Kiggavik Project

Environmental Impact Statement

Tier 3 Technical Appendix 2C

Explosives Management Plan

December 2011

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ABBREVIATIONS

AN .....Ammonium nitrate
ANFO ..... Ammonium nitrate fuel oil
AREVA ..... AREVA Resources Canada Inc.
CCME.....Canadian Council of Ministers of the Environment
DFO..... Fisheries and Oceans Canada
EHS..... Environmental, Health, and Safety
EIS .....Environmental Impact Statement
EPCM.....engineering, procurement, construction, and management
EPP ..... Environment Protection Plan
HADD .....Harmful Alteration, Disruption, or Destruction
INAC..... Indian and Northern Affairs Canada
MMER ..... Metal Mining Effluent Regulations
the Project.....Kiggavik Project
IOL .....Inuit Owned Land

1 INTRODUCTION

The Kiggavik Project will require ammonium nitrate (AN) to manufacture ammonium nitrate-fuel oil (ANFO) and emulsion explosives for controlled blasting during the mining of the Kiggavik and Sissons area deposits. This plan discusses explosives management and in particular ammonium nitrate pursuant to directives from the Nunavut Impact Review Board and Nunavut Water Board. At this stage, the explosives management plan is conceptual since mine construction has not commenced.

1.1 EXPLOSIVES USE

Explosives use management will have the primary goal of limiting loss of ammonia to mine rock and ore, which could subsequently leach into runoff. Explosives storage will be controlled and runoff from storage areas contained. Emulsions will be used for wet blasting; ANFO will be used for dry blasting to limit ammonia leaching. Consideration will be given to using 100% emulsion products to simplify the blasting procedure. Packaged explosives will be kept on site where required and for a backup for emulsion explosives and where required. All runoff into the pit and off of waste rock piles will be contained.

1.2 EXPLOSIVES REGULATIONS

The proposed explosives magazine for the Kiggavik Project will be designed in accordance with the Canadian Regulations for the Storage, Possession, Transportation, Destruction and Sale of Blasting Explosives and Initiation Systems (2008). The Regulations state that *"a magazine should be situated so that the accidental explosion of its contents is not likely to cause serious damage to other buildings or injury to persons*".

As well, the Kiggavik explosives magazine will conform to Nunavut Mine Health Safety Regulations (1994), Section 14.06 which state that:

> *Overhead power lines supplying electricity to a magazine or area where explosives are prepared shall*
>
> *a) be protected against power surges and lightning; and*
>
> *b) be terminated in a cable a minimum of 60 m horizontal distance form the magazine.*

And Section 14.08, subsection 2) which states:

The ground surrounding a magazine must be kept free of brush, timber or other combustible material for a distance of not less than 20 m from the magazine.

1.2.1 Impact on Fisheries

Fisheries and Oceans Canada (DFO) has established a set of guidelines for the use of explosives in or near Canadiean fisheries waters (Wright and Hopky, 1998). These guidelines set out that "No explosive may be used that produces or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during egg incubation". Under conditions where these guidelines cannot be met, the proponent is required to prepare a mitigation plan outlining additional procedures for protecting fish and their habitat. It is worth noting that this guideline limit only applies during spawning season and only at spawning beds. The DFO guidelines also set out an underwater overpressure limit of 100 kPa at fish habitat.

1.2.2 Nitrogen Compounds in Mine Effluent

Mines are subject to regulations limiting ammonia, nitrate and nitrate levels in mine effluents release into the environment. Discharge limits are typically defined in consultion with the regulators based on legislated water quality guidelines (e.g. metal mining effluent regulations (MMER)).

The ammonia limits in mine effluent in Nunavut are set by the water board in consultation with AREVA. The effluent limits are intended to allow the proponent to meet Canadian Environmental Quality Guidelines (CCME) aquatic life guidelines in the receiving environment at a pre-determined location. The receiving guidelines are as follows:

- Total unionized ammonia 0019 mg/L (dependent on water temperature); and
- Total NO_3-N = 13 mg/L.

The MMER does not have ammonia guidelines but states the undiluted effluent cannot be acutely toxic.

2 EXPLOSIVES MANAGEMENT

Mining involves drilling large diameter holes (blast holes) and loading these holes with an explosive to blast the material into sizes that can be handled. The depth of these blast holes is determined by the bench height. Blasted materials are then loaded into large trucks using a hydraulic shovel, loader, or backhoe, and hauled to an appropriate stockpile or disposal area.

2.1 EXPLOSIVE USE AND TYPE

At the beginning of mine operation, it is anticipated that the mined rock will be blasted using a bulk form of emulsion and ANFO mixture (70% emulsion to 30% ANFO). A bulk explosive truck will mix the appropriate blend of emulsion and AN prill and transfer this product to the pit for borehole loading of both dry and wet holes. A powder factor of 0.66 kg/bcm (0.25 kg/t) has been used for design purposes. Blasts are typically envisioned to be 200,000 to 300,000 tonnes each and will occur about two or three times per week.

For detailed information on the drilling and blasting design proposed for the Kiggavik Project, refer to Technical Appendix 2B “Drilling and Blasting Design and Related Regulatory Considerations”.

2.2 PRODUCT DESCRIPTION

Explosives will be required at the Kiggavik Project for blasting of rock and ore at the various mine locations. Transportation, storage, use, and handling of blasting materials are strictly regulated by the Federal *Explosives Act* and the *Transportation of Dangerous Goods Act*. Territorial regulations include the *Explosives Use Act* and Regulations and the *Mine Health and Safety Act* and Regulations. Further detail on the hazards associated with explosives material, refer to Technical Appendix 2U “Hazardous Material Management Plan”.

Material hazard class, potential impacts, site handling and storage requirements, and recommended personal protective equipment are summarized in Tables 2.2-1 to 2.2-3.

Table 2.2-1 Explosives – Hazard Class and Potential Impacts

Material	Hazard Class	Potential Impact
Ammonium Nitrate	5.1	Water & Soil Contamination
High Explosive Detonators	1	Negligible
Blasting Caps	1	Negligible

Table 2.2-2 Explosives – Safe Handling Procedures

Material	Safe Handling Procedures
Ammonium Nitrate	Keep away from heat and sources of ignition. Do not ingest or breathe dust. In case of insufficient ventilation, wear suitable respiratory equipment. Avoid contact with skin and eyes. Store in a cool, well-ventilated area separate from acids, alkalies, reducing agents and combustibles.
High Explosive Detonators	Store under dry conditions in a cool, well ventilated magazine in closed containers. Keep away from heat, sparks, and flames.
Blasting Caps	Store under dry conditions in a cool, well ventilated magazine.

Table 2.2-3 Explosives – Personal Protective Equipment

Material	Personal Protective Equipment		
	Eyes	Skin	Respiration
Ammonium Nitrate	Safety goggles	Nitrile or rubber gloves; protective clothing	NIOSH/MSHA approved respirator
High Explosive Detonators	Safety goggles	Nitrile or rubber gloves; protective clothing made from cotton	None usually required
Blasting Caps	Safety goggles	Nitrile or rubber gloves; protective clothing made from cotton	None usually required

2.3 EXPLOSIVES QUANTITIES

The Kiggavik Project is estimated to require a maximum of approximately 9,000 tonnes per year of blasting materials during peak mining operations. The majority of this represents ammonium nitrate, which is not an explosive until mixed with fuel oil. The bulk of explosives used for mining will be ammonium nitrate fuel oil (ANFO), which is a mixture of 70% ammonium nitrate (AN) and 30% diesel fuel. ANFO will be mixed in an on-site plant by qualified personnel on an as-needed basis.

The explosives contractor will be responsible for maintaining inventory of all explosives onsite which will be reported to the mine manager weekly. A sample inventory control form is included as Attachment A. Table 2.3-1 provides a summary of the estimated annual explosives use for the Kiggavik Project.

Table 2.3-1 Summary of Estimated Explosive Use by Year

Year	All Open Pits 70/30 Blend (tonnes)	Underground Mine ANFO (tonnes)
1	231	0
2	7,693	0
3	7,331	40
4	7,645	237
5	6,823	372
6	6,808	426
7	6,771	770
8	1,998	819
9	1,677	814
10	1,529	841
11	1,540	793
12	731	556
13	311	125
Total	**51,090**	**5,793**

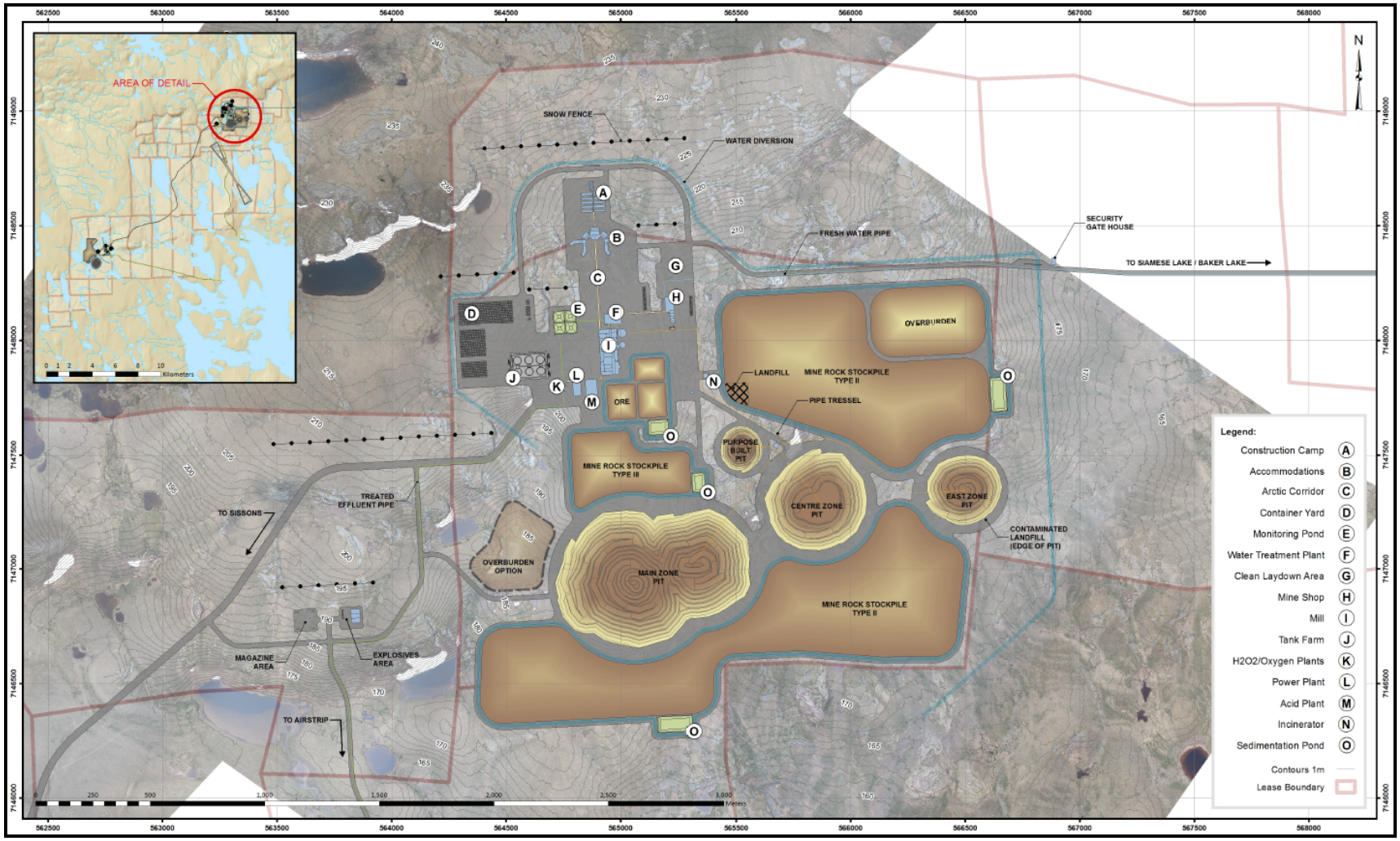
2.4 EXPLOSIVES STORAGE

Explosives components will be shipped to the Kiggavik site and the emulsion/ANFO blend will be mixed at site. Bulk storage facilities for emulsion and ammonium nitrate products will be constructed at the Kiggavik main site. The 70/30 emulsion/ANFO non-detonator sensitive blend is only considered an explosive agent when loaded at the hole. The explosive supplier will be responsible for designing and constructing the on-site manufacturing facility. Detonators, primers, pre-split explosives and miscellaneous blasting products will be shipped to site as explosives and be stored in site magazines. It is anticipated that four 4 m by 11 m magazines will be required for the following:

- Two magazines for pre-split and miscellaneous explosives;
- One for primers and detonating cords; and,
- One for detonators.

Figure 2.4-1 shows the proposed location of the ammonium nitrate storage area and emulsion plant. The powder magazine will be located in the same area 100 m beyond the detonator magazine. The roadway will be 5 wide, approximately, allowing only one-way traffic to and from the Main Zone pit area. It is estimated that the facility will contain a 40,000 kg capacity explosives magazine (pre-split powder and miscellaneous cartridge powder, primers and detonating cord), a magazine for blasting accessories (detonators, wire, etc.), bulk storage silos and a garage to house explosives delivery vehicles. The access road leading to this area will be located within the Kiggavik surface lease and access will be controlled.

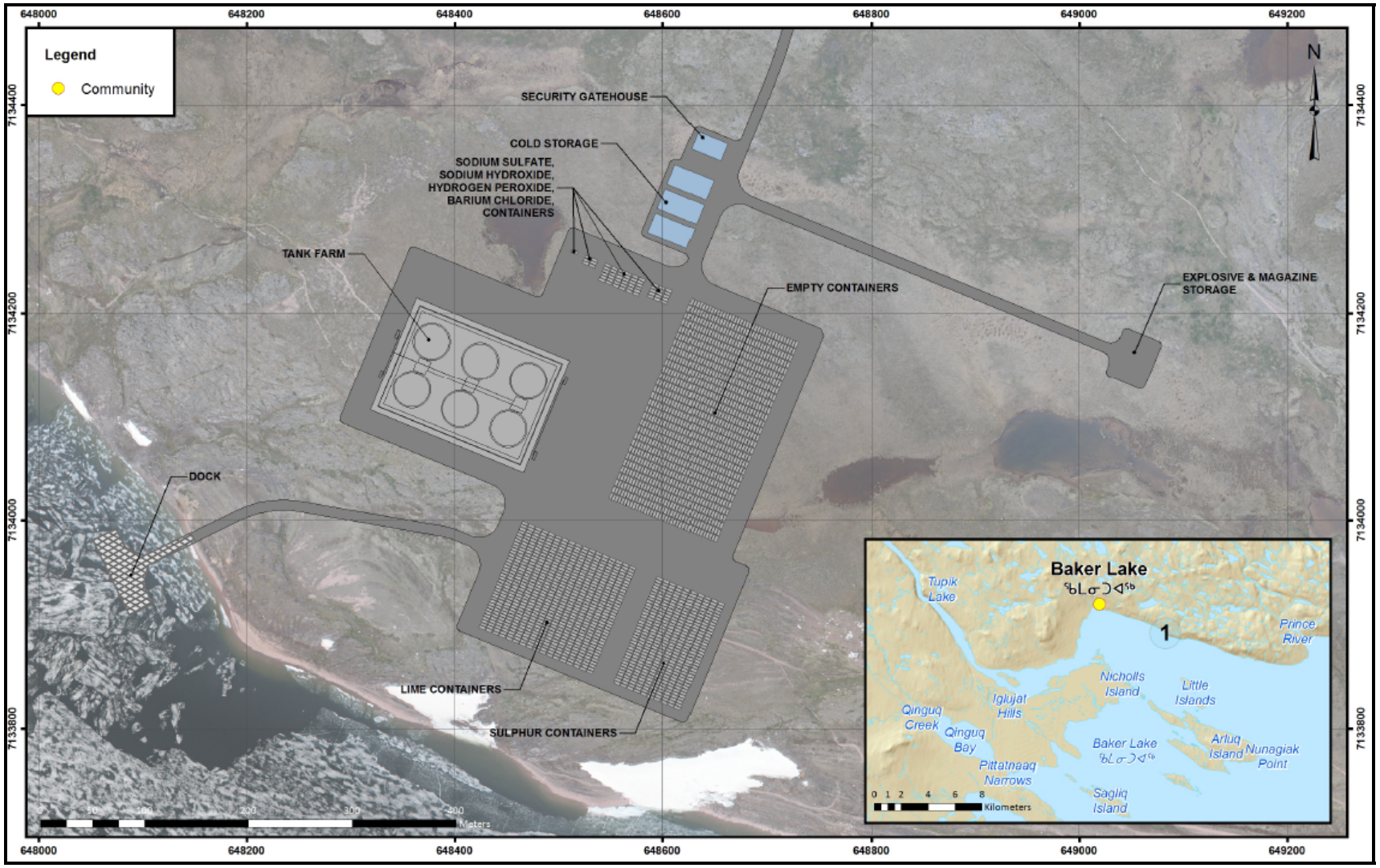
Figure 2.4-1 Kiggavik Site Layout



The explosives magazines will be comprised of a 2 m thick pad with surface areas of approximately 430 m^2 and 630 m^2 for the detonator and powder magazines, respectively. The explosives magazines will be designed to Type 4 magazine standards. There will be only one main magazine location for both the Kiggavik and Sissons sites. Explosives and accessories will be delivered to the pits by truck. Similarly, portal delivery to the underground mine will also be done by truck and temporary storage locations will be used as required.

A temporary storage area for explosive materials awaiting transport to the Project will be located at the Baker Lake port storage facility as indicated on Figure 2.4-2. This temporary storage area will be designed to conform to the same regulatory standards as the site magazine. Note that only explosives component materials will be stored at the port site and no explosives (emulsion/ANFO blend) will be produced or stored there.

Figure 2.4-2 Baker Lake Dock and Storage Facility Layout



2.5 TRANSPORT OF EXPLOSIVES

Transportation of explosives from the Baker Lake port storage facility to the Kiggavik site and from the Kiggavik magazine to mining areas will be conducted in such a manner as to safeguard human health and prevent impacts on the environment. The transfer will be arranged so that:

- delays between the points of transfer are minimized
- explosives are not left at any location other than designated locations
- explosives are not left unattended during transportation

Transportation of explosives at the mine site will be undertaken according to the requirements of applicable regulations including the *Explosives Act* and Nunavut Regulations. The explosives contractor and personnel are responsible for ensuring compliance to these regulations.

Nunavut Mine Health Safety Regulations state that mobile equipment used for transporting explosives onsite will:

- be kept in sound mechanical working condition
- be provided with orange diamond-shaped placards and with clearly visible signs marked "EXPLOSIVES" in letters not less than 150 mm in height when carrying explosives
- not be used to transport other goods or materials at the same time as explosives are transported
- be equipped with a type 20-ABC fire extinguisher
- not be loaded with explosives in excess of 80% of its rated carrying capacity
- have explosives secured or fastened so as to prevent any part of the load from becoming dislodged
- only be operated by an authorized person who is in attendance at all times
- carry only those persons necessary for handling explosives

- not be refueled if explosives or detonators are on board except where the mobile equipment is designed and used solely for transportation of bulk blasting agents

- have its engine shut off and its parking brake engaged while loading or unloading explosives, except where the vehicle uses an engine-powered device for loading and unloading

2.6 BLASTHOLE DESIGN

Production and blasthole designs for the proposed open pits at the Kiggavik Project have been designed based on standard design methods and are detailed in Technical Appendix 2B “Drilling and Blasting Design and Related Regulatory Considerations”.

3 AMMONIUM NITRATE MANAGEMENT

3.1.1 Nitrate Loss Mechanisms

Mines are subject to regulations limiting ammonia, nitrate, and nitrite levels in mine effluents released into the environment. The primary source of these nitrogen compounds is typically explosive used in blasting operations, as AN remains a significant component of most explosives used in the mining industry. The amount of AN entering a local water drainage system is related to site conditions, explosives used, explosive handling, and blast efficiency.

The key mechanism by which AN is lost to the water drainage system are as follows:

- Spillage during blasthole loading or transportation to the blast site;
- Dissolution by standing or flowing water through the blasthole;
- Erosion of explosive from high flowing water through the basthole; and,
- Leaching of undetonated explosive from the blasted puck, including both ore and mine rock.

Although the majority of explosives used will be from the surface open pits, the End Grid underground mine is also a potential source of nitrate loss.

3.1.2 Mitigation Strategy

In order to minimize potential impacts, an explosives management system will be implemented as part of the mine production start-up. In addition to what is included in this management plan, the explosives management strategy will include the following:

- An education program for all production employees that outlines the potential problem and appropriate mitigation techniques;
- A spill handling procedure;
- A monitoring program that is integrated with baseline water quality information; and,

- A review of blasting operations early in production to determine efficiency levels.

3.1.3 AN Storage Area

Ammonium nitrate (AN) dissociates readily in water to ammonia which, in its unionized form, is toxic to fish and other aquatic organisms. Storage on land away from water largely eliminates the risk of ammonia loss to water bodies. All AN for the Project will be stored in an enclosed warehouse in one tonne tote bags at the Kiggavik explosives storage area.

3.1.4 Emulsion Materials

Emulsion materials are acutely toxic to aquatic life. Release of these compounds directly to receiving water bodies would likely have negative effects on aquatic life. All emulsion materials will be stored at the emulsion plant where spills would be contained within the building.

3.1.5 Explosives Truck Wash

Water from the truck wash will have elevated ammonia concentrations from residual ammonium nitrate during transportation and handling. The explosives truck wash will be located at the emulsion plant. Water from the truck wash will be collected in a sump, pumped out as required and trucked to the water treatment facility.

3.1.6 AN Use

Explosive management systems and procedures will be implemented to minimize the impact of ammonia and nitrate levels in mine effluents. ANFO has no water resistance and will dissolve readily in water so spillage and blowback during loading operations will be controlled. Also, any wet holes will not be loaded with ANFO but a packaged emulsion product will be used in these instances.

4 BLASTING OPERATIONS

4.1 BLASTING

Blasting will be carried out by a certified blasting contractor following blasting regulations and safety protocols and under the supervision of mine supervisors. A revised detailed Explosives Management Plan will be developed by the blasting contractor and reviewed by the mine manager.

Blasting operations at the Kiggavik Project will involve a qualified and licensed explosives contractor responsible for all blasting operations. The explosives contractor will be responsible for the inspection of all explosives facilities and the safe operation of all explosives equipment. Weekly reports to the mine manager detailing total explosives consumption, inventory of ammonium nitrate onsite, other explosives, and safety concerns or incidents will be required.

Since the proposed open pits and underground deposits are some distance away from the explosives magazine, it will be necessary to transport prepared ANFO and blasting materials to the mine locations. Transport of ANFO and detonators will only be done by trained personnel on controlled roads under rigorous supervision. All explosives transport must comply with the *Canadian Explosives Act & Regulations* (1985).

The drilling of blast holes will be completed by mine personnel under the supervision of the mine supervisor and blasting contractor. Appropriate precautions will be taken to secure the area prior to blasting to ensure the safety of personnel. As well, precautions will be taken to minimize damage from flyrock and a blast clearance zone of 500 m from the pit crest has been set for all open pits at the Kiggavik Project.

4.1.1 Blasting in or Near Water

A blasting plan for blasting near water will be developed by the blasting contractor and included in the site-specific blasting management plans to address this issue. In circumstances where DFO guidelines cannot be met or where there is the potential for Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat, AREVA will work proactively with DFO representatives. Application for authorization to harm fish by means other than fishing might be required in accordance with DFO guidelines.

4.2 BLASTING SAFETY

Blasting safety procedures on breaking rock and frozen material are described below:

- No unauthorized person is allowed inside a posted blast area whether the holes have been loaded or not.

- The blasting supervisor and the blaster are responsible for the safe handling, loading and connection of a blast.

- The shift supervisor is responsible for the evacuation of all personnel and equipment from the blast area and the guarding of the blast.

- The general supervisor is responsible for notifying the appropriate personnel, and other departments and personnel who may be affected by a particular blast.

- Guards will be posted prior to blast time, and must remain guarding until they are told verbally by the shift supervisor that they can leave their position.

- Once guards are posted, the blast area must be inspected by the shift supervisor to ensure that no personnel or equipment remain inside the blast area.

- A blast-warning siren will be sounded for 1 minute. Three minutes after this the blast will be fired.

- The blaster will only fire the blast when given a direct verbal order to do so by the shift supervisor.

- Before firing a shot the blaster must ensure the immediate area is clear - i.e. aircraft etc.

- The shift supervisor and blaster will inspect the fired shot for indications of any problems such as misfires or cut-offs.

- Areas in which charged holes are awaiting firing shall be guarded or posted against unauthorized entry.

- Vehicles containing explosives shall not be taken to the repair shop or any other building for any purpose. No open flames or welding are to be used for field repairs unless explosives are first removed.

- Downhole initiation lines must be attached to a stake planted in the cuttings on all holes.

- All loaded patterns in addition to being marked with blasting signs shall be clearly delineated to outline the pattern.

- Redrills shall be marked with a plastic cone and be designated by a member of the blasting crew. The plastic drill cone shall be firmly implanted in the cuttings of the hole to be redrilled. The cone should be removed by the driller before drilling and inverted in the hole after drilling for pickup by the blasting crew.

- Where redrills are required on loaded patterns the drill must be guided by the blasting supervisor or blaster or a responsible person designated by them.

- Service vehicles and fuel trucks are not allowed on a loaded pattern. The drill must pull well clear of the loaded holes before work shall be done on it. Where the drill cannot be moved and service is required, it may be done only under the direct supervision of the blast supervisor or designate and all loaded holes must be covered.

4.3 SPILL PREVENTION

There potential for spills to occur at the ANFO mixing facility. Other incidents such as fire or explosion are also a risk. Detailed work instructions will be provided in the revised Explosives Management Plan that will be developed by the explosives contractor. In general, the following procedures will be implemented to prevent incidents involving spills, fire, or explosion:

- Ensure that fire extinguishers are provided both inside and outside the facility so that if extinguishers inside could not be used in an incident, outside ones are available. Fire extinguishers must be compatible with flammable materials (water-based where ammonium nitrate is involved).

- Used ANFO bags should be emptied completely and stored outside the facility at a safe distance from explosives to reduce the fire hazard risk.

- Any spills will be cleaned up and removed immediately to appropriate disposal facility. The spill will be reported and investigation of cause may be required.

- A “NO SMOKING” sign will be posted on visible walls of the facility.

- Ensure that lighters, matches, mobile phones, or radio transmitters or any item that might conduct electricity is not used at the explosives storage area.

- Follow all transportation, storage, use, and handling procedures outlined in this Plan.

- Report incidents of “near-miss” and actual accidents to appropriate personnel. Incidents will be investigated to help identify trends and reduce future reoccurrence.

4.4 DISPOSAL OF EXPLOSIVES

Explosives and explosive materials can be disposed of by burning, detonation, dissolution in water or solvent, or by chemical destruction. The selected disposal method will depend on the type of explosive, quantity, condition, and specifications from the manufacturer. All destruction of explosives will be carried out by licensed blasting personnel.

Destruction of large quantities of explosives will be carried out at a designated location at least 500 m from any building that could be damaged by the detonation. Personnel and other property damage will be avoided by sheltering the detonation area. Small quantities of explosives may be added to production charges in blast-holes for destruction.

Blasting personnel will adhere to the following procedures:

- Only a licensed person, or a person under the supervision of a licensed person, is allowed to dispose of or destroy explosives.

- Use a method of disposal that provides the greatest degree of safety to humans and protection of property and the environment. Take adequate precautions to protect against injury or damage to property.

- Ensure that the method of disposal is appropriate to the type and condition of explosives.

- Follow recommended disposal method indicated by manufacturer or responsible authorities.

- Unused explosives and explosive waste must be removed and disposed of under the supervision of or by the blasting contractor.

5 MONITORING AND REPORTING REQUIREMENTS

Explosives regulations and guidelines provide extensive detail regarding all aspects of the management and use of explosives. AREVA and its contractors will adhere to the applicable regulations and guidelines and will develop and maintain detailed management plans, operating procedures, and associated work instructions to include potential scenarios that could occur during the life of the Project. All monitoring and reporting will be completed as per requirements of the *Explosives Act* and other Nunavut regulatory requirements.

6 REFERENCES

AREVA Resources Canada (2011). Kiggavik Project Environmental Impact Statement. Tier 3 Technical Appendix 2B – Drilling and Blasting Design and Related Regulatory Considerations. December 2011

AREVA Resources Canada (2011). Kiggavik Project Environmental Impact Statement. Tier 3 Technical Appendix 2U – Hazardous Materials Management Plan. December 2011

AREVA Resources Canada (2011). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 10B - Spill Contingency and Landfarm Management Plant, December 2011

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Attachment A – Sample Form of Inventory Control Sheet

EXPLOSIVES INVENTORY

MAGAZINE TAG NO.:

PRODUCT DESCRIPTION*:

DATE	Shipped To/ Received From	STOCK			SIGNATURE
		IN	OUT	BALANCE	

*** Product description, such as brand name, strength, size of cartridge, detonator type, length and period, etc.**