Atlantic Gold

Appendix F.1

Assessment of Potential Open Pit Groundwater Inflows Beaver Dam Gold
Project Nova Scotia - April 2015
Completed for the Updated 2021 Beaver Dam Mine EIS

Peter Clifton & Associates
Consulting Hydrogeologists

ATLANTIC GOLD CORPORATION

ASSESSMENT OF POTENTIAL OPEN PIT GROUNDWATER INFLOWS
BEAVER DAM GOLD PROJECT
NOVA SCOTIA

Report: 1501_R01

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BEAVER DAM GOLDPROJECT
NOVA SCOTIA

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Report No: 1501_R01

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1 INTRODUCTION

Atlantic Gold Corporation is assessing the feasibility of developing an open pit gold mine at their Beaver Dam Project in Nova Scotia, Canada, and are currently preparing documentation for a Bankable Feasibility Study. The proposed open put has dimensions 690 m by 360 m at the crest, and has a maximum depth of 200 m.

This report provides an assessment of potential groundwater inflows to the proposed open pit at the Beaver Dam Project. The assessment is based on previous hydrogeological investigations by Jacques, Whitford and Associates Limited, and the results of recent hydraulic conductivity testing by Stantec Consulting Ltd.

Recommendations for monitoring of groundwater during mining and the periodic assessment of these data are included.

2 PROJECT SETTING

2.1 Location and Topography

The Beaver Dam Project is located in central Nova Scotia about 85 km NE of Halifax and about 25 km from the North Atlantic Ocean. Beaver Dam is about 20 km NE of Atlantic Gold's Touquoy Gold Project (Figure 1)

The project site lies in an area of relatively low local topographic relief at an elevation of around 140 m, with scattered drumlins to 160 m elevation. Regional surface water drainage is predominantly to the south east along several poorly drained stream channels and shallow lakes, and there are several low-lying boggy areas across the site.

Vegetation coverage in and around the project site consists of spruce, fir, and some hardwood. Logging has been conducted in the area, and there has recently been clear felling of timber in the immediate vicinity of the project site.

The proposed open pit adjacent to Cameron Flowage, a stillwater area on the Killag River and a remnant of past logging operations (JWA, 1986a). Cameron Flowage is around 1.2 km long by up to 120 m wide (Figure 2). All surface water generated within the drainage catchment that includes the proposed open pit flows into Cameron Flowage.

There is a shallow sediment settling dam located in the eastern part of the proposed open pit (Figure 2). This dam was used to trap sediment generated by the dewatering of the Seabright underground operations in the mid-1980s before discharging to Cameron Flowage.

2.2 Prior Mining History and Dewatering

The following discussion is mostly adapted from Schofield (2015).

Gold was discovered at Beaver Dam in 1868, with first production recorded in 1871.

Intermittent attempts to develop a mine in the area occurred until 1949, with the property changing ownership several times. Some of these attempts focused on the Austen Shaft which was collared in 1902 and developed initially to a depth of 30 m with crosscuts 19 m north and 12 m south at a depth of 22 m. The southern crosscut was extended to a length of 90 m in 1927, and an incline was sunk to 61 m in 1936 from the southern crosscut.

The Austen Shaft and associated underground workings are within the perimeter of the proposed Beaver Dam open pit.

In 1985 the leases were acquired by Seabright Resources Inc who subsequently conducted a number of exploration programs which delineated an auriferous zone between 20 m and 30 m wide over a strike length of 700 m and depth 600 m. Between 1986 and 1988 Seabright conducted exploration from a new underground development that reached a maximum depth of 105 m and spanned 400 m of strike. All of the Seabright workings are within the perimeter of the proposed open pit, and they are not connected with any of the developments from the Austen Shaft.

No records of rates of long-term mine dewatering during the previous phases of mining and underground exploration have been discovered. There are notations that the Austen Shaft was dewatered on at least six occasions – 1928, 1934, 1954-57, 1965, and twice by Seabright in the late 1980s.

Jacques, Whitford and Associates Limited conducted a hydrogeological investigation at Beaver Dam in 1986 prior to Seabright's underground exploration program (JWA, 1986b). This work included a pumping test to dewater the Austen Shaft and associated workings. The results of this testing program are discussed in Section 3.1.

2.3 Rainfall, Evaporation, and Temperature

Precipitation data are available from the Middle Musquodoboit weather station, 33 km west of the Beaver Dam project site (CRA, 2005).

Precipitation occurs as rain, and during the cooler winter months as snow. Average annual precipitation (including snow as equivalent rainfall) is around 1,400 mm, and this is evenly distributed throughout the year with average monthly precipitation of between 100 mm and 140 mm. Lake evaporation data presented in CRA (2005) indicates evaporation rates are negligible from November to April, and range between

40 mm/month and 110 mm/month from May to October. Annual lake evaporation is around 500 mm, which is about 40% of the annual precipitation.

Average monthly temperatures range between -6°C in January and 18°C in July.

2.4 Geology and Hydrogeology

The Beaver Dam gold deposit is within the Meguma Group, which is a sequence of Cambro-Ordovician sandstones and mudstones that form the southern half of the province of Nova Scotia. The Meguma Group is divided into two stratigraphic units: the basal Goldenville Formation and overlying Halifax Formation. The dominant lithologies are greywacke in the Goldenville Formation and argillite in the Halifax Formation. The Goldenville Formation is at least 5,600 m thick, and the average thickness of the Halifax Formation is 4,400 m.

The Meguma Group sedimentary sequence was uplifted and deformed into a series of tightly folded sub-parallel northeast trending anticlines and synclines during the Arcadian Orogeny. This sequence has been metamorphosed to between greenschist and amphibolite (staurolite) facies, and intruded by granites and minor mafic intrusives.

The Meguma Group sequence, and predominantly the Goldenville Formation, is host to most of the gold mineralisation that has been exploited in Nova Scotia since 1860.

The Beaver Dam Project is within the argillite dominated Moose River Member of the Goldenville Formation (Figure 3). This member also hosts the Touquoy deposit to the SW and Fifteen Mile Stream deposit to the NE (Figure 1).

The Moose River Member is folded into three sub-parallel anticlines at Beaver Dam, and the gold deposit is associated with the southern overturned limb of the central anticline which dips to the north at between 75° and 90°. The sequence at Beaver Dam is sinistrally offset by two northwest trending faults: the Mud Lake Fault and the Cameron Flowage Fault. The Mud Lake Fault is described from drill cores as a 2 m to 3 m zone of gouge within a 10 m to 20 m wide brecciated zone.

The Meguma Group sequence at Beaver Dam is covered by glacial till deposits of varying thickness and occasional shallow peat bogs. The range of grain size of the till materials is large, being from clay to boulder. Regionally the sheet of till deposits has a mean thickness of about 3 m, but locally it can be up to 20 m thick (eg, at drumlin deposits). At Beaver Dam the till sheet is about 5 m thick, and there is evidence of a sediment-filled gully up to 25 m deep which intersects the trace of the Mud Lake Fault.

Groundwater occurs at shallow depths at the Beaver Dam site, and Cameron Flowage is probably an area of groundwater discharge. The bedrock sequence forms a fractured rock aquifer system, and this overlain by a thin aquifer in the till. The degree of hydraulic connection amongst the smaller bedrock fracture systems is probably poor to moderate, and the main zones that are capable of storing and transmitting relatively large amounts of groundwater would be the larger scale faults.

The volume of groundwater stored in the bedrock aquifer is probably small, and this reflects the relatively small primary porosity of these rocks. Some of the larger bedrock structures may be hydraulically connected to surface water bodies which may become sources of aquifer recharge under a mine dewatering scenario.

Descriptions of drilling conditions through the Mud Lake Fault in JWA (1986b) indicate boreholes were quite unstable in this section, and groundwater flows were “low”. The latter comment appears to refer to the groundwater yielding capability of boreholes for the purpose of supplying water for drilling rigs. One borehole, BD-86-47, is noted to be a flowing artesian borehole with measured flow rate of 0.1 L/sec. BD-86-47 is located slightly north of the south east end of Cameron Flowage, and has a total depth of 500 m.

3 PREVIOUS HYDROGEOLOGICAL INVESTIGATIONS

Jacques, Whitford and Associates conducted a hydrogeological investigation at the Beaver Dam site in 1986 prior to the exploration work by Seabright Resources Inc (JWA, 1986b). The objectives of the investigation were to predict the rates of groundwater inflow to the proposed underground exploration development, and the quality of water flowing into the underground. The scope of the investigation included a pumping test to dewater the Austen Shaft, and several single borehole packer tests using some of the diamond core holes. The results of this work are discussed in Sections 3.1 and 3.2.

In 2014, Stantec Consulting Ltd conducted packer testing of one diamond core hole at the Beaver Dam site. The objective of this investigation was to determine the hydraulic conductivity of various parts of the bedrock sequence at Beaver Dam including the Mud Lake Fault. Results of this work are discussed in Section 3.3.

3.1 Austen Shaft Dewatering 1986

This test involved pumping from the Austen Shaft, and monitoring water levels in the shaft during pumping and recovery (JWA, 1986b). The maximum pumping water level that could be achieved during testing was around 22 m. This depth is equivalent to the depths of the crosscuts that were developed off the shaft in 1902.

The first pumping test commenced at 1:35pm on 18 June 1986. The static water level (SWL) in the shaft prior to pumping was noted to be 3.86 m below the datum for the test, which presumably was close to ground level. The pumping rate during the test was

2,275 kL/day (26.3 L/sec), and all of the available drawdown was exhausted after 16 hours of pumping.

A graph of drawdown versus time from this pumping test is presented in Figure 4. There are three linear segments in this drawdown-time graph, with the rate of drawdown tending to decrease at longer times during the test. The linear trends of drawdown versus time indicate that, in this instance. there is a linear relationship between water level and water storage volume in each of the three vertical intervals of the shaft and its associated developments. This also indicates that the rate of pumping during the test was much greater than the rate of groundwater seepage into the shaft and underground developments.

The total volume of water pumped from the Austen Shaft and associated developments in the June 1986 test was 1,520 kL.

A second group of pumping tests was conducted in July 1986. In one of these test pumping occurred until the available drawdown was exhausted, and the pumping rate was then reduced to maintain a steady water level. The final pumping rate of 2.9 L/sec (249 kL/day) was maintained for a period of 5½ hours. Note that this pumping rate can be interpreted as the maximum rate of groundwater seepage into all of the underground voids of the Austen Shaft and associated underground developments which extend to a depth of 61 m.

3.2 Packer Testing 1986

Jacques, Whitford and Associates selected nine existing diamond core holes for conducting single borehole packer injection tests to determine values of formation hydraulic conductivity. Boreholes for testing were selected on the basis of their inclination (near-vertical holes preferred), and the lithology and structure intersected (Mud Lake Fault, ore zones, the anticline axis, greywacke, argillite, and quartzite). Initially sixteen boreholes were selected a possible candidates for testing, however only nine were suitable. Packer test were conducted in 56 intervals within these boreholes. The locations of the boreholes used for packer testing are indicated on Figure 5, and listed in Table 1.

A “straddle” packer consisting of a 4.5 m length of perforated pipe with 1 m long inflatable packers at either end was used in this testing program. The packer assembly was run in and out of the hole on a wireline. Nitrogen gas was used to inflate the packers, and water was injected into the packed-off interval through a high-pressure hose.

Table 1 lists the intervals in each borehole that were tested, the lithology and structure in these intervals, and the values of hydraulic conductivity calculated from the test data by JWA (1986b). All boreholes listed in Table 1 are inclined with dip angles between -60° and -70° at the collars, and the depth intervals are the depths within the borehole, ie these are not vertical depth intervals.

The range of hydraulic conductivity values determined by the 1986 testing program is 3.7 x 10^{10} m/sec and 1.9 x 10^{-6} m/sec. The mean of the set of values is 2.5 x 10^{-7} m/sec, and the geometric mean (approximate median)(1) value is 4.8 x 10^{-8} m/sec.

Five of the 1986 packer tested intervals intersected to Mud Lake Fault. Hydraulic conductivity determined from this group of tests ranges between 1.2 x 10^{-9} m/sec and 1.9 x 10^{-6} m/sec, and the mean and geometric mean values are 3.7 x 10^{-7} m/sec and 1.5 x 10^{-8} m/sec, respectively.

All of the values of hydraulic conductivity determined from the 1986 packer testing program are relatively small, and are not unusual given the geological and structural settings.

3.3 Packer Testing 2014

Stantec Consulting Ltd conducted five packer tests in diamond cored borehole BD14-188 in December 2014 (Stantec, 2015). The location of BD14-188 is indicated on Figure 5.

BD14-188 was selected for packer testing so that the tested intervals included the hanging wall sequence, the Mud Lake Fault, and the foot wall sequence. Five intervals were tested, with test interval lengths ranging between 8 m and 64 m. Results are listed in Table 1.

Stantec note that one of the tested intervals in the hanging wall and both tested intervals in the footwall did not accept any of the injected water. The values of hydraulic conductivity inferred from these three tests are indicated by the "<" character in Table 1.

Hydraulic conductivity calculated from the two successful packer tests conducted in December 2014 are within the range of hydraulic conductivities calculated from the 1986 testing program. The value of K determined by the test of the Mud Lake Fault is

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[1] The geometric mean value of several hydraulic conductivity results based on similar tests is generally taken to be the best representative large-scale estimate of this parameter for subsequent use in groundwater flow rate calculations.

1.0 x 10^{-8} m/sec, which is again within the range of values determined for this structure in the 1986 testing.

Stantec note that the intersection of the Mud Lake Fault in BD14-188 had a significantly higher rock mass quality than was anticipated on the basis of cores from adjacent boreholes. The implication is that parts of the Mud Lake Fault have larger hydraulic conductivities than the value determined from this packer test.

The geometric mean value of all of the hydraulic conductivity results from the 1986 and 2014 testing programs is 4.5 x 10^{-8} m/sec.

4 ESTIMATES OF OPEN PIT GROUNDWATER INFLOW RATES

As groundwater occurs at shallow depths across the Beaver Dam site, groundwater seepage into the proposed open pit will be one issue that will need to be managed basically from the start of mining.

Groundwater can be expected to seep into an open pit developed at the Beaver Dam site through the surficial glacial till deposits, and though fractures and structures in the bedrock. As dewatering progresses and groundwater levels in the vicinity of the open pit are lowered, some surface water bodies which are presently groundwater discharge areas may become areas of groundwater recharge. The main effect of this recharge will be to maintain some of the seepage into the open pit.

4.1 Seepage from Till

Atlantic Gold’s Touquoy Project, 20 km SW of Beaver Dam, has similar geological and hydrogeological settings to Beaver Dam, with a thin sheet of surficial glacial till overlying folded and fractured argillite and greywacke. The estimated average groundwater inflow rate into an open pit at Touquoy from the till is 450 kL/day (5.2 L/sec) (Peter Clifton & Associates, 2006). Given the proposed open pits at Touquoy and Beaver Dam have similar crest perimeter lengths, this estimate of groundwater inflow rate from the till can also be applied to the Beaver Dam site.

Some spatial variation in the rates of groundwater inflow from the till must be expected around the crest of the pit. There are likely to be sections of the wall where seepage rates are negligible and other sections where the seepage is noticeable. Some seasonal variation in seepage rates from the till is also expected. The recommended approach for managing groundwater seepage from the till is discussed in Section 5.

4.2 Seepage from Bedrock

The results of extensive packer testing of the bedrock at Beaver Dam did not identified any large-scale permeable units from which large rates of groundwater seepage into an open pit could be expected. The geometric mean (approximate median) value of the entire set of hydraulic conductivity values determined from these tests is 4.5×10^{-8} m/sec. This is a relatively small value of this parameter, however this is consistent with the lithology of the sequence at Beaver Dam apparent from diamond cores.

Some caution is needed when using the results of packer tests conducted in diamond core holes. Packer tests in core holes may underestimate the actual hydraulic conductivity of the tested interval due to blinding, or blocking, of permeable fractures by fine grained drill cuttings or viscous drilling fluid. It is not possible to quantify the magnitude of these effects, and they may not necessarily be a significant factor. The set of hydraulic conductivity results from the tests at Beaver Dam appears reasonable given the lithology and the type of aquifer (fractured bedrock).

One uncertainty is the role of the Mud Lake Fault in groundwater seepage into the proposed Beaver Dam open pit. All of the packer tests which have been conducted in the Mud Lake Fault produced hydraulic conductivity estimates which are not significantly different from the remainder of the tests. However, the Mud Lake Fault is described as a 2 m to 3 m zone of gouge within a 10 m to 20 m wide brecciated zone, and is noted to be associated with borehole instability issues during drilling. The Mud Lake Fault is only known from cores, and it was not intersected by any of the underground developments associated with the Austen Shaft and the Seabright workings.

Even if the actual hydraulic conductivity of the Mud Lake Fault is larger than indicated by the results of the packer tests, the longer-term groundwater inflow rates to an open pit at Beaver Dam through this structure will be influenced more by the small hydraulic conductivities of the greywacke and argillite sequence. Recommendations for managing groundwater pressures in the Mud Lake Fault are included in Section 5.

Figure 6 is a graph of hydraulic conductivity versus depth based on the results of the packer tests. Only the results of the testing in 1986 have been included in this graph. While there is generally weak correlation between hydraulic conductivity and depth apparent in Figure 6, there is a tendency for the smaller values of K to occur at greater depths. This is an expected trend, and can be explained by slight dilation of fractures at shallower depths.

An estimate of the rate of groundwater inflow through the bedrock to an open pit at Beaver Dam can be made using a model which assumes that all of the flow enters the pit through the north and south walls (ie, the longer walls in the pit – see Figure 2). For a pit wall 800 m long and 100 m deep, and assuming a bulk formation hydraulic conductivity of 4.5 x 10^{-8} m/sec (the geometric mean of the packer test results) and hydraulic gradient of 1 (a conservative assumption), the estimated rate of groundwater seepage is 311 kL/day. The estimated groundwater seepage rate into the 100 m deep pit from both the north and south walls would thus be 622 kL/day (7.2 L/sec). In deeper sections of the pit, groundwater inflows are expected to be smaller than these values due to the lower formation hydraulic conductivities that tend to occur with increasing depth at Beaver Dam.

It is recommended that a range of groundwater seepage rates from bedrock at Beaver Dam of between 100 kL/day (1.2 L/sec) and 1,000 kL/day (12 L/sec) be used for planning purposes.

5 RECOMMENDATIONS FOR MANAGING GROUNDWATER SEEPAGE

From a mine dewatering perspective there are two groundwater seepage issues at the proposed Beaver Dam open pit that require attention:

- Seepage from the glacial till deposits into the open pit (eg seepage that migrates along the till/bedrock contact)
- Seepage from the bedrock sequence into the open pit and the associated groundwater pressures in the pit walls – this is an important issue that can influence open pit wall stability

The above issues follow from the hydrogeological setting of the site, and different approaches are required to control inflows and seepage from these sources.

5.1 Seepage from Till

The glacial till at Beaver is a sheet of poorly sorted sediment with a fine grained matrix averaging 5 m thick. There is evidence of a sediment-filled gully up to 25 m deep which intersects the trace of the Mud Lake Fault.

Rates of seepage from the till exposed around the perimeter of the open pit will vary, and will primarily be related to the proportion of fine grained matrix material. Larger rates of seepage can be expected where the till is relatively coarse and contains a small proportion of fines.

Seepage rates from the till to the open pit will also vary by small amounts seasonally due to normal seasonal changes in the level of the water table. Seepage rates from the till are expected to be greatest following the spring thaw and during the early summer months.

Where the till consists of relatively coarse grained gravels with a small proportion of fines there is the potential for larger groundwater inflows to occur. Whether these inflow rates are sustained will depend on the lateral extent of the gravel deposits, and the degree of interconnection between the gravels and surface water bodies. This may require further investigation if the risk is considered significant.

The estimated rate of groundwater seepage from the till into an open pit at Beaver Dam 450 kL/day. This is considered to be an average value, with seasonal variations superimposed.

Although the total rate of groundwater seepage from the till into the open pit is not expected to be large, if left unmanaged this could result in erosion, slumping of the till, and possibly water flowing over the crest of the pit. It is recommended that this seepage be intercepted and diverted before it reaches the open pit. This can be achieved with an open drain at the base of the till which is dug a short distance into the top of the bedrock, and one or more sumps at low points in the drain to collect the seepage and pump it from the pit. Because the expect flow rates are relatively small, the cross section area of the drain can safely be of order 1 m^2 and still provide sufficient carrying capacity. The drain may need to be lined where it crosses major structures to prevent recharge occurring to the bedrock groundwater system as this may cause problems for pit wall stability.

Where thicker accumulations of till occur drains and sumps will need to be positioned deeper within the open pit to intercept any seepage.

Figure 7 presents a conceptual design of a drain at the base of the till in an open pit at Beaver Dam. The distance between the edge of the drain and the inner pit crest (ie, bedrock crest) is about 30 m. This is also the recommended length of sub-horizontal drain holes in the pit walls (see Section 5.2).

5.2 Seepage from Bedrock

The ambient water table at Beaver Dam is close to the land surface and the bedrock sequence is saturated. Groundwater will therefore flow into an open pit at Beaver Dam, and dewatering will be required to maintain dry working conditions. Lowering of groundwater pressures in the pit walls will also be required for wall stability purposes, and dewatering of the bedrock sequence exposed in the walls will be important from this perspective. Dewatering facilities will also be needed in the pit to remove surface water that collects after rainfall.

Seepage through the bedrock sequence at Beaver Dam will largely be controlled by geological structures, and will vary around the pit due to variations in the density of joints and fractures, and the occurrence of major faults.

Managing groundwater pressures in the pit walls at Beaver Dam will require groundwater levels to be monitored in piezometers behind the walls, and groundwater pressures in the walls to be dissipated by means of sub-horizontal drain holes. It is recommended that drain holes be located to intersect permeable structures 20 m to 30 m back from the walls. If possible, drain holes should be selectively located in areas where seepage is an obvious issue rather than placing them at regular spacing on every bench of the pit. A greater density of drains may be required to control groundwater pressures within and near the Mud Lake Fault.

Figure 7 presents a conceptual design of pit wall drainage by means of sub-horizontal drain holes. Drains should be about 30 m long, and can be drilled with a blast hole rig. Flows from drains will generally diminish over time, and drains on the higher benches may eventually cease flowing as the mine is developed. Discharge from drains should be directed to a sump either through a series of pipes or channels. Collaring of drain holes may be necessary if large and persistent flow rates are encountered, however in most cases flows are expected to be no greater than a trickle and should diminish over time.

Monitoring of groundwater levels will require piezometers to be constructed at the pit crest, and progressively on some benches as the open pit is developed. Piezometers can be vertical boreholes drilled to a depth of 40 m to 50 m, possibly with a blast hole drilling rig, and cased with 32 mm or 40 mm PVC pipe which has been slotted from 10 m below surface. The annulus outside the slotted casing should be packed with graded sand (~2 mm grain size) to about 3 m above the top of the slots. Slots can be cut with a hacksaw, or machine slotted casing can be used if this is available.

Piezometers located at the pit crest will require the glacial till sequence to be collared to below the till/bedrock contact so that groundwater in the till cannot seep into the borehole. These piezometers should also include annular bentonite clay seals of height about 1 m on top of the sand pack. It may be necessary to modify the design of these piezometers during construction to ensure that the bentonite seal is a few metres below the till/bedrock contact.

All piezometers should be finished with steel surface casing about 0.7 m above ground level, and these casings should be painted bright orange or green so that they are clearly visible. Piezometers should be surveyed to determine locations and reference elevations for measuring water levels against.

For planning purposes, allowance should be made for piezometers at the pit crest to be around 200 m apart, ie there will be nine or ten piezometers around the crest of the proposed Beaver Dam open pit. Transects of piezometers every 50 m vertically down the pit wall should be constructed at every second crest piezometer.

Data from the piezometers will provide profiles of the phreatic surface which will be important for assessing pit wall stability. If access to piezometers over the longer term is uncertain, consideration should be given to equipping these facilities with pressure transducers that connect to logging units at the crest of the pit.

6 REMAINING HYDROGEOLOGICAL ISSUES

Hydrogeological issues at Beaver Dam that may need to be considered are:

- Quality and quantity of any groundwater that may need to be discharged off site, ie in excess of what can be utilised in the mining operations
- Groundwater and surface water monitoring programs that may need to be established under statutory requirement for mining operations in Nova Scotia

A possible issue that may need to be considered given the setting is the effect of freezing temperatures on groundwater seepage close to the pit walls. The expansion of water that occurs at temperatures below 4°C and when ice is formed has the potential to cause slight dilation of the rock mass and joints. This process may lead to exfoliation at the pit walls. Whether this will be a significant process in an open pit at Beaver Dam is unclear. Avoiding this condition would require that the wall rocks be completely dewatered, especially close to the face of the pit.

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Table 1: Beaver Dam Project Packer Testing Results

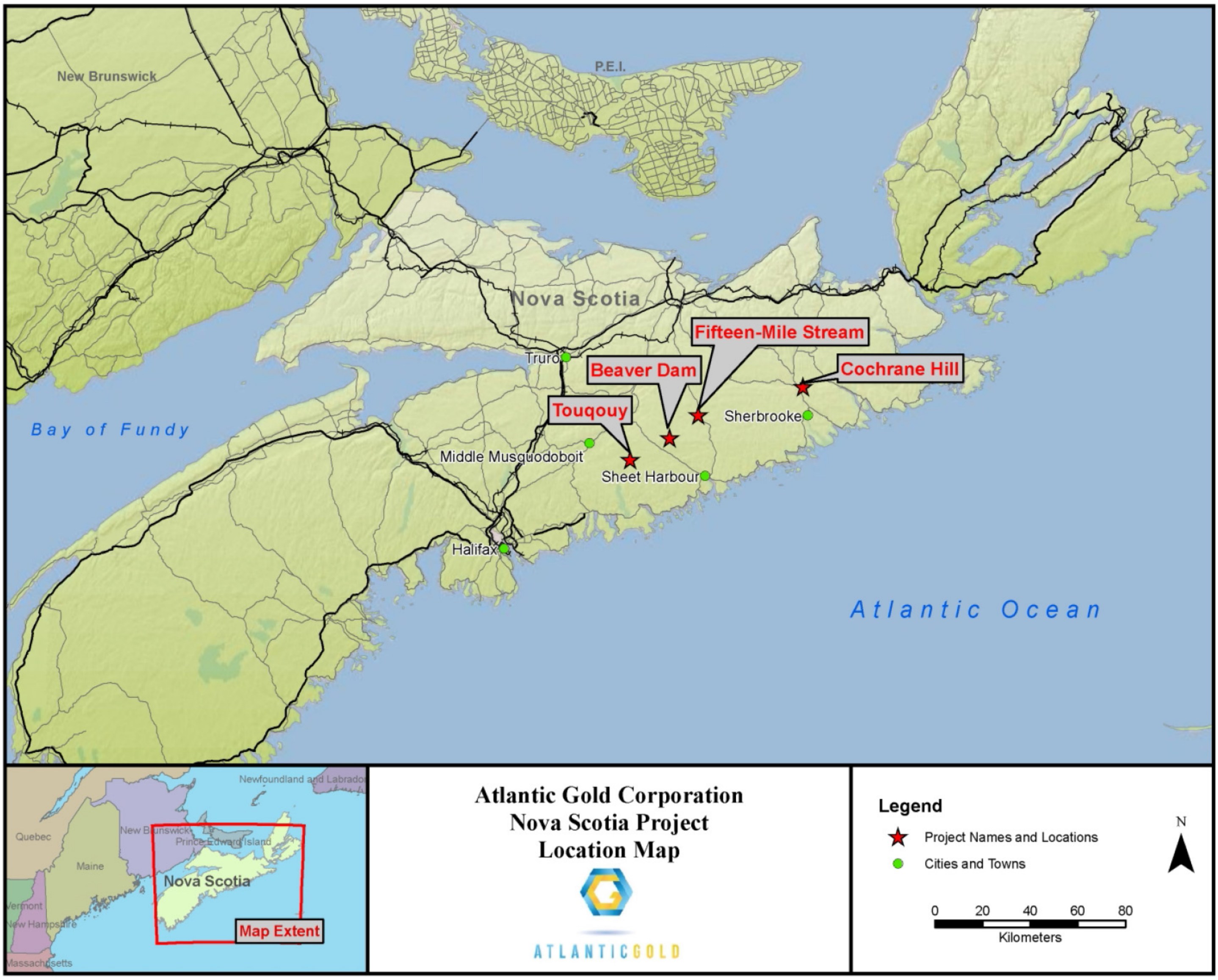
Borehole	From	To	Lithology / Structure	K (m/sec)
BD85-005	15.2	19.8	Argillite	5.2×10^{-7}
	19.8	24.4	Argillite	9.0×10^{-8}
	24.4	29	Argillite	1.8×10^{-7}
	50.3	54.9	Greywacke	1.4×10^{-6}
BD85-007	15.2	19.8	Argillite	4.7×10^{-8}
	19.8	24.4	Argillite, Quartzite	1.1×10^{-8}
	24.4	29	Quartzite	8.4×10^{-7}
	56.4	61	Greywacke / Fault	2.0×10^{-9}
	65.5	70.1	Greywacke	5.4×10^{-7}
	88.4	93	Argillite	3.0×10^{-8}
BD85-013	21.6	26.2	Greywacke	2.0×10^{-8}
	25.9	30.5	Greywacke, Quartzite	2.4×10^{-8}
	81.7	86.3	Greywacke, Argillite	5.8×10^{-8}
	86	90.6	Argillite	4.1×10^{-8}
	90.2	94.8	Argillite	2.8×10^{-8}
	94.5	99.1	Argillite	2.5×10^{-8}
	98.8	103.4	Argillite	4.3×10^{-8}
BD85-016	10.6	15.2	Greywacke, Quartzite	8.0×10^{-7}
	15.2	19.8	Quartzite	1.6×10^{-6}
	19.8	24.4	Quartzite	4.9×10^{-8}
	76.2	80.8	Greywacke, Argillite	2.5×10^{-7}
	80.8	85.3	Greywacke, Argillite	3.0×10^{-7}
	85.3	89.9		3.9×10^{-7}
BD85-029	13.7	18.3	Argillite	4.7×10^{-7}
	24.1	28.7	Greywacke	9.9×10^{-8}
	33.5	38.1	Greywacke	9.4×10^{-7}
	39.6	44.2	Greywacke	9.0×10^{-8}
	102.1	106.7	Greywacke, Argillite	4.9×10^{-8}
	106.7	111.3	Greywacke	1.6×10^{-8}
BD85-043	19.8	24.4	Quartzite	8.3×10^{-9}
	24.4	29	Greywacke, Argillite	2.6×10^{-8}

continued…

Table 1 (cont): Beaver Dam Project Packer Testing Results

Borehole	From	To	Lithology / Structure	K (m/sec)
BD85-043 (cont)	47.2	51.8	Greywacke	1.0 x 10^{-6}
	51.8	56.4	Greywacke	2.3 x 10^{-7}
	62.5	67.1	Greywacke	2.7 x 10^{-9}
	67.1	71.6	Greywacke	3.4 x 10^{-9}
	117.3	121.9	Greywacke	1.0 x 10^{-9}
	121.9	126.5	Greywacke	7.6 x 10^{-10}
	126.5	131.1	Greywacke	2.6 x 10^{-9}
	131.1	135.6	Greywacke, Argillite	1.6 x 10^{-9}
	135.6	140.2	Argillite	5.5 x 10^{-10}
	140.2	144.8	Argillite	3.7 x 10^{-10}
BD85-082	15.2	19.8	Greywacke	3.6 x 10^{-8}
	19.8	24.4	Greywacke	1.1 x 10^{-6}
	24.4	29	Quartzite / Fault	1.9 x 10^{-6}
	30.5	35.1	Greywacke	8.0 x 10^{-7}
	41.1	45.7	Quartzite	6.1 x 10^{-7}
	45.7	50.3	Quartzite	4.6 x 10^{-7}
BD85-083	39.6	44.2	Greywacke / Fault	1.5 x 10^{-8}
	48.8	53.3	Greywacke / Fault	1.0 x 10^{-8}
	57.9	62.5	Greywacke / Fault	1.2 x 10^{-9}
	71.6	76.2	Argillite	7.1 x 10^{-9}
	80.8	85.3	Greywacke, Argillite	2.7 x 10^{-8}
BD85-090	19.8	24.4	Quartzite	3.1 x 10^{-8}
	24.4	29	Greywacke	3.0 x 10^{-8}
	29	33.5	Greywacke, Quartzite	2.4 x 10^{-8}
	33.5	38.1	Greywacke, Quartzite	8.1 x 10^{-8}
BD14-188	12	23	Hanging wall	<1.0 x 10^{-8}
	33	50	Hanging wall	5.0 x 10^{-9}
	117	125	Fault	1.0 x 10^{-8}
	147	160	Foot wall	<2.0 x 10^{-9}
	147	210	Foot wall	<4.0 x 10^{-10}

Notes: “K” is hydraulic conductivity
Boreholes with prefix “BD-85” tested in 1986 (JWA, 1986b)
Borehole BD14-188 tested in 2015 (Stantec, 2015)



Location plan provided by Atlantic Gold Corporation

FIGURE 1

Beaver Dam Project
Regional Location Plan

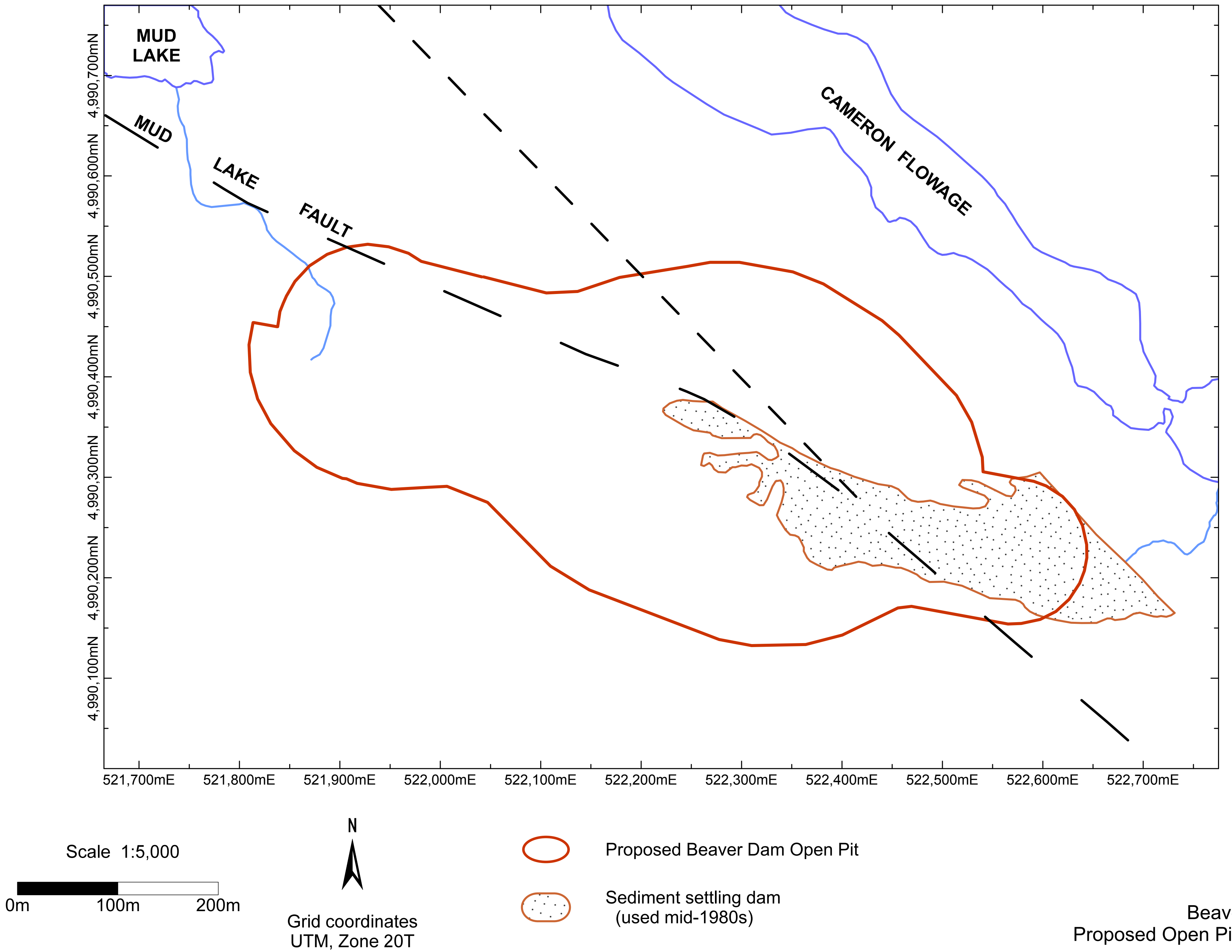
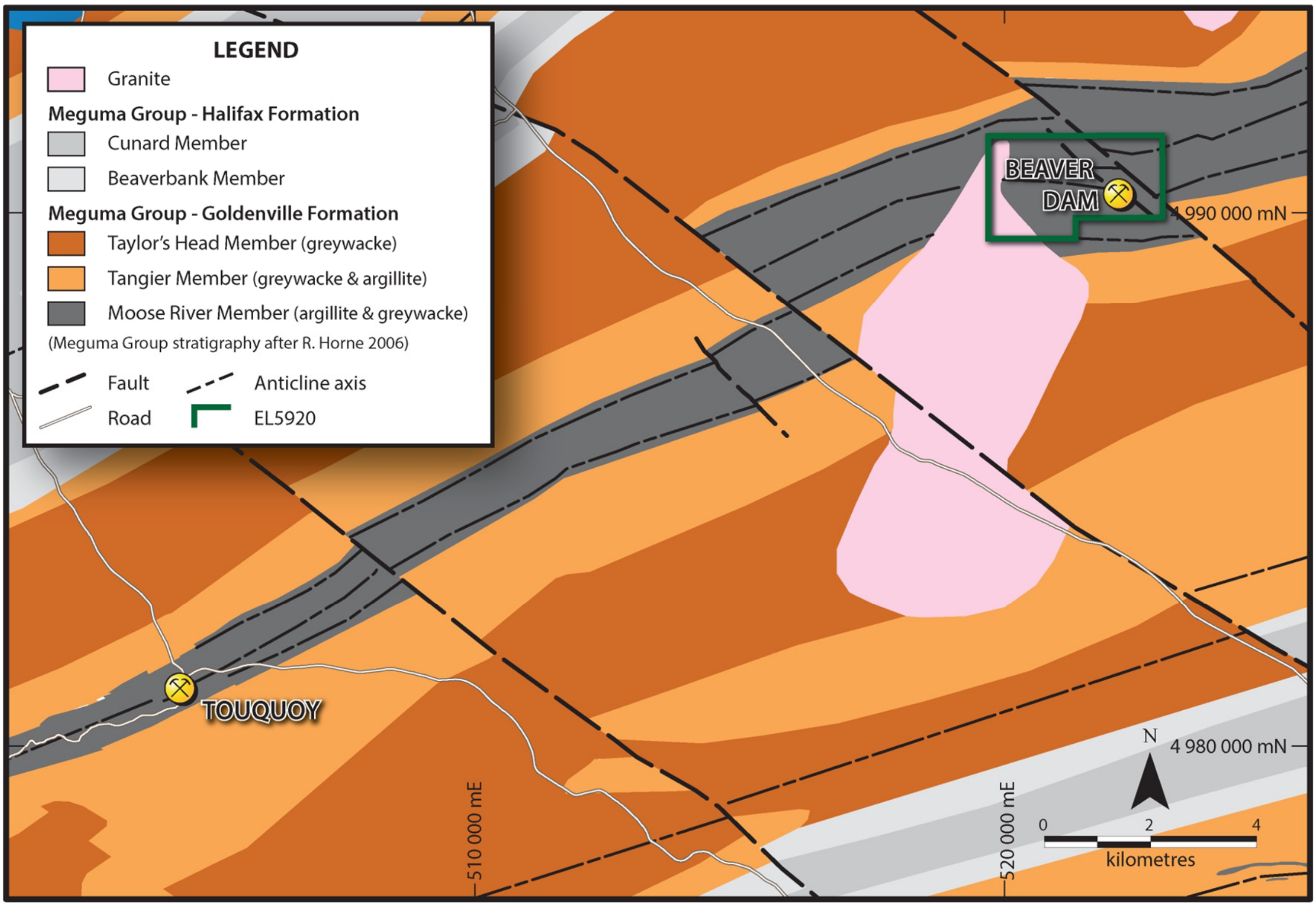


FIGURE 2

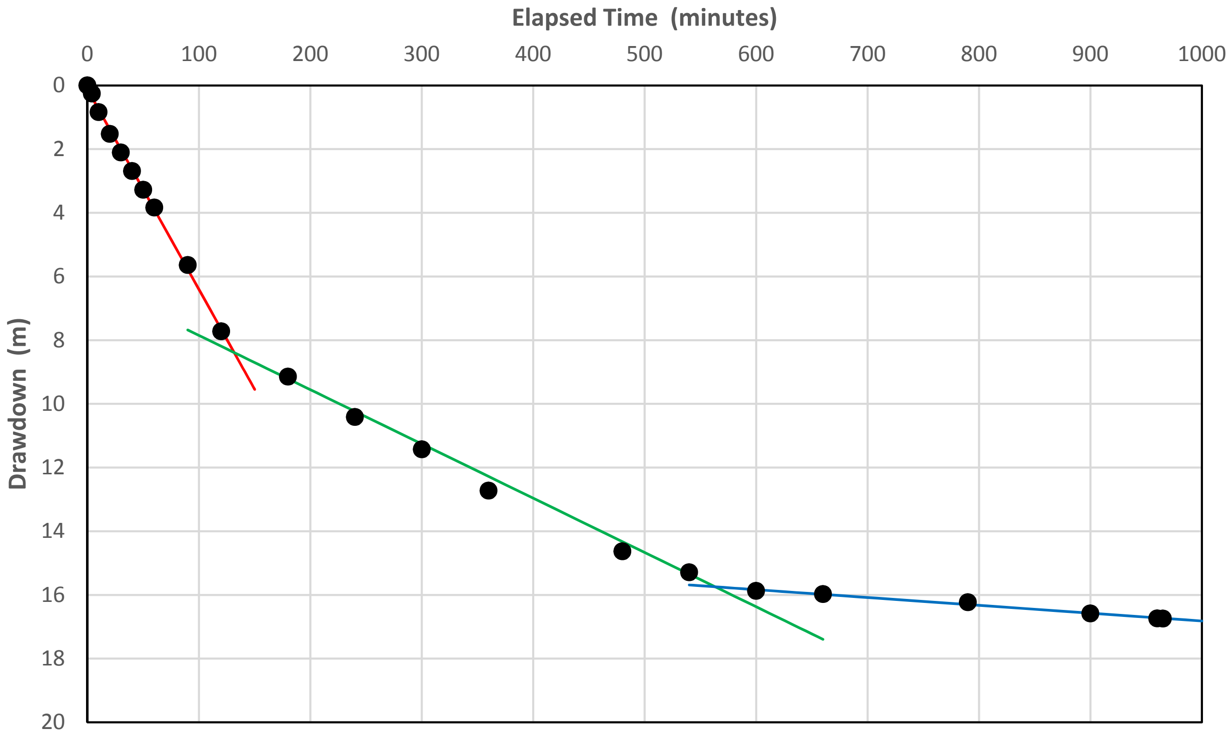
Beaver Dam Project
Proposed Open Pit Location Plan



Geological interpretation provided by Atlantic Gold Corporation

FIGURE 3

Beaver Dam Project
Regional Geology



Austen Shaft pumping test, 18 June 1986

Rate of pumping: 2,275 kL/day (26.3 L/sec)

Duration of test: 965 minutes (16 hours); held constant during test

Three linear segments apparent in drawdown vs time graph.

Rate of drawdown in each linear segment:

Time (minutes)	**Rate of drawdown (m/minute)**	**Drawdown (m)**
0 - 120	6.28×10^{-2}	0 - 7.7
120 - 600	1.70×10^{-2}	7.7 - 15.9
600 - 965	2.46×10^{-3}	15.9 - 16.7

AUSTEN SHAFT PUMPING TEST, JUNE 1986 | **FIGURE 4**

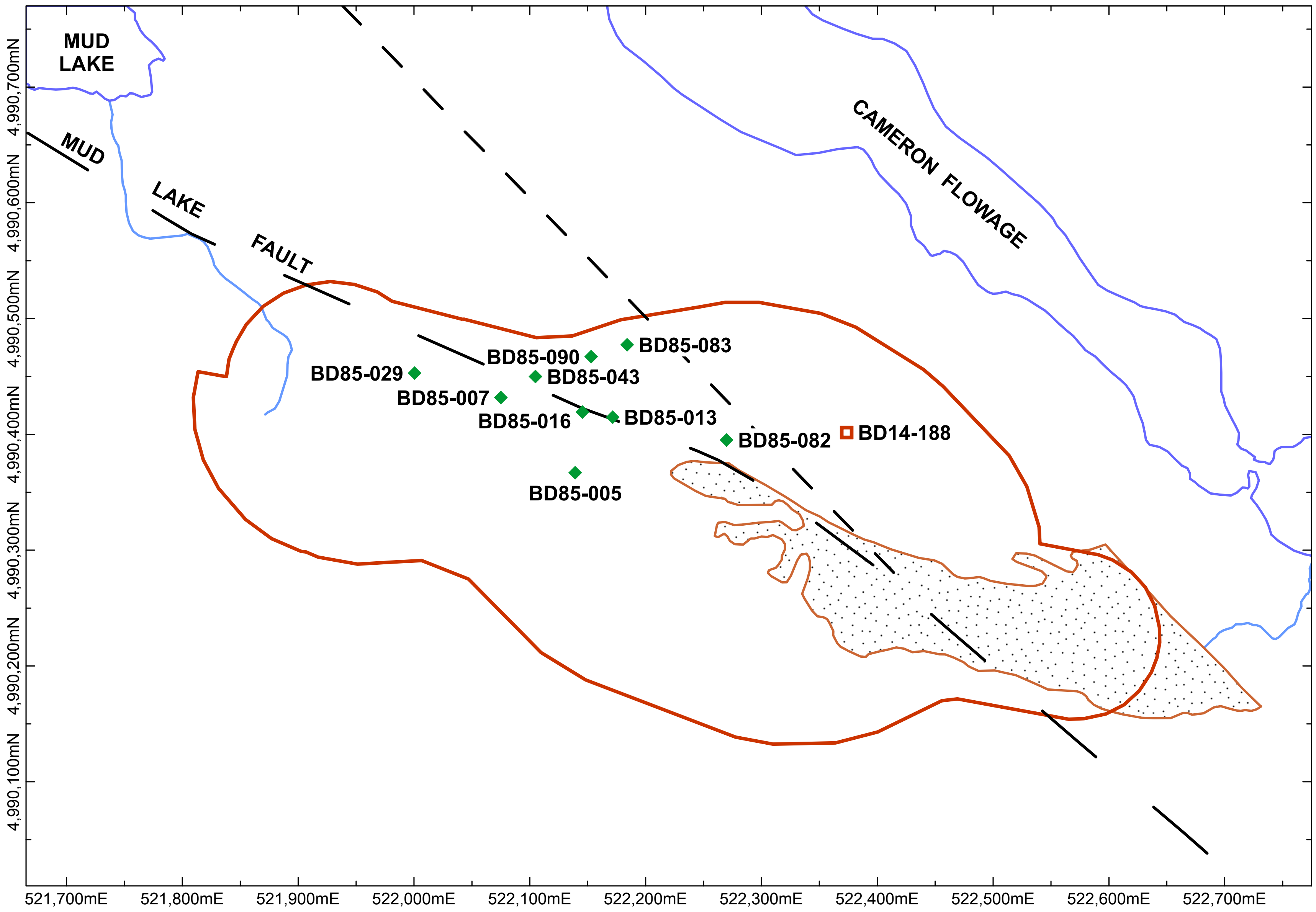
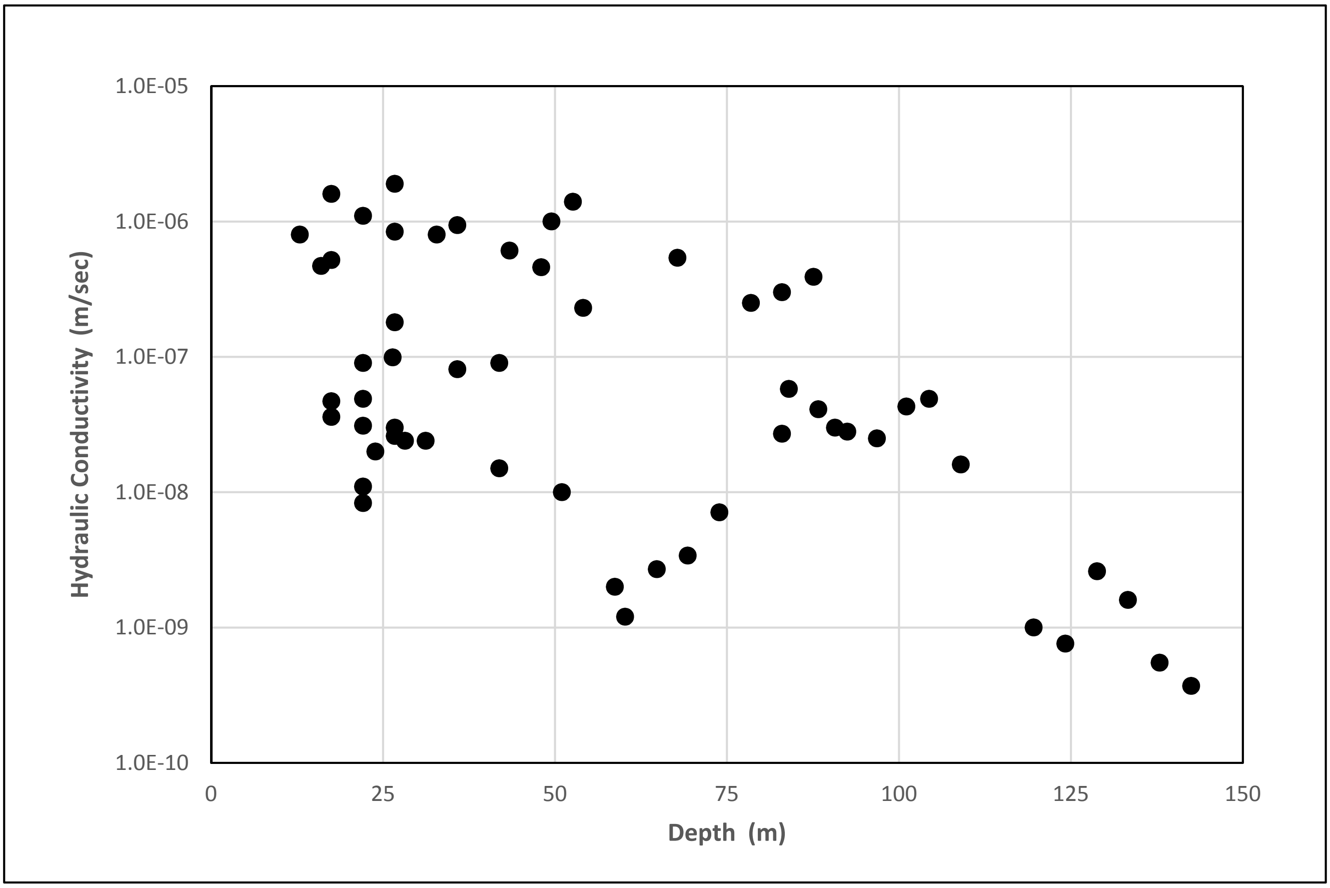


FIGURE 5

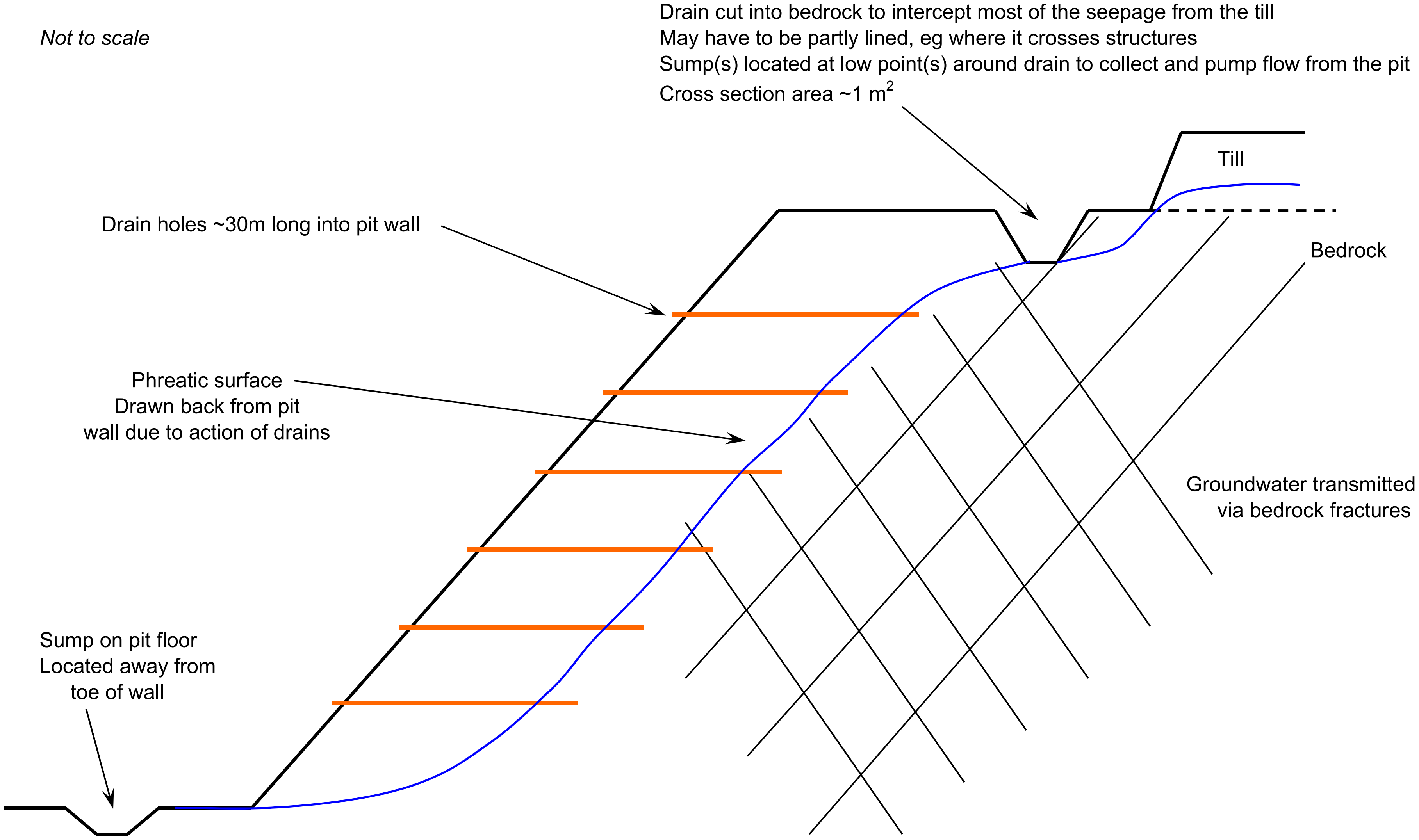
Beaver Dam Project
Locations of Packer Tested Boreholes



Values are from the 1986 packer tests (JWA, 1986b)

Depths are the mid point of the tested interval
The length of all tested intervals was 4.6m
Depths are not corrected for borehole inclination

HYDRAULIC CONDUCTIVITY VERSUS DEPTH	**FIGURE 6**



Not to scale

Drain cut into bedrock to intercept most of the seepage from the till
May have to be partly lined, eg where it crosses structures
Sump(s) located at low point(s) around drain to collect and pump flow from the pit
Cross section area ~1 m^2

Drain holes ~30m long into pit wall

Phreatic surface
Drawn back from pit
wall due to action of drains

Sump on pit floor
Located away from
toe of wall

Groundwater transmitted
via bedrock fractures

FIGURE 7
Conceptual Design of Pit Wall and Till Drainage Systems at Beaver Dam