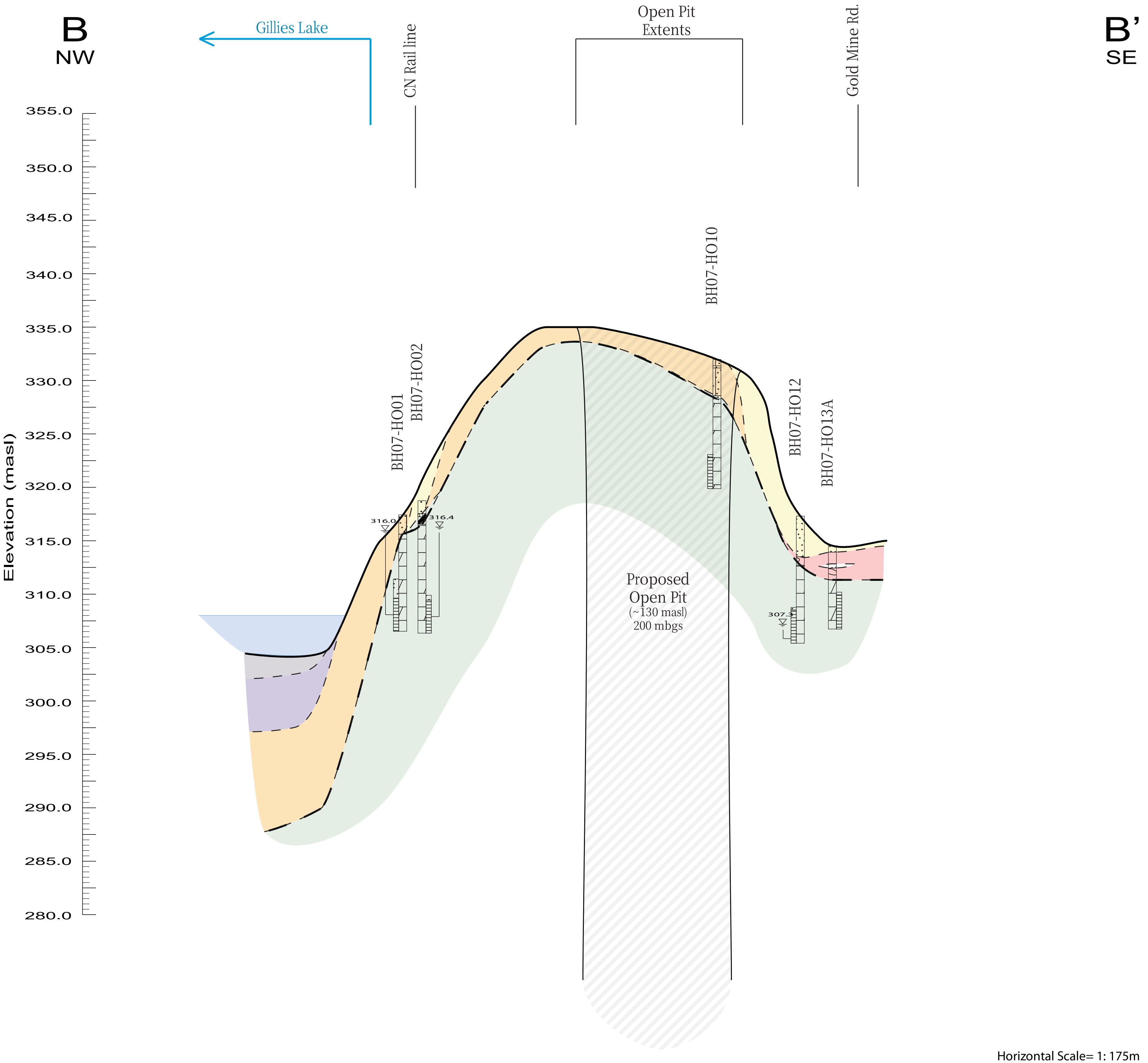
Project # TC81525*1300
Date: July 2009
Client:

Drawn by: RM
Checked by: SG
Revision No.: 2

UTM NAD 83
Zone 17N



AMEC Earth and Environmental
A Division of AMEC Americas Limited
505 Woodward Ave.
Hamilton, ON L8H 6N6



Note Geologic information from MOE Water Well records and AMEC drilled boreholes (2007).

Horizontal Scale= 1: 175m
Vertical Scale= 1: 5m
VE= 35x

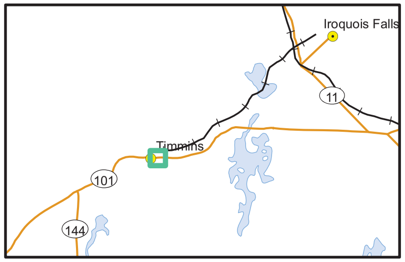
HYDROGEOLOGICAL ASSESSMENT HOLLINGER MINE

Figure 3.5

Regional Hydrostratigraphic
Cross Section B-B'

Legend

- Organics
- Clay
- Silt
- Sand
- Silty Sand to Sandy Silt
- Gravel
- Bedrock (Greenstone)
- 271.7 Monitoring well screened interval and sand pack
- 150.2 Static Water level from other sources
- 271 Water Found interval

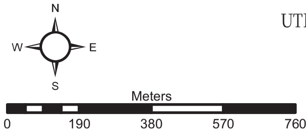


Source: National Topographic Database (Canvec) base map shapefiles, 1:10 000 nominal scale.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

Project # TC81525*1300
Date: July 2009
Client:

Drawn by: RM
Checked by: SG
Revision No.: 2



UTM NAD 83
Zone 17N

AMEC Earth and Environmental
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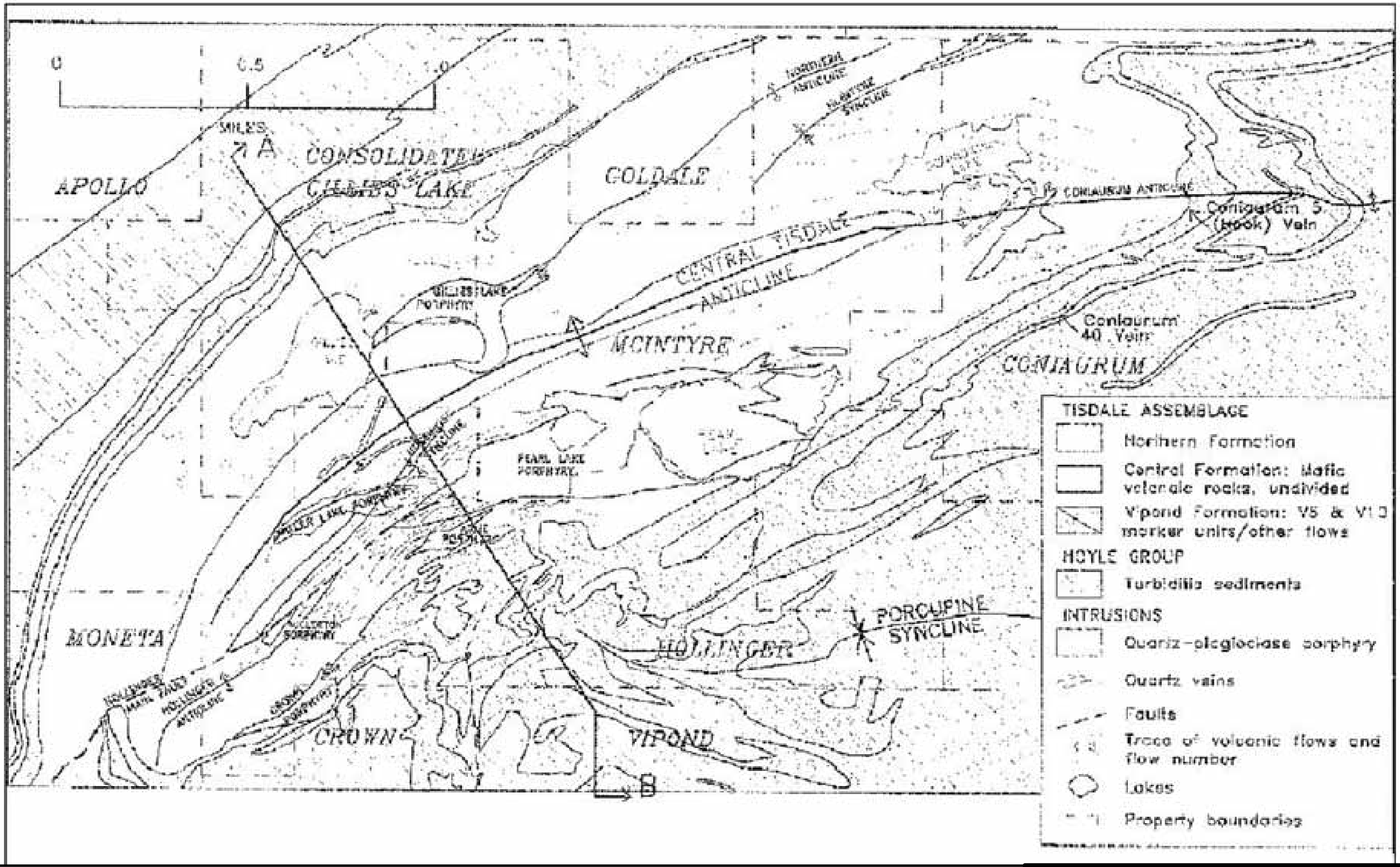
505 Woodward Ave.
Hamilton, ON L8H 6N6



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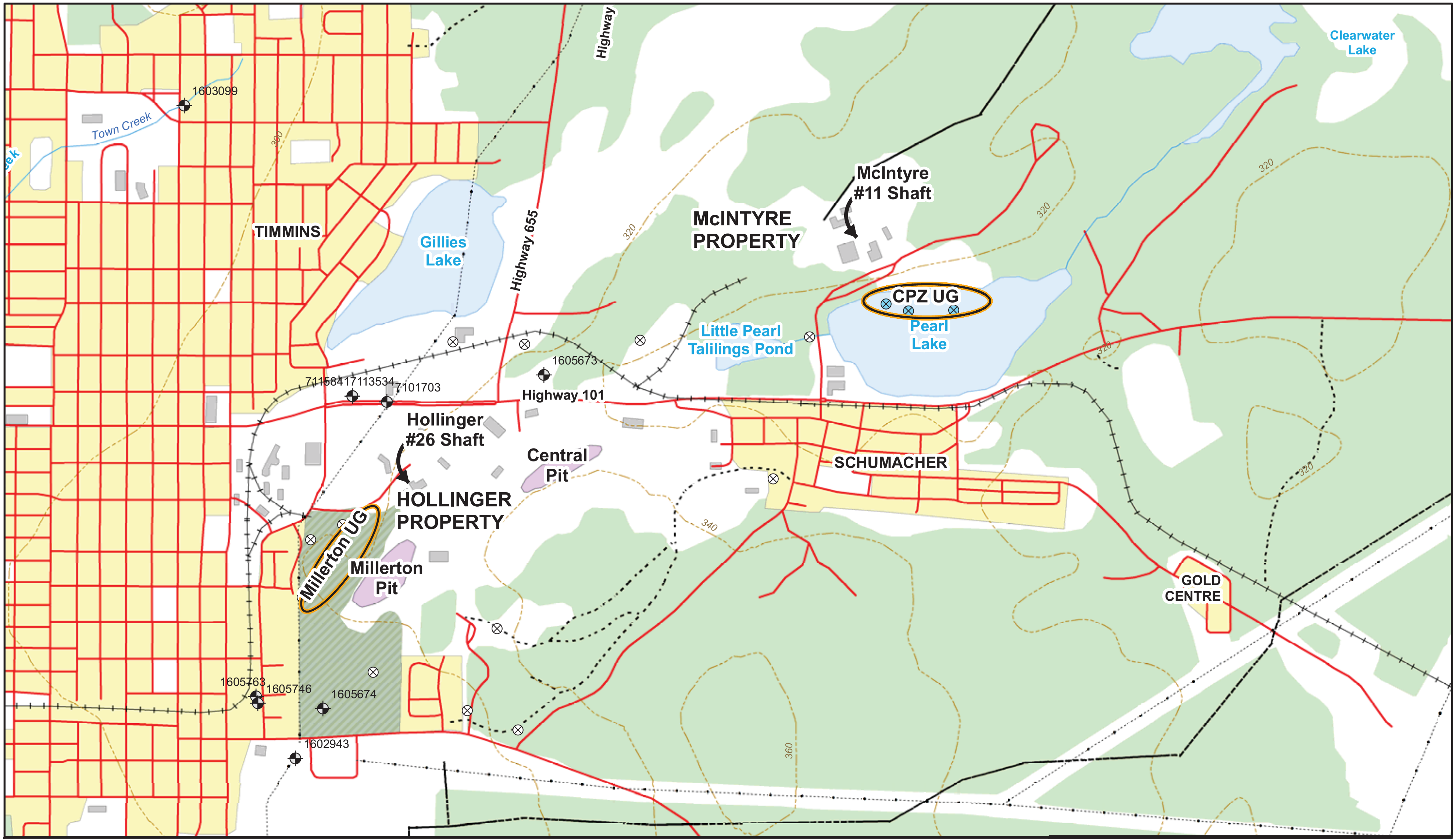
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Bedrock Geology

SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.6 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-6 - Bedrock Geology.mxd



Legend

- Underground Works (Approximate)
- Private wells in MOE WWR database
- AMEC Monitoring well
- AMEC Borehole (drilled through lake ice)
- Municipal Pumping well
- Power Transmission Line
- Trail (other)
- Road segment
- Railway (small)

N

0 140 280 420

Meters

amec

HOLLINGER BASELINE STUDIES

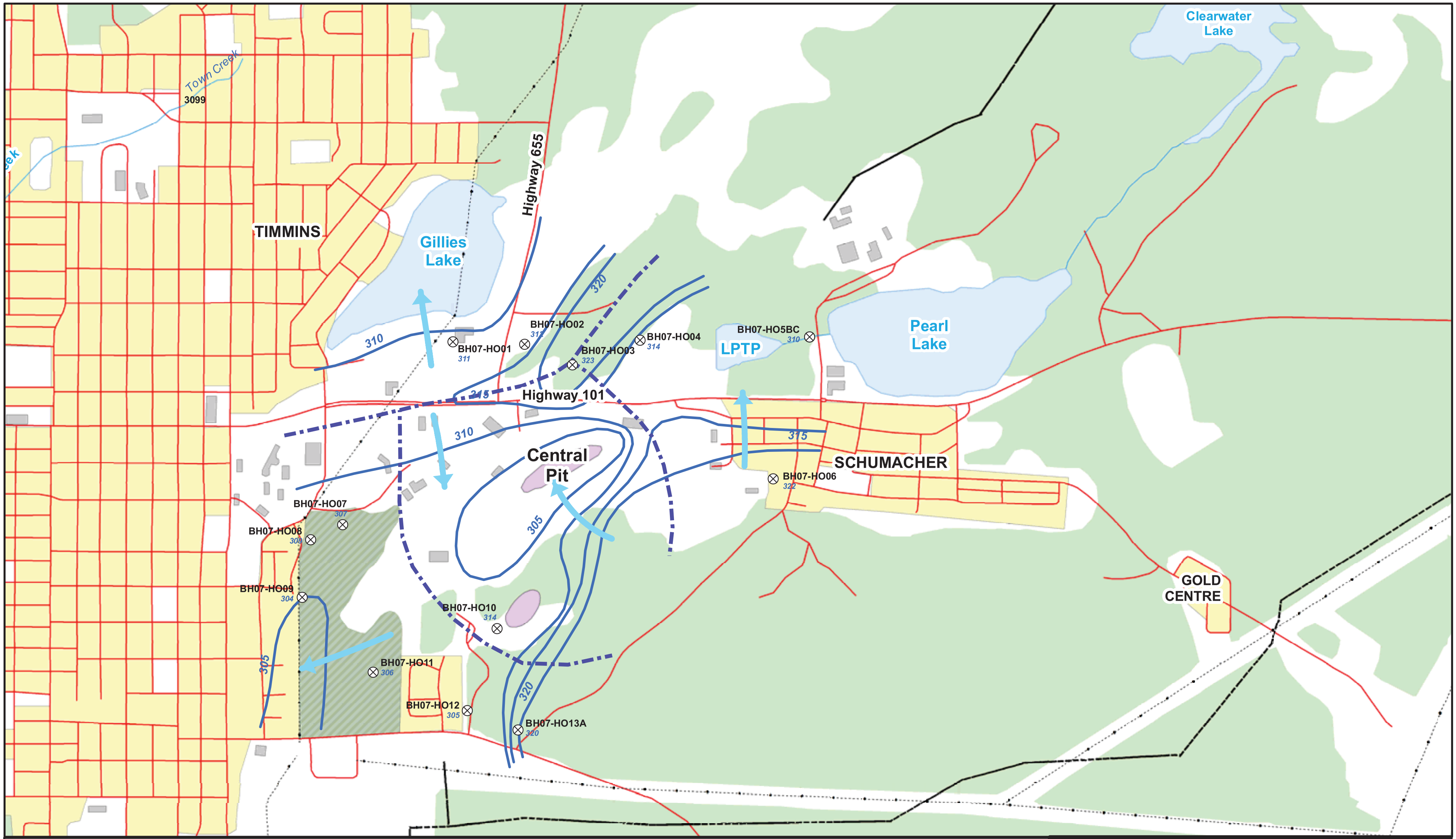
TIMMINS ONTARIO

Locations of Private Wells in the MOE WWR database

SCALE: 1:20,000 DATE: JULY 2009

PROJECT No: TC81525 FIGURE: 3.7 REV: 1

P:\EM\Projects\2008\TC81525 Hollinger Permitting\GIS_Data\PTTW_Investigation_Dec2008\Site_Plan.mxd



Legend

- ⊗ AMEC Monitoring well
- Groundwater flow direction
- Potentiometric surface contour (masl) using shallow bedrock groundwater levels for 2007.
- Approximate Watershed divide
- Power Transmission Line
- Road segment
- Existing Excavation

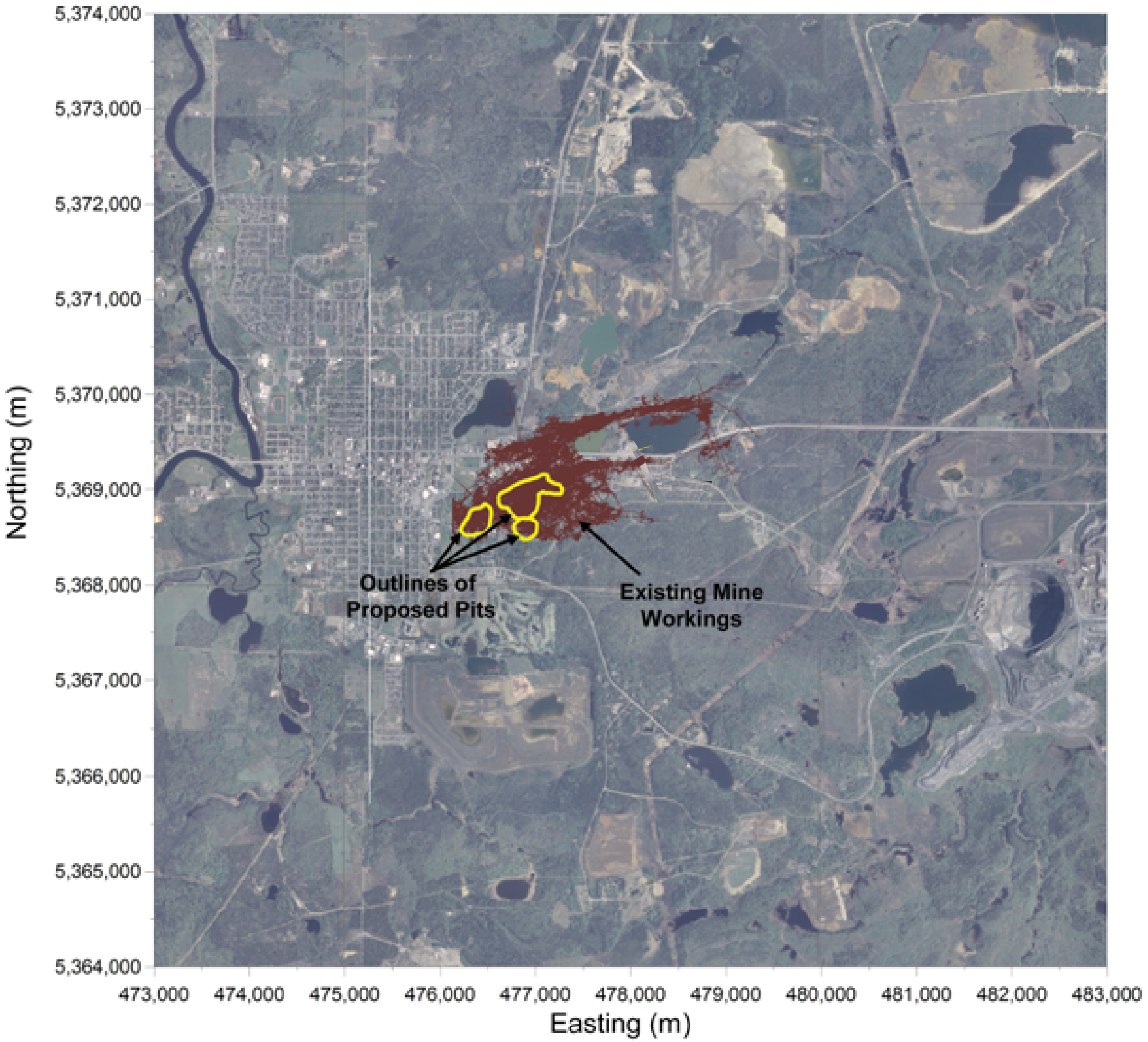
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Interpreted Shallow Groundwater Flow System (Plan View)

SCALE: 1:20,000	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.8 REV: 1

P:\EM\Projects\2008\TC81525 Hollinger Permitting\GIS_Data\PTTW_Investigation_Dec2008\Site_Plan.mxd



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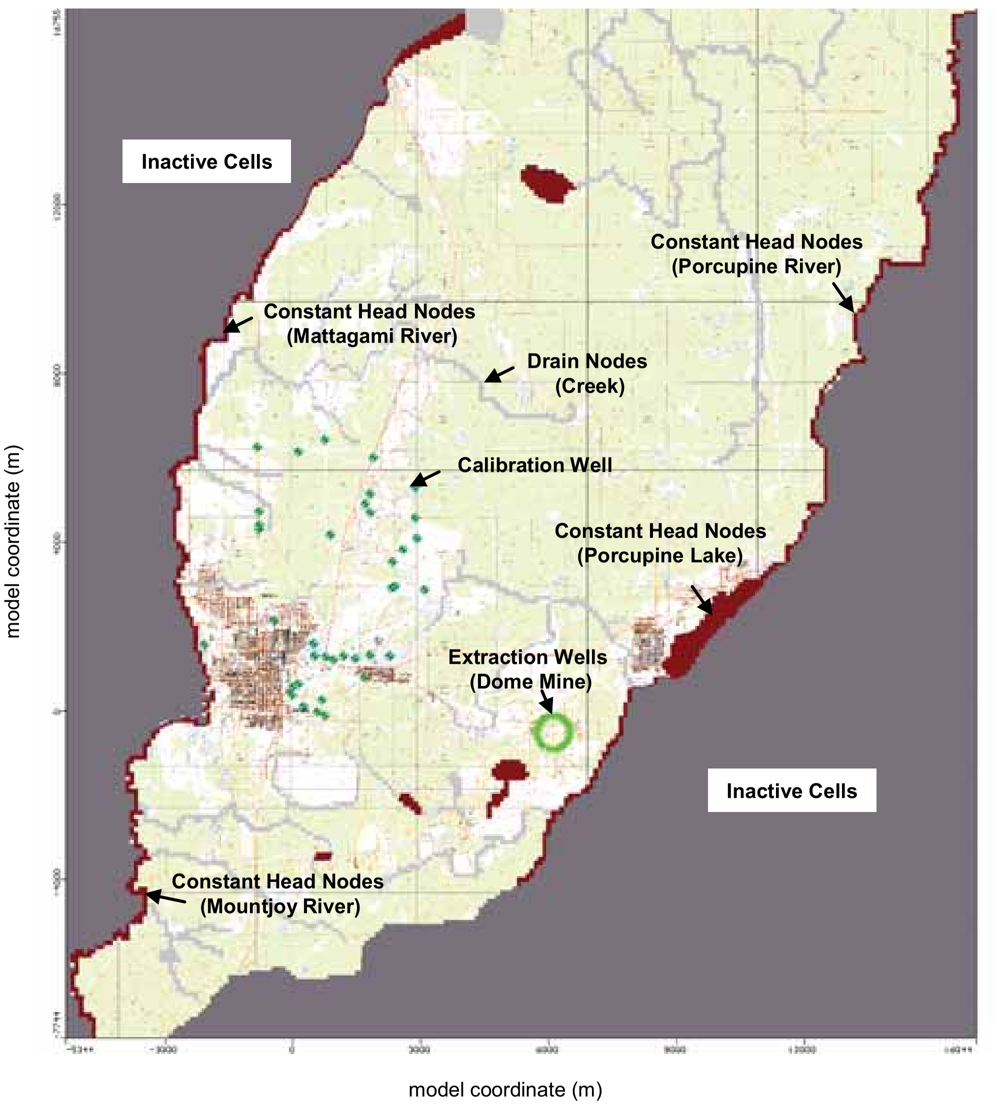
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Hollinger Model
Simulated Mine Workings

SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.9 REV: 1



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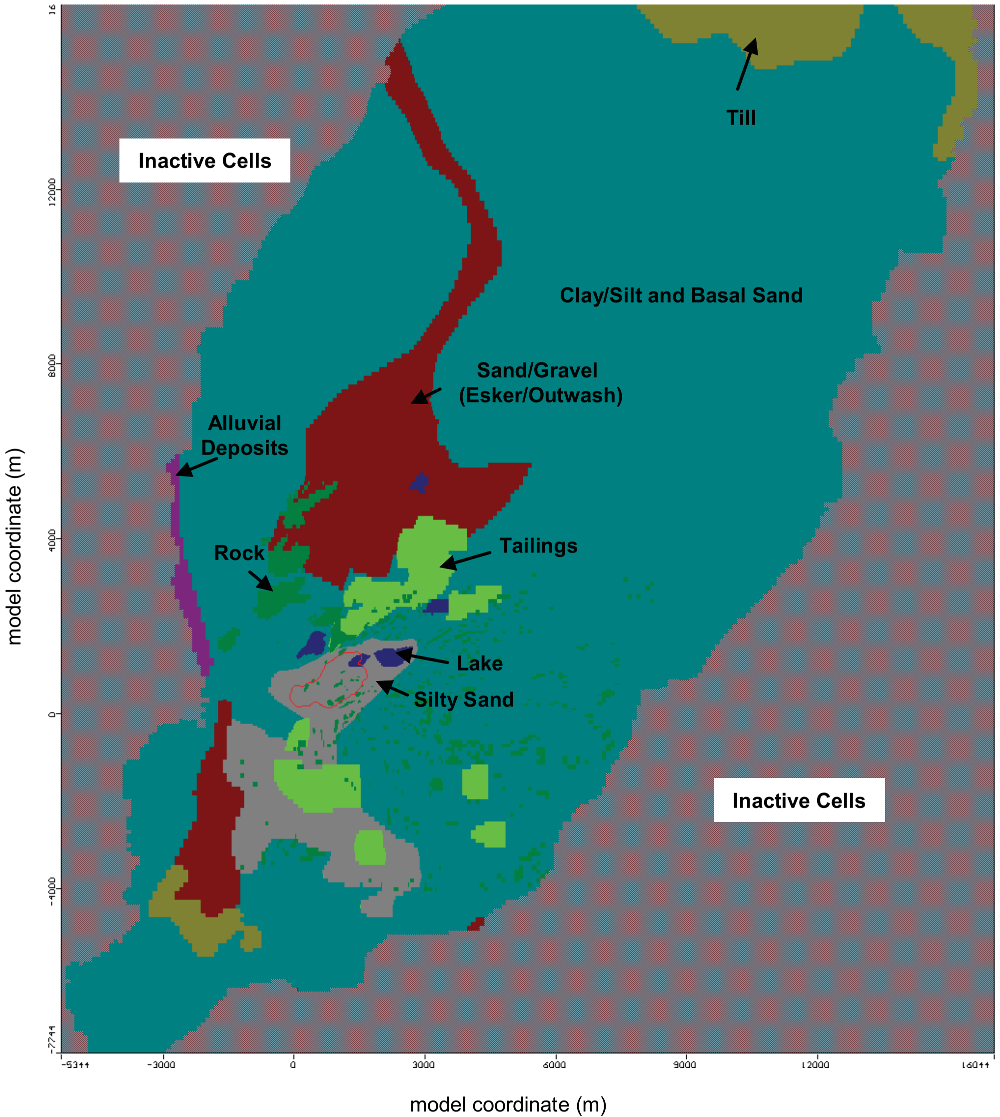
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Hollinger Model
Domain and Boundary Conditions

SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.10 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-10 - Domian and Boundary Conditions.mxd



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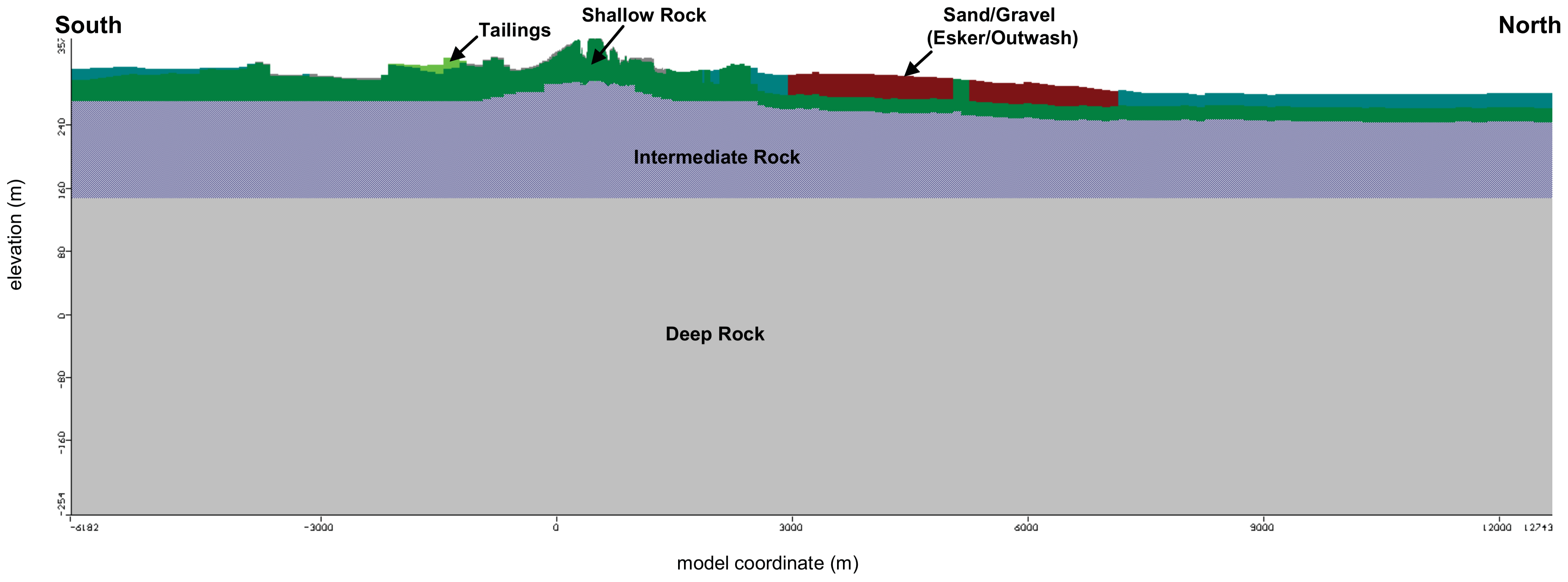
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Plan Veiw of Hollinger Model Hydraulic Conductivities

SCALE: As Shown
DATE: JULY 2009
PROJECT No: TC81525
FIGURE: 3.11
REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-11 - Hydraulic Conductivities.mxd



N

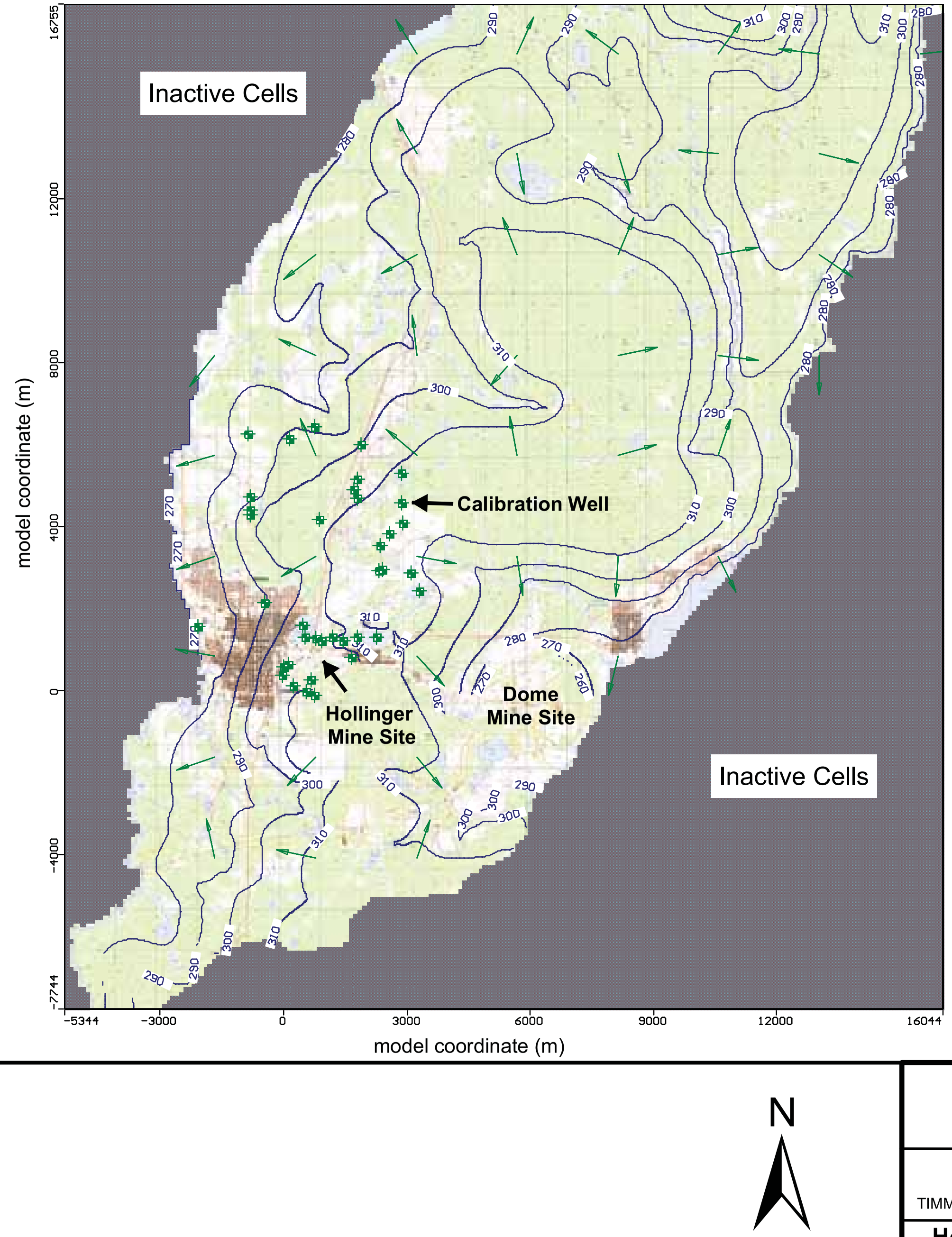
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Cross Section (North-South) of Hollinger Model Hydraulic Conductivities

SCALE: As Shown
DATE: JULY 2009
PROJECT No: TC81525
FIGURE: 3.12
REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-12 - Cross Section Hydraulic Conductivities.mxd



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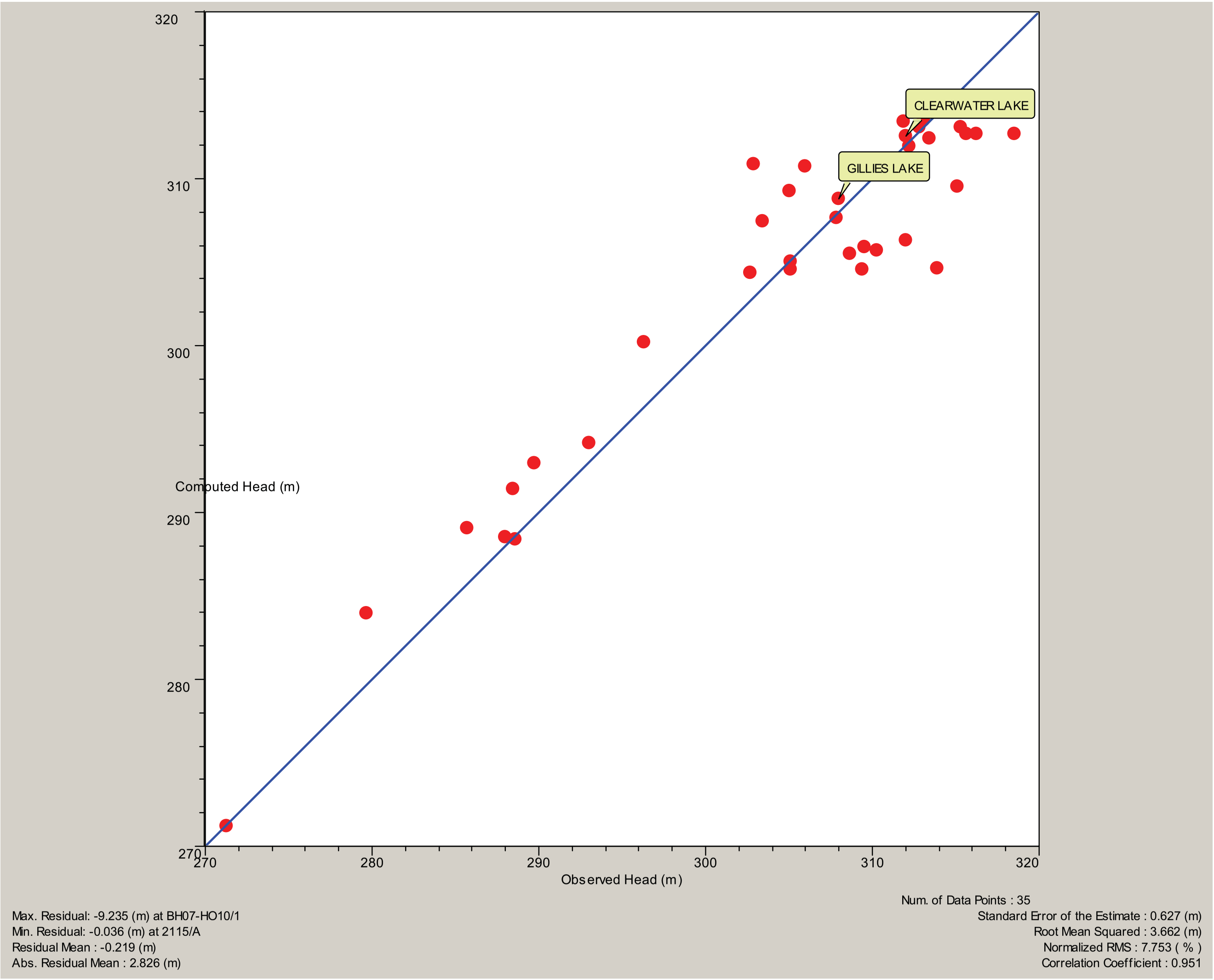
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Hollinger Model Simulated Groundwater Flow System in Overburden and Shallow Rock (Current Conditions)

SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.13 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-13 - Groundwater Flow.mxd



Max. Residual: -9.235 (m) at BH07-HO10/1
Min. Residual: -0.036 (m) at 2115/A
Residual Mean : -0.219 (m)
Abs. Residual Mean : 2.826 (m)

Num. of Data Points : 35
Standard Error of the Estimate : 0.627 (m)
Root Mean Squared : 3.662 (m)
Normalized RMS : 7.753 (%)
Correlation Coefficient : 0.951

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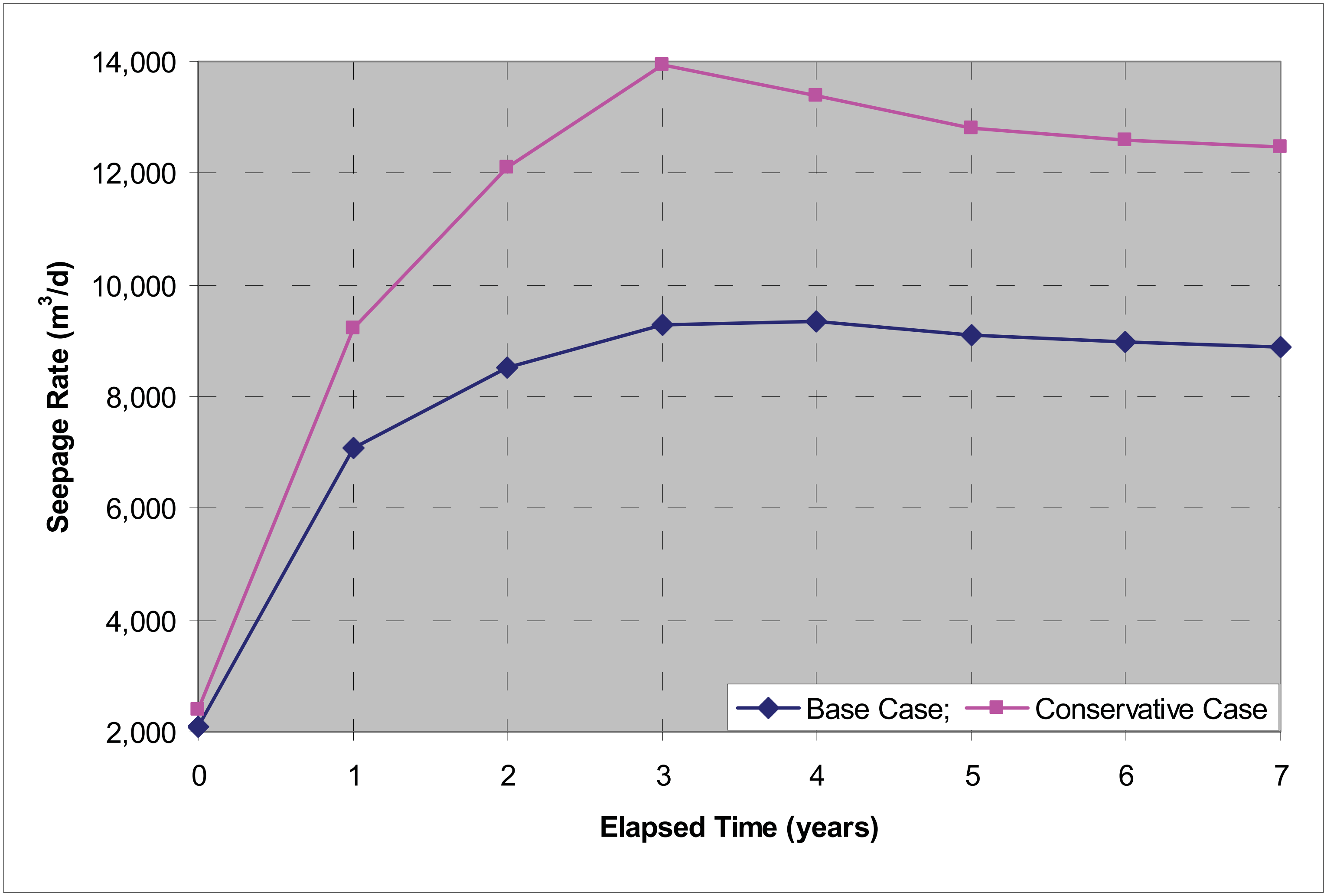
HOLLINGER BASELINE STUDIES
TIMMINS ONTARIO

Compute versus Observed Hydraulic Heads (Current Conditions)

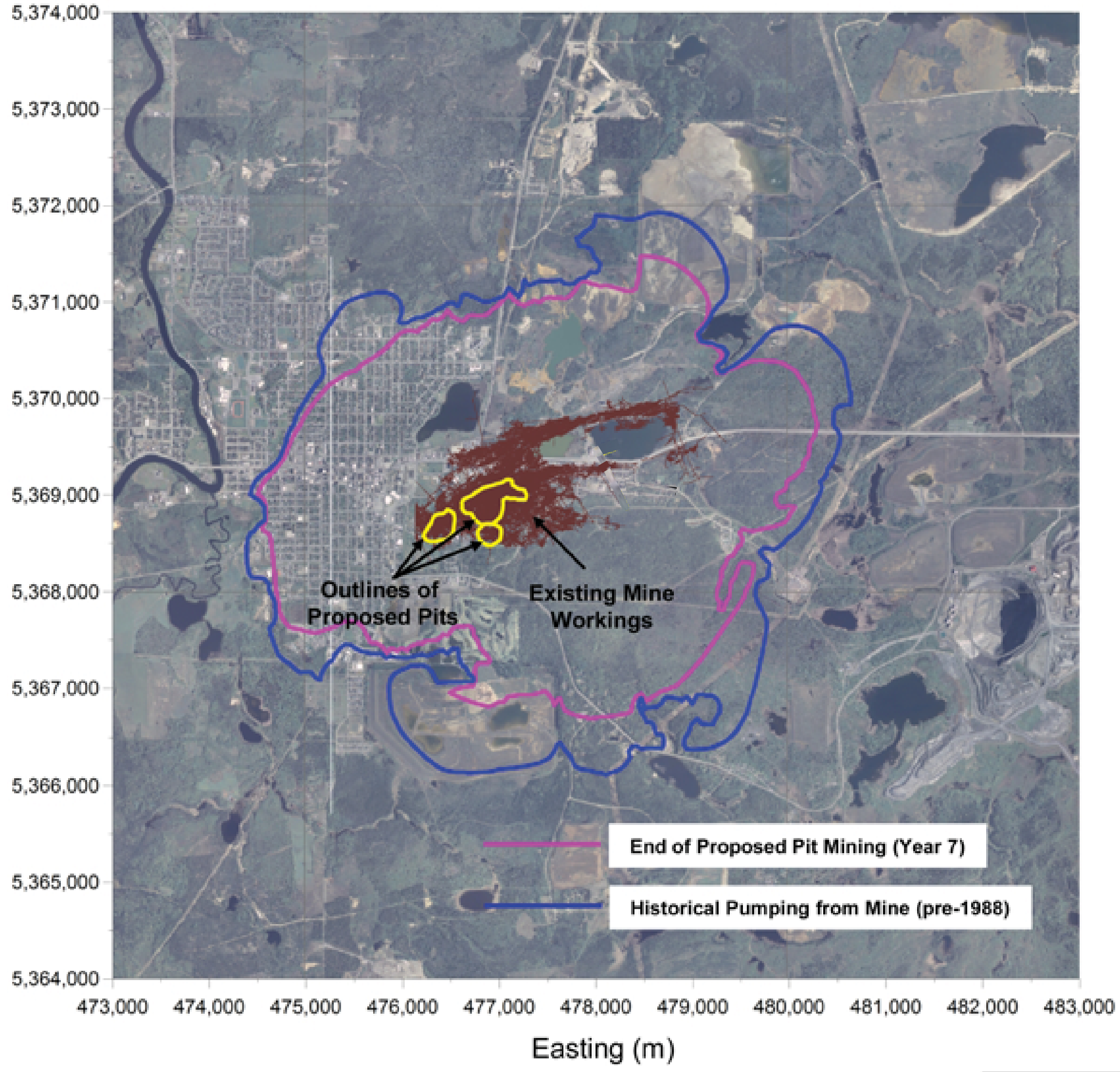
SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.14 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-14 - Hydrualic Heads.mxd



HOLLINGER BASELINE STUDIES TIMMINS ONTARIO	
Predicted Seepage Rates into Proposed Pits, main Access Ramp and Existing Mine Workings	
SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.15 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-15 - Seepage Rates.mxd



N

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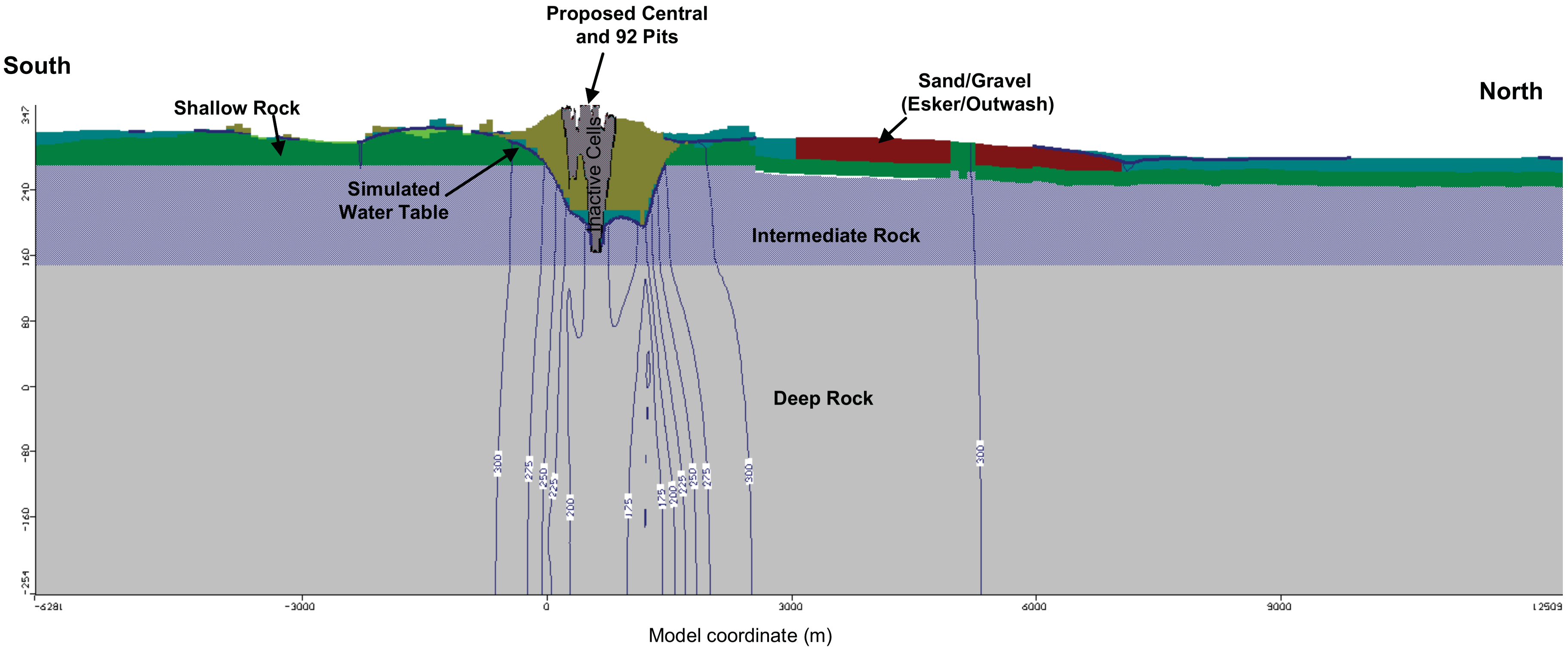
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Model Predicted 1 m Drawdown in Shallow Rock (Base Case)

SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.16 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-16 - Shallow Rock Drawdown.mxd



N

HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Hollinger Pit Model Simulated Water Table Configuration at the End of Excavation (South - North Cross Section)

SCALE: As Shown

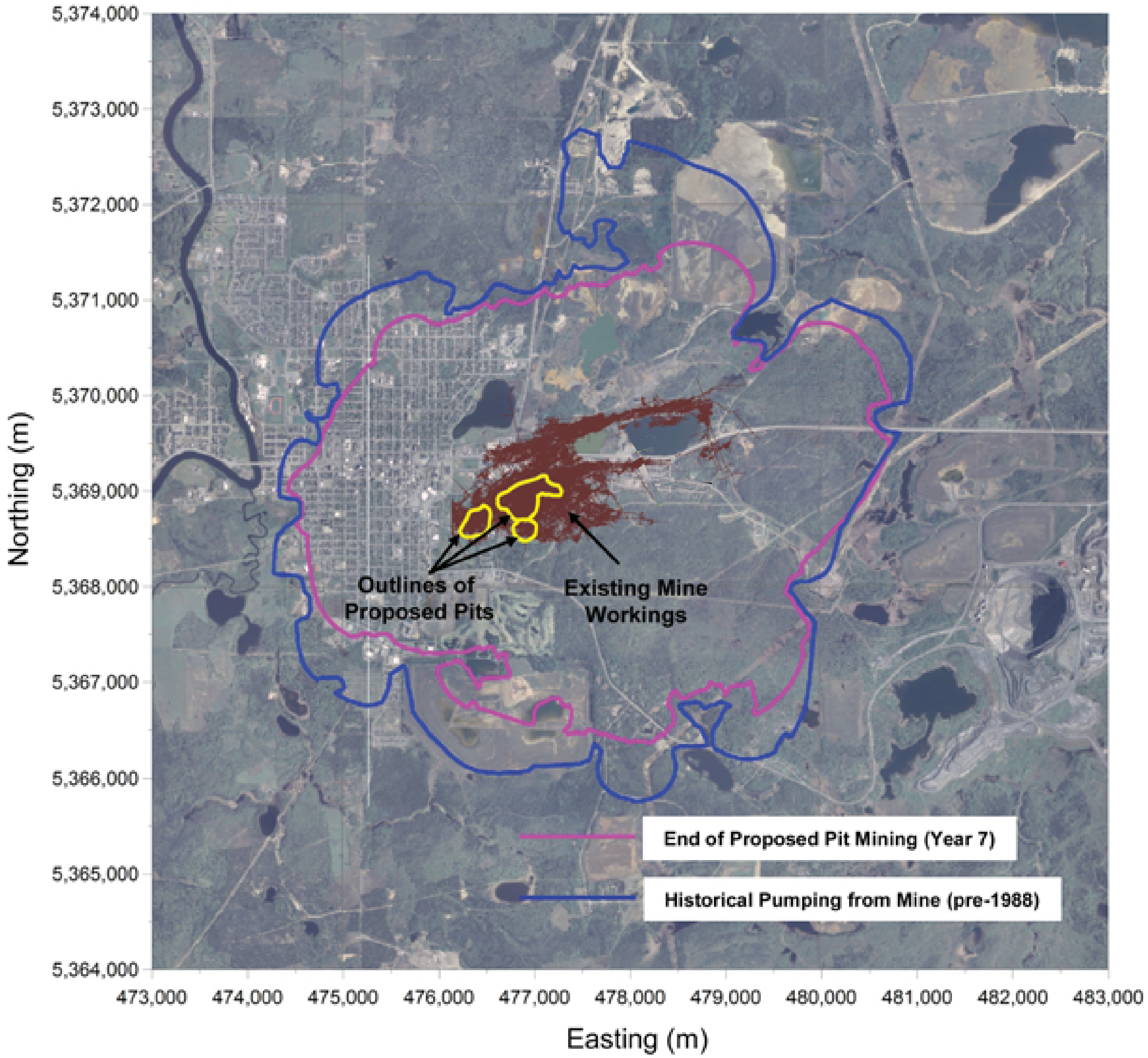
DATE: JULY 2009

PROJECT No: TC81525

FIGURE: 3.17

REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-17 - Water Table.mxd



N

amec

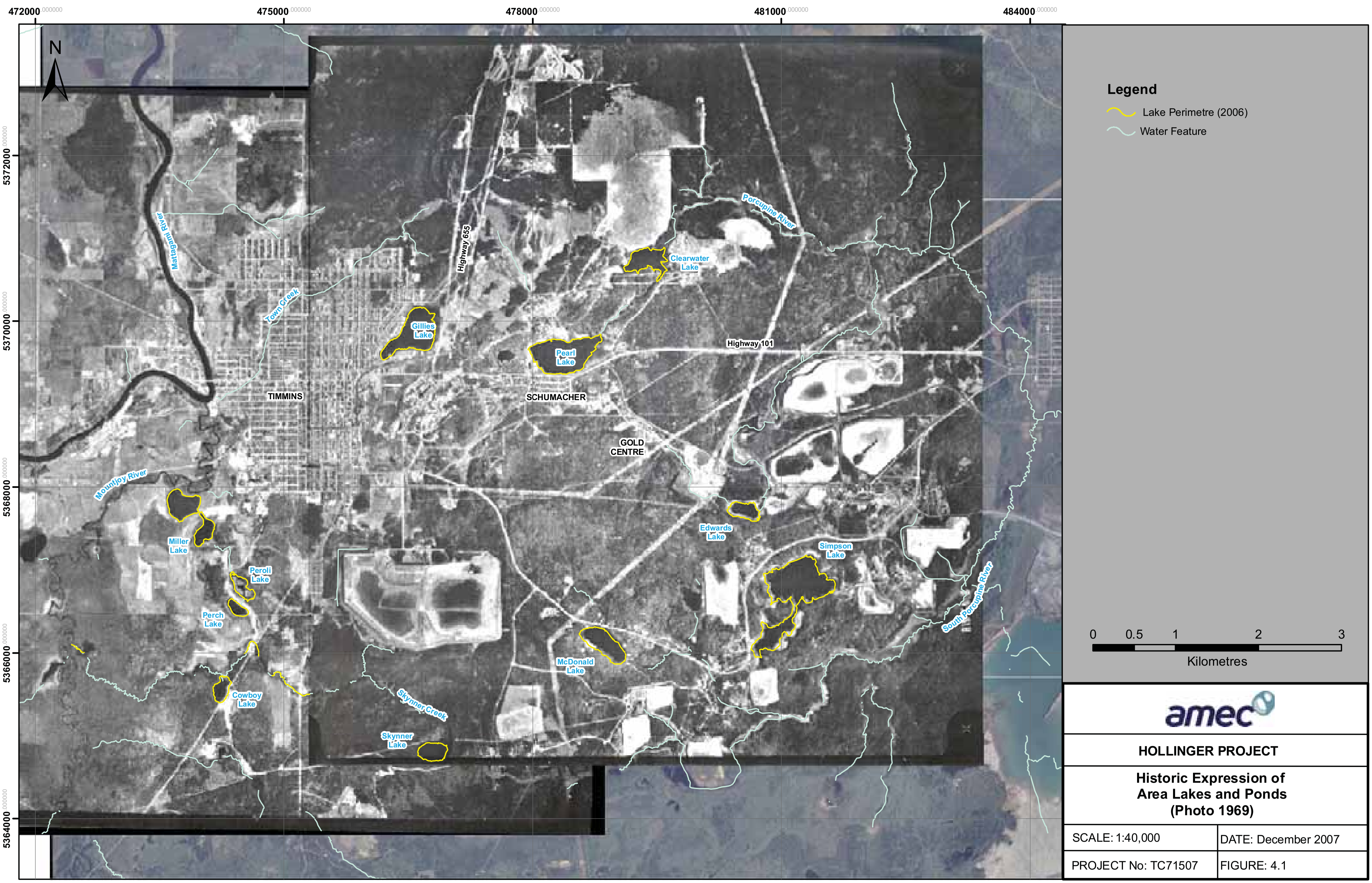
HOLLINGER BASELINE STUDIES

TIMMINS ONTARIO

Model Predicted1 m Drawdown in Shallow Rock (Conservative Case)

SCALE: As Shown	DATE: JULY 2009
PROJECT No: TC81525	FIGURE: 3.18 REV: 1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS_Data\NEW_DATA_2009\Figure 3-18 - Drawdown.mxd



amec

HOLLINGER PROJECT

Historic Expression of Area Lakes and Ponds (Photo 1969)

SCALE: 1:40,000	DATE: December 2007
PROJECT No: TC71507	FIGURE: 4.1

P:\EM\Projects\2007\TC71507 Hollinger Baseline Studies\GIS data\Aquatics Mapping\1969_AirPhoto.mxd

TABLE 3.1
FLOW MEASUREMENTS (m^3/d) FROM 2008

	South Porcupine	North Porcupine	Skynner Creek
November 2008	7,800	24,800	-
Early May 2009	154,000	265,000	55,500
Mid May 2009	-	110,000	16,300
June 2009	18,300	14,400	5,300

TABLE 3.2
HYDROSTRATIGRAPHIC UNITS

Hydrostratigraphic Unit	Approximate Range in Thickness (m)	Composition	Expected Hydraulic Conductivity
Unit 1 (surficial layer, unconfined aquifer)	0 to 12	Fill material, peat, sands	Moderate (sand) to high (waste rock and peat)
Unit 2 (middle aquitard)	0 to 5	Silt, clay and clayey silts	Low
Unit 3 (lower overburden aquifer)	0 to >70	Sands, glacial till	Moderate
Unit 4 (shallow fractured bedrock aquifer)	0 to 30 into bedrock	Slates, greywackes, conglomerates and volcanics	Moderate to low
Unit 5 (intermediate Regional Bedrock System)	30 to 120 into bedrock	Slates, greywackes, conglomerates and volcanics	Typically low (potentially higher hydraulic conductivity along fault and fracture zones)
Unit 6 (deep regional bedrock system)	120 to 400 into bedrock	Slates, greywackes, conglomerates and volcanics	Typically low (potentially higher hydraulic conductivity along fault and fracture zones)

TABLE 3.3
SUMMARY OF CONSTANT HEAD PACKER TEST AND FALLING HEAD MONITORING WELL TEST RESULTS

Borehole ID	Depth (m)	Pressure 1 (psi)	Hydraulic Cond. (m/s)	Pressure 2 (psi)	Hydraulic Cond. (m/s)	Pressure 3 (psi)	Hydraulic Cond. (m/s)	Geometric Mean (m/s)
BH 07- 01	5.5-10.88							3.70E-06
Falling head	7.52 - 10.88							6.70E-06
BH 07- 02	3.05-12.19	10	6.64E-10	20	7.09E-08	30	7.59E-08	1.53E-08
	6.10-12.19			20	2.05E-10	30	2.65E-10	2.33E-10
	9.14-12.19	10	5.26E-10	20		30		5.26E-10
BH 07- 03	8.53-27.73	20	5.89E-08	40	3.21E-08	80	1.16E-07	6.02E-08
	27.73-46.93	20	9.81E-09	40	9.03E-09	90	4.84E-09	7.54E-09
	46.93-66.14	20	2.94E-08	40	9.03E-09	80	4.84E-09	1.09E-08
	66.14-85.34	20	2.94E-08	40	1.30E-07	80	2.02E-07	9.18E-08
	85.34-104.54	20	9.81E-09	40	7.22E-09	80	4.73E-09	6.94E-09
	104.54-123.74	20	9.81E-09	40	7.22E-09	80	9.38E-08	9.38E-08
	123.74-142.95	10	9.48E-08	30	4.72E-07	50	8.51E-08	1.56E-07
	142.95-162.15	3	1.79E-07	6	1.38E-06			4.98E-07
	162.15-181.05	10	1.81E-05	20	1.48E-06	30	6.38E-07	2.57E-06
BH 07- 03 Shallow	0.00-2.13	10		30		50	3.38E-08	3.38E-08
BH 07- 04	6.10-12.10	20	1.21E-09	30	2.02E-10	40	1.67E-10	3.44E-10
	3.48-12.10	20	6.52E-10	30		50	2.01E-09	1.14E-09
	9.14-12.10	15		25		40	4.81E-10	4.81E-10
falling head test								
	3.048 - 12.1							2.04E-08
	6.0 -12.1							9.73E-08
	9.1-12.1							9.86E-08
BH 07- 05	85.34-104.54	8	5.85E-06					5.85E-06
	104.54-123.74	Falling head						3.65E-06
	123.74-142.64	20	1.79E-06	40	8.60E-07	44	9.40E-07	1.13E-06
	142.64-161.84	10	1.48E-06	20	7.69E-07	40	8.17E-07	9.75E-07
	161.84-181.05	0	3.85E-05					3.85E-05
BH 07- 06	3.05-12.19	10	7.87E-08	20	8.02E-08	30	6.68E-08	7.50E-08
	3.09-12.19	10	2.36E-07	20	7.27E-08	30	7.23E-08	1.07E-07
	9.14-12.92	10	1.87E-08	20	6.20E-09	30	8.78E-09	1.01E-08
BH 07- 08	Falling Head							6.59E-07
BH 07- 09	14.02-33.22	6	2.09E-06					2.09E-06
	33.22-52.43	0	2.71E-06					2.71E-06
	52.43-71.63	10	1.94E-08	20	1.48E-08	30	1.07E-08	1.45E-08
	71.63-90.83	10	5.25E-08	20	1.48E-08	30	1.19E-08	2.10E-08
	90.83-110.03	0	1.39E-05					1.39E-05
	110.03-129.24	0	5.62E-06					5.62E-06
BH 07-09 Shallow	3.81-9.14	10	1.22E-06	20	3.67E-07	30	3.18E-07	5.22E-07
	6.09-9.14	10	8.49E-07	20	3.01E-07	30	3.60E-07	4.51E-07
BH 07- 10	6.09-11.92	10	4.26E-07	20	1.43E-07	30	1.35E-07	2.02E-07
	9.14-11.92	10	4.03E-07	20	1.33E-07	30	1.52E-07	2.01E-07
BH 07-11								
Falling Head	10-13.7							1.80E-07
BH 07- 12	9.14-12.19	10	5.54E-08	20	1.42E-07		1.19E-07	9.77E-08
	9.14-12.19	10	6.80E-07	20				6.80E-07
BH 07- 13	8.84-28.04	4	6.07E-06					6.07E-06
	28.04-47.24	10	2.03E-08	20	1.96E-08	30	7.80E-09	1.46E-08
	47.24-66.45	10	2.28E-08	20	1.71E-08	30	1.37E-08	1.75E-08
	66.45-85.65	0	4.37E-07					4.37E-07
	85.65-104.85	10	5.22E-08	20	6.10E-08	30	1.68E-07	8.12E-08
	104.85-124.05	10	6.06E-08	20	6.80E-08	30	1.55E-07	8.62E-08
	124.05-143.26	10	9.15E-08	20	1.74E-07	30	4.09E-07	1.87E-07
	143.26-162.46	10	1.31E-07	20	1.37E-07	30	2.57E-06	3.58E-07
	162.46-181.66	10	1.46E-07	20	5.48E-07	30	2.57E-06	5.90E-07

TABLE 3.4
GROUNDWATER LEVEL DATA

Monitoring Well ID	Ground Elevation[1] (masl)	Water Levels (mtoc)			Top of Screen (mbgl)	Bottom of Screen (mbgl)
		Event 1	Event 2	Event 3		
BH07HG01	311.0	1.65	1.83	0.9	7.9	10.9
BH07HG02	312.5	1.90	2.30	1.39	9.4	12.4
BH07HG03	362.0	3.60	Lost	Lost	3.1	6.1
BH07HG03D	326.0	NC	22.50	21.32	145	155
BH07HG04	321.0	11.85	12.60	8.29	9.1	12.1
BH07HG05C	313.0	NC	0.52	0.42	3.1	4.6
BH07HG05BR	313.0	NC	2.8	2.6	172	182
BH07HG06	327.5	9.70	9.93	5.76	9.2	12.2
BH07HG07	314.0	NC	9.08	8.49	8.9	11.9
BH07HG08	320.0	NC	11.01	11.80	9.2	12.2
BH07HG09A	314.5	7.58	Dry	Dry	6.8	9.8
BH07HG09B	314.5	NC	12.73	12.4	35	45
BH07HG09C	314.5	NC	12.50	13.59	101	111
BH07HG010	326.5	Dry	Dry	Dry	9.1	12.1
BH07HG011	310.5	NC	6.40	5.91	10.7	13.7
BH07HG012	313.0	9.60	9.58	9.38	8.9	11.9
BH07HG013A	324.0	NC	5.90	4.77	4.8	7.8
BH07HG013B	324.0	NC	11.71	10.68	13	23
BH07HG013C	324.0	NC	13.84	12.71	143	153

Notes: [1] from LIDAR ground surface
Event 1 – week of July 19, 2007
Event 2 – week of September 25, 2007
Event 3 –week of November 12, 2007
NC = the well was not complete at the time of this event
mtoc = metres below top of casing (assume 1m stick-up)
mbgl = metres below ground level

TABLE 3.5
GROUNDWATER CHEMISTRY

Parameters	Units	ODWS	MW-1	MW-2	MW-3	MW-4	MW-5A	MW-5B	MW-6	MW-7	MW-8	MW-9B	MW-9C	MW-11	MW-12	MW-13A	MW-13B	MW-13C
General Chemistry			BH07HG-01	BH07HG-02	BH07HG-03	BH07HG-04	BH07HG-05A	BH07HG-05B	BH07HG-06	BH07HG-07	BH07HG-08	BH07HG-09B	BH07HG-09C	BH07HG-03	BH07HG-12	BH07HG-13A	BH07HG-13B	BH07HG-13C
Alkalinity (as CaCO3)	mg/L	30-500 OG	269	319	288	**<1**	301	191	346	**531**	269	265	328	233	257	183	215	193
Conductivity	uS/cm		1280	1180	1470	7120	1390	980	1040	2150	1250	1030	1100	603	1140	1320	846	925
DOC	mg/L	5 AO	3.4	3.9	4	**17**	4.7	2.1	1.4	3.9	3.1	4.4	2.2	0.5	1	1.8	**5.1**	1
Hardness (as CaCO3)	mg/L	80-100 OG	**410**	**920**	**200**	**5200**	**750**	**460**	**500**	**1600**	**840**	**30**	**350**	**280**	**440**	**440**	**17**	**330**
Nitrate (as N)	mg/L	10 MAC	<0.1	<0.1	2.1	3.2	0.3	<0.1	0.2	0.8	5.1	1	1.3	1	0.4	<0.1	<0.2	0.3
Nitrite (as N)	mg/L	1 MAC	<0.001	<0.001	0.07	0.01	<0.01	<0.01	0.02	0.02	0.03	0.6	<0.01	0.02	<0.01	<0.001	0.2	<0.01
pH	pH Units	6.5-8.5	7.9	8	8.2	3.9	7.9	8	8	7.9	8	**8.6**	8	8	8	8	**9.4**	8
Sulphate	mg/L	500 AO	142	250	318	**6060**	424	248	196	**808**	363	146	90	73	57	435	145	64
Total Dissolved Solids (TDS)	mg/L	500 AO	404	433	**620**	**1220**	441	376	358	**549**	454	**527**	450	283	466	476	484	396
Metals																		
Arsenic	mg/L	0.025 IMAC	0.001	0.003	0.001	<0.005	0.008	0.02	0.006	<0.001	<0.001	0.008	0.001	<0.001	<0.001	<0.001	**0.16**	0.002
Cadmium	mg/L	0.005 MAC	<0.0001	<0.0001	<0.0001	**0.12**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.05 MAC	<0.005	<0.005	<0.005	<0.030	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	mg/L	1 AO	0.001	0.001	0.002	**2.5**	0.002	<0.001	0.003	0.005	0.003	0.008	0.002	0.002	<0.001	0.002	0.007	0.003
Iron	mg/L	0.3 AO	**0.38**	**0.88**	<0.100	**61**	**3**	**0.37**	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Lead	mg/L	0.01 MAC	<0.0005	<0.0005	<0.0005	**0.007**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Manganese	mg/L	0.05 AO	**0.24**	**0.9**	**0.068**	**130**	**0.52**	**0.19**	**0.047**	**0.25**	**0.42**	**0.068**	**0.036**	**0.006**	**0.3**	**0.49**	**<0.002**	**0.007**
Zinc	mg/L	5 AO	0.067	0.032	0.018	**33**	0.02	0.015	0.018	0.015	0.02	0.03	0.016	0.01	<0.005	0.024	0.01	0.021

Notes:

Parameters expressed as mg/L, unless otherwise noted. Exceedences of the ODWS are indicated by **BOLD** entries.

ODWS - Ontario Drinking Water Standards (Ministry of the Environment, 2003)

MAC - Maximum Acceptable Concentration IMAC - Interim Maximum Acceptable Concentration AO - Aesthetic Objective OG - Operational Guideline

TABLE 3.6
INITIAL AND CALIBRATED GROUNDWATER FLOW MODEL INPUT PARAMETERS

Simulated Aquifer Units and Zones	Initial(1)	Calibrated	Comments/Expected Range(2)
Hydraulic Conductivity (cm/s)			
Overburden			
Sand/gravel	1x10^{-2}	1x10^{-2}	Esker, outwash areas 10^{-2} cm/s - 10^{-1} cm/s
Silty sand/tailings	1x10^{-4}	5x10^{-4}	Expected to be in the order of 10^{-4} cm/s
Clay/silt and basal sand	1x10^{-4}/1x10^{-6}(3)	5x10^{-4}/5x10^{-6}	Horizontal hydraulic conductivity value represents average over depth hydraulic conductivity of clay/silt and basal sand zones. Vertical hydraulic conductivity value represents hydraulic conductivity of clay/silt zone.
Till	1x10^{-4}	1x10^{-4}(4)	10^{-5} cm/s to 10^{-4} cm/s
Silty clay	1x10^{-6}	3x10^{-6} and 1x10^{-6}	Underneath Pearl Lake and Gillies Lake, respectively Expected to be in the order 10^{-6} cm/s to 10^{-5} cm/s
Alluvial deposits	1x10^{-3}	1x10^{-3}(4)	Relatively small area along Mattagami River
Bedrock			
Shallow rock(5)	1x10^{-4}	1x10^{-4}	10^{-5} cm/s to 10^{-4} cm/s
Intermediate rock(6)	1x10^{-5}	2x10^{-5}(7)	10^{-6} cm/s to 10^{-4} cm/s
Deep rock	1x10^{-6}	1x10^{-6}	10^{-7} cm/s to 10^{-5} cm/s
Recharge Rate (mm/year)			
Esker/outwash	300	300	250 to 350 mm/yr
Silty sand/sandy silt	100	100	Expected to vary from 20 to 60 mm/yr (thin overburden) to 100 to 200 mm/yr
Till	100	100(4)	100 to 200 mm/yr
Silty clay	30	40	20 to 60 mm/yr
Bedrock outcrop	30	30	20 to 40 mm/yr

Notes:
(1) Initially assigned input parameters were modified through the model calibration process
(2) Combination of literature (Freeze and Cherry, 1979; Anderson and Woessner, 1992) and site-specific data
(3) 1x10^{-4}/1x10^{-5} – horizontal over vertical hydraulic conductivity value
(4) Not subject to calibration, model is not sensitive to this parameter
(5) Upper 30 m thick bedrock zone
(6) Upper 120 m thick bedrock zone located below the shallow rock zone
(7) An additional variant with higher hydraulic conductivity zone of 2x10^{-4} cm/s located at the contact between intermediate and deep rock was simulated as part of the predictive sensitivity analysis (Section 3.6.3)

TABLE 3.7
OBSERVED AND COMPUTED WATER LEVELS FOR CURRENT CONDITIONS

Well/Lake ID	Easting (m)	Northing (m)	Observed Head (m)	Computed Head (m)	Discrepancy (m)	Comment
1500	475,314	5,373,002	288.0	288.5	0.5	MOE database
1522	476,254	5,374,427	288.4	291.4	3.0	MOE database
1598	476,864	5,374,707	288.6	288.4	-0.1	MOE database
1858	477,914	5,372,977	315.1	309.5	-5.6	MOE database
2115	474,039	5,369,848	271.3	271.2	0.0	MOE database
2545	477,914	5,373,427	312.0	306.3	-5.7	MOE database
2546	478,014	5,374,277	296.3	300.2	3.9	MOE database
2569	477,815	5,373,175	307.9	307.7	-0.2	MOE database
3099	475,664	5,370,427	285.7	289.0	3.3	MOE database
3635	475,314	5,372,577	293.1	294.2	1.1	MOE database
3636	475,314	5,372,677	289.7	292.9	3.2	MOE database
867	475,264	5,374,527	279.7	283.9	4.3	MOE database
BH-M-03-03	479,205	5,371,157	316.3	312.7	-3.5	McIntyre Mine
BH-M-03-06	478,435	5,371,202	311.9	313.4	1.5	McIntyre Mine
BH-M-03-07	478,521	5,371,247	313.1	313.5	0.4	McIntyre Mine
BH-M-03-08	478,455	5,371,806	313.4	312.4	-1.0	McIntyre Mine
BH-M-03-09	478,978	5,372,859	312.2	312.0	-0.2	McIntyre Mine
BH-M-03-11	478,688	5,372,094	315.7	312.7	-3.0	McIntyre Mine
BH-M-04-12	479,026	5,372,368	315.3	313.1	-2.2	McIntyre Mine
BH07-HO01	476,630	5,369,576	309.6	305.9	-3.7	
BH07-HO02	476,887	5,369,567	310.2	305.7	-4.5	
BH07-HO04	477,303	5,369,582	308.7	304.4	1.7	
BH07-HO05B	477,912	5,369,594	312.8	305.5	-3.2	
BH07-HO06	477,780	5,369,083	317.4	NA	NA	
BH07-HO07	476,233	5,368,918	305.1	304.6	-0.5	
BH07-HO08	476,119	5,368,864	309.4	304.6	-4.8	
BH07-HO09	476,088	5,368,656	<305.1(dry)	305.0	>-0.1	
BH07-HO10	476,788	5,368,544	<313.9(dry)	304.6	>-9.2	
BH07-HO11	476,343	5,368,387	303.5	307.5	4.0	
BH07-HO12	476,681	5,368,249	302.9	310.9	8.0	
BH07-HO13B	476,864	5,368,179	318.5	312.7	-5.8	
Charlebois Lake	478,977	5,373,580	306.0	310.8	4.8	
Clearwater Lake	479,423	5,370,724	312.0	312.6	0.6	
Gillies Lake	476,590	5,369,874	308.0	308.8	0.8	
PW87	476,995	5,372,452	305.0	309.3	4.3	Winding Woods water supply well

NA- Not available, computed head is below the well screen

TABLE 3.8
STORAGE INPUT PARAMETERS UTILIZED IN TRANSIENT MODEL RUNS(1)

Simulated Aquifer Material/Zone	Specific Storage (m^{-1})	Specific Yield (-)
Overburden		
Sand/gravel	$1x10^{-5}$	$2x10^{-1}$
Silty sand/tailings	$1x10^{-4}$	$1x10^{-1}$
Clay/silt and basal sand(2)	$1x10^{-4}$	$5x10^{-2}$
Till	$1x10^{-4}$	$1x10^{-1}$
Silty clay	$5x10^{-4}$	$2x10^{-2}$
Alluvial deposits	$1x10^{-5}$	$1x10^{-1}$
Bedrock		
Shallow weathered rock	$1x10^{-5}$	$1x10^{-2}$
Intermediate rock	$1x10^{-6}$	$1x10^{-3}$
Deep rock	$1x10^{-6}$	$1x10^{-3}$

Notes:
(1) Literature data (Anderson and Woessner, 1992; Walton, 1988; Johnson, 1967; Rusmussen, 1963)
(2) Lumped properties of the overburden layer comprised of the upper silty clay and lower basal sand units

APPENDIX A

CURRENT PTTW AND C. OF A. (see Appendix B of main report)

APPENDIX B

BOREHOLE LOGS

RECORD OF MONITORING WELL No. BH07-HO01 Co-Ord. 0476630 E, 5369576 N

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**
Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **26 Jul 07** Date Completed: **27 Jul 07**
Logged by: **SRL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **2, 07/11/07**

LITHOLOGY PROFILE / SOIL SAMPLING / FIELD TESTING / LAB TESTING

Geodetic Ground Surface Elevation: 311.10 m

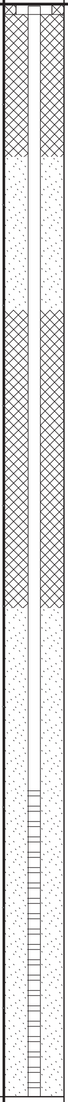
FIELD TESTING: Penetration Testing ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: ★ Rinse pH Values 2 4 6 8 10 12; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit; ✳ Passing 75 um (%); ○ Moisture Content (%) 20 40 60 80

DESCRIPTION	Elevation (m) / Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Moisture Content (%)
ORGANICS	310.8 0.3					
brown SILTY SAND trace gravel, moist, compact		AU				
		SS	1	24	12	14 13
	309.3 1.8	SS	2	40	50/10cm	
TCR: 54% RQD: 20%	307.8 3.3	RC	3			
TCR: 73% RQD: 32%	306.3 4.8	RC	4			
TCR: 90% RQD: 27%	304.8 6.3	RC	5			
TCR: 80% RQD: 23%	303.3 7.8	RC	6			
TCR: 100% RQD: 66%	301.8 9.3	RC	7			
TCR: 100% RQD: 23%	300.2 10.9	RC	8			
END OF BOREHOLE						

DEPTH (m): 5, 10
ELEVATION (m): 310, 309, 308, 307, 306, 305, 304, 303, 302, 301

INSTRUMENTATION INSTALLATION



COMMENTS

- 1 flushmount in bentonite
- 1 riser pipe in bentonite
- 1 riser pipe in sand
- 1 slotted pipe in sand

AMEC Earth & Environmental
A division of AMEC Americas Limited
131 Fielding Road
Lively, Ontario
Canada P3Y 1L7
Tel +1(705) 682-2632
Fax +1(705) 682-2260
www.amec.com

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Page: 1 of 1

RECORD OF MONITORING WELL No. BH07-HO02 Co-Ord. 0476887 E, 5369567 N

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **27 Jul 07** Date Completed: **27 Jul 07**

Logged by: **AM**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **2, 07/11/07**

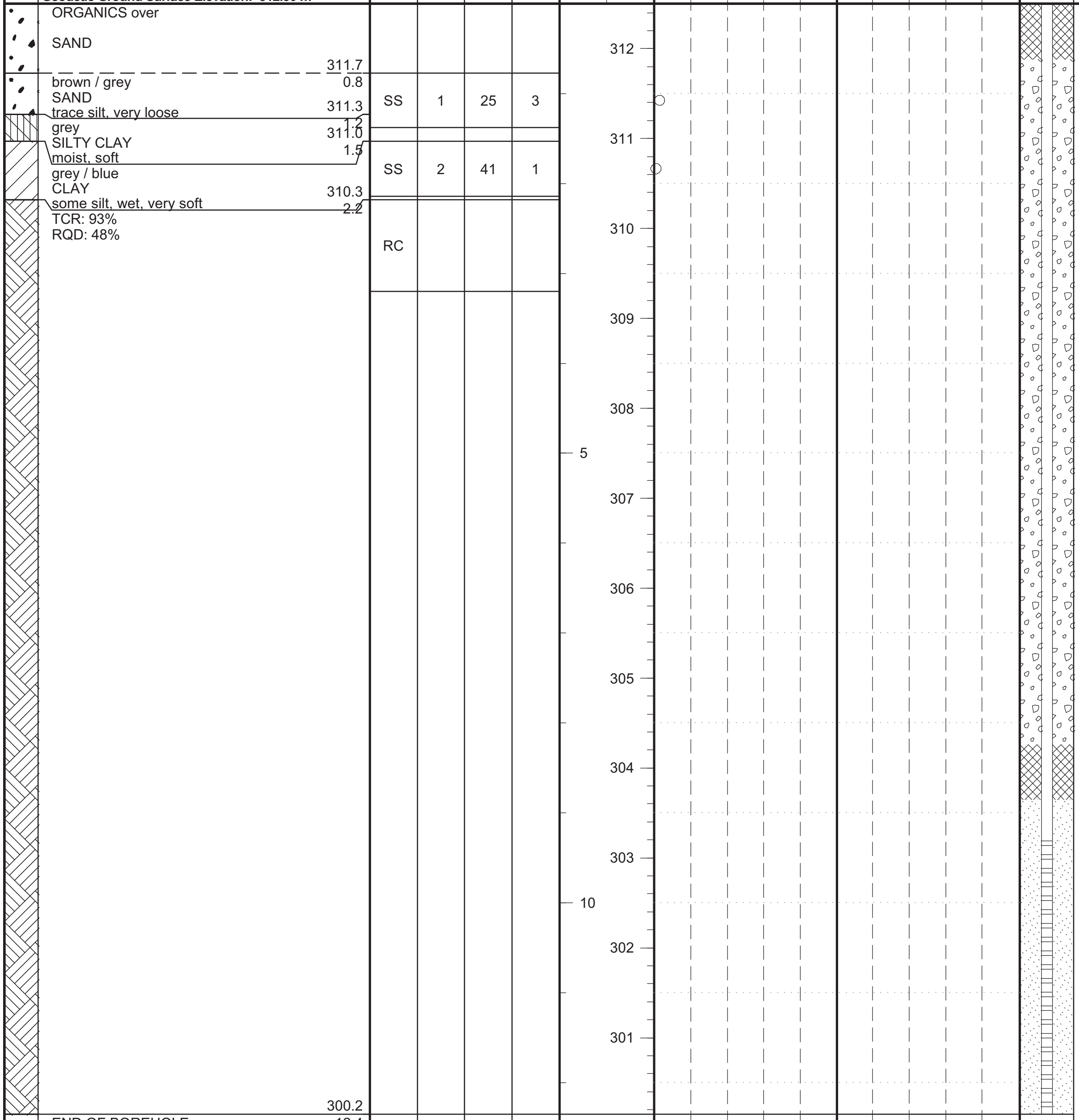
LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 312.50 m

DESCRIPTION	Elevation (m)	Depth (m)
ORGANICS over SAND	311.7	0.8
brown / grey SAND trace silt, very loose	311.3	1.2
grey SILTY CLAY moist, soft	311.0	1.5
grey / blue CLAY some silt, wet, very soft	310.3	2.2
TCR: 93% RQD: 48%	300.2	12.4
END OF BOREHOLE (no refusal)		

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	25	3
SS	2	41	1
RC			



FIELD TESTING

Penetration Testing
○ SPT ● DCPT
MTO Vane* △ Intact ▲ Remould
Nilcon Vane* ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING

★ Rinse pH Values 2 4 6 8 10 12
Soil Vapour Reading △ parts per million (ppm) 100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%) 20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS

▨ 1 riser pipe in bentonite
▨ 1 riser pipe in backfill
▨ 1 riser pipe in sand
▨ 1 slotted pipe in sand

AMEC Earth & Environmental
A division of AMEC Americas Limited
131 Fielding Road
Lively, Ontario
Canada P3Y 1L7
Tel +1(705) 682-2632
Fax +1(705) 682-2260
www.amec.com

Scale: 1 : 75

RECORD OF MONITORING WELL No. BH07-HO03 Co-Ord. 0477059 E, 5369493 N

Project Number:	TC71507.100	Drilling Location:		Logged by:	AM
Project Client:	PJV	Drilling Method:	200 mm Hollow Stem Augers	Compiled by:	KKJ
Project Name:	Environmental Baseline Study	Drilling Machine:	Track Mounted Drill	Reviewed by:	TIM
Project Location:	Hollinger, Timmins, Ontario	Date Started:	27 Jul 07 Date Completed: 27 Jul 07	Revision No.:	2, 07/11/07

FIELD TESTING: Penetration Testing ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: ★ Rinse pH Values 2 4 6 8 10 12; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit; ✳ Passing 75 um (%); ○ Moisture Content (%) 20 40 60 80

COMMENTS:
- ▨ 1 riser pipe in bentonite
- ░ 1 riser pipe in sand
- ▤ 1 slotted pipe in sand

Geodetic Ground Surface Elevation: 326.00 m

DESCRIPTION	Elevation (m) / Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
FILL mostly gravel - type B	325.2				
brown / orange GRAVEL & SAND some clay, trace cobbles, loose	0.8 324.6	SS	1	75	9
TCR: 100% RQD: 77%	1.5 323.0	RC	2		
TCR: 100% RQD: 20%	3.0 321.4	RC	3		
	4.6 319.9				
END OF BOREHOLE	6.1				

DEPTH (m): 5
ELEVATION (m): 325, 324, 323, 322, 321, 320

AMEC Earth & Environmental
A division of AMEC Americas Limited
131 Fielding Road
Lively, Ontario
Canada P3Y 1L7
Tel +1(705) 682-2632
Fax +1(705) 682-2260
www.amec.com

Scale: 1 : 75

RECORD OF MONITORING WELL No. BH07-HO04 Co-Ord. 0477303 E, 5369582 N

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**
Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **17 Jul 07** Date Completed: **17 Jul 07**
Logged by: **AM**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **2, 07/11/07**

Field testing legend: Penetration Testing ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

Lab testing legend: ★ Rinse pH Values 2 4 6 8 10 12; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit; ✳ Passing 75 um (%); ○ Moisture Content (%) 20 40 60 80

Comments: ▨ 1 riser pipe in bentonite; ▨ 1 riser pipe in sand; ▨ 1 slotted pipe in sand

Geodetic Ground Surface Elevation: 321.00 m

DESCRIPTION	Elevation (m) / Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Moisture Content (%)
UNSAMPLED	320.7 0.3	AU				
red SILTY SAND damp	320.2 0.8	SS	1	77		26
brown SAND and GRAVEL trace silt and clay, damp	319.8 1.2	SS	2	90		18
TCR: 91% RQD: 41%	319.3 1.7	RC	3			
TCR: 100% RQD: 66%	318.0 3.1	RC	4			
TCR: 94% RQD: 62%	316.3 4.7	RC	5			
TCR: 100% RQD: 100%	314.8 6.2	RC	6			
TCR: 100% RQD: 52%	313.4 7.6	RC	7			
TCR: 77% RQD: 59%	311.9 9.1	RC	8			
TCR: 100% RQD: 86%	310.6 10.4	RC	9			
TCR: 91% RQD: 13%	308.9 12.1	RC	10			
END OF BOREHOLE						

DEPTH (m): 5, 10
ELEVATION (m): 320, 319, 318, 317, 316, 315, 314, 313, 312, 311, 310, 309

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Scale: 1 : 75

RECORD OF MONITORING WELL No. BH07-HO05B Co-Ord. 0477912 E, 5369594 N

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**
Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **27 Jul 07** Date Completed: **28 Jul 07**
Logged by: **SRL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **2, 07/11/07**

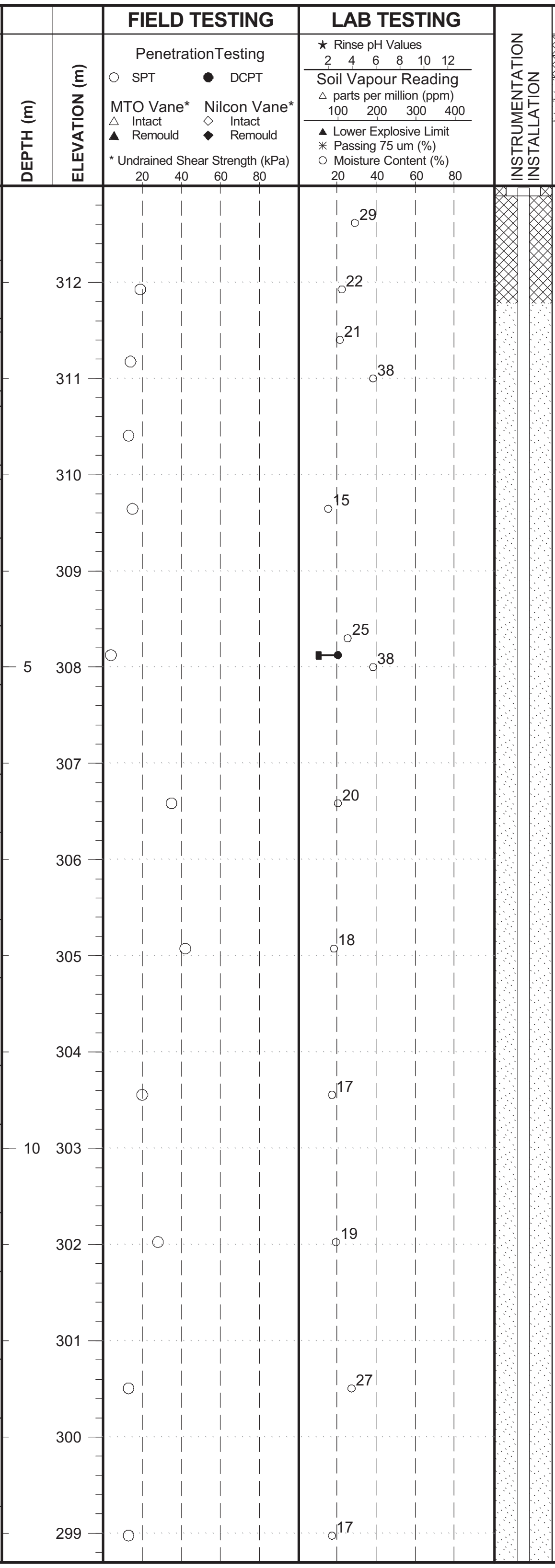
LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 313.00 m

DESCRIPTION	
GRASS over black SILTY SAND - moist	312.2 0.8
GRAVEL trace silt, sand, organics, wet, compact	311.5 1.5
grey SANDY SILT trace clay, compact	311.2 1.8
grey SILTY SAND some organics, compact	310.7 2.3
grey SAND trace silt, compact	308.4 4.6
grey CLAYEY SANDY SILT trace gravel, firm	308.1 4.9
grey SANDY SILT trace clay, wet, loose	306.9 6.1
grey SAND trace silt, wet, dense	303.9 9.1
grey SILT variable sand, trace clay, wet, compact	

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
AU	1		
SS	2	13	19
SS	3	16	14
SS	4	51	13
SS	5	51	15
SS	6	100	4
SS	7	92	35
SS	8	92	42
SS	9	89	20
SS	10	92	28
SS	11	84	13
SS	12	97	13



COMMENTS

1 flushmount in bentonite
1 riser pipe in bentonite
1 riser pipe in sand
1 slotted pipe in sand

heaved 610 mm

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Continued on Next Page

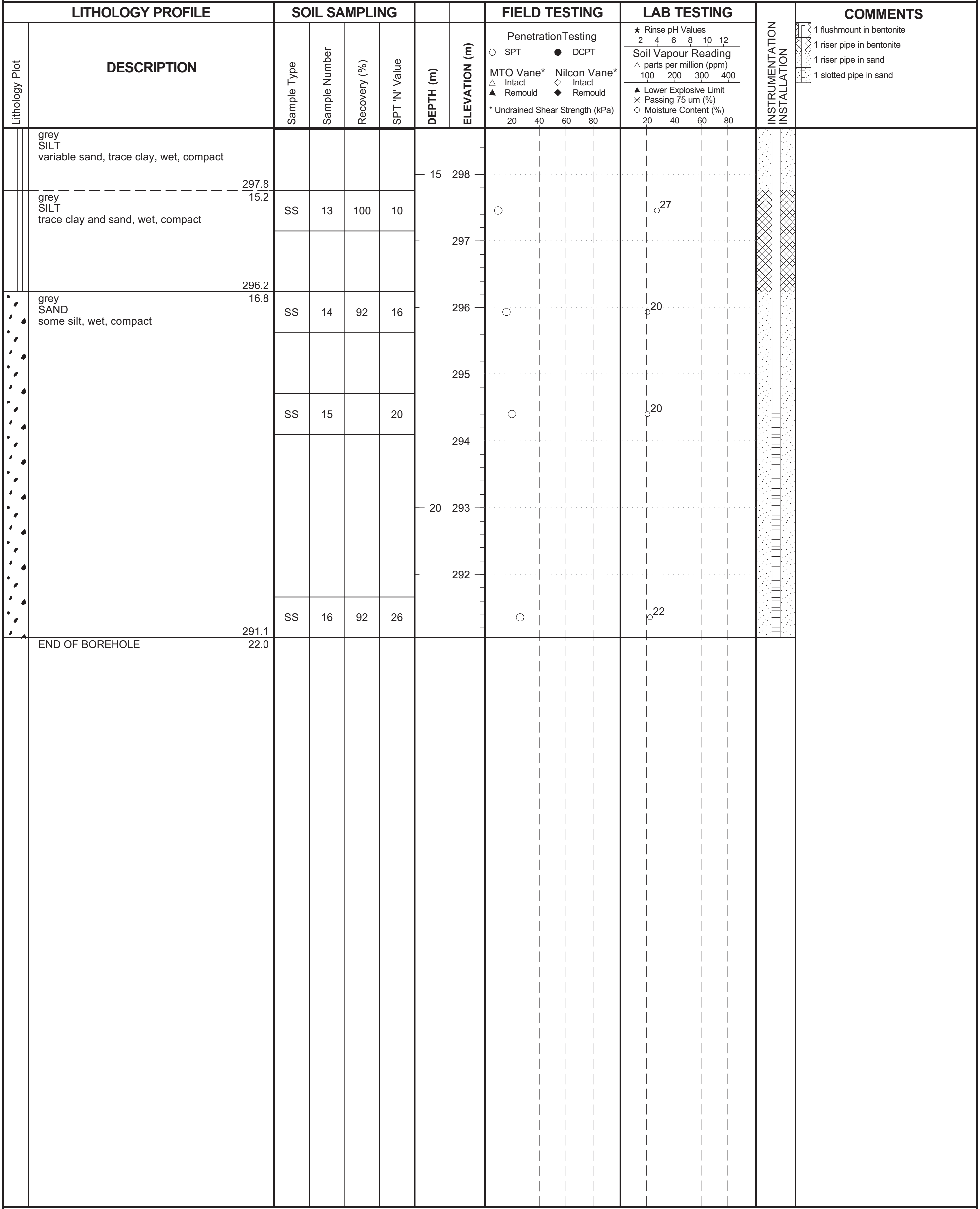
Scale: 1 : 75

RECORD OF MONITORING WELL No. BH07-HO05B Co-Ord. 0477912 E, 5369594 N

Project Number: **TC71507.100**

Drilling Location:

Logged by: **SRL**



COMMENTS

- ▥ 1 flushmount in bentonite
- ▨ 1 riser pipe in bentonite
- ░ 1 riser pipe in sand
- ▤ 1 slotted pipe in sand

Elevation / Depth	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Moisture Content (%)
	grey SILT variable sand, trace clay, wet, compact					
297.8 15.2	grey SILT trace clay and sand, wet, compact	SS	13	100	10	27
296.2 16.8	grey SAND some silt, wet, compact	SS	14	92	16	20
		SS	15		20	20
		SS	16	92	26	22
291.1 22.0	END OF BOREHOLE					

RECORD OF MONITORING WELL No. BH07-HO05C Co-Ord. 0477912 E, 5369594 N

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	**SRL**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**27 Jul 07** Date Completed: **28 Jul 07**	Revision No.:	**2, 07/11/07**

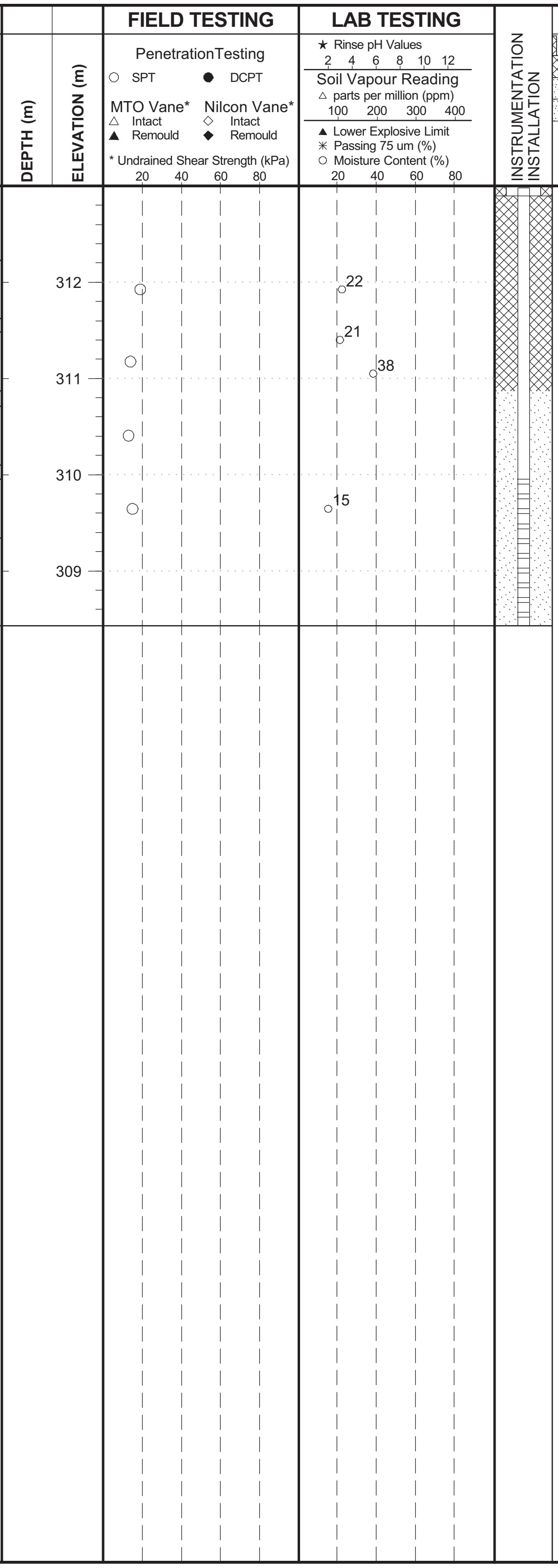
LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 313.00 m

DESCRIPTION	Elevation (m)	Depth (m)
GRASS over black SILTY SAND - moist	312.2	0.8
GRAVEL trace silt, sand, organics - wet	311.5	1.5
grey SAND trace silt	311.2	1.8
grey SILTY SAND some organics	310.7	2.3
grey SAND trace silt	308.4	4.6
END OF BOREHOLE		

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
AU	1		
SS	2	13	19
SS	3	16	14
SS	4	51	13
SS	5	51	15



COMMENTS

- 1 flushmount in bentonite
- 1 riser pipe in bentonite
- 1 riser pipe in sand
- 1 slotted pipe in sand

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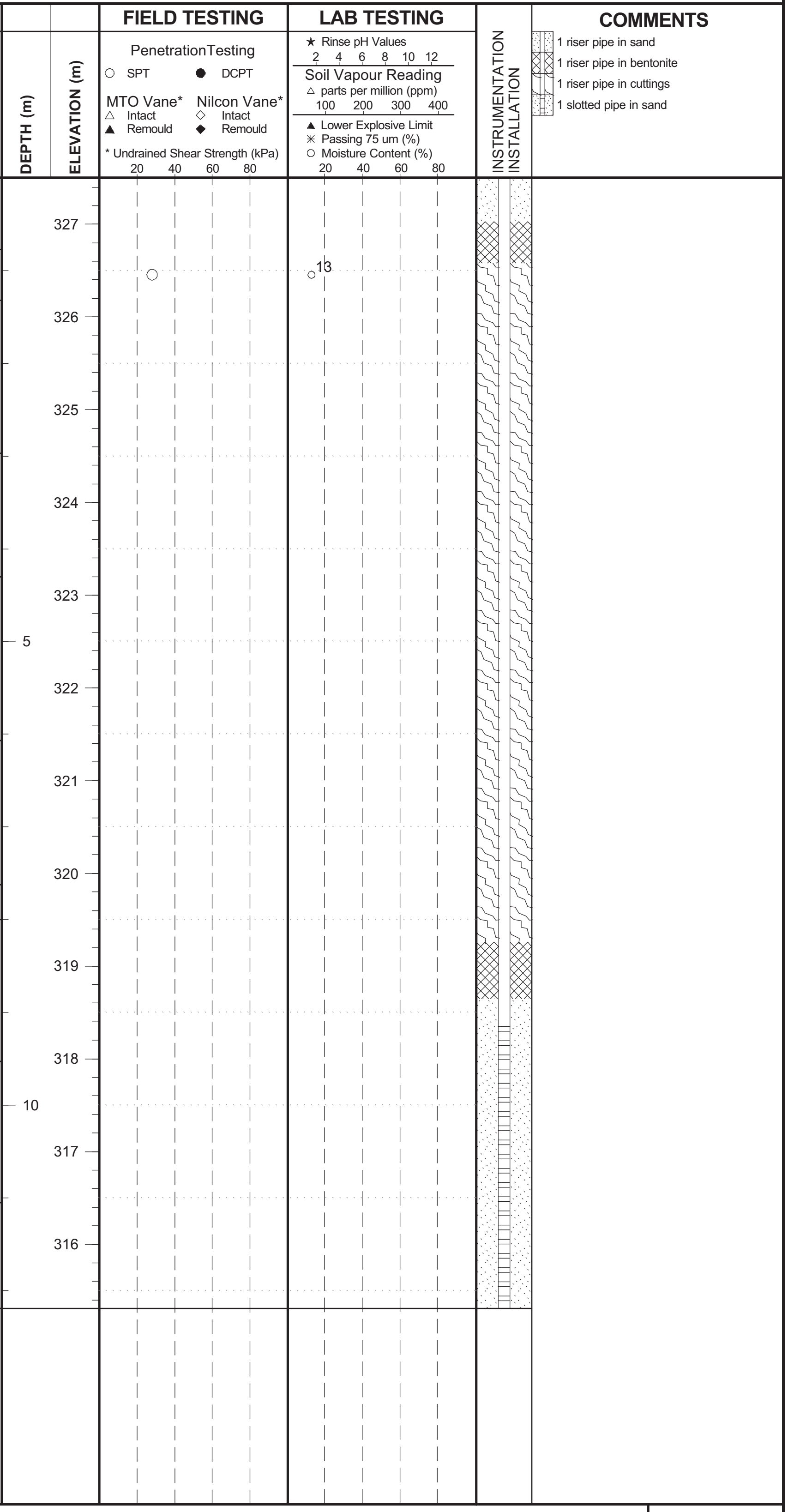
Scale: 1 : 75

RECORD OF MONITORING WELL No. BH07-HO06 Co-Ord. 0477780 E, 5369594 N

Project Number:	**TC71507.100**	Drilling Location:	**Guy Back Yard**	Logged by:	**AC**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**20 Jul 07** Date Completed: **20 Jul 07**	Revision No.:	**2, 07/11/07**

Geodetic Ground Surface Elevation: 327.50 m

LITHOLOGY PROFILE DESCRIPTION		SOIL SAMPLING Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
FILL mostly gravel, trace organics	326.7	AU			
brown / orange SAND some clay, silt, trace organics, compact	0.8 326.2	SS	1	36	28
TCR: 94% RQD: 86%	1.3 324.5	RC	1		
TCR: 101% RQD: 91%	3.0 323.2	RC	2		
TCR: 100% RQD: 100%	4.3 321.4	RC	3		
TCR: 88% RQD: 75%	6.1 319.9	RC	4		
TCR: 100% RQD: 100%	7.6 319.5	RC	5		
TCR: 100% RQD: 93%	8.0 318.0	RC	6		
TCR: 100% RQD: 95%	9.5 316.5	RC	7		
TCR: 100% RQD: 100%	11.1 315.3	RC	8		
END OF BOREHOLE	12.2				



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RECORD OF MONITORING WELL No. BH07-HO07 Co-Ord. 0476233 E, 5368918 N

Project Number:	**TC71507.100**	Drilling Location:	**Close to Gate "D"**	Logged by:	**AC**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**17 Jul 07** Date Completed: **18 Jul 07**	Revision No.:	**2, 07/11/07**

LITHOLOGY PROFILE

DESCRIPTION

Geodetic Ground Surface Elevation: 314.00 m

ORGANICS over

orange / brown
SAND
some gravel, trace organics
- dry, compact
312.5
1.5

brown / light brown
SAND
trace silt, dry, loose
311.7
2.3

light brown
SILTY SAND
trace clay, moist / dry, compact
310.2
3.8

light brown
SAND
trace silt, dry, compact
309.4
4.6

light brown
SILTY SAND
trace clay, moist, compact
304.9
9.2

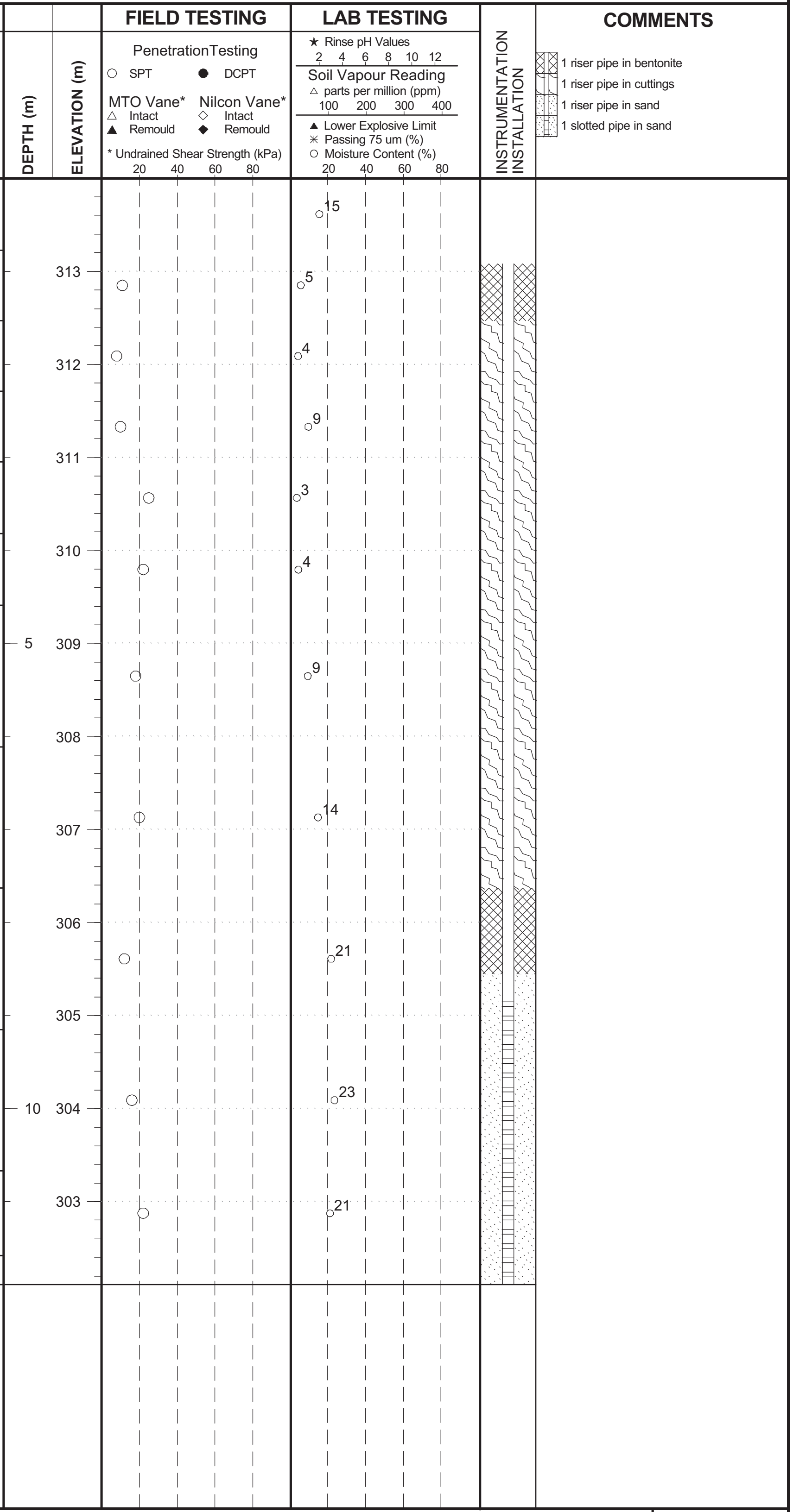
brown
SAND
trace silt, wet, compact
302.4
11.6

brown / light brown
SAND
trace rock, wet
302.1
11.9

END OF BOREHOLE
DUE TO AUGER REFUSAL ON POSSIBLE
BOULDERS OR BEDROCK

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
AU			
SS	1	33	11
SS	2	26	8
SS	3	33	10
SS	4	26	25
SS	5	40	22
SS	6	27	18
SS	7	34	20
SS	8	20	12
SS	9	27	16
SS	10	62	22
AU			



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RECORD OF MONITORING WELL No. BH07-HO08 Co-Ord. 0476119 E, 5368864 N

amec

Project Number:	**TC71507.100**	Drilling Location:	**Old Tee Off on Golf Course**	Logged by:	**AC**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**18 Jul 07** Date Completed: **19 Jul 07**	Revision No.:	**2, 07/11/07**

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 320.00 m

DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
ORGANICS over brown / orange SAND some gravel, moist, compact to loose to compact	AU			
	SS	1	13	23
	SS	2	7	16
	SS	3	20	5
	SS	4	26	29
316.1 3.9	SS	5		
TCR: 43% RQD: 0% 315.3 4.7	RC	1		
TCR: 94% RQD: 0% 314.2 5.8	RC	2		
TCR: 94% RQD: 94% 313.7 6.3	RC	3		
TCR: 95% RQD: 82% 312.2 7.8	RC	4		
TCR: 50% RQD: 27% 311.0 9.0	RC	5		
TCR: 100% RQD: 95% 309.4 10.6	RC	6		
TCR: 100% RQD: 90% 307.8 12.2	RC	7		
END OF BOREHOLE				

FIELD TESTING

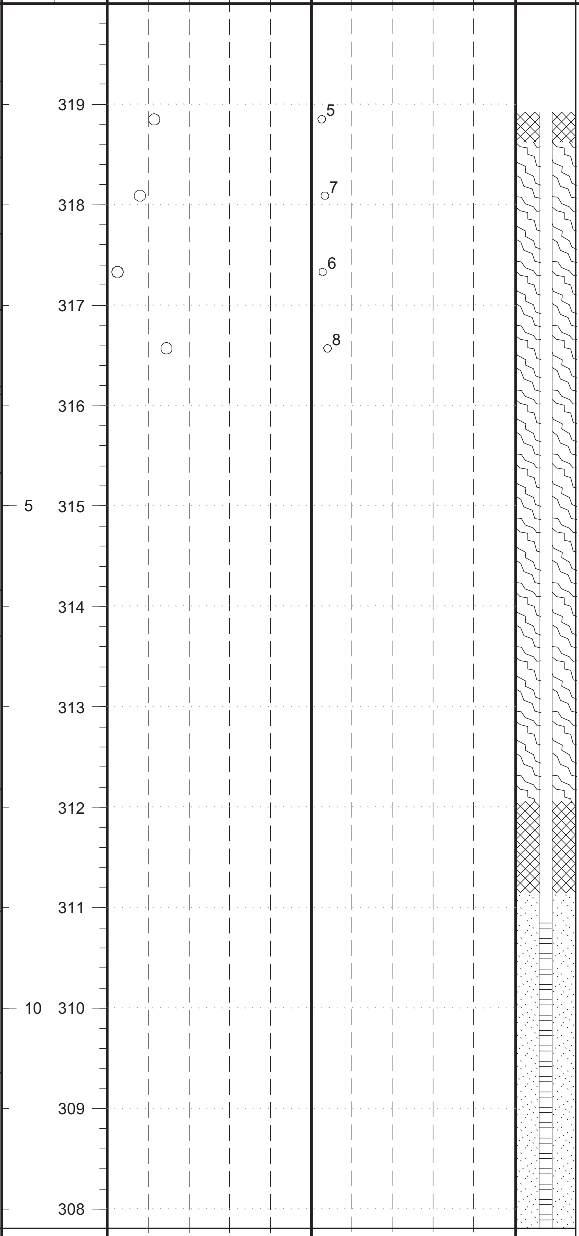
PenetrationTesting
○ SPT ● DCPT
MTO Vane* △ Intact ▲ Remould
Nilcon Vane* ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING

★ Rinse pH Values 2 4 6 8 10 12
Soil Vapour Reading △ parts per million (ppm) 100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%) 20 40 60 80

COMMENTS

- ▨ 1 riser pipe in bentonite
- ▨ 1 riser pipe in cuttings
- ▨ 1 riser pipe in sand
- ▨ 1 slotted pipe in sand



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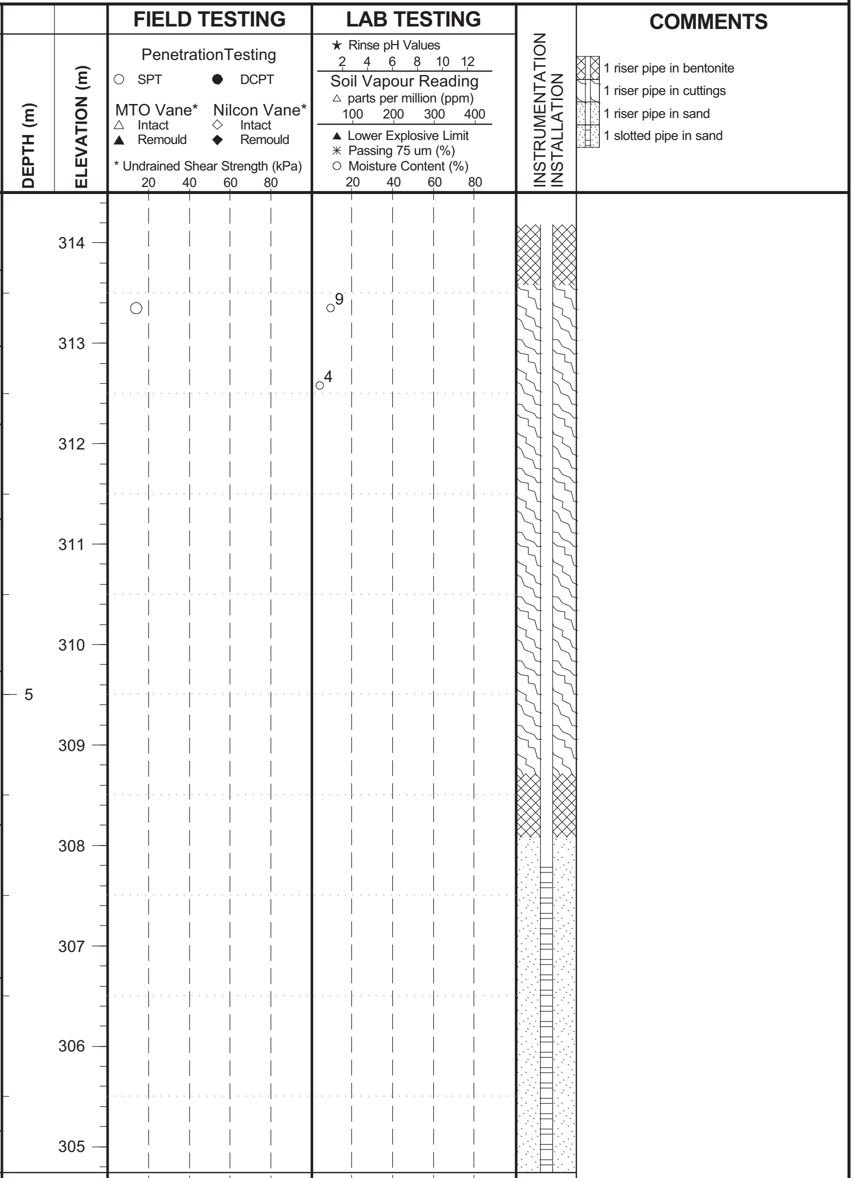
RECORD OF MONITORING WELL No. BH07-HO09 Co-Ord. 0476088 E, 5368656 N

amec

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**
Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **19 Jul 07** Date Completed: **19 Jul 07**
Logged by: **AC**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **2, 07/11/07**

Geodetic Ground Surface Elevation: 314.50 m

LITHOLOGY PROFILE DESCRIPTION	Elevation (m) / Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
FILL mostly gravel	313.7	AU			
brown / orange GRAVELLY SAND trace silt, compact	313.7 0.8	SS	1	13	14
	312.2	SS	2		
TCR: 53% RQD: 0%	312.2 2.3	RC	2		
	311.3				
TCR: 100% RQD: 86%	311.3 3.3	RC	3		
	309.7				
TCR: 100% RQD: 83%	309.7 4.8	RC	4		
	308.2				
TCR: 90% RQD: 85%	308.2 6.3	RC	5		
	306.7				
TCR: 100% RQD: 90%	306.7 7.8	RC	6		
	304.7				
END OF BOREHOLE	9.8				



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RECORD OF MONITORING WELL No. BH07-HO10 Co-Ord. 0476788 E, 5368544 N

amec

Project Number:	**TC71507.100**	Drilling Location:	**Mine Tour**	Logged by:	**AC**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**20 Jul 07** Date Completed: **20 Jul 07**	Revision No.:	**2, 07/11/07**

LITHOLOGY PROFILE / SOIL SAMPLING

Geodetic Ground Surface Elevation: 326.50 m

DESCRIPTION	Elevation / Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
150 mm of ORGANICS over SILTY SAND damp, compact	325.9	SS	1	63	13
brown SAND	325.7 0.6 0.8	SS	2	59	33
brown SANDY SILT damp, dense	325.0				
brown SANDY SILT trace gravel and clay, compact to loose	1.5	SS	3	67	11
		SS	4	75	8
	323.1	SS	5	64	9
brown SAND some gravel and silt, wet, loose	3.4 322.8 322.7 3.7				
BEDROCK TCR: 100% RQD: 97%	3.8 322.2	RC	6		
TCR: 52% RQD: 48%	4.3 320.4	RC	7		
TCR: 97% RQD: 80%	6.1 318.9	RC	8		
TCR: 94% RQD: 83%	7.6 317.5	RC	9		
TCR: 100% RQD: 98%	9.0 315.9	RC	10		
TCR: 98% RQD: 89%	10.6 314.4	RC	11		
END OF BOREHOLE	12.1				

FIELD TESTING

PenetrationTesting
○ SPT ● DCPT
MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould
* Undrained Shear Strength (kPa)
20 40 60 80

LAB TESTING

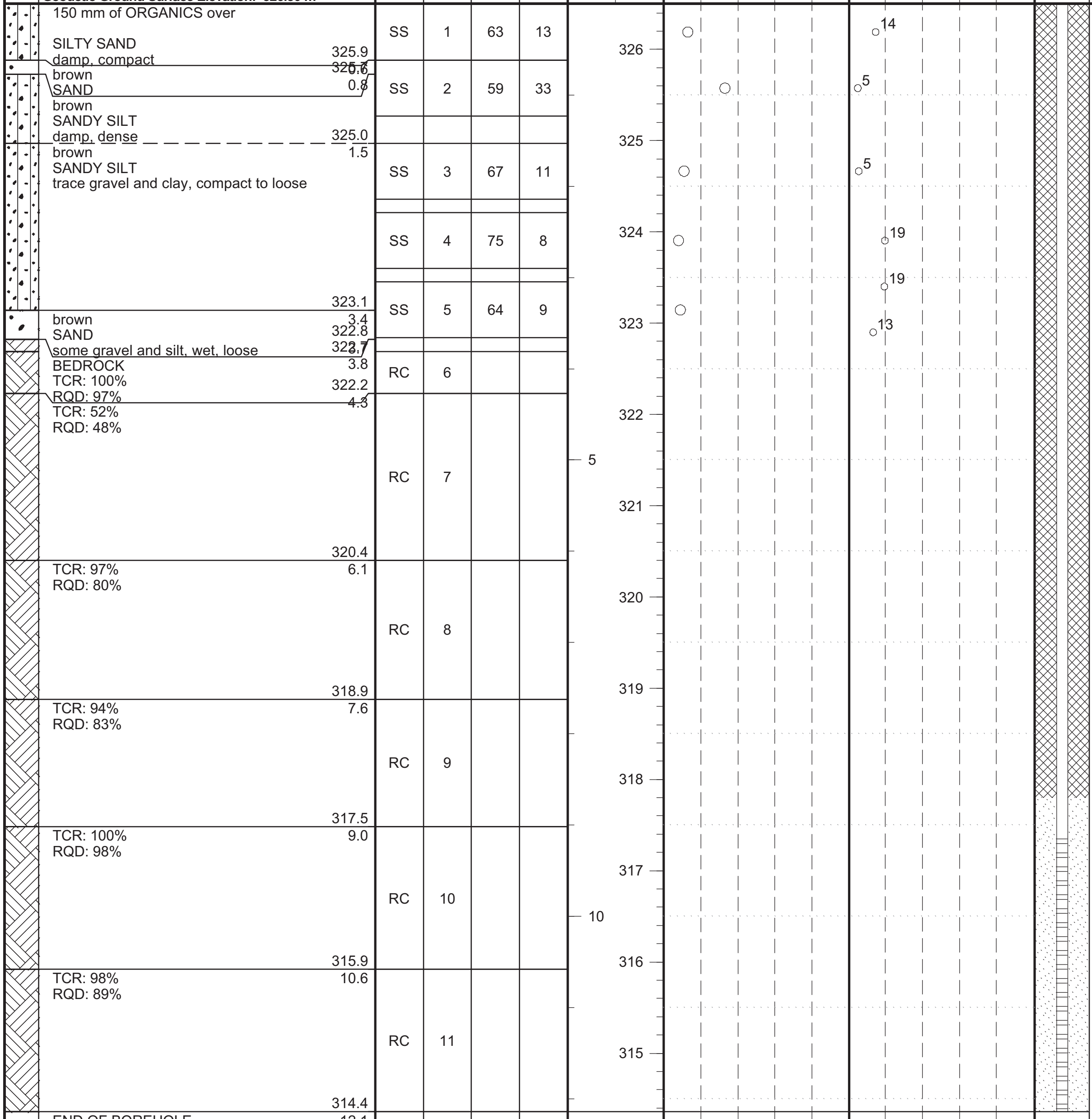
★ Rinse pH Values
2 4 6 8 10 12
Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS

▩ 1 riser pipe in bentonite
▨ 1 riser pipe in sand
▤ 1 slotted pipe in sand

Grain Size Analysis
Sand 28% / Silt 69%



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RECORD OF MONITORING WELL No. BH07-HO11 Co-Ord. 0476343 E, 5368387 N

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location: **Golf Course**
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **19 Jul 07** Date Completed: **19 Jul 07**

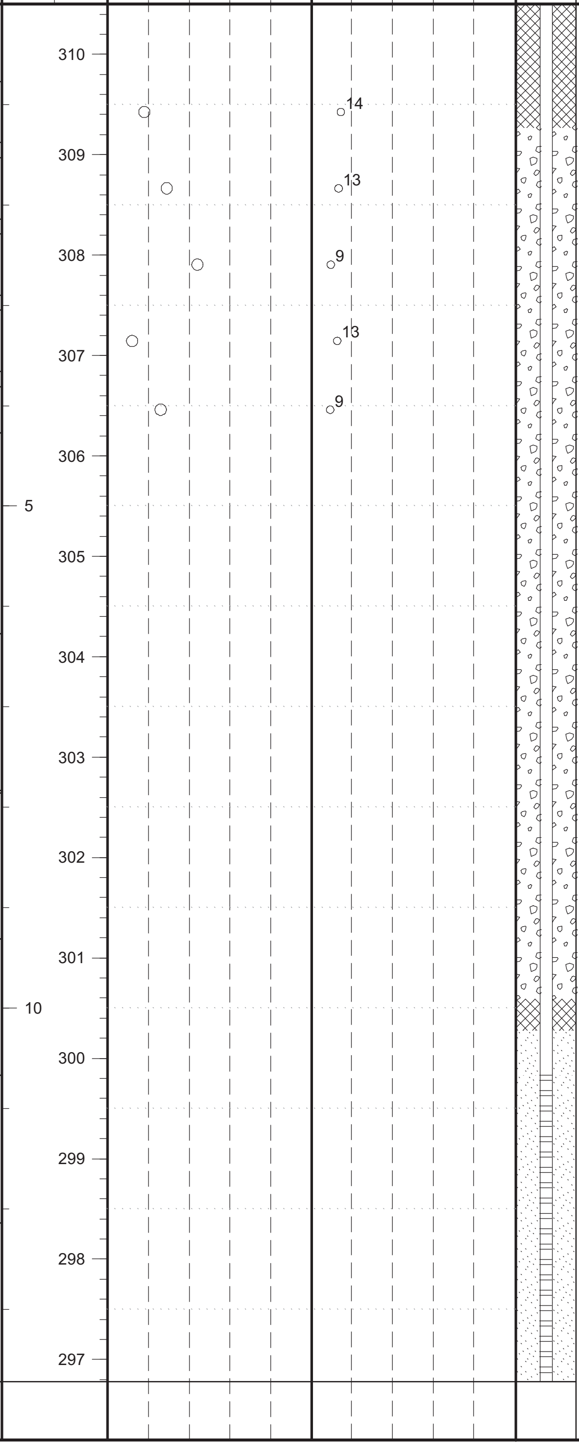
Logged by: **AC**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **2, 07/11/07**

Geodetic Ground Surface Elevation: 310.50 m

LITHOLOGY PROFILE: DESCRIPTION	Elevation (m) / Depth (m)	SOIL SAMPLING: Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	LAB TESTING: Moisture Content (%)
UNSAMPLED	309.7					
brown SAND	309.6 0.8					
grey SILT trace sand, damp, compact	1.0	SS	1	84	18	14
		SS	2	92	29	13
	308.2					
brown to grey / brown SANDY SILT trace gravel and clay at depth, moist, dense to compact	2.3	SS	3	56	44	9
		SS	4	80	12	13
	306.2	SS	5	85	26	9
BOULDERS	4.3	RC	6			
		RC	7			
	302.6	~~SS~~	~~8~~			
TCR: 70%	7.9	RC	9			
	301.2					
TCR: 60%	9.3	RC	10			
	299.8					
TCR: 100% RQD: 38%	10.7	RC	11			
	298.4					
TCR: 64%	12.1	RC	12			
	296.8					
END OF BOREHOLE	13.7					

FIELD TESTING: Penetration Testing ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: ★ Rinse pH Values 2 4 6 8 10 12; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit; ✳ Passing 75 um (%); ○ Moisture Content (%) 20 40 60 80



COMMENTS

▩	1 riser pipe in bentonite
▨	1 riser pipe in backfill
░	1 riser pipe in sand
▤	1 slotted pipe in sand

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Page: 1 of 1

RECORD OF MONITORING WELL No. BH07-HO12 Co-Ord. 0476681 E, 5368249 N

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	**AC**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started: **26 Jul 07**	Date Completed: **26 Jul 07**	Revision No.:	**2, 07/11/07**

LITHOLOGY PROFILE / SOIL SAMPLING

Geodetic Ground Surface Elevation: 313.00 m

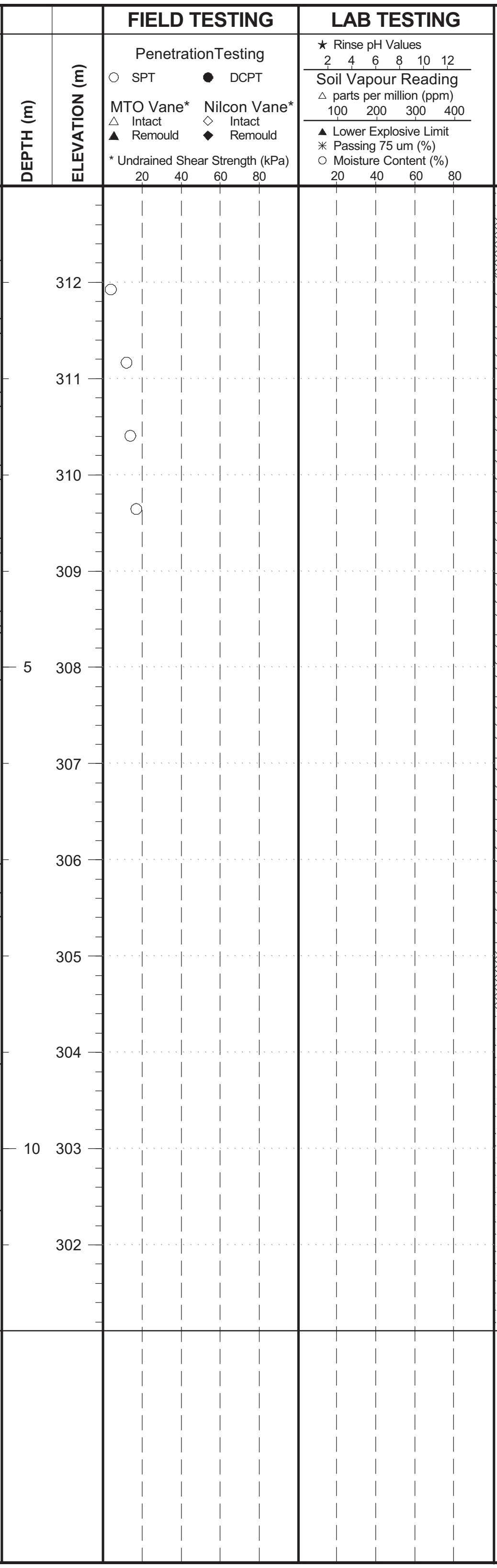
DESCRIPTION	Elevation / Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
ORGANICS over SAND	312.2 0.8				
brown SAND some silt, moist, loose to compact		SS	1	33	4
		SS	2	41	12
		SS	3	84	14
	309.2 3.8	SS	4	84	17
BOULDERS		SS	5		
	308.4 4.6	SS	6		
TCR: 100% RQD: 0%	307.9 5.1	RC	7		
TCR: RQD:	306.0 7.0	RC	8		
TCR: 100% RQD: 0%	305.7 7.3	RC	9		
TCR: 64% RQD: 55%	305.4 7.6	RC	10		
TCR: 83% RQD: 78%	303.9 9.1	RC	11		
TCR: 100% RQD: 85%	302.4 10.6	RC	12		
TCR: 97% RQD: 82%	301.1 11.9	RC	13		
END OF BOREHOLE					

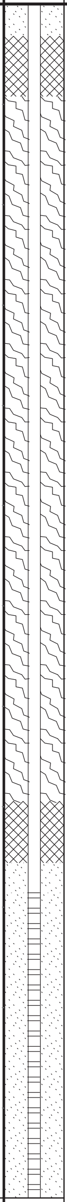
FIELD TESTING

Penetration Testing
○ SPT ● DCPT
MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould
* Undrained Shear Strength (kPa)

LAB TESTING

★ Rinse pH Values
Soil Vapour Reading
△ parts per million (ppm)
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)





COMMENTS

- 1 riser pipe in sand
- 1 riser pipe in bentonite
- 1 riser pipe in cuttings
- 1 slotted pipe in sand

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RECORD OF MONITORING WELL No. BH07-HO13A Co-Ord. 0476864 E, 5368179 N

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	**SRL**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started: **26 Jul 07**	Date Completed: **26 Jul 07**	Revision No.:	**2, 07/11/07**

LITHOLOGY PROFILE · SOIL SAMPLING · FIELD TESTING · LAB TESTING · INSTRUMENTATION INSTALLATION · COMMENTS

Penetration Testing: ○ SPT ● DCPT
MTO Vane*: △ Intact ▲ Remould
Nilcon Vane*: ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa): 20 40 60 80

★ Rinse pH Values: 2 4 6 8 10 12
Soil Vapour Reading: △ parts per million (ppm): 100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%): 20 40 60 80

▨ 1 riser pipe in bentonite
░ 1 riser pipe in sand
░ 1 slotted pipe in sand

Geodetic Ground Surface Elevation: 324.00 m

DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Moisture Content (%)	COMMENTS
brown SAND some silt, trace gravel, organics, rootlets 323.4	AU	1			9	79 cm stick up
0.6 COBBLES TCR: 36% RQD: 0% 322.8	RC	2				
1.3 COBBLES TCR: 27% RQD: 0% 322.3	RC	3				
1.7 brown SANDY SILT trace clay, gravel 321.9	SS	4	33	50 / 0.9	14	
2.1 BOULDER TCR: 37% RQD: 30% 320.8	RC	5				
3.2 TCR: 75% RQD: 58% 319.3	RC	6				
4.7 TCR: 93% RQD: 88% 317.8	RC	7				
6.3 TCR: 105% RQD: 105% 316.2	RC	8				
7.8 END OF BOREHOLE						

DEPTH (m): 5
ELEVATION (m): 323, 322, 321, 320, 319, 318, 317

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Scale: 1 : 75

RECORD OF MONITORING WELL No. BH07-03D Co-Ord. 0477061 E, 5399490 N

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location:
Drilling Method: **200 mm Dual Rotary**
Drilling Machine: **Truck Mounted Drill**
Date Started: **08 Sep 07** Date Completed: **08 Sep 07**

Logged by:
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 07/11/07**

LITHOLOGY PROFILE

Lithology Plot

DESCRIPTION

Geodetic Ground Surface Elevation:

FILL
mostly gravel
- type B

brown / orange
GRAVEL & SAND
some clay, trace cobbles, loose

TCR: 100%
RQD: 77%

TCR: 100%
RQD: 20%

0.8
1.5
3.0
4.6
6.

SOIL SAMPLING

Sample Type | Sample Number | Recovery (%) | SPT 'N' Value

DEPTH (m) | ELEVATION (m)

FIELD TESTING

Penetration Testing
○ SPT ● DCPT
MTO Vane* △ Intact ▲ Remould
Nilcon Vane* ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa)
20 40 60 80

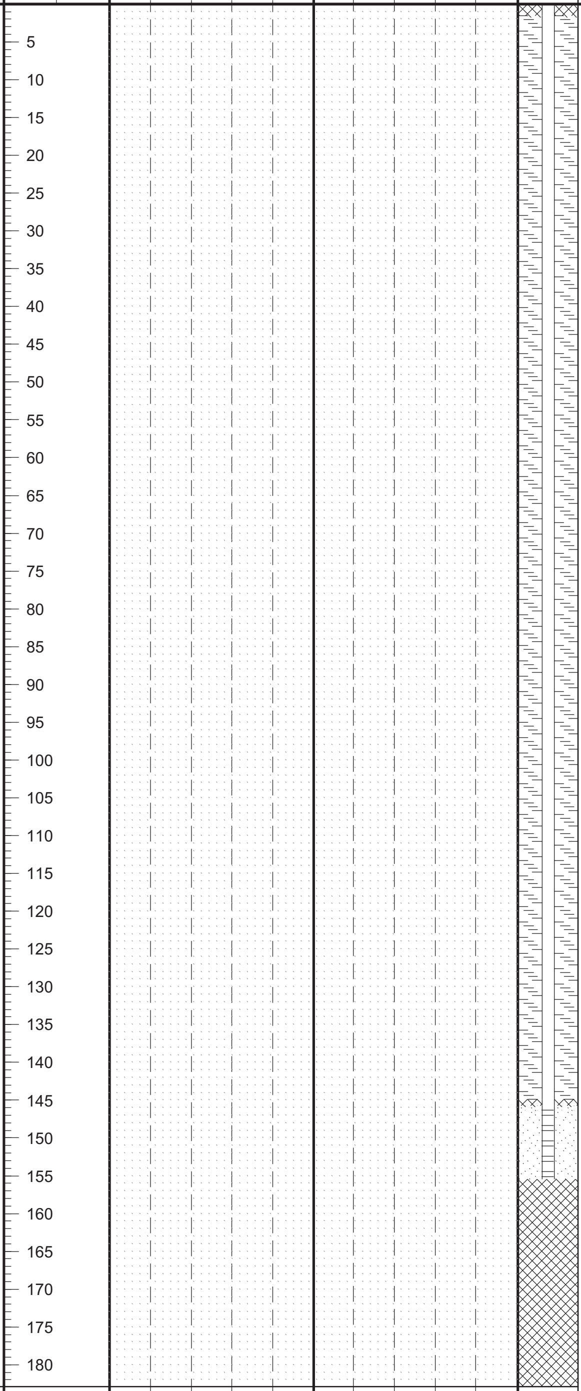
LAB TESTING

★ Rinse pH Values
2 4 6 8 10 12
Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS

- ⊠ 1 riser pipe in bentonite
- ▤ 1 riser pipe in grout
- ▒ 1 riser pipe in sand
- ▥ 1 slotted pipe in sand
- ▩ no installation, only bentonite



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Scale: 1 : 1000

RECORD OF MONITORING WELL No. BH07-05BR Co-Ord. 0477910 E, 5369595 N

amec

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	
Project Client:	**PJV**	Drilling Method:	**200 mm Dual Rotary**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Truck Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**09 Sep 07** Date Completed: **11 Sep 07**	Revision No.:	**1, 07/11/07**

LITHOLOGY PROFILE

Lithology Plot

DESCRIPTION

Geodetic Ground Surface Elevation:

GRASS over
0.8
1.5
black
1.
SILTY SAND
2.
GRAVEL
4.
trace silt, sand, organics, compact
4.
grey
6.
SANDY SILT
9.
trace clay, compact
15.
grey
16.
SILTY SAND
22.
some organics, compact

grey
SAND
trace silt, compact

grey
CLAYEY SANDY SILT
trace gravel, low plasticity, soft

grey
SANDY SILT
trace clay, loose

grey
SAND
trace silt, dense

grey
SILT
variable sand, trace clay, compact

grey
SILT
trace clay and sand, compact

grey
SAND
some silt, compact

SOIL SAMPLING

Sample Type | Sample Number | Recovery (%) | SPT 'N' Value

DEPTH (m) | **ELEVATION (m)**

5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180

FIELD TESTING

Penetration Testing
○ SPT ● DCPT

MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould

* Undrained Shear Strength (kPa)
20 40 60 80

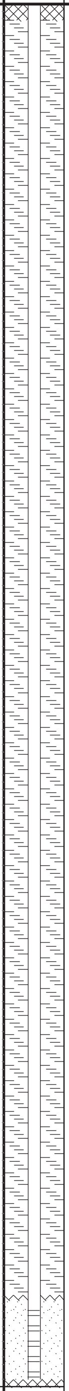
LAB TESTING

★ Rinse pH Values
2 4 6 8 10 12

Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400

▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION



COMMENTS

▨ 1 riser pipe in bentonite
▨ 1 riser pipe in grout
▨ 1 riser pipe in sand
▨ 1 slotted pipe in sand
☒ no installation, only bentonite

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Scale: 1 : 1000

Page: 1 of 1

RECORD OF MONITORING WELL No. BH07-09B/C Co-Ord. 0476085 E, 5368656 N

amec

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location:
Drilling Method: **200 mm Dual Rotary**
Drilling Machine: **Truck Mounted Drill**
Date Started: **12 Sep 07** Date Completed: **14 Sep 07**

Logged by:
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 07/11/07**

LITHOLOGY PROFILE

Lithology Plot

DESCRIPTION

Geodetic Ground Surface Elevation:

FILL
mostly gravel
brown / orange
GRAVELLY SAND
trace silt, compact
TCR: 53%
RQD: 0%
TCR: 100%
RQD: 86%
TCR: 100%
RQD: 83%
TCR: 90%
RQD: 85%
TCR: 100%
RQD: 90%

0.8
2.
3.3
4.
6.
7.
9.

SOIL SAMPLING

Sample Type
Sample Number
Recovery (%)
SPT 'N' Value

DEPTH (m)

5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130

ELEVATION (m)

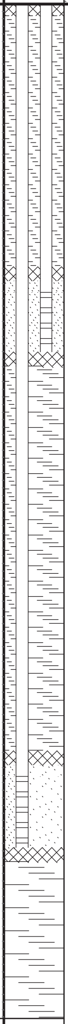
FIELD TESTING

PenetrationTesting
○ SPT ● DCPT
MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould
* Undrained Shear Strength (kPa)
20 40 60 80

LAB TESTING

★ Rinse pH Values
2 4 6 8 10 12
Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION



COMMENTS

- ▨ 2 riser pipes in bentonite
- ▤ 2 riser pipes in grout
- ▒ 2 riser pipes in sand
- ▥ 1 slotted pipe on right, 1 riser on left in sand
- ▨ 1 riser pipe in bentonite on left side
- ▤ 1 riser pipe in grout on left side
- ▒ 1 riser pipe in sand on left side

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Scale: 1 : 1000

RECORD OF MONITORING WELL No. BH07-13B/C Co-Ord. 0476862 E, 5368180 N

amec

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	
Project Client:	**PJV**	Drilling Method:	**200 mm Dual Rotary**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Truck Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**05 Sep 07** Date Completed: **07 Sep 07**	Revision No.:	**1, 07/11/07**

LITHOLOGY PROFILE | **SOIL SAMPLING** | **FIELD TESTING** | **LAB TESTING** | **COMMENTS**

Lithology Plot | **DESCRIPTION** | Sample Type | Sample Number | Recovery (%) | SPT 'N' Value | **DEPTH (m)** | **ELEVATION (m)** | INSTRUMENTATION INSTALLATION

Geodetic Ground Surface Elevation:

FIELD TESTING:

Penetration Testing
○ SPT ● DCPT
MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould
* Undrained Shear Strength (kPa)
20 40 60 80

LAB TESTING:

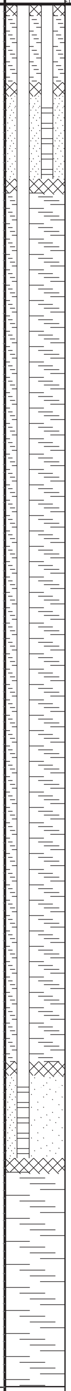
★ Rinse pH Values
2 4 6 8 10 12
Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

COMMENTS:

- ▨ 2 riser pipes in bentonite
- ▨ 2 riser pipes in grout
- ▨ 2 riser pipes in sand
- ▨ 1 slotted pipe on right, 1 riser on left in sand
- ▨ 1 riser pipe in bentonite on left side
- ▨ 1 riser pipe in grout on left side
- ▨ 1 riser pipe in sand on left side

DESCRIPTION	
brown SAND some silt, trace gravel, organics, rootlets	0.6 1.3 1.
COBBLES TCR: 36% RQD: 0%	2. 3.2 4.
COBBLES TCR: 27% RQD: 0%	6. 7.
brown SANDY SILT trace clay, gravel	
COBBLES TCR: 37% RQD: 30%	
TCR: 75% RQD: 58%	
TCR: 93% RQD: 88%	
TCR: 105% RQD: 105%	

DEPTH (m): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180



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RECORD OF BOREHOLE No. HS07-01A

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	**SRL**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**29 Jul 07** Date Completed: **29 Jul 07**	Revision No.:	**1, 07/11/07**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS
Lithology Plot	**DESCRIPTION** **Local Ground Surface Elevation:**		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	**DEPTH (m)**	**ELEVATION (m)**	PenetrationTesting ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading △ parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit ✳ Passing 75 um (%) ○ Moisture Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	
	WATER						▽					
	brown SAND & GRAVEL	0.1	AU	1								
	END OF HANDHOLE DUE TO SLOUGHING	0.5										

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▽ Groundwater level recorded on completion at a depth of: 0 m.

Scale: 1 : 10

RECORD OF BOREHOLE No. HS07-01B

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **29 Jul 07** Date Completed: **29 Jul 07**

Logged by: **SRL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 07/11/07**

LITHOLOGY PROFILE

SOIL SAMPLING

FIELD TESTING

PenetrationTesting
○ SPT ● DCPT
MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould
* Undrained Shear Strength (kPa)
20 40 60 80

LAB TESTING

★ Rinse pH Values
2 4 6 8 10 12
Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS

Local Ground Surface Elevation:

Lithology Plot	DESCRIPTION	Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)
	WATER						▽	
	grey SAND trace gravel, silt increasing with depth	0.1	AU	1				
	END OF HANDHOLE DUE TO SLOUGHING	0.6						

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▽ Groundwater level recorded on completion at a depth of: 0 m.

Scale: 1 : 10

RECORD OF BOREHOLE No. HS07-02A

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **29 Jul 07** Date Completed: **29 Jul 07**

Logged by: **SRL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 07/11/07**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS
Lithology Plot	DESCRIPTION Local Ground Surface Elevation:	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading △ parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit ✳ Passing 75 um (%) ○ Moisture Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	
	brown to grey ORGANICS some silt, decomposed wood - wet, very soft	AU	1								
		AU	2			▽					
	grey 0.5 FILL 0.5 mostly gravel, crushed stone	AU	3								
	END OF HANDHOLE DUE TO AUGER REFUSAL ON POSSIBLE BOULDERS OR BEDROCK										

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▽ Groundwater level recorded on completion at a depth of: 0.31 m.

Scale: 1 : 10

Page: 1 of 1

RECORD OF BOREHOLE No. HS07-02B

amec

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**
Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **29 Jul 07** Date Completed: **29 Jul 07**
Logged by: **SRL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 07/11/07**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS
Lithology Plot	DESCRIPTION Local Ground Surface Elevation:		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing ○ SPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading △ parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit ✳ Passing 75 um (%) ○ Moisture Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	
	brown to grey SILTY SAND possible tailings - wet		AU	1								
			AU	2			∇					
	brown SAND trace gravel	0.9	AU	3			1					
	END OF HANDHOLE	1.2										

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∇ Groundwater level recorded on completion at a depth of: 0.76 m.

Scale: 1 : 10

RECORD OF BOREHOLE No. HS07-03A

Project Number:	**TC71507.100**	Drilling Location:		Logged by:	**SRL**
Project Client:	**PJV**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Environmental Baseline Study**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Hollinger, Timmins, Ontario**	Date Started:	**29 Jul 07** Date Completed: **29 Jul 07**	Revision No.:	**1, 07/11/07**

FIELD TESTING

Penetration Testing

○ SPT ● DCPT

MTO Vane* △ Intact ▲ Remould

Nilcon Vane* ◇ Intact ◆ Remould

* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING

★ Rinse pH Values 2 4 6 8 10 12

Soil Vapour Reading △ parts per million (ppm) 100 200 300 400

▲ Lower Explosive Limit

✳ Passing 75 um (%)

○ Moisture Content (%) 20 40 60 80

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS
Lithology Plot	DESCRIPTION Local Ground Surface Elevation:	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)			INSTRUMENTATION INSTALLATION	
	WATER 0.0					▽					
	grey SILTY SAND some gravel, trace organics, occasional cobbles	AU	1						○ 16		
	END OF HANDHOLE 0.5 DUE TO AUGER REFUSAL ON POSSIBLE BOULDERS OR BEDROCK										

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▽ Groundwater level recorded on completion at a depth of: 0 m.

Scale: 1 : 10

Page: 1 of 1

RECORD OF BOREHOLE No. HS07-03B

Project Number: **TC71507.100**
Project Client: **PJV**
Project Name: **Environmental Baseline Study**
Project Location: **Hollinger, Timmins, Ontario**

Drilling Location:
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **29 Jul 07** Date Completed: **29 Jul 07**

Logged by: **SRL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 07/11/07**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS
Lithology Plot	**DESCRIPTION** Local Ground Surface Elevation:	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading △ parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit ✳ Passing 75 um (%) ○ Moisture Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	
▨	WATER					▽					
	END OF HANDHOLE 0.2 DUE TO AUGER REFUSAL ON POSSIBLE BOULDERS OR BEDROCK										

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▽ Groundwater level recorded on completion at a depth of: 0 m.

Scale: 1 : 10

Page: 1 of 1

RECORD OF BOREHOLE No. PLBH08-01 Co-Ord. 0478187 E, 5369713 N

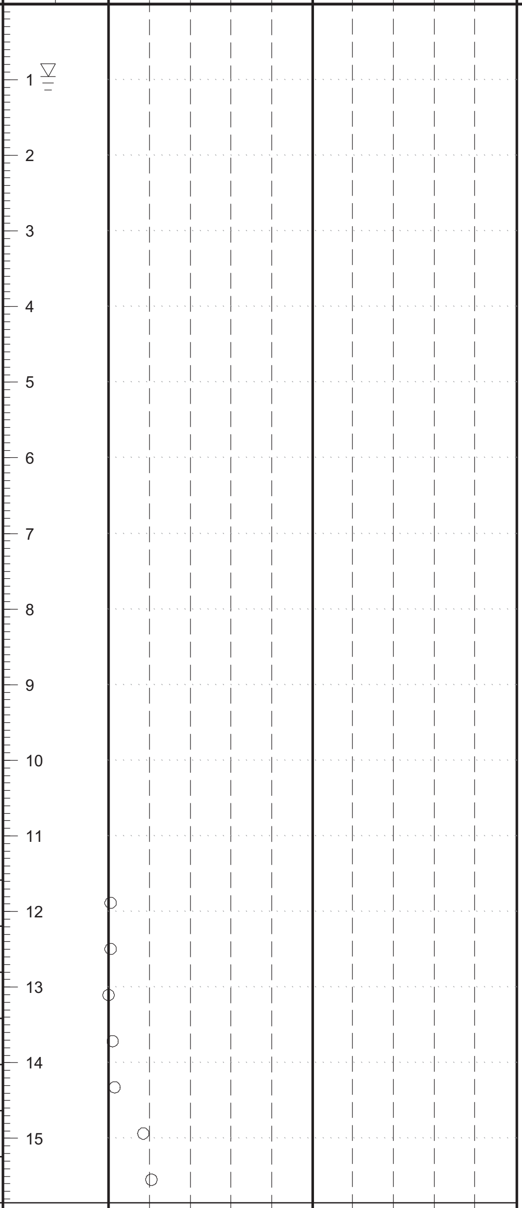
Project Number: **TC71507**
Drilling Location: **Pearl Lake**
Logged by: **RGL**
Project Client: **Goldcorp**
Drilling Method: **200 mm Hollow Stem Augers**
Compiled by: **KKJ**
Project Name: **Pearl Lake Soils Investigation**
Drilling Machine: **Track Mounted Drill**
Reviewed by: **TIM**
Project Location: **Timmins, Ontario**
Date Started: **20 Mar 08** Date Completed: **20 Mar 08**
Revision No.: **1, 23/06/08**

FIELD TESTING
Penetration Testing
○ SPT ● DCPT
MTO Vane* △ Intact ▲ Remould
Nilcon Vane* ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING
★ Rinse pH Values 2 4 6 8 10 12
Soil Vapour Reading △ parts per million (ppm) 100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%) 20 40 60 80

LITHOLOGY PROFILE: DESCRIPTION Local Ground Surface Elevation:	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
ICE				
WATER 0.9				
dark grey ORGANICS wet 5.8				
grey SAND some silt, trace clay, wet, very loose 11.6	SS	1	100	1
	SS	2	100	1
grey SAND some silt, wey, very loose to compact 12.8	SS	3	100	0
	SS	4	100	2
	SS	5	100	3
grey SAND wet, compact 14.6	SS	6	100	17
	SS	7	100	21
END OF BOREHOLE (no refusal) 15.9				

DEPTH (m): 1 ▽ 2 3 4 5 6 7 8 9 10 11 12 13 14 15



INSTRUMENTATION INSTALLATION

COMMENTS

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▽ Groundwater level recorded on completion at a depth of: 0.94 m.

Scale: 1 : 100

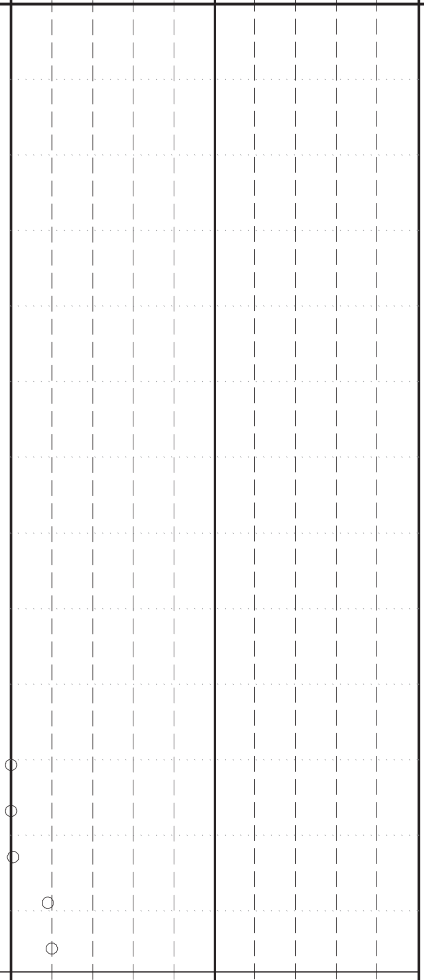
Page: 1 of 1

RECORD OF BOREHOLE No. PLBH08-02 Co-Ord. 0478267 E, 5369687 N

amec

Project Number: **TC71507**
Project Client: **Goldcorp**
Project Name: **Pearl Lake Soils Investigation**
Project Location: **Timmins, Ontario**
Drilling Location: **Pearl Lake**
Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **Track Mounted Drill**
Date Started: **26 Mar 08** Date Completed: **26 Mar 08**
Logged by: **RGL**
Compiled by: **KKJ**
Reviewed by: **TIM**
Revision No.: **1, 23/06/08**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS
Lithology Plot	DESCRIPTION Local Ground Surface Elevation:	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT ● DCPT MTO Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	★ Rinse pH Values 2 4 6 8 10 12 Soil Vapour Reading △ parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit ✳ Passing 75 um (%) ○ Moisture Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	
	ICE										
	WATER 0.9					1					
	ORGANICS 5.5										
	grey CLAYEY SILT wet, vert loose 9.8	SS	1	100	0	10					
	grey SILT some sand, trace clay, wet 10.4	SS	2	100	0						
		SS	3	100	1	11					
	grey SAND some silt, wet, very loose to compact 11.4	SS	4	60	18	12					
	grey SAND wet, compact 12.2	SS	5	84	20						
	END OF BOREHOLE (no refusal) 12.8										



AMEC Earth & Environmental
A division of AMEC Americas Limited
131 Fielding Road
Lively, Ontario
Canada P3Y 1L7
Tel +1(705) 682-2632
Fax +1(705) 682-2260
www.amec.com

Scale: 1 : 100

RECORD OF BOREHOLE No. PLBH08-03 Co-Ord. 0478429 E, 5369690 N

Project Number:	**TC71507**	Drilling Location:	**Pearl Lake**	Logged by:	**RGL**
Project Client:	**Goldcorp**	Drilling Method:	**200 mm Hollow Stem Augers**	Compiled by:	**KKJ**
Project Name:	**Pearl Lake Soils Investigation**	Drilling Machine:	**Track Mounted Drill**	Reviewed by:	**TIM**
Project Location:	**Timmins, Ontario**	Date Started: **26 Mar 08**	Date Completed: **26 Mar 08**	Revision No.:	**1, 23/06/08**

LITHOLOGY PROFILE

Local Ground Surface Elevation:

DESCRIPTION	DEPTH (m)
ICE	
WATER	1.0
ORGANICS	6.1
grey SAND trace silt, wet, very loose	8.5
grey SILT some clay, wet	8.8
grey SAND trace clay, wet, loose	9.5
grey SAND wet, compact	11.6
END OF BOREHOLE (no refusal)	12.5

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	59	2
SS	2	84	2
SS	3	59	6
SS	4	77	8
SS	5	100	9
SS	6	84	17
SS	7	59	24

DEPTH (m) ELEVATION (m)

FIELD TESTING

Penetration Testing
○ SPT ● DCPT
MTO Vane* Nilcon Vane*
△ Intact ◇ Intact
▲ Remould ◆ Remould
* Undrained Shear Strength (kPa)
20 40 60 80

LAB TESTING

★ Rinse pH Values
2 4 6 8 10 12
Soil Vapour Reading
△ parts per million (ppm)
100 200 300 400
▲ Lower Explosive Limit
✳ Passing 75 um (%)
○ Moisture Content (%)
20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS

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Fax +1(705) 682-2260
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▽ Groundwater level recorded on completion at a depth of: 1.04 m.

Scale: 1 : 100

APPENDIX C

LOCAL WATER WELL RECORDS

Well Computer Print Out Data as of June 30 2009

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TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
TISDALE TOWNSHIP CON 04(010)	17 477335 5372832^{L}	1990/07 2401	05 05	FR 0084	006 / 015 075 / 1:0	DO		1604386 (74126) SAND CLAY LYRD 0050 GRVL HPAN LYRD 0076 ROCK FCRD 0085
TISDALE TOWNSHIP CON 04(010)	17 477914 5372977^{W}	1973/08 3404	07	FR 0065	016 / 041 040 / 4:0	DO	0069 08	1601858 () BRWN SAND SILT 0023 BLUE CLAY 0045 GREY FSND SILT 0065 GREY FSND 0077
TISDALE TOWNSHIP CON 05(008)	17 478870 5373683^{L}	2003/10 1737	03	FR 0077	/ 020 / 1:0	NU	0067 10	1605591 (261907) BRWN FSND 0030 GREY CSND 0042 GREY MSND 0075 BLCK ROCK HARD 0077
TISDALE TOWNSHIP CON 05(009)	17 477914 5373427^{W}	1978/06 3424	06	FR 0085	027 / 080 007 / 4:0	DO	0081 08	1602545 () BRWN SAND LYRD 0004 GREY SAND LYRD 0039 RED SAND SILT 0089
TISDALE TOWNSHIP CON 05(009)	17 478014 5374277^{W}	1978/07 3424	06	FR 0069	026 / 051 030 / 3:40	 DO	0065 08	1602546 () BRWN SAND LYRD 0003 GREY SAND LYRD 0038 RED GRVL ROCK LYRD 0073
TISDALE TOWNSHIP CON 05(009)	17 478014 5373577^{W}	1984/04 2401	05 04	FR 0110	085 / 110 005 / 1:0	DO	0109 03	1603526 () SAND 0112
TISDALE TOWNSHIP CON 05(010)	17 477271 5373692^{L}	1998/05 2401	06 05	FR 0086	008 / 085 010 / 1:0	CO DO	0086 03	1605232 (187487) SAND GRVL 0045 CLAY SAND LYRD 0060 SAND 0089
TISDALE TOWNSHIP CON 05(010)	17 477814 5373177^{W}	1978/08 2401	06 06	UK 0072	020 / 070 025 / 2:0	CO		1602569 () SAND 0068 GRVL 0070 SPST 0102
TISDALE TOWNSHIP CON 05(011)	17 476064 5374377^{W}	1981/05 2401	05 05	FR 0048	009 / 040 040 / 1:0	DO		1603076 () SAND 0020 CLAY 0025 SAND 0035 HPAN BLDR 0045 GRSN STNS 0062
TISDALE TOWNSHIP CON 05(011)	17 476254 5374427^{W}	1969/10 2401	02	FR 0048	010 / 030 001 / 1:0	DO	0043 07	1601522 () MSND 0047 GRVL 0050
TISDALE TOWNSHIP CON 05(011)	17 476464 5373694^{L}	1995/11 2401	05	FR 0060	/ 022 009 / 1:0	DO		1605030 (165749) CLAY 0045 SAND GRVL 0060
TISDALE TOWNSHIP CON 05(011)	17 476335 5374325^{L}	1990/08 2401	05	FR 0062	008 / 060 010 / 1:0	DO		1604402 (74139) SAND 0050 SAND GRVL 0060 BLCK ROCK 0062
TISDALE TOWNSHIP 04(010)	17 477323 5371403^{L}	1988/03 3424	09	FR 0025	004 / 032 085 / 48:0	PS	0058 20	1604083 () FILL 0003 BLCK MUCK 0004 BRWN SAND 0014 SAND CLAY 0025 SAND 0080 HPAN 0080
TISDALE TOWNSHIP 11(005)	17 476327 5374327^{W}	2006/07 7133	06		008 / 015 010 / 1:0	DO		1605857 (Z41317) A033522 BRWN SAND LOOS 0014 GREY FSND LOOS 0038 GREY ROCK DNSE 0043
TIMMINS TOWN 04(010)	17 477021 5371506^{W}	1987/08 3424	06	FR 0025	003 / 032 084 / 8:0	DO	0059 12	1604016 () FILL 0003 BLCK MUCK 0004 BRWN SAND 0014 CLAY SAND 0025 SAND MGRD 0069 HPAN BLDR 0077 ROCK 0077
TIMMINS TOWN 05(009)	17 478113 5374330^{W}	2007/11 7037	79	FR 0102	013 / 013 007 / 1:0	DO		7053074 (Z70616) A055058 GREY SAND ROCK GRVL 0092 GREY GRVL SAND ROCK 0102

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
TIMMINS TOWN 05(010)	17 477460 5372943^{W}	1987/07 2401	05 05	FR 0105 FR 0115	009 / 300 003 / 1:0	DO		1604015 (00700) SAND 0025 CLAY 0050 HPAN 0105 GRSN 0302
TIMMINS TOWN 05(011)	17 476084 5374406^{W}	1987/07 2401	05 05	FR 0080 FR 0050 FR 0075	011 / 080 003 / 1:0	DO		1603996 (00692) FSND 0040 GRVL 0048 GRSN 0090

Notes:

1. UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
2. Date Work Completed
3. Well Contractor Licence Number
4. Casing diameter in inches
5. Unit of Depth in Feet
6. See Table 4 for Meaning of Code
7. STAT LVL: Static Water Level in Feet ; PUMP LVL: Water Level After Pumping in Feet
8. Pump Test Rate in GPM, Pump Test Duration in Hour : Minutes
9. See Table 3 for Meaning of Code
10. Screen Depth and Length in feet
11. See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	…	Code	Description	…	Code	Description	…	Code	Description	…	Code	Description
BLDR	BOULDERS		FCRD	FRACTURED		IRFM	IRON FORMATION		PORS	POROUS		SOFT	SOFT
BSLT	BASALT		FGRD	FINE-GRAINED		LIMY	LIMY		PRDG	PREVIOUSLY DUG		SPST	SOAPSTONE
CGRD	COARSE-GRAINED		FGVL	FINE GRAVEL		LMSN	LIMESTONE		PRDR	PREV. DRILLED		STKY	STICKY
CGVL	COARSE GRAVEL		FILL	FILL		LOAM	TOPSOIL		QRTZ	QUARTZITE		STNS	STONES
CHRT	CHERT		FLDS	FELDSPAR		LOOS	LOOSE		QSND	QUICKSAND		STNY	STONEY
CLAY	CLAY		FLNT	FLINT		LTCL	LIGHT-COLOURED		QTZ	QUARTZ		THIK	THICK
CLN	CLEAN		FOSS	FOSILIFEROUS		LYRD	LAYERED		ROCK	ROCK		THIN	THIN
CLYY	CLAYEY		FSND	FINE SAND		MARL	MARL		SAND	SAND		TILL	TILL
CMTD	CEMENTED		GNIS	GNEISS		MGRD	MEDIUM-GRAINED		SHLE	SHALE		UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE		GRNT	GRANITE		MGVL	MEDIUM GRAVEL		SHLY	SHALY		VERY	VERY
CRYS	CRYSTALLINE		GRSN	GREENSTONE		MRBL	MARBLE		SHRP	SHARP		WBRG	WATER-BEARING
CSND	COARSE SAND		GRVL	GRAVEL		MSND	MEDIUM SAND		SHST	SCHIST		WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED		GRWK	GREYWACKE		MUCK	MUCK		SILT	SILT		WTHD	WEATHERED
DLMT	DOLOMITE		GVLY	GRAVELLY		OBDN	OVERBURDEN		SLTE	SLATE			
DNSE	DENSE		GYPS	GYPSUM		PCKD	PACKED		SLTY	SILTY			
DRTY	DIRTY		HARD	HARD		PEAT	PEAT		SNDS	SANDSTONE			
DRY	DRY		HPAN	HARDPAN		PGVL	PEA GRAVEL		SNDY	SANDY			

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Water Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial		
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
TISDALE TOWNSHIP CON 01(009)	17 477683 5367497^{L}	1998/07 2401	06 06		/ 200 025 / 1:0	DO		1605238 (187521) SAND BLDR 0022 GREN ROCK 0344
TISDALE TOWNSHIP CON 02(010)	17 476956 5369457^{W}	2004/10 7284	20				0025 0051 10	1605673 (Z17181) A014697 BRWN SAND SILT 0025 GREY SILT SAND 0035 BRWN SAND SILT 0026 BRWN SAND GRVL SILT 0060
TISDALE TOWNSHIP CON 02(011)	17 476064 5368077^{W}	1980/07 2401	05 05	FR 0180 FR 0130	039 / 240 004 / 1:0	DO		1602943 () SAND 0026 GRSN 0242
TISDALE TOWNSHIP CON 03(012)	17 475664 5370427^{W}	1977/09 3404	06	FR 0061	015 / 060 007 / 1:30	DO	0059 04	1603099 () BRWN SAND LYRD 0065
TISDALE TOWNSHIP ()	17 475923 5368300^{W}	2005/09 6894	04			NU	0010 10	1605763 (Z08564) A008469 BRWN FSND MSND 0015 SILT WBRG 0020
TISDALE TOWNSHIP ()	17 475929 5368275^{W}	2005/06 6894	04			NU	0010 10	1605746 (Z23123) A008468 BRWN FSND 0015 GREY SILT 0020
TIMMINS TOWN ()	17 476268 5369381^{W}	2008/10 7383						7115841 (M02075) A072189
TIMMINS TOWN ()	17 476163 5368256^{W}	2004/09 1752	40	FR 0005			0010 20	1605674 (Z14276) A014235 BRWN LOAM 0000 BRWN SAND 0010 GREY SAND 0033
TIMMINS TOWN ()	17 476268 5369381^{W}	2008/07 7383						7113534 (M01189) A072189
TIMMINS TOWNSHIP (UN ()	17 476393 5369360^{W}	2007/10 7284			/ / :0	NU		7101703 (Z68505)