Tahera
Diamond Corporation

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November 14th, 2005

Chief Administrative Officer
Nunavut Water Board
P.O. Box 119
Gjoa Haven, Nunavut
X0B 1J0

Delivered by Email

**RE: Part D, Item 14 Explosives Management Plan**

Please find enclosed the Explosives Management Plan to satisfy Part D, Item 14 of water license NWB1JER0410.

Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Sincerely,

Greg Missal
VP, Government and Regulatory Affairs
Tahera Diamond Corporation

Cheryl Wray
Environmental Supervisor
Tahera Diamond Corporation

Tahera
Diamond Corporation

# Explosives Management Plan

## Jericho Diamond Mine

## Version 2

## November 2005

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# 1. INTRODUCTION

As part of the mining operations at the Jericho Diamond Project (Jericho), the use of explosives is required and will include ammonium nitrate to manufacture ANFO and emulsion explosives for blasting at the mine during operations. The purpose of this updated Explosives Management Plan is to describe how Jericho Diamond Mine intends to minimize environmental impacts, specifically water quality and wildlife, while carrying out the blasting operations. It describes actions that that are taken to manage spills at point source which in turn will assist in reducing ammonia levels released to the environment.

Control and use of explosives are covered by both Federal and Territorial regulations. Tahera and our contractors have in place policies and procedures to meet, or exceed the regulations. The main applicable statutes are the:

- Transportation of Dangerous Goods Act
- Canada Explosives Act
- Northwest Territories/Nunavut Mine Health and Safety Act and Regulations.

In addition to the Standard Operating Procedures developed specifically for Explosives Management, there will be overlap or referencing to other guidelines governing:

- Training
- Hazardous Materials Management
- Emergency Response
- Mine Operation Procedures.

For operations, bulk explosives will be manufactured onsite by a licensed contractor, currently Dyno Nobel Nunavut Inc. (DNNI) who has provided a detailed operations manual for transportation, storage and handling of explosives. The recommended formulations are of commercial quality, industry-proven and accepted worldwide. The bulk explosives manufacturing will be operated by DDNI who has specific open pit arctic diamond mine experience. DNNI will also be providing down-the-hole delivery of the product to the blast hole by means of the new facilities and equipment licensed and approved by National Resources Canada, Explosives Division.

In addition to the raw ingredients, DNNI provides commercial packaged explosives and accessories that will be transported to the mine site. This will include detonators, boosters, detonating cord and packaged explosives for specialty applications. These materials will be stored on site in approved explosive magazines until issued for use.

# 2. EXPLOSIVES MANAGEMENT

The purpose of this document is to focus on environmental stewardship with regards to blasting and explosives management. Jericho Diamond Mine management has the overall responsibility for the planning, execution and management of explosives at the mine site.

Good handling techniques and spill control systems will limit ammonia leaching from the waste rock and kimberlite piles that will in turn minimize ammonia levels reporting to the Processed Kimberlite Containment Area (PKCA). To minimize leaching, emulsions will be used for wet blasting; ammonium nitrate-fuel oil (ANFO) will be used for dry blasting to limit ammonia leaching. Packaged explosives will be kept on site as a backup to emulsion explosives and where required. All runoff into the pit will be contained and transferred to the PKCA.

## 2.1. JERICHO SITE STORAGE

The attached drawing (Figure 1) shows the location of the ammonium nitrate storage area at the east end of the spur road east of the Waste Rock Dump. The emulsion plant location is west of this storage pad on the same spur road. Caps and powder will be stored in Sea Can magazines 250 m off the spur road, as shown. All these items are on one road that will have an access control gate at the west end to maintain security.

### 2.1.1 AN PRILL

The ammonium nitrate storage area is approximately 250m east of the emulsion plant and is intended to hold a one-year supply of bagged product. The prill is of granular or "pellet" form and is delivered in one-tonne totes and stacked at the AN storage pad (Figure 1). Until a building is in place the bags will be covered with tarpaulin.

The ammonium nitrate totes will be transferred from the AN storage area to the emulsion plant using a dedicated boom truck. Inside the plant, on a concrete floor complete with sumps, the bagged AN is opened and then augered into the bulk delivery truck on an as need basis inside the emulsion plant. The bulk truck will mix the appropriate blend of diesel fuel with the AN prill and transfer this product to the pit for borehole loading of dry holes. The ANFO product is water soluble and will require strict attention to ensure that this product is only used in dry holes. If wet holes are present, alternate products or methods will be used.

Should an AN spill occur, the spill is immediately cleaned up and reported to Environmental Personnel for subsequent reporting to the Spill Line.

### 2.1.2 EMULSION PLANT

The manufacturing process will be capable of producing various emulsion blends. The most likely product will be 70% emulsion: 30% ANFO blend. The plant will be able to hold a maximum of 30,000kg in the emulsion silo.

The AN Prill is transferred to the plant in the one-tonne totes. The prill will be added to the two solution tanks. Within the tanks, water and the AN prill are heated to produce an oxidizer phase. The tanks are in a concrete containment berm that holds 110% of the volume of the largest tank.

In the fuel blend area of the plant, fuel oil is blended with emulsifiers and other additives in a proprietary process to create the fuel phase. Quality control checks on both the fuel and oxidizer phases are conducted.

The two phases are mixed in a blender to form an emulsion explosive which is stored in the emulsion tank. From there it is pumped to the delivery truck system on an as needed basis.

This is an industry-proven, patented manufacturing process. The explosives contractor has Standard Operating Procedures and Hazardous Operations Procedures in place. The procedures cover items such as: receiving AN Prill, conditioning and testing the component phases, blending of the emulsion, equipment calibration, and preventative maintenance.

Chemicals used in the process will be stored according to their MSD sheets and copies will be posted in a conspicuous area. Copies will be provided to Tahera management for environmental and safety record-keeping.

### 2.1.3 MAGAZINES

The three magazines are on a pad some 250m west of the emulsion plant. The magazines are separated by berms that meet the "donor-receiver" conditions of safe storage. The magazines will be a Type 4 sea can style magazine (Appendix A) measuring 10ft. x 40ft. x 8ft. in size. The magazines are permitted for a capacity of 25,000kgs and will conform to standards as prescribed by Natural Resources Canada, Explosives Division and approved by the Mine Safety Division of the NWT/NU.

Magazines will be kept locked at all times when an authorized person is not present. Clearly visible "Danger Explosives" and "No Smoking or Open Flame" signage will be posted on the magazines and warning signs will be on the road approaching the storage area.

The magazines will be dedicated to storing blasting accessories such as boosters, delays, detonating cord and detonators. The detonators and delays will be stored in a separate magazine as required by the regulations.

Access to the magazines is restricted to authorized personnel only and logbooks will be kept in each magazine for tracking purposes. The magazines will be supplied and permitted by DNNI.

## 2.2. ON-SITE HANDLING

On-site transportation will be in accordance with Section 14 of the Mines Act and Regulations and the Transportation of Dangerous Goods Act. The vehicles will be in sound mechanical condition and equipped with flashers, buggy whips, signage and fire extinguishers as required. Loaded vehicles will not be left unattended. Authorized personnel will be responsible for the security of the explosives under their control.

### 2.2.1 AUTHORIZED PERSONNEL

Authorized personnel will be persons holding a Blasting Certificate or Provisional Blasting Certificate that is issued in accordance with Part VII of the Mine Health and Safety Act and Regulations.

Emulsion plant process personnel will be certified as needed (e.g. boiler certification, supervision etc.). It will be the responsibility of the explosives contractor to maintain current certification and to provide the information when requested.

### 2.2.2 BULK DELIVERY TRUCKS

The explosives contractor will utilize either an ANFO Mini Mixer or a "Triple Threat Truck" (TTT) to deliver bulk explosives product to the blast hole. The ANFO truck will be used in dry conditions whenever possible.

The TTT has three compartments and can deliver three types of blend. This flexibility will allow the blaster to accommodate wet-hole conditions that may be encountered.

This state-of-the art truck features a pump and hose reel for delivering the product. The truck operator takes periodic density samples to ensure quality control.

The truck has an onboard electronic metering system for tracking consumption and blends. The blaster will sign off delivery sheets after each delivery to ensure that accurate tracking is attained.

Equipment condition reports will be completed by each operator and checked by the supervisor for deficiencies daily. All explosives delivery trucks will be regularly maintained to ensure mechanical deficiencies are dealt with expeditiously and all safety systems are fully operational.

### 2.2.3 HOUSEKEEPING

Careful planning by the blaster means that very little, if any, product is left on the truck at the end of the workday. The bulk delivery truck is washed daily and this water reports to the Emulsion Plant sump, in where wash water from the lunchroom, change room, and the washing of dirt from the exterior of the truck all reports to. This water is then treated in the same manner as other satellite facilities and trucked to the Waste Water Treatment Facility.

The magazines will be kept free of empty boxes and swept clean on a regular basis. Similarly the blasters vehicles will be kept tidy with any empty packaging taken to the dump daily to be burned. No explosives are allowed to be stored in the vehicle when not in use. A weekly inspection and immediate remedying of deficiencies will be maintained.

### 2.2.4 ACCOUNTING

The blaster will be held accountable to ensure that all accessories and explosives are accounted for. Blasting accessories that are not used during the workday will be returned to their respective magazine and signed in. The magazines will be regularly audited for accuracy.

Missing explosives must be reported to a supervisor. Any explosives that are found must also be reported to a supervisor. Only an authorized person will be allowed to handle those items.

### 2.2.5 DISPOSAL

Explosives that have been identified as deteriorated or damaged will need to be destroyed. This may change the characteristics of the explosive and the supplier will be consulted on the appropriate handling and disposal.

If the quantities are small, then they would be added to blast holes in a production blast. This will safely destroy them, since the area will have been evacuated and guarded under normal blasting procedures which are detailed in the following section. If larger quantities require disposal or destruction, the explosives supplier is asked to recommend the appropriate method of disposal and subsequent course of action to be followed.

# 3 BLASTING OPERATIONS

The blasting practices at the Tahera Jericho Operation will be similar to most other northern hard rock open pit mining operations. The majority of mined rock will be blasted using a bulk form of emulsion. The emulsion (70% emulsion: 30% ANFO) is water resistant and is therefore ideally suited variable blasting applications. Other variations of water resistant products suitable for wet conditions are available in both bulk and packaged format. During dry conditions, some ANFO ("Heavy ANFO") may be tested.

It is important to note that the mine is starting as a "green field" operation and the blasting operation practices will change as the mine ramps up to full production over the first two years. In year 1 the blasting requirements are based on obtaining the necessary rock to construct the initial site infrastructure and access the first supply of kimberlite ore. Since this activity is essentially pioneering and consists of breaking as little as 1.5M tonnes of rock the product and the practices in this year will be unique.

Current northern diamond industry experience powder factors between 0.46 – 0.5 kg/t. The Jericho EIA used a powder factor of 0.8kg/bcm (0.3 kg/t). The total amount of ammonium nitrate required to support the operation in year 1 is approximately 750,000 kg. An additional 250,000kg will be brought in as a contingency.

For year two of mining, the AN prill to be purchased is a high-density product that has a talc coating to mitigate dust losses to the environment. This product is in use at the Ekati Diamond Mine and has proven to be quite effective.

## 3.1 PLANNING

The Jericho operation will be utilizing qualified personnel that have gained experience at other northern mines. This familiarity with permafrost and ground conditions will supplement the blast design and planning work.

Designs will be standardized wherever possible, but through careful tracking and analysis opportunities for optimization of fragmentation and mineability. Opportunities for continuous improvement of other areas of the drilling and blasting process may also be identified. Drill pattern designs will be planned so that hazardous situations such as drilling into a "bootleg" will be minimized.

A daily morning meeting will involve the blast supervisor, mine supervisor, engineer and management. The intent of the meeting will be to ensure that the blasting and mining sequences that were developed are being followed and that areas requiring preparation are understood and prioritized.

The pit engineer will be the lead on maintaining the plans and blast designs. Each blast will have a unique number for identification and tracking. The blasting supervisor will have input into blast designs and will have authority to make minor adjustments in the field to suit the actual conditions encountered.

On blast days, the engineer will ensure that all blast holes have been surveyed and are ready for plotting on the daily map. These survey locations will be used to track misfires, cutoffs and for designing the pattern on the next bench.

The blast supervisor will coordinate: drill site preparation, drill deployment, drill maintenance, blast crew priorities, explosives delivery, stemming needs and blast pattern signage / security.

The mine supervisor will work cooperatively with the blast supervisor for the drill site preparation, delivery of stemming material, blast safety zone requirements and personnel evacuation / guarding.

The daily activities of the blast crew will include the measuring, priming, loading and stemming of the holes. Sometimes the actual depths of the holes are different from the design depths. The blaster will record these differences along with presence and depth of any water encountered. This information is important for quality control and future design work.

## 3.2 SAFETY PROCEDURES

There are several precautions that must be in place for the safety of the workers in the mine. While the mine supervisor holds senior authority over the workers, blasters have complete authority to control all activities on a blast site.

The drilling/blasting and earthworks contractors will have in place Standard Operating Procedures and training programs to ensure that the operations are in compliance with regulations and company policies.

The area to be blasted will be prepared to the satisfaction of the blasting supervisor. A smooth floor will provide a safe work area for the drilling and blasting crew. The blast pattern will be staked by the mine surveyors in accordance to the engineers design. Access to the blast pattern must be attained from the blaster in charge.

The pattern will be drilled in the sequence prescribed by the blast supervisor. Once loading of holes has begun, other activities will be coordinated so that no normal blasthole drilling takes place within 8m of a loaded hole.

Loading will be under the direction of the blaster in charge of the pattern. The blaster will follow the loading quantities of the engineered design. Modifications due to field conditions will be noted and reported. The explosives contractor will deliver the bulk product to the hole and track the quantity. The blaster will sign for the delivery and all of the paperwork handed in at shift-end.

Should wildlife be present in the blast area the blast may be suspended until wildlife has moved to safe zones as dictated by the blast supervisor.

When the pattern is ready for blasting, notifications will be made in a clear and consistent manner. Guards will be placed, personnel evacuated and the blast will be fired when it is determined to be safe to do so. After the blaster has inspected the blast an "all clear" signal will be given to allow workers back into the work area.

## 3.3 VEHICLES AND EQUIPMENT

The perimeter of the staked pattern will be clearly marked so that unauthorized equipment or personnel can be kept out of the work area. All non-essential blasting equipment must not come within 8m of a loaded blast hole. Only the bulk-delivery trucks, blasters vehicle, or stemming loader will be allowed on the pattern when it is loaded. Once blasthole tie-in has commenced no vehicles will be allowed on the blast pattern.

Authorized vehicles will be modified to meet the requirement of Section 14.41 of the Mines Health and Safety Act and Regulations. Other vehicles may be authorized by the Chief Inspector of Mines.

Drills will be moved off of a blast pattern for servicing. Welding, cutting, burning or smoking will not be permitted within 20m of a loaded blast hole. Exceptions to this rule would be if a re-drill is required to improve the safety of the blast. In this instance the drill would be guided into place by the blaster or shiftboss.

Blast planning will take into consideration the aircraft schedule serving the Jericho Diamond Mine. Blast times will normally occur during lunch breaks to minimize impacts to production. If a blast is required during a time in which an aircraft is known to be in the area, management will follow the same procedure established by other northern mining operations and notify the pilot.

## 3.4 ADVERSE WEATHER CONDITIONS

During adverse weather conditions the blast supervisor will notify the mine supervisor of the precautions to be taken. In the event of electrical storms the blast sites will be evacuated and no blasting connections will be made.

In the event of poor visibility (e.g. ice fog or semi white-outs) the blast pattern should be well-lighted and clearly demarked. Explosives vehicles will be parked in a safe position or used in well-lit area.

## 3.5 SMOKE, DUST AND FLYROCK

While smoke and dust are common to every blast, some by-products of blasting include gases such as CO, $CO_2$ and $NO_x$ in higher concentrations can be harmful to humans and wildlife. The gas concentrations are related to product quality which can degrade due to items such as groundwater conditions, length of time between loading and blasting or the manufacturing process itself. Fortunately the gases disperse quickly. The blaster will not give the "all-clear" until completely satisfied that the gases have dispersed and that the area is safe to approach. At that time the guards will be removed allowing access to the area.

Flyrock is a potentially dangerous situation and can be minimized by best practices in blast design, face-up, confinement and stemming. The blaster and blasting supervisor assess the potential for flyrock in every blast and from that determine the blasting danger zone and where guards and personnel must be evacuated to.

## 3.6 MISFIRES

The reporting and handling of misfires is defined in Section 14.56 of the Mines Health and Safety Act and Regulations. All misfires and cutoffs will be documented in a logbook kept for this purpose. The logbook will be in the care and custody of the blasting supervisor but will be periodically reviewed by the engineer.

When a misfire or cutoff has been identified it will be treated as a loaded hole until made safe. A blast sign and markers will be placed around the hole to ensure that no equipment or personnel come within the minimum 8m required by the Regulations.

The location of misfired holes will be surveyed and shown clearly on the daily mine map. The locations will remain on the maps until the hazard has been removed and area made safe.

The logbook will include the date, pattern number and any other observation that is deemed pertinent. The misfire or cutoff will be made safe by an authorized person and this information added to the logbook. The authorized person will date and sign the log-book.

The engineer will use the survey location and logbook information to try to correlate the incident to ground-conditions, blast design or product-quality issues.

## 3.7 REPORTS AND RECORD-KEEPING

The misfire logbook discussed above is a special instance of the daily reporting and record-keeping expected of the blasters and blast supervisors. It is the responsibility of the blaster in charge to sign in and sign out blasting accessories from the magazines; conduct and record magazine inspections and inventory audits; acknowledge receipt of bulk product delivered to the blast hole; and to do a blast report.

The blast report includes the following information:

- Deviations from the engineered design.
- Date and time of the blast.

- Name of the blaster and helpers.
- Description of weather conditions.
- Pattern number and number of holes.
- Accessories used (e.g. number and times of the delays)

The pit engineer will keep files on all blast patterns. This will be a common file system to minimize duplication and waste of space. Only the pit engineer or blast supervisor will have access to the files.

## 3.8 CONTINUOUS IMPROVEMENT

The explosives contractor has a reputation for product quality and safety, technical support and operational capability. Working with Tahera and the mining contractors it is expected that a team-based collaborative effort will result in value-added improvements.

Key Performance Measures will be established to benchmark progress and set goals. Primary goals will be to protect the environment and the safety of the workers. Other goals to be monitored will be wall-control (pre-shears), productivity, product quality and cost.

The framework of the continuous improvement system will be patterned after those in use at other minesites, however it will be on a much smaller scale. Outside specialist consultants may be used to enhance the process or focus goals as needed.

The low mining rates anticipated at the Jericho Diamond Mine will allow time for analysis of blast performance that can be applied quickly to subsequent blasts.

## 3.9 SPILL CONTAINMENT

Ammonium Nitrate (AN) is commonly used as a fertilizer and itself is not an explosive. AN is water soluble is easily dissolved in a solution, which can be toxic to aquatic life and acts as a nutrient in water which can promote the growth of algae, therefore AN spills must be prevented.

As the truck moves from hole-to-hole, occasional small amounts of product may drip from the hose to the ground. The blaster, or helper, will shovel these drops into the nearest blast hole to assist in the prevention of pit water contamination. ANFO or emulsion spills must be cleaned up immediately to prevent the contamination of the pit water which reports to the PKCA. Water monitoring of the pit water and PKCA will provide an indication of ammonia present prior to release to the Environment.

# 4 FISHERIES CONSIDERATIONS

The Department of Fisheries and Oceans (DFO) expressed concern about the potential impact to fish due to vibration from blasting. This concern extended to the fish that use Stream C1. Tahera Diamond Corporation has committed to protecting the fisheries area.

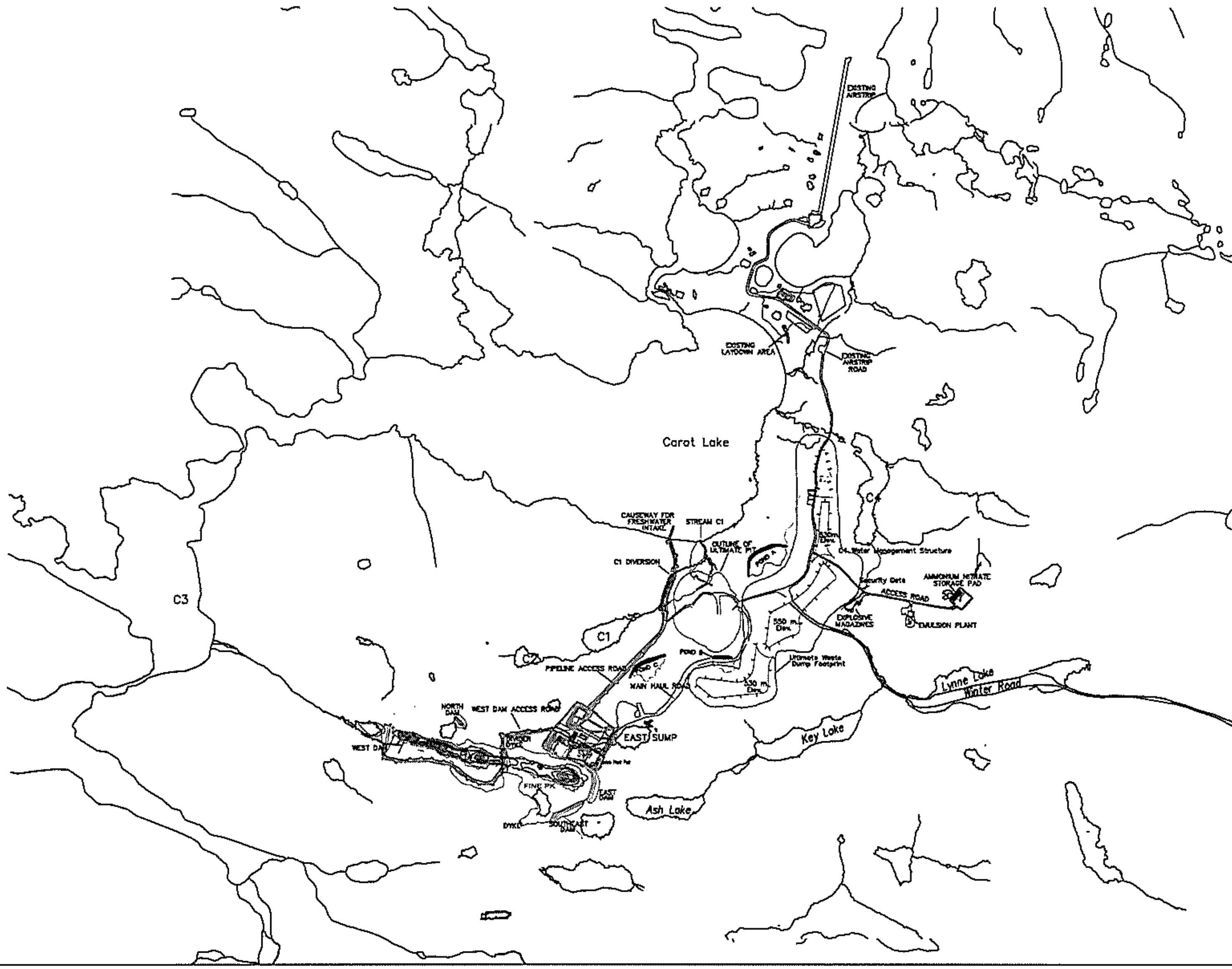
With respect to blast vibration, it will be minimized by the use of hole-by-hole blast delays. This methodology will keep vibration levels below those recommended. The Peak Particle Velocity (PPV) committed to was 13mm/s with an Instantaneous Pressure Change (IPC) of 100kPa.

A recent study at the Diavik Diamond Mine indicate there could be some negative effects to lake trout (char) eggs during the first two weeks of the embryo stage from vibration due to blasting. Those recommendations indicate that keeping blast vibrations below 20mm/s in the lake will accommodate a healthy gestation period for lake trout embryos. Typical spawning time for this species of lake trout is about September 15.

Our commitment to keep PPV levels at, or below, 13mm/s at the edge of Carat Lake fall well below recommended levels. This will ensure a healthy environment for lake trout or slimy sculpin eggs. Blast vibration will be monitored to set a baseline and follow through until the end of October as spawn times will change slightly year to year.

Vibration monitoring was conducted in 2005 by the Explosives Contractor and information collected can be found in Appendix B.

# FIGURES




| Notes: | | |
|---|---|---|
| Dwn: CRT | | Tahera Diamond Corporation |
| NOV 7, 2005 | SCALE: 1:25,000 | FIGURE 1 SITE PLAN |

# APPENDIX A

# SECTION 3 - TYPE 3 MAGAZINE

**(10-cm Stud-Frame)**

**3.1** Type 3 magazines built to the *Revised 1982 Magazine Standards for Blasting Explosives and Detonators* will no longer be permitted as an option for new magazines commencing on May 31, 2001. Refer to Part III, Section 3.0, for the phase-out period of existing magazines.

# SECTION 4 - TYPE 4 MAGAZINE

**(Metal Plate)**

## 4.1 Uses

**4.1.1** Magazines built to this standard are suitable for use as permanently located (usually walk-in-type) or portable magazines for the storage of industrial explosives.

Much of what is stated for a Type 1 magazine with respect to the metal fabricated components such as the door, locks and hinges, etc., is referenced and applicable to a Type 4 magazine.

There are two versions: one generally described as the larger walk-in-type magazine known as a Type 4 magazine, and a smaller version known as a Type 4S, which differs only in door height, the number of hinges, and door-stiffening angle iron.

Notes:

- With the exception of the province of Quebec,[13] Type 4 magazines can be fabricated in two ways, i.e., with ballistic material in the walls or without. Type 4 magazines fabricated WITHOUT bullet-resistant materials in the wall may only be used for the storage of detonators (refer to subsection G.2.2).
- Magazines built with NO bullet-resistant materials in the walls must be identified with the letter "D" to represent detonator storage only on the licence opposite to the magazine type. In addition, the letter "D" must be shown in a prominent location, e.g., on the inside of the door and on the outside of the magazine as part of the magazine code/tag system of identification (refer to Section G.11) so that it can be readily observed by an explosives inspector.

**4.1.2** The formation of missiles in the event of an accidental explosion of the contents is an unknown factor, not readily determinable. For special considerations in locating magazines on factory sites, in complexes containing numerous magazines, or in populated areas, refer to the *Q/D Principles*. For such locations, Type 1 magazines with their structural reinforcement are preferred.

## 4.2 Basic Construction

**4.2.1** Type 4 and Type 4S magazines are fabricated from 6-mm metal plate. The walls shall contain at least 7.6 cm of bullet-resistant material (refer to subsection to subsection 4.1.1, and to 4.11 for exception), and the roof must be 4.7-mm or heavier metal plate.

## 4.3 Materials

**4.3.1** Metal plates and shapes shall be mild steel unless otherwise specified.

**4.3.2** Plywood shall be exterior fir ply type. Faces exposed on the interior shall be good one side (GIS).

## 4.4 Foundation

**4.4.1** All magazines shall be mounted on large metal I-beam skids giving a minimum ground clearance of 10 cm or more for structural rigidity and portability.

The whole structure can be raised to truck dock height to facilitate loading and off-loading by mounting the magazine, for example, on concrete highway dividers, steel A-frames or earth mounds.

Notes:

- No structural wood support is permitted under the magazine.
- Magazines built to these standards will, in all likelihood, be moved/relocated several times during their life span and, as a result, are subjected to substantial stresses from the actual move, be it lifted onto flatbed trucks, towed over rough terrain, or seasonal cycles including frost heave. Such torsional stresses can lead to a poor door fit or jamming and weld cracking.

Torsional stresses can be minimized with larger I-beams, additional sub-floor supports and welding techniques as outlined in CAN/CSA-S16.1-94 *Limit States Design of Steel Structures*, and good engineering practice as outlined in the *National Building Code of Canada*. The size and number of these structural members are left to the fabricator/designer to incorporate into the magazine.

## 4.5 Framework and Walls

**4.5.1** The walls shall be fabricated with continuously welded seams from 6-mm or more metal plate. Corner seams shall be welded both inside and outside to ensure complete penetration and increased strength required for lifting of the entire structure. Rolled external corners are recommended for structural integrity.

Lifting lugs are often required to support the substantial weight of a portable magazine (with or without bullet-resistant material) during a relocation.

Notes:

- Lifting points must be designed by a professional engineer using good engineering practice as outlined in the *National Building Code of Canada* and welding techniques as outlined in CAN/CSA -S16.1-94 *Limit States Design of Steel Structures* (refer to subsection G.2.3).
- Internal support bracing for the walls and roof is strongly recommended when transporting any large magazine.

Metal "I" and "U" channels or angles of 7.6 cm (3") or greater depth shall be fastened at suitable vertical intervals around the interior walls. When required for structural rigidity, these channels/angles may be used as the framework.

The walls shall be filled with bullet-resistant material as outlined in subsection 4.11 (refer to Illustration 11).

Notes:

- Wall spacing of 7.6 cm is required for either washed hard crushed stone or washed coarse gravel.
- Wall spacing of 15 cm (double the thickness) is required for sand as a substitute bullet-resistant material, i.e., requires larger channels or angle wall studs.

The inner walls shall be fully sheathed with 20-mm (0.75") plywood fastened to the channels with the good side exposed to the inside of the magazine. However, the top 30 cm may be removable to permit filling between the channels with bullet-resistant material. The bottom 15 cm may also be removable to permit removal of this material. Fasteners shall be plated and countersunk. The door and ventilators shall be the only openings.

Note: Metal "I" and "U" channels or angles of 7.6 cm (3") or greater depth may not be required for small Type 4S magazines used for the storage of detonators only, i.e., no ballistic resistance required. They are recommended for larger detonator storage magazines to provide enhanced structural rigidity.

## 4.6 Floor

**4.6.1** The floor shall be fabricated from 6-mm metal plate with continuously welded seams. Joints between the walls and floor should be welded both inside and outside.

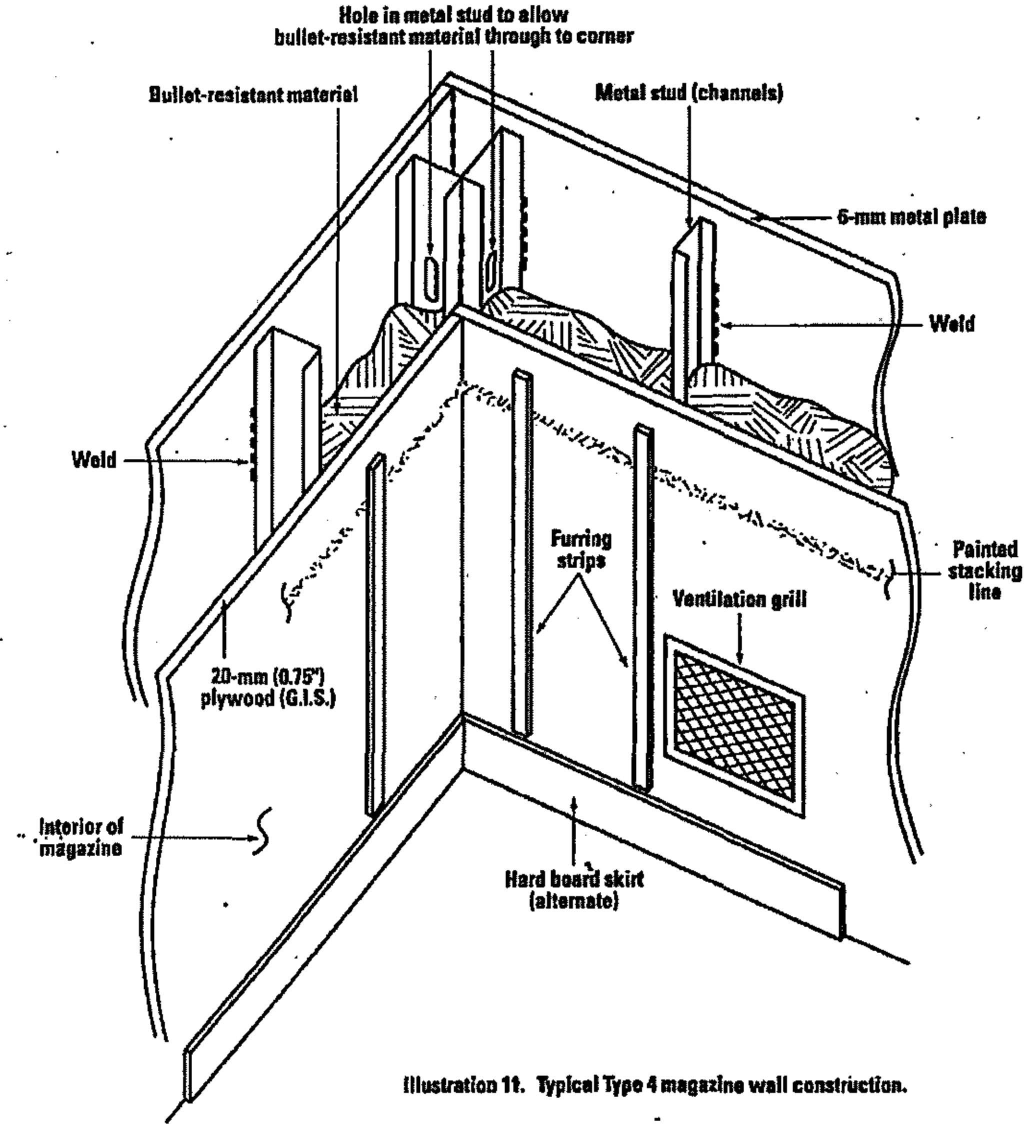



Illustration 11. Typical Type 4 magazine wall construction.

**4.6.2** The floor shall be completely covered with 20-mm plywood fastened with countersunk plated or other non-sparking fasteners. An alternate durable non-sparking surface suitable for rolling materials-handling equipment may be acceptable, such as aluminum checked plate, concrete, and shiplap hardwood flooring normally used for highway trailer floors. The finished floor should be level with the top of the door stop on the sill plate.

Note: A non-sparking flooring with non-absorbing surface characteristics is recommended if storing AN/FO because of the potential for oil residue to soak into wood flooring.

## 4.7 Roof[#8]

**4.7.1** The roof shall be fabricated from 4.7-mm or heavier metal plate with continuously welded seams. Joints between the walls and roof should be welded both inside and outside. Seams shall be watertight.

> Note: In Quebec, with the requirement for crushed gravel in the roof, it is permissible to weld on the outside only, following the installation of the crushed gravel.

## 4.8 Door Frame

**4.8.1** The door and frame are to be considered as a total unit in an effort to minimize the distortion found from extremes in temperature cycling and settling following field installation.

The door frame will be fabricated and welded as a unit, i.e., top, bottom and two sides, from 12.7 cm x 7.6 cm x 0.6 cm steel tubing unless otherwise specified.

> Note: It is recommended that the top horizontal tubular header and footer be extended on either side of the door frame by approximately 25 cm (10") and that external corner gussets be incorporated to facilitate stiffening the frame and thus minimize distortion resulting from frost heave, magazine transport, etc. This is strongly recommended for larger magazines over 6 m (20') in length.

The vertical portion of the tubular frame, with the exception of the horizontal header and footer, is to be filled with bullet-resistant material up to the same height as the interior stacking line as described in subsection 4.11. A door stop consisting of square steel bar stock shall be welded to the top and both sides of the door frame after having temporarily installed the door to account for any warpage during fabrication (refer to Illustrations 12 and 13).

At the option of the fabricator/client, a similar square steel bar stock or an angle iron stop can be incorporated at floor level to facilitate keeping the environmental weather elements such as rainwater or melting snow from running under the door and along the finished floor.

The floor should be level with the top of the door stop on the sill plate. On the other hand, eliminating the bottom door stop will facilitate the movement of a pallet loader in and out of the magazine. Ultimately, the final choice is up to the client, taking into consideration the potential environmental problems when the bottom door stop is not installed.

> Note: Frame distortion and subsequent door warpage have been noted from extreme temperature cycling and magazine settling following field installation and thus may aid a forced pry attack. To minimize such an attack, the exterior of the frame may be built up with flat stock so as to be flush with the door and therefore compensate for the door warpage. This is to be a field retrofit only and added if directed by an explosives inspector.

A less preferred method is to field weld an angle iron on the exterior of the door frame. One leg of the angle would be perpendicular to and mounted close to the door opening. If necessary, the angle iron can be positioned on three sides of the door opening (not the hinge side). Again, this retrofit may only by added at the discretion of an explosives inspector.

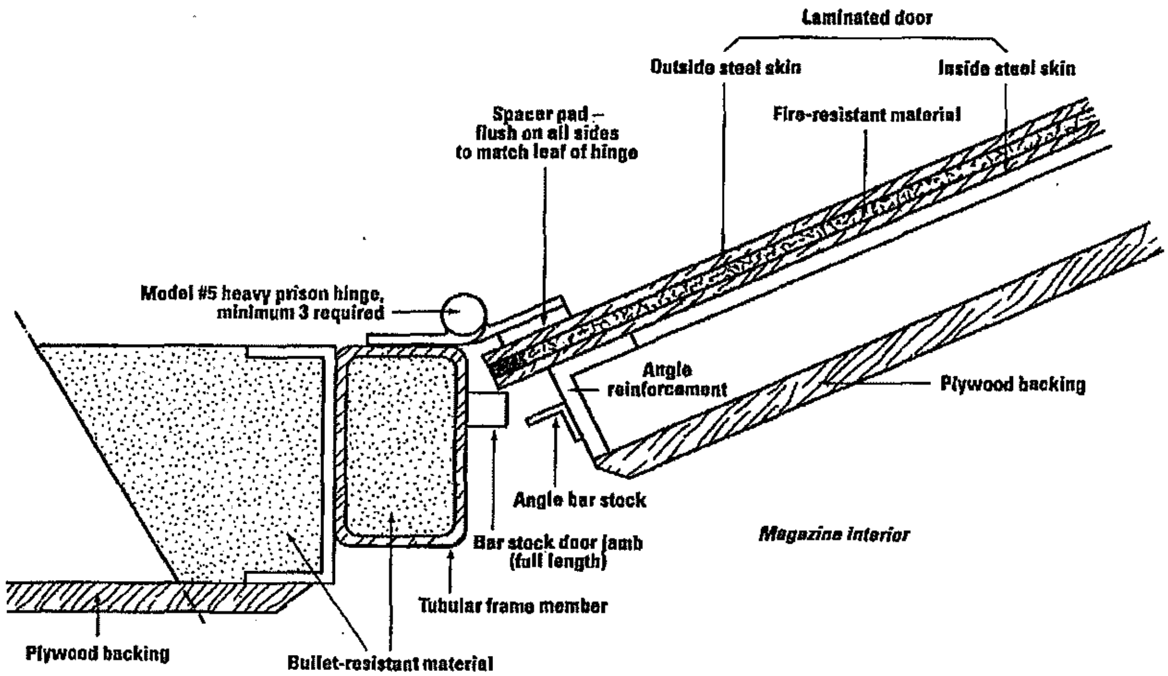



Illustration 12. Typical hinge configuration (plan view).

*Note: Door partially open illustrating full-length security bar (stock) behind hinge.*

*Magazine exterior*

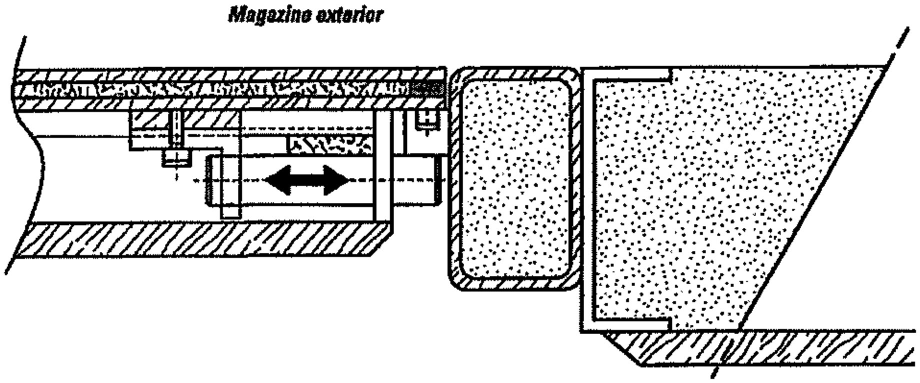


**Illustration 13.1. Typical Types 1 and 4 magazine door and frame in closed position.**

*Note: Plan view.*

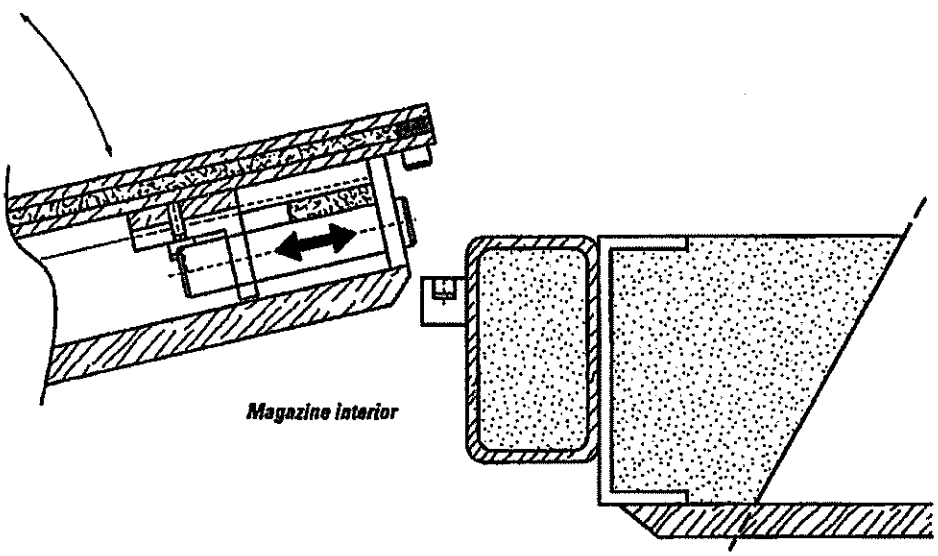



**Illustration 13.2. Typical Types 1 and 4 magazine door and frame in open position.**

*Note: Plan view.*

## 4.9 Door(s), Lock(s) and Hinges for Type 4 and Type 4S

**4.9.1** The door(s), lock(s) and hinges for a Type 4 walk-in magazine or similarly constructed door shall conform in all respects with those of a Type 1 magazine as specified in subsection 1.10 (refer to Illustrations 6, 7, 12 and 13 and Appendix B).

Notes:

- Padlocks are NOT permitted for a door constructed to a Type 4 or 4S design.
- See subsection 4.16 for a temporary alternate locking mechanism and the design criteria permitted for transit mode only with no explosives on board.
- For wider and heavier doors, four (4) hinges are recommended (refer to subsection 1.10.12).

**4.9.2** For a Type 4S magazine where the door is LESS THAN 1.22 m (4') in height, there shall be:

- a minimum of TWO heavy-duty #5 institutional prison hinges. Refer to subsection 1.10.12 and reference #11 in the endnotes.
- The door shall be fitted with a sliding lock bolt train secured at a minimum of three points along the door jamb as per subsection 1.10.2 and subsections 1.10.6 to 1.10.8 inclusive.
- The door frame shall be a minimum of 7.6 cm x 5.0 cm x 0.6 cm steel tubing.
- The door stiffening angle shall be a minimum of 6.35 cm x 6.35 cm x 0.64 cm.

Rim or mortise mounted cylinders and deadbolt-type locks coupled with the sliding bolt train system shall have a weakened weather protector hood as outlined in subsection 1.10.9 and shown in Illustration 6.

## 4.10 Ventilators

**4.10.1** **General:** Ventilators shall be provided to ensure that the interior of the magazine is kept dry and as cool as possible. The number of ventilators required will depend on local climatic conditions (which are impossible to generalize) and the size of the magazine.

Note: A minimum ventilation area of 50 $cm^2/m^3$ of magazine volume is a useful guide.

When roof ventilators are not provided, then side ventilators must be installed above the stacking line and near the floor level to promote good air circulation.

# APPENDIX B

DYNO
Dyno Nobel Canada Inc.

## FINAL MEMO - VIBRATION RESTRICTIONS AT THE TAHERA DIAMOND MINE

To: Tahera Diamond Corporation

From Geneviève Porlier, Coop Student/Technical Representative, Dyno Nobel Canada Inc.
Email: gporlier@dnci.ca Fax no. 867-920-7597

cc.: Gary Gutwillinger <ggutwillinger@dnci.ca>

Aug. 23rd 2005

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Based on Tahera's acquired data over the past two months, an extensive dissection of monitored blasts was done in order to meet the 13mm/sec vibration restrictions imposed by the Department of Fisheries and Oceans[1]. The aim of Dyno Nobel's study was to give Tahera's engineers a tool to predict and control the vibrations impacting Carat Lake's fish species in general and, in particular, the slimy sculpin species.

**Résumé of June-July blasts**

The blast results have been very satisfying. Indeed, of the sixteen blasts analyzed, only one blast reached the aforementioned limit of 13mm/sec, when the 480-022 blast caught a peak particle velocity (PPV) of 13.14mm/sec on July 18th. All the other blasts were under or significantly under the DFO's vibration limits.[2]

All blasts had very low average particle velocities (0.9 to 3.89mm/sec), with some particle velocities of each blast reaching peaks that approached the upper limit. More information and time would be needed in order to properly control these scattered peaks: for example, analysis of the prominence of overburden of the toe, the emplacement of the free faces or the respect of the drilling map may have helped to better define and control these PPVs. However, the close

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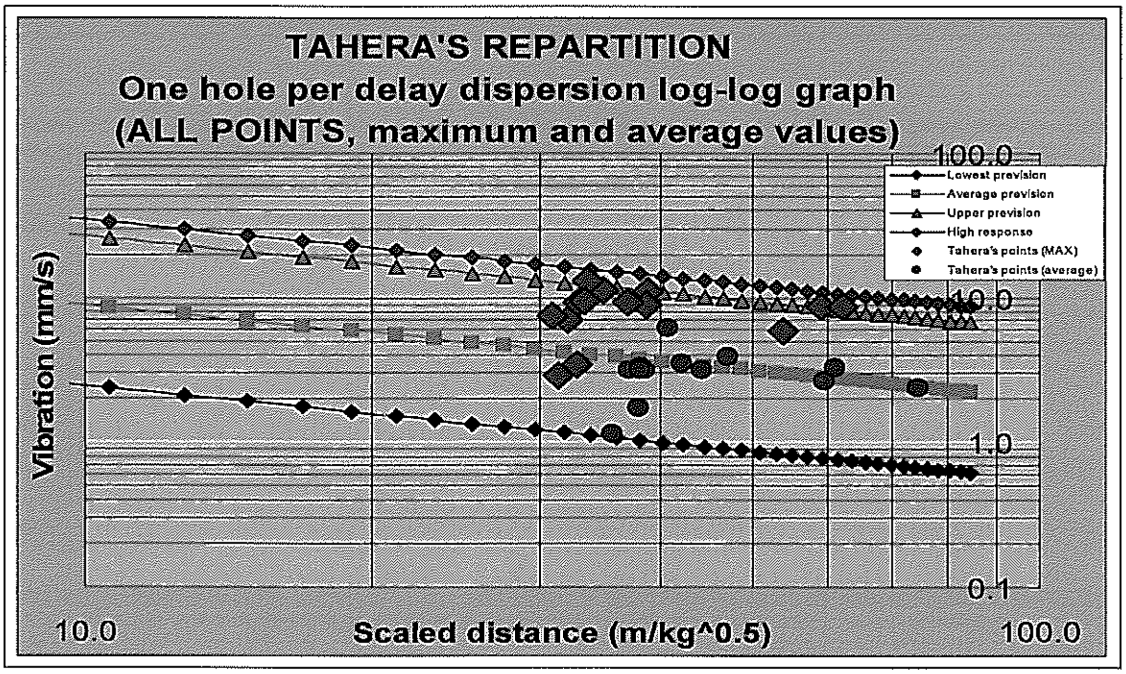
[1] "Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters", Wright and Hopky, Department of Fisheries and Oceans, 1998.
[2] A complete résumé of all the blasts and their characteristics is included at the end of this report report s Annex C.

monitoring of the design of the tie-in maps and sequence, the blasting of one hole per delay, the measurement of every hole before and after loading, and the adjustment of the drilling pattern gave results that were satisfactory for this exercise.

**Predicting ground vibrations from blasting**

In order to provide a foundation for next summers' ground control, the following graph was developed. It was drawn using all of the analysed and monitored blasts since July 15th. The four straight lines are previsions from theory[3], adapted to this summers' results; together they frame the lowest of average particle velocity, up to the highest of the peak particle velocities.




The use of the scaled distance allows the comparison of holes of different weight of loading and different distance from the monitor. According to it, the highest response line for Tahera's data may be forecasted by the following formula:

**Vibration (mm/sec) = 155 * (scaled distance) ^ -0.65**

The scaled distance is calculated by the quotient of the closest point between the blast in question and the vibration monitor, in meters, and the square root of the weight of explosives, in kilograms. This formula should represent the highest possible peak particle velocity of a blast

[3] Blasters' Handbook, ISEE 17th Edition 1998

when the input is the highest quantity of ANFO used in that blast. Therefore, this formula is simple to use when the quantity of explosives per hole and the distance between the closest point of the blast and monitor is known.

Also, the average prevision for the average vibrations occurring during a blast may be forecasted by the following formula: **Vibration (mm/sec) = 40 * (scaled distance) ^ -0.65.** More details may be seen on the graph called "Tahera's repartition" in **Annex A**; though this formula is much less useful for the purpose of controlling the highest level of ground vibration.

These equations take into account only the weight of explosives and the distance from the monitor: more factors were available to define the equations, such as the percentage of rock and the intervals between detonations. In the beginning, the author thought that some large differences in geologic structures, such as rock compared to till, should give very different vibration results. Based on this assumption, the results from till blasts were separated from the rock blasts and these results have been included as **Annex B**. The results in till blasts were not significantly different from the results in rock, however the size of the sample from till blasts may be misleading. No conclusion is made of the geologic factor because of limited sample size. Also, no conclusion is made about the intervals between detonations, because the difference in weight of explosives and distance between each blast and each hole prohibit comparison.

**Length-of-holes categories**

Finally, to increase precision, four classes representing different length of holes were made: 2.8 to 3.2m, 4.7 to 5.6m, 8.3 to 9.3m and 10.4 to 11.0m. Separating the blasts into such classes groups the different lengths of collar and therefore the quantity of explosives per hole and thus provides grouping of the behaviour of the ground to blasting. The full description of these classes may be found in **Annex C**.

The first class grouped the two trench blasts, C1-004 and C1-005. However these blasts were filled of chubs and no information was booked describing the distribution of the quantity of explosives per hole. Therefore this category was not usable or considered.

The three other categories successively included 3, 8 and 3 blasts. Obviously no conclusion can be afforded with both categories having only 3 blasts per graph, nevertheless they were printed for a possible ulterior usage. However the 8.3 to 9.3m category can still be quite reliable, and if ever the data gathering continues over the next years it may become a very useful tool.

**Conclusion**

Tahera's engineers did a good job controlling ground vibration as indicated by the measured blasts. The DFO's limit was respected during this summer's slimy sculpin spawning season, and for the two coming and still vibration-critical years, the current work will provide an additional vibration management tool.

Geneviève Porlier

Technical representative for Dyno Nobel Canada Inc., Université Laval coop student