TECHNICAL MEMORANDUM

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TO:	Mr. Frederic Guerin, AREVA	**DATE:**	August 6, 2008
FROM:	Laurent F. Gareau, M.Sc., P.Eng. Brent Topp, B.Sc., P.Geo.	**JOB NO:**	08-1362-0506/5001
EMAIL:	LGAREAU@GOLDER.COM; BTOPP@GOLDER.COM		
RE:	**ASSESSMENT OF UNAUTHORIZED RELEASE, KIGGAVIK PROJECT**		

1.0 INTRODUCTION

In response to an unauthorized release of drilling fluid containing high suspended solids into Andrew Lake at the Kiggavik Exploration Site, Golder Associates Ltd. (Golder) was asked by AREVA Resources Canada Inc. (AREVA) to:

- assess the water quality in Andrew Lake;
- install silt barriers to contain sediment at the inflow point of Andrew Lake;
- install sandbag berms to mitigate future sediment inflows into Andrew Lake;
- interview site personnel to assess the causes of the unauthorized release; and
- review changes to the drilling methods and/or suggest alternate drilling methods that would decrease the potential for future unauthorized releases.

2.0 UNDERSTANDING OF THE INCIDENT

Our understanding of the incident is based on reports from AREVA personnel, photographs, and visual inspection of the site. We understand that an unauthorized release of drilling fluid, containing suspended solids flowed into Andrew Lake on July 6, 2008. The drilling fluids flowed overland several hundred metres before reporting to the lake. Regulatory agencies were contacted and drilling was halted until the situation could be assessed and mitigated.

3.0 FIELDWORK

Golder mobilized to the site between July 12 and 14, 2008 in order to achieve the objectives outlined in Section 1.0. Graham Parsons and Brady Balicki of Golder's Saskatoon office mobilized for this purpose.

3.1 Turbidity and Total Suspended Solids Monitoring

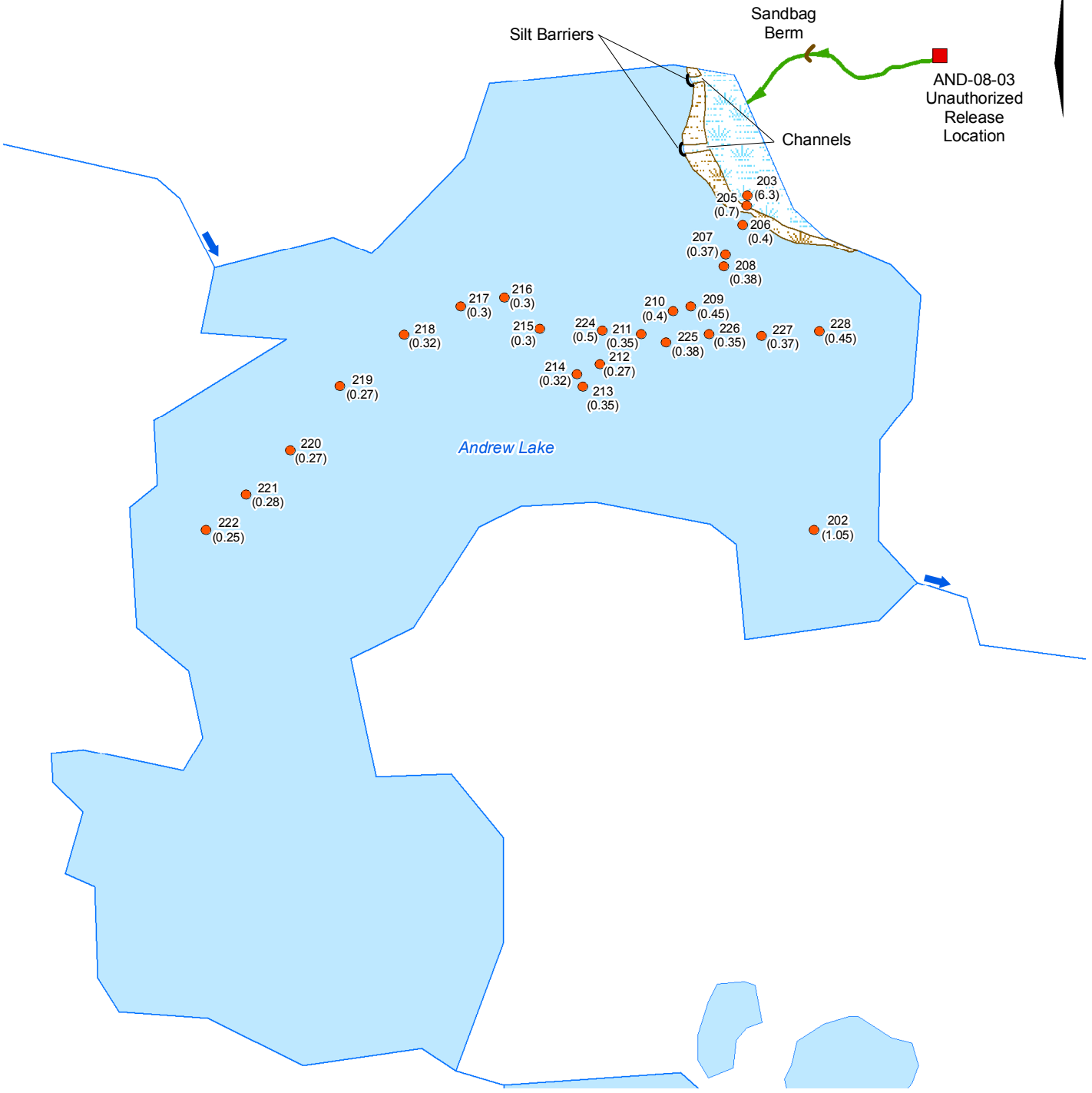
To assess the concentration gradient from the point of entry to the lake to the main body of the lake, a survey was carried out on July 13, 2008. The survey involved collecting turbidity measurements at 26 locations in Andrew Lake. The meter used to for turbidity measurements was a LaMotte 2020 turbidity meter with measurements reported in Nephelometric Turbidity Units (NTU). NTU is a measure of how much light is scattered by suspended particles in the water. The greater the scattering, the higher the turbidity. Therefore, low NTU values indicate high water clarity, while high NTU values indicate low water clarity. Coincident water samples were collected at 12 locations to evaluate total suspended solids (TSS) levels in Andrew Lake. The samples were shipped to the Saskatchewan Research Council laboratory in Saskatoon for analysis.

3.2 Silt Barrier Installation

Two silt barriers were installed in Andrew Lake to reduce the likelihood of suspended particulate matter from drilling fluid from moving into the main body of Andrew Lake. The silt barriers consisted of 15 m long x 1.5 high laminated polyester fabric with enclosed foam floats along the length of the upper side and anchor chain, which passes through a sleeve along the bottom side of the barrier. The barrier is impermeable to water and is staked at either end with sections of rebar. Water also cannot pass over or under the barrier and the ends are staked to solid ground. The barriers were placed across the two channels in the offshore ridge, at the locations shown in Figure 1, to prevent direct flow from the wetland area (Photo 1) to the main body of the lake.

3.3 Sandbag Barrier Installation

An arc shaped barrier of approximately 25 m in length was constructed within the drainage pathway between drill location (AND-08-03) and Andrew Lake. The ground was prepared by excavating a shallow (~0.3 m) deep trench and placing a sheet of polyethylene in the base of the trench, extending downhill. The sandbags were then placed on top of the poly liner and another row of sandbags was placed immediately downhill of the trench, on ground surface. The leading edge of the poly liner was then stretched back over top of this row of sandbags and another row of sandbags was placed over top to hold it in place. Photo 2 shows the completed sandbag barrier while an aerial view is shown on Photo 3. A second sandbag barrier was installed as a precautionary measure near a second drill (AND-08-04), though drilling fluids from this drill did not flow to Andrew Lake.



Legend

- NTU Sample Location and Value
- Unauthorized Release Path
- Sandbag Berm
- Silt Barrier
- Tundra Barrier
- Marsh
- Lake
- Flow

Reference:
NTS Digital Water

PROJECT
KIGGAVIK PROJECT

TITLE
ANDREW LAKE MONITORING AND MITIGATION

Golder Associates
Saskatoon, Saskatchewan

PROJECT		08-1362-0506	FILE No.
DESIGN			SCALE AS SHOWN REV. 0
GIS	JRC	31/07/08	
CHECK			**FIGURE: 1**
REVIEW			

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Photo 1 Vegetated berm located between the wetland (left) and the main body of Andrew Lake.

Photo 2 Sandbag berm located along unauthorized release pathway between Andrew Lake and the drill locations.

The sandbag barriers are intended to delay flow containing suspended particulates creating a shallow pool on the upstream side of the berm that will allow suspended material to settle out on the ground surface. The barriers will remain in place for the remainder of the summer. The sandbag barriers will be decommissioned by:

- removing the sandbags;
- removing the poly liner; and
- placing the excavated soil back into the shallow trench.

3.4 Personnel Interviews

Interviews were undertaken with AREVA personnel (Dan Zunti, Noella Gardiner, and Kim Sarauer) and with BOART Longyear personnel (Jeff Flath). The objective of the interviews was to establish the pertinent details and causes of the incident.

Zunti, Gardiner, Sarauer Interview: Drilling started on Borehole ANDW-08-03 on June 27, 2008. On July 6, 2008, discoloured water was observed to be flowing into Andrew Lake. Field personnel discussed with senior project staff and a decision was made to shut down drilling at this borehole location. Mr. Zunti and Ms. Gardiner began an on-site rotation on July 7, so their understanding of the incident reflects both direct knowledge of the follow up activities and communications with their counterparts on the previous on-site rotation. Ms. Sarauer was on-site over the period of the release and follow-up.

Drilling procedures used at this location were similar to drill procedures used on previous boreholes at the site, and in the opinion of the interviewees, the drill procedures were consistent with the exploration permits. Two reasons were suggested for the impacts on Andrew Lake:

1) The duration of drilling at this particular location. Due to difficult drilling conditions, progress on this borehole was very slow, requiring extensive reaming and repeated attempts to stabilize the borehole. This generated significantly more cuttings than typical at a particular drilling location.
2) The unregulated flow of return water. Water is pumped from the lake into a pair of holding tanks near the drill. This water is heated and used for drilling. When the tanks are full, they are allowed to overflow onto the ground. It is suspected that the added overflow water was partially responsible for transporting the drill fluid into Andrew Lake.

Flath Interview: Mr. Flath is the drill foreman for BOART Longyear, the drilling contractor on the project. He was not on site when the release occurred, however his understanding of the logistics of the incident was similar to that reported by Zunti/Gardiner/Sarauer. Mr. Flath reports that the drilling procedures used on this borehole were consistent with the drilling procedures used on other boreholes drilled on the property. He further reports that the drilling equipment

was functioning properly at the time of the release, and that the equipment used was consistent with BOART Longyear's contractual requirements. Two reasons were suggested for the impacts on Andrew Lake, identical to the suggestions made by AREVA personnel:

1) The duration of drilling at this particular location. Due to difficult drilling conditions, progress on this borehole was very slow, requiring extensive reaming and repeated attempts to stabilize the borehole. This generated significantly more cuttings than typical at a particular drilling location.
2) The unregulated flow of return water. Water is pumped from the lake into a pair of holding tanks near the drill. This water is heated and used for drilling. When the tanks are full, they are allowed to overflow onto the ground. It is suspected that the added overflow water was partially responsible for transporting the drill fluid into Andrew Lake.

3.5 Permit Review

Permits and correspondence provided by AREVA and relating to the commitments made by AREVA with respect to the exploration activities were reviewed:

1) Kivalliq Inuit Association (KIA), April 3, 2007 letter from KIA to Barry McCallum, Manager, Nunavut Affairs, AREVA, entitled "*Land Use License No. KVL306C20*".

   Fuel and Chemical Storage: The Licensee shall not allow any petroleum or chemical products to spread to surrounding Lands or into water bodies.

   Drilling: All drill fluids must be disposed of into a properly constructed sump or a naturally occurring, contained depression and drill fluids should be recycled wherever possible.

   Drilling: Drill sumps shall not be located within 30 metres of any water body…

2) Indian and Northern Affairs Canada (INAC), April 5, 2007 letter from INAC to Mr. Barry McCallum, AREVA, entitled "*Land Use Permit N2006C0037, Type of Operation: Mining (Exploration), Location: Judge Sissons Lake, Kivalliq, Nunavut*".

   Section 31(1)(e): The Permittee shall not locate any sump within (31) metres of the normal high water mark of any stream.

   Section 31(1)(g): The Permittee shall not allow any drilling waste to spread to the surrounding lands.

3) Nunavut Impact Review Board (NIRB), March 28, 2008 letter from NIRB to the Honourable Chuck Strahl, Minister of INAC, entitled "*Extension Request for AREVA's Land Use Permit with Indian and Northern Affairs Canada for their Kiggavik-Sissons Exploration project*".

Additional Terms and Conditions, Point 5: The Proponent is required to use biodegradable and non-toxic additives. The *Canadian Environmental Protection Act* lists CaCl (sic) as a toxic substance.

Appendix A of the Screening Decision Report: No fuel, drill cuttings, chemicals, wastes or sediment will be deposited into any water body as per the *Fisheries Act*, Section 36(3).

4) Nunavut Water Board (NWB), May 12, 2008 letter from NWB to Tina Hessdorfer, Licensing Coordinator, AREVA, entitled "*NWB License No. 2BE-KIG0812"*.

Part F, Conditions Applying to Drilling Operations, Point 3: The Licensee shall not conduct any land based drilling within thirty (30) metres of the ordinary high water mark of any water body, unless otherwise approved by the Board in writing.

Part F, Conditions Applying to Drilling Operations, Point 4: The Licensee shall ensure that all drill waste, including water, chips, muds and salts (CaCl2) … shall be disposed of in a properly constructed sump or an appropriate natural depression located at a distance of at least thirty (30) metres from the ordinary high water mark of any adjacent water body, where direct flow into a water body is not possible and no additional impacts are created.

Part H, Conditions Applying the Spill Contingency Planning, Point 4: The Licensee shall ensure that any chemicals, petroleum products or wastes associated with the project do not enter water.

The various permits suggest that disposal of drilling fluids onto the ground is an acceptable practice, provided that:

- the disposal occurs at least 30 metres from a water body;
- the disposal occurs in a properly constructed sump or appropriate naturally occurring contained depression;
- the disposed fluids to not enter water or encroach onto "surrounding lands". Our interpretation is that "surrounding lands" refers to lands outside of the surface lease;
- drilling is occurring through zones above or below the zones where radioactive cuttings are generated. When radioactive cuttings are generated, the standard practice is to separate the cutting from the return water, recycle the return water, and store the radioactive cuttings with the radioactive core; and
- the drilling fluid does not contain any hazardous materials such as petroleum products. It is noted that in general hot water is used for drilling (instead of calcium chloride).

On this basis, it is concluded that the key regulatory issue with the unauthorized release is the fact that drilling wastes encroached on Andrew Lake.

4.0 CAUSES OF THE INCIDENT

Based on the investigations carried out, we conclude that the drill fluid management procedures used on the project are not inconsistent with the permit requirements and that the immediate factors causing the incident were the long duration of drilling at the location, and the compounding effect of return water in mobilizing the drill fluid towards the lake.

The direct cause of the incident was the failure to identify the impact in time (and hence to implement mitigative measures in a timely manner).

5.0 IMPACT ASSESSMENT

The assessment of impacts of drilling fluids released to the receiving environment is focussed primarily on Andrew Lake and potential changes to water quality. Fine particulate matter contained in the drilling fluid has the potential to result in elevated Total Suspended Solids (TSS) levels in Andrew Lake. Andrew Lake is small, very shallow waterbody with a surface area of 0.54 $km^{2,}$ and a maximum and mean depth of ~ 1 m and 0.2 m, respectively.

Turbidity sampling site locations are documented using GPS, and are shown on Figure 1. corresponding turbidity measurements and TSS levels are indicated in Table 1. TSS can be a major contributor to turbidity though other materials such as organic detritus and plankton can also contribute to turbidity. At Andrew Lake, TSS measurements were also collected at some locations where turbidity was measured (Table 1).

Table 1
Turbidity Measurements (NTU) and TSS (mg/L) for Andrew Lake

Location (Waypoint No.)	NTU	TSS (mg/L)
202	1.05	2
203	6.30	5
205	0.70	7
206	0.40	1
207	0.37	1
208	0.38	1
209	0.45	1
210	0.40	1
211	0.35	2
212	0.27	1
213	0.35	1
222	0.25	1

Both turbidity and TSS levels are slightly elevated within the wetland margin that is largely enclosed by a ridge of higher ground and organic material that separates the wetland from the main body of Andrew Lake (Photo 1). Both NTU and TSS levels are low for the main body of the lake. For comparison, TSS and turbidity were measured in Andrew Lake in August of 2007 prior to recent drilling activity. Analytical results from those water samples indicated that TSS was 4 mg/L and Turbidity was 1.8 NTU. With the exception of location 203 and 205, all levels are below values measured previously.

Based on water quality measurements, elevated turbidity and TSS appear isolated to the nearshore margin that is partially enclosed by a natural barrier. Values may have been higher initially but sampling results do not indicate any residual impact in Andrew Lake.

6.0 MITIGATIVE MEASURES

The mitigation strategy is designed to limit the movement of drilling fluids and the associated fine particulate matter. Fine particulates occur along the flow pathway between the drill and Andrew Lake, and while the material was not flowing once drilling ceased, there is potential for fine particulate material to be transported from the drill site to the lake during rainfall events.

In addition, material could be washed along the flow pathway to the lake and possibly move from the isolated wetland area into the main body of Andrew Lake. The objective of the mitigation strategy is to reduce the amount of material that could be washed into the lake by creating barriers to movement along the drainage pathway and isolate any material that enters the lake to the small existing wetland area along the shoreline. To accomplish this objective a 25 m long sandbag berm was constructed along flow pathways where drying drilling fluid occurred.

Within the lake, most of the fine particulates settled in a wetland area along the shoreline that is bounded by the lake shoreline and a low ridge (Photo 1 and Photo 3). However, the ridge is breached in two locations where mobilized particulates could potentially flow into the main body of the lake. At these two locations vinyl silt barriers were installed to block the channels and prevent particulates from moving into the main body of Andrew Lake (Figure 1).

7.0 REVISED DRILLING PROCEDURES

The following revisions to drilling procedures have been implemented in order to prevent a future recurrence of this issue.

1) Return water manifold. The drill water pipeline has been fitted with a manifold and a return water hose. When the holding tanks are full, the manifold switch is thrown so that the flow of water is then redirected into the source water body.

2) Daily inspections. The drill crew leader performs an inspection of the drill fluid dispersion twice daily. In the event that drill fluid begins to flow towards a water body, mitigative measures (sandbag barriers) will be implemented.

3) Drill return sump (as needed). A metal sump is used to collect drill fluid return on an as needed basis. In the event that drill fluids begin to disperse widely, the return fluid can be collected in this sump and diverted by pumping it to another location further away from potential receptors (water bodies).

Photo 3 Location of sandbag berms along drainage pathways. Furthest berm is along the unauthorized release pathway where drilling fluids reported to Andrew Lake. The nearest berm was installed along a second pathway and is intended to intercept flow from a second drill.

8.0 CLOSURE

This report details the apparent causes of the unauthorized release of drilling fluids into Andrew Lake and documents mitigation efforts to reduce the potential impact to the receiving environment. Based on water quality data collected near the unauthorized release site in Andrew Lake, it is concluded that while concentrations of particulate material was elevated near the point of discharge in Andrews Lake, the natural ridge occurring inside the existing lake shoreline served to limit the movement of suspended material into the main body of Andrew Lake. Any subsequent remobilization of the drilling fluid due to precipitation events is unlikely to result in elevated TSS levels in Andrew Lake due to the installation of sandbag barriers along the flowpath between the drilling site and Andrew Lake, and impermeable floating barriers placed along

breach points within the natural ridge barrier. As the drill cuttings consolidate, the potential for significant future remobilization will be reduced so that the sandbag barriers can eventually be removed (proposed for autumn of 2008).

We trust that the findings and recommendations provided in this report meet your needs at this time. Should you require further information or clarification on any aspects of this report please do not hesitate to call either Laurent Gareau, or Brent Topp.

BT/LG/ldmg

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