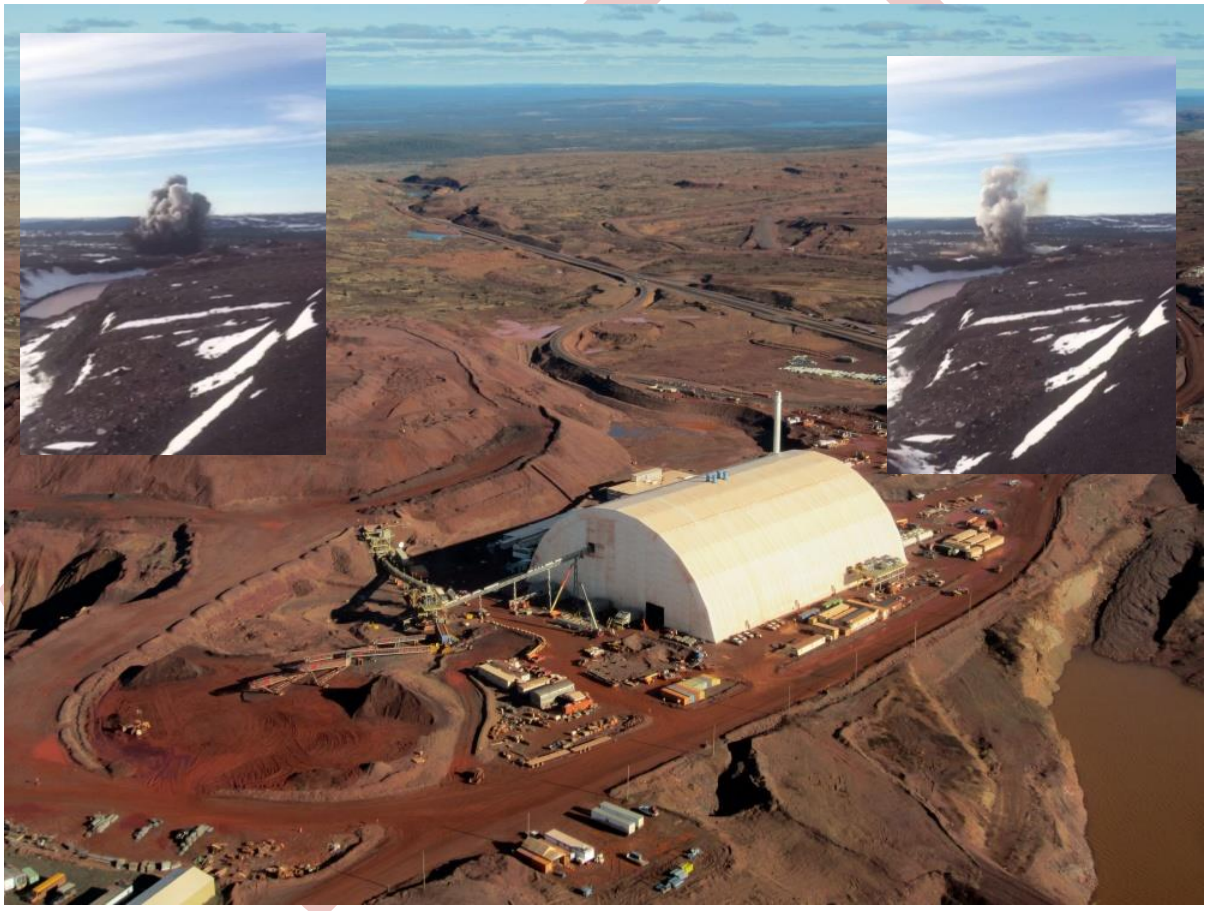
MANAGEMENT PLAN

PREVENTION AND MANAGEMENT OF BLAST GENERATED NOx

Tata Steel Minerals Canada Ltd.

Direct Shipping Ore Project



November 2015

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1. Purpose

This procedure outlines responsibilities and guidelines for manage and assist in the minimisation and management of blast fumes, in particular oxides of nitrogen (NOx) at the Direct Shipping Ore (DSO) Project operated by Tata Steel Minerals Canada Ltd., near Schefferville, QC.

2. Scope

Those involved in blasting operations need to be aware of the causes, risks and consequences of the oxide of nitrogen (NOx) gases that may emanate from their blasting activities. The aim of this Plan is to provide information and recommended guidelines to assist in the prevention and management of blast generated NOx gases from surface blasting operations. The Plan is specific to NOx gases and covers the following areas:

- the likely causes of NOx gases from blasting
- possible control measures to prevent or minimise blast generated NOx gases
- management of NOx gases from blasting should they occur

This document provides a mitigation strategy based on the Code of Practice for Prevention and Management of Blast Generated NOx Gases in Surface Blasting established by the Australian Explosives Industry and Safety Group (AEISG) (Edition 2, August 2011)[1].

3. Background

3.1 Requirement for a Blast Generated NOx Management Strategy

Air quality studies conducted by TSMC in the context Environmental Impact Assessments for Provincial and Federal authorities show that air emissions (such as dust, NOx, CO and SO_2) generated during blasting events can negatively affect the air quality in the vicinity of the pits where blasting is conducted.

As part of an EIA submitted to the Canadian Environmental Assessment Agency (CEAA) in the fall of 2015 for the Howse Property Project (HPP), TSMC has committed to the development and implementation of a Plan for the prevention and management of blast generated NOx. This Plan will be put into effect when blasting at the HPP starts. This plan is applicable to blasting at the following pits: Howse, Fleming 7N and Timmins 3N. However, its application will be extended to other active pits as deemed necessary.

3.2 Theory – NOx in Blast Fumes

The group of gases known as Oxides of Nitrogen or NOx, of which the most common are nitric oxide (NO) and nitrogen dioxide (NO2), are often found as by-products in the post-blast gases of ammonium nitrate-based explosives. Together, these gases are loosely referred to as “NOx”. Nitric oxide is invisible, but nitrogen dioxide ranges from yellow to dark red depending on the concentration and size of the gas cloud. These gases are pollutants. NOx from blasting constitutes only a small proportion of the total NOx emissions from human activities

[1] http://www.aeisg.org.au/images/stories/aeisg_cop_nox_edition_02aug2011.pdf

(primarily power generation and motor vehicles) and natural sources. However blasting produces a sudden localised release of gases with potentially high concentrations of NOx. Such gas emissions pose a health risk if people are exposed to them before the plumes can dissipate.

Despite a long history of blast-related NOx emissions, very few quantitative studies have been done under realistic field conditions. The underlying causes of high NOx are fuel-deficiency in the explosive or detonation reactions that do not continue to completion. There are many ways in which these conditions may arise.

In the absence of a single general cause or general solution, this Plan was developed by TSMC as an aid to identifying the local cause of NOx and as a prompt for possible ways to address those causes. It should be understood that, given the complexity of the problem and the inherent variability in the blasting environment, NOx events may still occur even after prevention and mitigating actions have been put in place. The Plan therefore include advice on managing blasts that could produce NOx gases.

3.3 Causes of NOx Gases in Blasting

The post-blast gases and fumes are generated as a result of the ammonium nitrate-based explosive detonation at the blast site. The factors that trigger the formation of the NOx are various but the following factors are among the main contributors in the generation of post-blast fumes during the mining process:

- Explosive formulation and quality assurance;
- Geological Conditions;
- Climate/seasonality;
- Blast design;
- Explosive product selection;
- Contamination of explosive in the blast-hole;
- On-bench practices.

Section 5 of the Code of Practice for Prevention and Management of Blast Generated NOx Gases in Surface Blasting should be consulted as an aid to identifying causes and mitigation measures.

As a result, the formation of the toxic fumes can be managed through some preventive controls considering the geological conditions during the design phase, designing an appropriate design for the blast, selecting an appropriate product formulation for the detonation, considering the weather condition during the time of loading; implementing on-bench practiced to minimise the potentials for water ingress into blasting area; minimising the contamination of explosives in blast holes.

4. Management Procedures

4.1 Blast Design by Explosives/Precursor Manufacturer/Supplier

The manufacturer and/or supplier of the precursors or bulk explosives must ensure products are formulated appropriately to prevent/minimise the generation of NOx gases during blasting. The products should be authorised, with quality control systems in place to ensure that the manufactured/supplied products meet specifications.

For each blast, a copy of the Blast Design datasheet must be forwarded to TSMC on-site Environmental team. An example "Blast Design" datasheet is provided in Appendix A of this Plan.

The explosives manufacturer/supplier must provide documentation for modification and alterations to explosive and/or precursor formulations. Documentation must be provided to TSMC on-site Environmental team and must cover the following aspects:

1. recording any modification/alteration and updating relevant authorisations, Technical Data Sheets, Material Safety Data Sheets, work procedures, and training programs as and where relevant;
2. ensuring changes continue to meet the requirements of this Code;

4.2 Pre-Blast Environmental Assessment

In collaboration with the blasting manager, TSMC on-site Environmental team will complete a Pre-Blast Environmental Assessment. A copy of the Pre-Blast Environmental Assessment list is provided in Appendix B.

The assessment covers 6 criteria:

- Explosive Formulation and Quality Assurance
- Geological conditions
- Blast Design
- Explosive product selection
- On bench practices
- Contamination of explosives in the blast hole

The assessment may be conducted days before a blasting event is scheduled.

4.3 Pre-Blast and Post-Blast Checklist

Appendix C contains an example of the Pre-Blast / Post-Blast checklist, currently in use at the site. The Pre-Blast / Post-Blast checklist

The following parameters will be added to the Pre-Blast section of the checklist:

a) Acknowledgement of the Environmental Assessment by the responsible for drilling and blasting
b) Meteorological conditions: wind speed, wind direction, temperature, precipitation
c) For pits located in the vicinity of the Workers' camp (ex.: Howse, Fleming 7N, Timmins 3N) , blasting must be conducted while the wind is NOT blowing in direction of the Workers' camp

The following parameters will be added to the Post-Blast section of the checklist:

a) Visual Rating Scale: Assessment of the Post-Blast fume should using the AEISG visual NOx fume rating scale.
b) duration of any post-blast NOx gas event;
c) direction of movement of any post-blast NOx plume;
d) movement of any post-blast NOx gas plume relative to the established exclusion zone and any established management zone;
e) results/readings of any NOx monitoring equipment employed for the blast;
f) video results of blasts where relevant

4.4 Blast Log

Appendix D contains an example of the Blast Log used for recording blasting events. This information log will continue to be used at the site for all blasts.

VISUAL NOX FUME RATING SCALE

Level	Typical Appearance
Level 0 No NOx gas	
Level 1 Slight NOx gas	
1A Localised	
1B Medium	
1C Extensive	
Level 2 Minor yellow/orange gas	
2A Localised	
2B Medium	
2C Extensive	
Level 3 Orange gas	
3A Localised	
3B Medium	
3C Extensive	
Level 4 Orange/red gas	
4A Localised	
4B Medium	
4C Extensive	
Level 5 Red/purple gas	
5A Localised	
5B Medium	
5C Extensive	

Assessing the amount of NOx gases produced from a blast will depend on the distance the observer is from the blast and the prevailing weather conditions. The intensity of the NOx gases produced in a blast should be measured on a simple scale from 0 to 5 based on the table above. The extent of the NOx gases also needs to be assessed and this should be done on a simple scale from A to C where:-

A = Localised (ie NOx Gases localised across only a few blast holes)

B = Medium (ie NOx Gases from up to 50% of blast holes in the shot)

C = Extensive (ie Extensive generation of NOx Gases across the whole blast)

Pantone colour numbers have been included in the following Field Colour Chart to ensure colours will be produced correctly thereby ensuring a reasonable level of standardisation in reporting NOx gas events across the blasting industry.

Level	Colour	Pantone Number
Level 0 No NOx gas		Warm Grey 1C (RGB 244, 222, 217)
Level 1 Slight NOx gas		Pantone 155C (RGB 244, 219, 170)
Level 2 Minor yellow/orange gas		Pantone 157C (RGB 237, 160, 79)
Level 3 Orange gas		Pantone 158C (RGB 232, 117, 17)
Level 4 Orange/red gas		Pantone 1525C (RGB 181, 84, 0)
Level 5 Red/purple gases		Pantone 161C (RGB 99, 58, 17)

5. Documentation and Retroaction

5.1 Documentation

For each blast, the following documents will be reviewed and filed by TSMC on-site environmental team:

a) Blast Design by blasting company or responsible
b) Pre-Blast Environmental Assessment
c) Pre-Blast and Post-Blast Checklist
d) Blast Log

5.2 Retroaction

Any reported significant NOx event or trends should be investigated to minimize the potential for ongoing generation of NOx gases and to mitigate the potential impacts of any such event. Such investigation should involve the explosives manufacturer and/or supplier.

The fault tree (see Section 6 Code of Practice for Prevention and Management of Blast Generated NOx Gases in Surface Blasting) should assist any investigation and ensure all relevant factors are considered and adequately addressed. The results of any investigation of post-blast NOx gases should then be factored into the site specific procedures to minimize their production and to mitigate impacts.

Appendix A

Blast Design Datasheet

Example Datasheet Currently in Use. To Be Amended As Per This Plan.

BLAST DESIGN

GREY ROCK MINING

Layout Date #: May 2/15

Planned Blast Date #: MAY. 01, 2015

Project: KIVIVIC 1C - PHASE 1 Job #: 1474 429 Client: TATA Steel Minerals Canada Blast #: DE-K1C-730_7&8

# of Holes:	134	Bottom Primer Type:	Spartan 350
Diameter:	165.1mm	Bottom Detonator Type:	NonEL Det 25-500 18m
Pattern:	5.18m x 5.18m	Column Primer Type:	Spartan 200
Row 1 Burden:		Column Detonator Type:	NonEL Det 25-500 12m
Target Drilling Elevation:	730.0 m	Total Drilling - no sub:	m
Sub-Drill:	1.0 m	Total Drilling - with sub:	m
Primary Explosive:	BlastGel 1070	Estimated Volume:	22,571 m³
Explosive Density:	g/cm³	Rock Density:	g/cm³
Collar:	2.1 m	Tonnage:	t
Approx. Explosive Qty:	14,671 kg	Design Powder Factor:	0.65 kg/m³

GUARDING LOCATIONS (show number on Blast Area Plan)

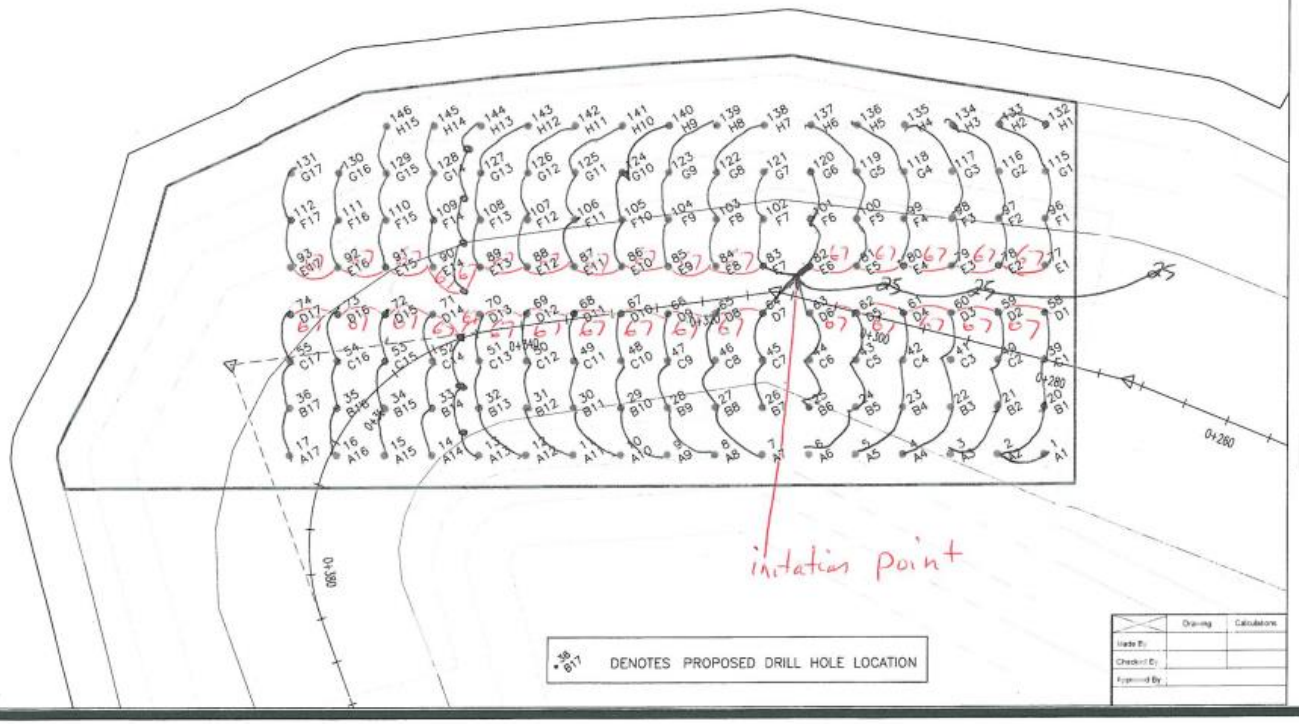
1:			6:		
2:			7:		
3:			8:		
4:			9:		
5:			10:		

Geographic Coordinates of Blasting Area:

N54° 58' 28.91"
W62° 46' 14.92"

PROPOSED DESIGN

BLAST PLAN



	Drawing	Calculations
Made By:		
Checked By:		
Approved By:		

BLAST AREA PLAN

Blast Design by: Roderick Loger

Blaster-in-Charge: Roderick Loger

Appendix B

Pre-Blast Environmental Assessment List

Pre-Blast Environmental Assessment
TSMC DSO - SCHEFFERVILLE

Blast #: **Pit ID:**	**Scheduled Blast Date:**
Assessed by:	**Assessement Date:**

Assessment Criteria	**Likelihood**	**Notes**
PB 1: Explosive Formulation and Quality Assurance		
Explosive product incorrectly formulated		
Explosives product change		
Inadequate mixing of raw materials		
Delivery system metering incorrectly		
Delivery system settings for explosive product delivery overridden		
Explosive precursors not manufactured to specification		
Precursor degradation during transport and storage		
Raw material changes		
Other:		
PB 2: Geological conditions		
Lack of relief in weak/soft strata		
Inadequate confinement in soft ground		

Explosive product seeping into cracks		
Dynamic water in holes		
Moisture in clay		
Blast hole wall deterioration between drilling and loading eg cracks, voids, hole contraction		
Chemistry of rock type e.g. limestone		
Other:		
PB 3: Blast Design		
Explosive desensitisation due to the blast hole depth		
Inappropriate priming and/or placement		
Mismatch of explosives and rock type		
Inter-hole explosive desensitisation		
Intra-hole explosive desensitisation in decked blast holes		
Initiation of significant explosive quantities in a single blast event		
Other:		
PB 4: Explosive product selection		
Non water-resistant explosive products loaded into wet or dewatered holes		
Excessive energy in weak/soft strata desensitising adjacent explosive product columns		
Primer of insufficient strength to initiate explosive column		
Desensitisation of explosive column from in-hole cord initiation		
Inappropriate explosive product for application		
Other:		
PB 5: On bench practices		
Hole condition incorrectly identified		

Blast not drilled as per plan		
Dewatering of holes diverts water into holes previously loaded with dry hole explosive products		
Blast not loaded as per blast plan		
Other:		
PB 6: Contamination of explosives in the blast hole		
Explosive product mixes with mud/sediment at bottom of hole.		
Interaction of explosive product with drilling muds.		
Penetration of stemming material into top of explosive column (fluid/pumpable explosive products only)		
Water entrainment in explosive product		
Moisture in ground attacking explosive product		
Contamination of explosives column by drill cuttings during loading		
Rainfall on a sleeping shot.		
Other:		

Appendix C

Pre-Blast / Post-Blast Checklist

Example checklist Currently in Use. To Be Amended As Per This Plan.

ScotiaBlast Ltd.
DRILLING & BLASTING

MUNICIPAL GROUP OF COMPANIES
NORTHERN OPERATIONS

Pre-Blast Checklist / Liste à Cocher Avant-Sautage

Date / Date : May 3/15

General Contractor / Entrepreneur Général : Grey Rock

Project / Projet : Goodwood Quarry

Blaster-in-charge / Boutefeu en charge : Roderick Lodge

Inspect immediate and surrounding area for structures and roads leading into the affected area / Inspectez la zone immédiate et environnante pour les structures et les routes menant à la zone touchée ☑

Inspect work area for any hazards or dangerous conditions / Inspectez la zone de travail pour tous les dangers ou des conditions dangereuses ☑

Conduct tailgate meeting - Review all hazards, safety equipment required and job descriptions / Effectuez réunion sur chantier - Examiner tous les dangers, l'équipement de sécurité requis et les procédures de travail ☑

Ensure locates for utilities are completed / Assurez-vous de localiser les services ☑

Review blast design and adjust according to site conditions as required before loading / Revoyez la conception du tir et ajustez selon les conditions du site avant le chargement au besoin ☑

Ensure required blast protection is in place / Assurez-vous que le contrôle des projections nécessaire est en place
i.e. : bell covering, protective measures for structures, blasts mats, collart control /
C'est-à-dire : couvre fils, des mesures de protection pour les stuctures, matelas, contrôle des collets ☑

Notify owner, general contractor and local residents of the blasts / Avertissez propriétaire, entrepreneur général et les habitants des sautage ☑

Ensure the guarding procedures are reviewed, including the following: / Assurez-vous que les procédures d'évacuation sont examinées, y compris ce qui suit:
- Confirm guard locations and assign guards as per blast area plan / Confirmez la zone d'évacuation et attribuez des gardes selon la zone sur le plan ☑
- Check radios for group communication / Vérifiez radios pour la communication de groupe ☑
- Review clearing procedure and site specific guarding procedure with all personnel / Revisez la procédure d'évacuation et les zones de garde avec l'ensemble du personnel ☑

Program and install seismographs at nearest structure / Programmez et installez des sismographes où la structure la plus proche N/A ☐

Check blast area and remove all equipment and materials / Vérifiez que tous les équipements et matériaux à l'intérieur de la zone d'évacuation soient enlevé ☑

Put video tape blast / Installez caméra pour sautage N/A ☐

Post-Blast Checklist / Liste à Cocher Après-Sautage

Review blast area / Révisez la zone de dynamitag
- Visually and physically confirm blast has completely fired / Visuellement et physiquement confirmez que le sautage a bien détoné. ☑
- (If misfire occurred, refer to Accident Prevention Program) / (Si sautage raté, reportez-vous au programme de prévention des accidents). ☑

Investigate surroundings for possible damage / Vérifiez les alentours si dommage causé ☑

Retrieve seismographs / Récupérez les sismographes N/A ☐

Ensure before leaving site all materials and explosives have been picked up / Assurez-vous avant de quitter les lieux tous les matériaux et des explosifs ont été ramassés ☑

*****Note: Abandoning explosives is a criminal offence*** / ***Remarque: L'abandon d'explosifs est une infraction pénale*****

Ensure all explosives counted and properly stored with amount returned on bill of lading / Assurez-vous que tous les explosifs stockés balance avec le montant utilisé ☑

Return blast report completed to office / Retournez le rapport de sautage complété au bureau ☑

Return video to office / Retournez le vidéo au bureau ☑

Wildlife and environment survey conducted / Enquête de l'environnement et de la faune mené ☑

Comments / Commentaires

<Original signed by>

Blaster-in-charge sign / Signature Boutefeu en charge :

Form 28003

Appendix D

Blast Log

Example Datasheet Currently in Use.

CONSBEC INC.
MINING+CONSTRUCTION

BLAST LOG

DESIGN ☐
REPORT ☑

DATE Sunday, May 3rd TIME
CONTRACT / JOB # KRC-730-06a
LOCATION Kirwick Pit

BLASTER Randall Fraser (Please Print)
SIGNATURE <Original signed by>

№ 019507

DESIGN:

BLAST TYPE Non Electric, Open Face
SIZE OF HOLES 8"
NO. OF HOLES 79
NO. OF DELAYS
MAX. LOAD PER DELAY
HOLES PER SERIES
POWDER FACTOR

LOADING:

COLLAR 2.4m - 3.0m
COLUNM LOAD Bulk emulsion
TOE LOAD Spartan 200g. boosters
SUBGRADE 1m

EXPLOSIVES:

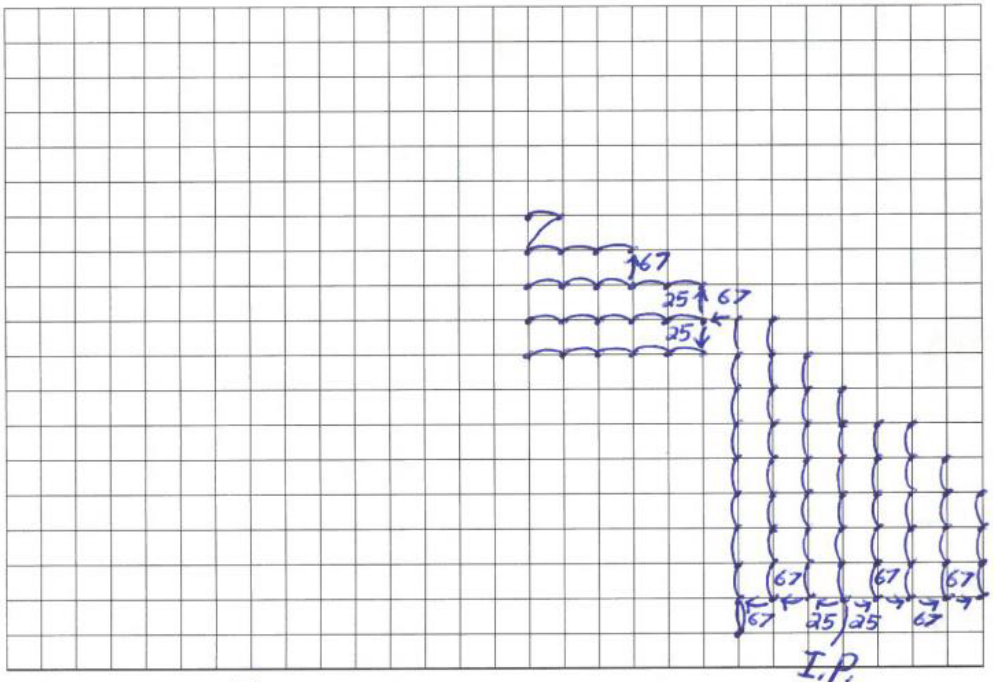
	TYPE/BLEND	kgs/ # units
1)	Emulsion 80/20	
2)	Spartan 200g.	149
3)		

DETONATORS / INITIATORS:

	TYPE	LENGTH	# UNITS
1)	Nonel EZ det 25/500	18m	79
2)	EZ det 25/500	24m	74
3)	EZ det 67m	9m	17
	Electric	3.5m	1

DIMENSIONS: 0m

WIDTH
LENGTH
AVE CUT AVE. DRILL DEPTH
PATTERN : BURDEN 7 SPACING 7



PRE BLAST DESIGN ☒

NOTES / REMARKS: No evidence of life seen before blast, no evidence of life seen after blast.
HAZARDS & DISTANCE : none

IS THERE A GARDING PLAN & PROCEDURE? (YES) NO
ARE GARDS IN PLACE? (YES) NO
WAS THERE A CUT SHEET PROVIDED BY THE DRILLER? (YES) NO
CUT SHEET #'s

POST BLAST REPORT ☒

FLYROCK DAMAGE: None

MISFIRE: YES (NO)
IF YES, REPORT TO DEPT. OF LABOUR

SEISMIC DATA: N/A UNIT #'s
WIND DIRECTION VELOCITY: Calm
ATMOSPHERIC CONDITIONS: Clear / sunny
BULK USED? (YES) NO
BULK TRUCK NUMBER's 121
BULK TRUCK DRIVER Tim Sira