

C11 Drill and Blast Management Plan

Aim and Objective					
<b>C-11 Drill and Blast Management Plan</b> (DBMP) sets out the approach to managing and mitigating the impacts of drilling and blasting during construction. Implementation of the DBMP in conjunction with the Drilling and Blasting Method Statement will provide the basis for ensuring the drilling and blasting procedures and processes are carried out in accordance with required approvals and do not result in injury, loss of life, damage to property or the environment.					
Summary of Impacts and Risks					
<p>Drilling and blasting operations associated with the construction of the project pose a risk to construction personnel, communities and the environment. The potential risks and impacts associated with undertaking the drilling and blasting activities include:</p> <ul style="list-style-type: none"><li>Procedures and processes before, during and after drilling and blasting not being followed, resulting in injury, loss of life, damage to property or the environment.</li><li>Inappropriate transport, handling and storing of explosives resulting in unplanned explosions.</li><li>Inadequate community engagement and consultation resulting in injury, loss of life, damage to property.</li><li>Noise, vibration and air quality impacts.</li></ul> <p>Note that the DBMP is to be implemented in conjunction with <b>P-1 Construction Environmental and Social Management Plan</b>, <b>P-2 Biodiversity Management Plan</b>, <b>P-3 Stakeholder Engagement and Communications Plan</b>, <b>P-6 Grievance Redress Mechanism</b>, <b>P-8 Worker's Health and Safety Plan</b>, <b>P-9 Worker's Code of Conduct</b>, <b>P-7 Security Management Plan</b>, <b>P-11 Traffic Management Plan</b>, <b>P-13 Hazardous Materials Management Plan</b>, <b>P-14 Spill Prevention and Emergency Response Plan</b>, <b>P-15 Air Quality Management and Dust Control Plan</b>, <b>C-13 Noise and Vibration Management Plan</b>, <b>M-6 Construction Works Monitoring Plan</b>, <b>M-2 Water Quality Monitoring Plan</b>, and <b>M-7 Air Quality and Noise Monitoring Plan</b>.</p>					
Mitigation and Management Actions					
#	Issue or Risk	Action	Timing / Frequency	Responsibility	
C-11-1.	Permits and approvals	<ul style="list-style-type: none"><li>Prior to drilling and blasting activities, the relevant permits and licences required under Solomon Islands law for the importation, storage and use of explosives (User's Licence and Dealer's Licence) will be obtained.</li></ul>	Prior to start of drilling and blasting activities	HEC Construction Manager	
C-11-2.	Health, safety and environmental controls	<ul style="list-style-type: none"><li>All drilling and blasting operations will be conducted in accordance with <b>Annex C-11-I Drilling and Blasting Method Statement</b>.</li><li>Appropriate PPE will be provided and worn at all times in accordance with <b>P-8 Workers Health and Safety Plan</b> and <b>M-7 Air Quality and Noise Monitoring Plan</b>.</li><li>Reporting of accidents or other incidents will be undertaken in accordance with the procedures set out in <b>P-1 CESMP</b> and <b>P-8 Workers Health and Safety Plan</b>.</li><li><b>P-8 Workers Health and Safety Plan</b> (specifically Annex P-8-VIII Tunnel Work Safety Guideline), <b>P-7 Security Management Plan</b>, <b>P-13 Hazardous Materials Management Plan</b>, <b>P-15 Air Quality Management and Dust Control Plan</b>, and <b>C-13 Noise and Vibration Management Plan</b> will be implemented to ensure impacts to workers, property and communities from drilling, blasting and tunnelling are minimised.</li><li>Implementation of <b>P-2 Biodiversity Management Plan</b> and <b>C-3 Forest Clearance Plan</b> will be implemented to minimise impacts on flora, fauna, and habitats.</li></ul>	Prior to and during all drilling and blasting activities	HEC Construction Manager HEC HSE Manager	
C-11-3.	Impacts of noise and vibration on sensitive receptors	<ul style="list-style-type: none"><li>Noise and vibration measures detailed in <b>C-13 Noise and Vibration Management Plan</b> and <b>Annex C-11-I Drilling and Blasting Method Statement</b> will be implemented.</li><li>Drilling and blasting in areas close to villages (e.g. access roads, powerhouse), blasting at the dam site, and movement of heavy vehicles through villages will be restricted to the period 7:00am to 5:00pm.</li><li>Where possible, machinery will be chosen to reduce noise and vibration.</li><li>All mobile and stationary equipment will be equipped with fully functioning noise mufflers and baffles.</li></ul>	Prior to and during all drilling and blasting activities	HEC Construction Manager	
C-11-4.	Air quality impacts to sensitive receptors	<ul style="list-style-type: none"><li>Dust controls will be implemented in accordance with <b>P-15 Air Quality Management and Dust Control Plan</b>.</li></ul>	Prior to and during all drilling and blasting activities	HEC Construction Manager HEC HSE Manager	
C-11-5.	Community engagement	<ul style="list-style-type: none"><li>The community will be notified at least 7 days (one week) prior to drilling or blasting activities. Public notification will be undertaken in accordance with the Drilling and Blasting Method Statement (<b>Annex C-11-I</b>) and <b>P-3 Stakeholder Engagement and Communications Plan</b>.</li><li>Complaints and grievances will be addressed in accordance with <b>P-6 Grievance Redress Mechanism</b>.</li></ul>	Prior to and during all drilling and blasting activities	HEC Construction Manager HEC HSE Manager	
Monitoring Requirements					
#	Title	Description	Target / Performance Indicator	Timing / Frequency	Responsibility
C-11-A.	Permits and Approvals	Copies of permits and all associated supporting material are obtained and kept on Project Space.	All documentation is on Project Space	Six monthly audit of documentation.	HEC Construction Manager
C-11-B.	Drilling and blasting inspections	Inspections of all drilling and blasting operations for compliance with the <b>Drilling and Blasting Method Statement (Annex C-11-I)</b> .	No FORs or NCRs issued.	Daily.	HEC Construction Manager HEC HSE Manager
Supporting Documents					
Annex	Name		Description		
C-11-I.	Drilling and Blasting Method Statement		Drilling and Blasting Method Statement prepared by HEC and dated 04 January 2023. Details the procedures, process, construction schedule, safeguards/environmental requirements, and use of explosive materials at the site.		

## ANNEX C-11-I Drilling and Blasting Method Statement

PROJECT : TINA RIVER HYDROPOWER PLANT

## Drilling and Blasting Method Statement

DOCUMENT No. : ST-C-C-AR-MS-03

EMPLOYER : TINA HYDROPOWER LIMITED  
EPC CONTRACTOR : HYUNDAI ENGINEERING CO., LTD.  
OWNER'S ENGINEERS : STANTEC

### ISSUE STATUS

REV. No.	DATE	DESCRIPTION	PREPARED	REVIEWED	APPROVED
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4	19.12.2022	ISSUED FOR REVIEW	J.H KIM	J.B YOU	E.M.MOON
3	23.09.2022	ISSUED FOR REVIEW	J.H KIM	J.B YOU	E.M.MOON
2	08.01.2022	ISSUED FOR REVIEW	J.H KIM	J.B YOU	E.M.MOON
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## **1 Scope and General**

### **1.1 Independent Blasting Consultant**

Mr. Barry Crowdey, Managing Director of Blastcon Australia PTY LTD, has been engaged as a independent blasting consultant to comply with Employer's Requirement. Mr. Barry has reviewed and consulted with this Drilling and Blasting Method Statement. Refer to *Attachment A. Blast Consultant Resume and Capability Statement*.

### **1.2 Scope of Work**

HEC have been engaged by Tina River Hydro Development Project to undertake the Drilling and Blasting at their Tina River Hydro projects. HEC is obligated to risk assess, design, and execute a program of blasting to guarantee and improve the rate of excavation.

HEC will conduct a Blasting Evaluation to determine specific site geological characteristics, which will influence the transmission of blast-related ground and air vibrations. Further modifications to charge weights will be based on the shot/blast results.

The purpose of this document is to outlining in detail the relevant plan for explosive at the site including construction schedule, safeguards/environmental requirements and use of explosive materials.

Blasting shall be performed using controlled methods such as pre-splitting, cushion blasting, smooth wall blasting, and line drilling. All blasting operations shall be seismically monitored. Blasting techniques shall be developed and applied, and revised as necessary, to maintain the tolerances necessary for proper construction and operation of the Permanent Works. Excavation adjacent to the final rock faces shall be carried out in such manner that the final rock face shall be stable and undisturbed. Whenever further blasting may damage the rock upon or against which concrete or fill is to be placed, the use of explosives shall be discontinued and the excavation shall be completed by wedging, barring, channeling, line drilling and broaching, or other suitable methods. All blasting operations shall be in accordance with the approved blasting plan.

The Blasting plan(s) shall be submitted separately for review by the Employer not less than 30 days prior to starting a new phase of work a proposed blasting plan(s) as per Employer Requirement section 2B.3.7.1 Blasting Submittals.

Blasting of rocks shall be done along Lot 2 and Lot 3 of Access road and the volume of blasting to be generated by Access road construction is 322,359m<sup>3</sup>, which has been calculated according to approved detail design. The below table shows the volume of earthwork and blasting method will be applied to the solid rock only, including the amount of Lot 2-1. the blast material shall be brought into the crusher plant to generate aggregates for construction use if this material meets the project specification.



Table 1. Volume of excavation of Access road

Access road	Volume of Excavation (m <sup>3</sup> )			
	Soil	Rippable rock	Solid rock	Total
LOT 1	176,036			176,036
LOT 2-1	141,699		432	142,131
LOT 2-2	344,143	81,862	116,071	542,076
LOT 2-3	17,949		64,494	82,443
LOT 3-1	258,270		133,896	392,166
LOT 3-2	1,596		7,466	9,062
<b>Total</b>	<b>939,693</b>	<b>81,862</b>	<b>322,359</b>	<b>1,343,914</b>

Table 2. Volume of excavation of Main Works

Main Works	Volume of Excavation (m <sup>3</sup> )			
	Soil	Rippable rock	Solid rock	Total
Diversion	8,623		24,249	
RCC Dam	32,629		48,388	
Spillway				
Intake	14,094		8,876	
Headrace Tunnel	16,720		81,489	
Penstock	29,285		24,599	
Powerhouse	<b>15,312</b>		<b>6,817</b>	
Tailrace	<b>5,352</b>			
Switchyard	<b>9,019</b>		<b>1,831</b>	
120BP for RCC	<b>23,639</b>		<b>49,353</b>	
Temporary access road to 120 BP	<b>18,625</b>		<b>38,481</b>	
<b>Total</b>	<b>173,298</b>		<b>284,083</b>	

※ Entire amount of the ground material is based on the Rev.C design other than temporary access road around the dam site. Excavation method such as blasting, breaker or ripper with dozer would be applied depending on geological condition.

### 1.3      **Referenced Documents**

AS 2187.0 – 1998	Explosives - Storage, Transport and Use -Terminology
AS 2187.1 – 1998	Explosives - Storage, Transport and Use - Storage
AS 2187.2 – 2006	Explosives - Storage and Use - Use of Explosives
QLD Work Health and Safety Act 2011, Regulations 2011	
QLD Mining and Quarrying Safety and Health Act 1999, Regulation 2017	
Explosives Act 1999, Regulation 2017	
LAWS OF SOLOMON ISLANDS [1996 EDITION] CHAPTER 79 EXPLOSIVES	

## 2 Location of the blasting works

The blasting works will be executed along the Lot 2 and Lot 3 of Access Road as per the detail design. The location of blasting works is shown in the following figure.

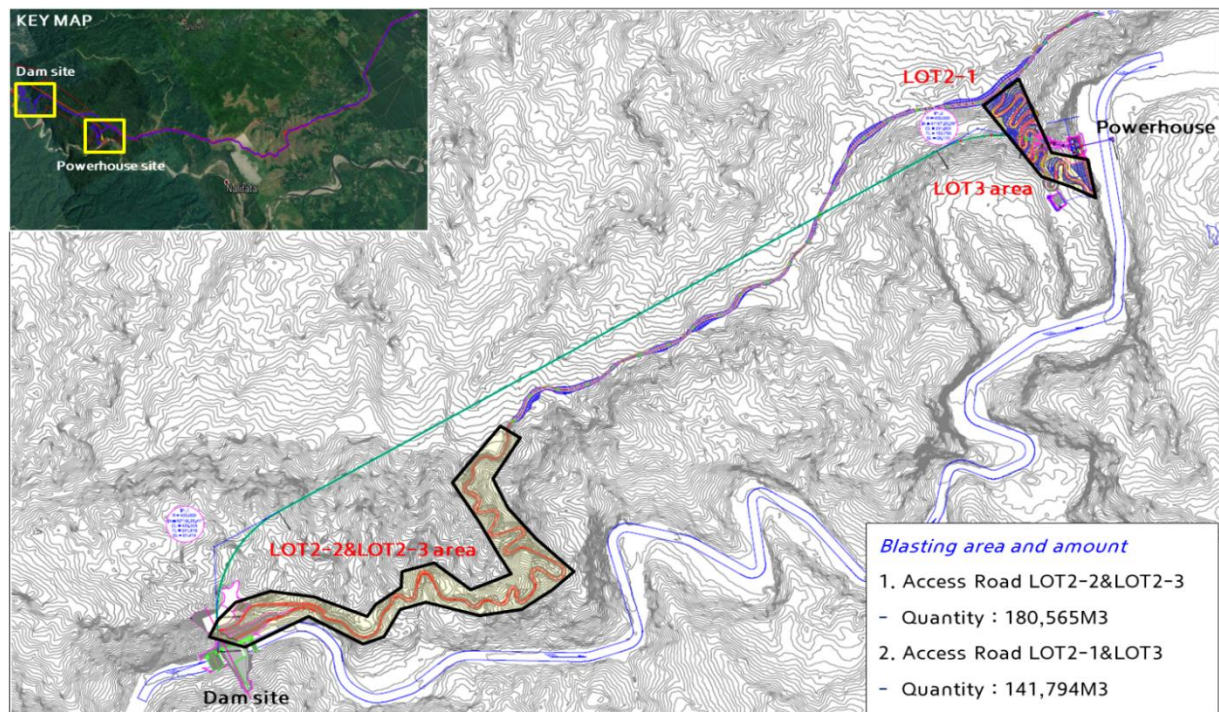


Figure 1. Location of blasting

The total amount of blasting is 322,395m<sup>3</sup>

Figures below shows the location of blasting and the amount of each lots.

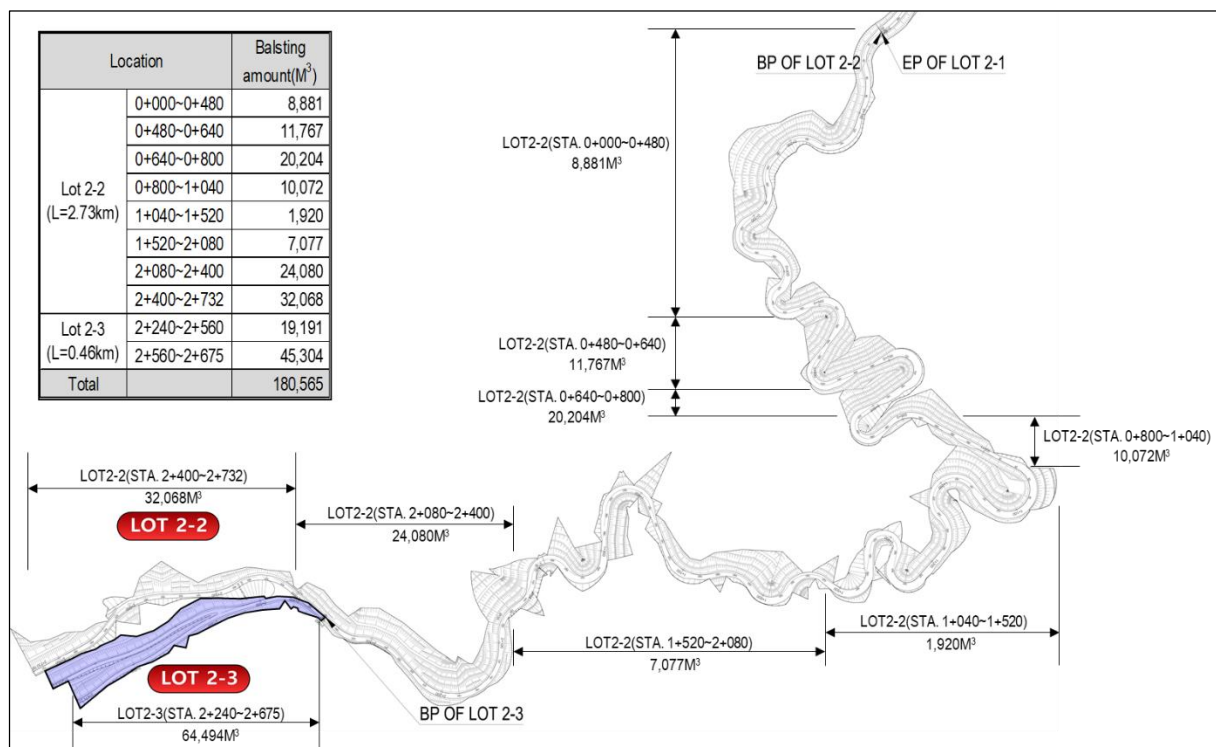


Figure 2. Amount of blasting rock of Lot2-2 and Lot2-3 area

Figure above shows the amount of blasting rock at each section of LOT2-2 and LOT2-3 area.

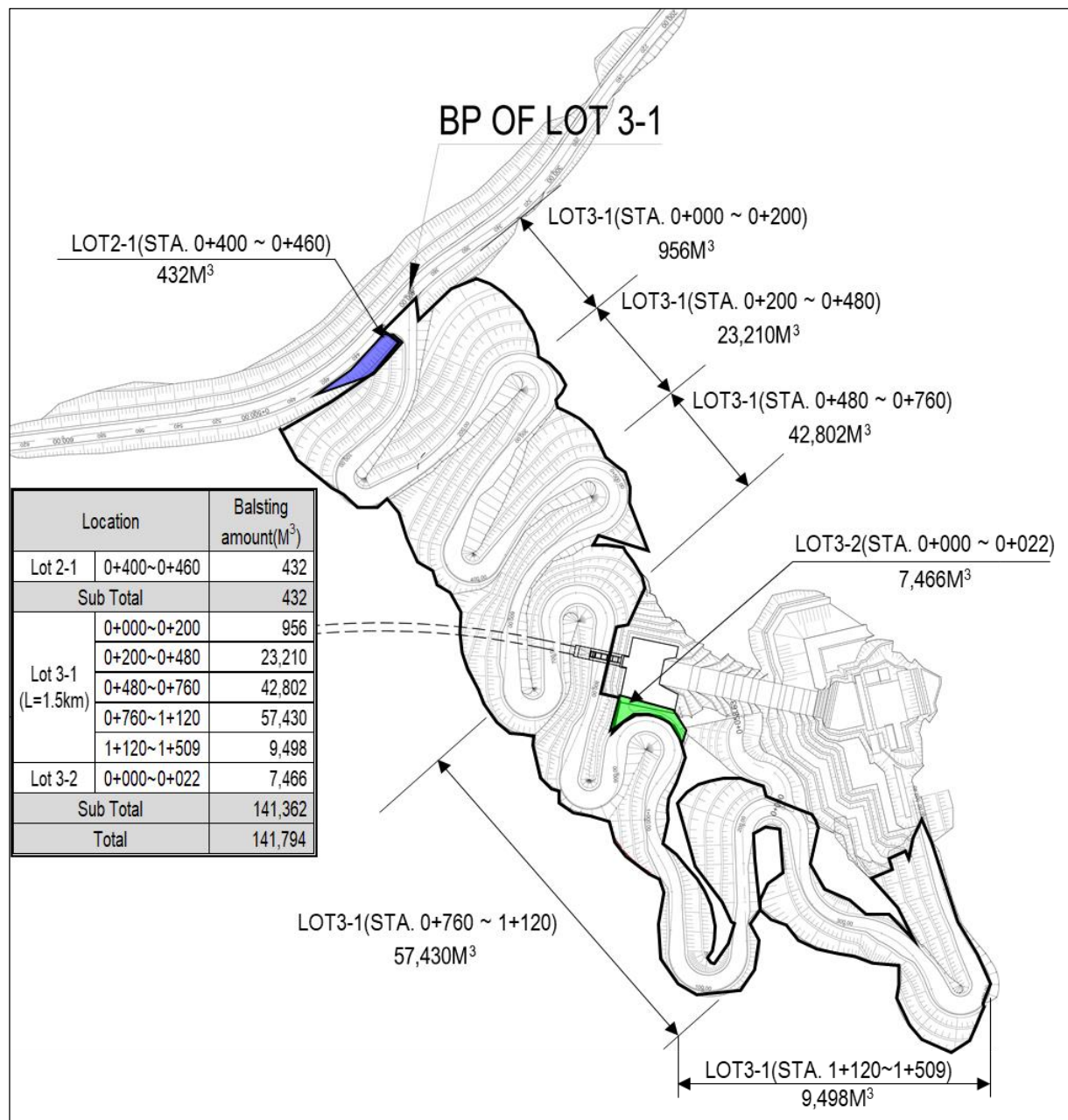


Figure 3. Amount of blasting rock of Lot2-1 and Lot3 area

Figure above shows the amount of blasting rock at each section of LOT2-1 and LOT3 area.

### 3 General Requirements

#### 3.1 Risk

Users of explosives shall be constantly aware of the dangers associated with the transportation, handing and placement of explosives.

Wherever explosives are to be used, a competent person (s) shall carry out a detailed risk assessment to identify all foreseeable potential hazards and take appropriate steps to eliminate or reduce the likelihood and mitigate the severity of any effects of such hazards, so that risks are at an acceptable level.

#### 3.2 Planning

Prior to the commencement of any production blasting, an investigation of the site and its environment shall be carried out to identify any potential hazards and risks and a risk assessment prepared.

The Employer Requirements requires that blasting plans for all blasts shall be submitted to the Employer a minimum of 24-hours prior to the blast. Contractor shall submit a written plan outlining in detail all transportation, storage and handling

Protocols for explosives at the site including lists of all explosives, specifications for all magazines and the locations and security measures for all storage. The plan shall conform to the requirements of all applicable regulations and referenced standards and be incorporated into the hazardous materials management plan.

The plan shall include, but not be limited to, details of:

The location and construction of any on-site magazines and the type and quantities of explosives to be stored in the magazine and the security measures to be implemented at the magazine.

Contractor shall submit for review by the Employer not less than 30 days prior to starting a new phase of work a proposed blasting plan(s) for accomplishing excavation by use of explosives. The blasting plan(s) shall include, but not be limited to, the following:

- a) Trial blasts
- b) Location, depth, area, anticipated excavation lines and relationship to specified dimension lines, adjacent excavations and work.
- c) Diameter, spacing, burden, depth, pattern and orientation of blast holes.
- d) Type, strength, a mount in terms of weight and cartridges of explosives to be used in each hole, on each delay and total of each blast.
- e) Distribution of charge in each hole and priming of each hole.
- f) Type, sequence and number of delays; delay pattern (including delays in trunk lines); wiring, detonation cord, and / or shock tube diagram including any for blast, size and type of hook- up /trunk/signal lines and lead lines; and type and capacity of firing source
- g) Stemming of holes and matting or covering of blast area, including surface detonating chords, shock tubes and delays.
- h) Type(s) of vehicles to be used for transporting explosives to and on-site, and the anticipated size and frequency of deliveries explosives from the off-site supplier. Route to be taken when transporting explosives between the on-site magazines and the work areas.
- i) Provisions and procedures to transport explosives from the ground surface to the underground blast location.
- j) Provisions to inventory and control all explosives arriving on-site, removed from magazines for use and any unused explosives returned to the magazine.

### **3.3 Public Notification**

No blasting operation shall be carried out unless reasonable precautions are first taken to advise all persons' resident in the neighborhood. Thus, Awareness training program on the subject such as blasting locations, schedules, signage, warning alarms and mitigation measures shall be provided to the workers and affected communities. To minimize the impact to communities, blasting operation shall be carried out between 7am and 5pm. Specific alarm device (e.g., horn signals, air whistle) and procedures will be equipped before each blasting activity to alert all workers and community members. Before the detonation takes place, HEC will check that there are no people inside the controlled area and maintain the exclusion during the blasting and mopping up afterwards. Drones can be used to monitor areas of concern around the area for trespassers and onlookers.

Further, blasting operation will be notified to the Guadalcanal Province (GP) senior police officer at Henderson Police Station, and to the provincial secretary or other senior GP administration officer at least 24 hours prior to blasting.

Community awareness program will be provided 1 week prior to blasting activity. The blast controller will co-work with HEC CLOs to conduct face-to face awareness training prior to blasting activity. During awareness training blasting details such as blasting location, blasting schedule, blasting signage,



warning alarm, blast guard location and any information regarding blasting activity will be provided. Figure below shows the distribution of village around blasting area. The nearest village is Habusi 350m from Powerhouse and table indicating each villages composition, each village consists of one or two families, is sparsely scattered, and does not have cell phone, so only the chairman's contact information is recorded.

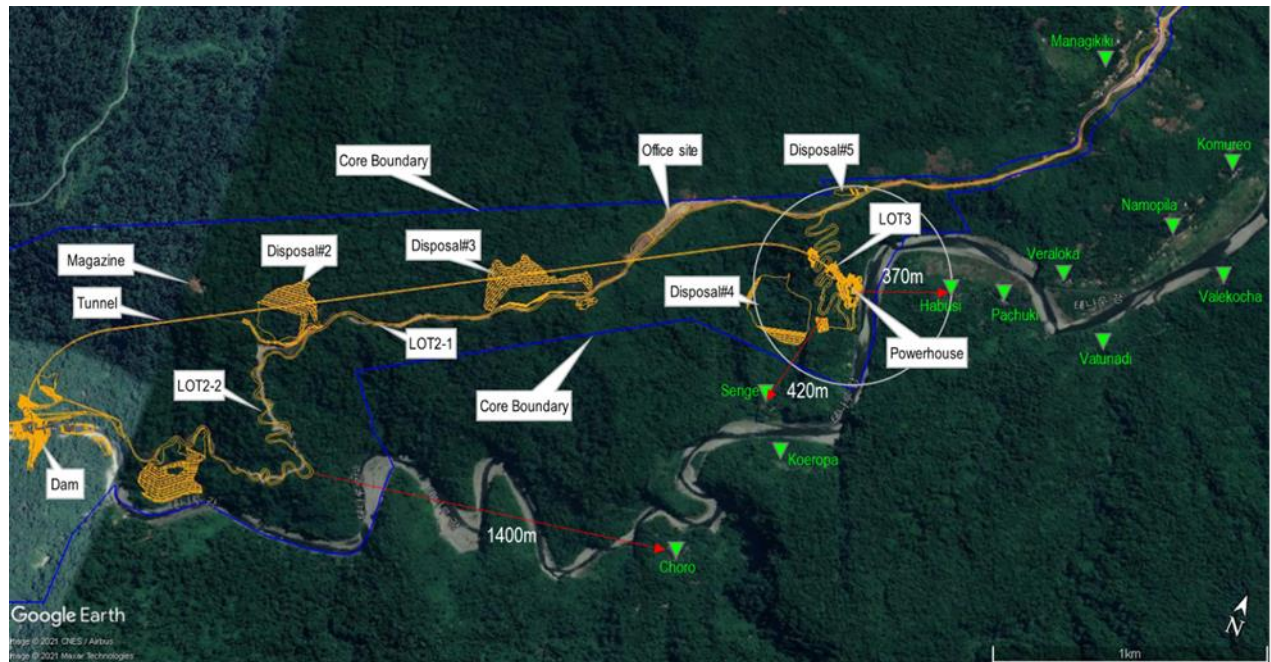


Figure 4. Map of villages near the project site

Table 3. Detail of Namopila community

COMMUNITY			CONTACT PERSON	POSITIONS
Namopila Cluster	Choro	1 Family	Maxley Chumba 715 9248	Chairman of Namopila Cluster
	Senge	1 Family		
	Koeropa	1 Family		
	Habusi	2 Family		
	Pachuki	2 Family		
	Veraloka	2 Family		
	Vatunadi	2 Family		
	Namopila	30 Family		
	Valekocha	2 Family		
	Komureo	2 Family		

### 3.4 Execution

All blasting activities shall be conducted by blasting experts who hold all necessary licenses or permits required for the use of explosives under the direction of experienced and fully qualified foremen. The Contractor has hired a qualified independent blasting consultant to review each blasting plan for compliance with all applicable codes, laws regulations, and requirement's.

Blasting Managing Director, Mr Lee Yongmin will oversee all aspects of tasks performed on site and will ensure that the workspace has been inspected and assessed before any works start.

HEC has hired blasting managing director, blasting experts and drillers who will be engaged in blasting work, especially required qualification and skill.

And HEC will hire local labors for simple work, for simple job such as support drillers and blasting experts, who has relevant experience as per P4 HRLMP.

### 3.5 Sources of Ignition Near Explosives

Operations that can lead to ignition or initiation of explosives shall not be carried out near (minimum 20m) to where explosives are being handled.

Non-electrical detonator to be used is designed to reduce the risk of initiation by static electricity, stray electrical currents and radio wave transmissions. However, high-electrical shocks, such as lightning, may cause initiation. All ignition sources, such as matches and lighters, are strictly prohibited within minimum 20m radius of the detonator.

### 3.6 Blast and Drilling Equipment

Blasting and drilling equipment shall be in a sound condition and suitable for the blasting and drilling operation being undertaken. Faulty or poorly maintained blast and drilling equipment shall not be used. The designated shot firer shall ensure that the blast equipment is fit for its intended purpose and safe to operate.

### 3.7 Training Competencies

Name	Skills/Competency
Lee Yongmin	Explosive supervisor
Lee Joonhan	Blasting Expert /Shotfirer
Lee Young Chul	Blasting Expert / Shotfirer
Jo Chungyul	Driller
Lee Sunghan	Driller
Lee Jongheum	Driller
Jung Sungsik	Driller

Refer to Attachment B. Blasting Experts License

### 3.8 Reporting of Theft or Loss of Explosives

Where a discrepancy, theft, or attempted theft of explosives has been verified, it shall be immediately reported to HSE Manager Mr D Y KIM and appropriate authorities.

### 3.9 Reporting of Damage or Injury

Where property is inadvertently damaged by blasting operations, it shall be immediately reported to Hyundai Engineering Co. Ltd HSE Manager Mr. D Y Kim, Project management and the appropriate authorities.

### 3.10 Emergency Procedure Fire in bulk explosive truck

Due to the inherent risk of an uncontained explosion resulting from a fire in a Bulk Explosive Vehicle, all personnel, contractors, road haulage truck drivers and residents (within two [2] Kilometers in all directions of the fire) must be evacuated to a point not less than one [1] kilometers from the Bulk Explosive Truck fire.

Emergency services must be contacted, and roadblocks established no closer than the above evacuation points and at a point intersecting at no less than two [2] kilometers from the Explosive Truck

fire. No person can enter the evacuation zone until deemed safe. (Drone or Helicopter observation should be considered)

Fire Brigade Services must be informed that the fire involves an oxidizer in the form of water- resistant Ammonium Nitrate Suspension and are not to enter area or attempt to fight Explosive Truck fire.

#### Emergency Contacts (Local number):

Construction Manager	HSE Manager	Project Manager
<b>J.B YOO</b>	<b>D. Y KIM</b>	<b>E. M MOON</b>
<b>716 9559</b>	<b>741 1755</b>	<b>758 4604</b>

#### 3.11 Hazardous Substances

All hazardous chemicals have Safety Data Sheets (SDS) and will be always onsite

#### 3.12 Accident and Incident Reporting

According to ESMP P8 section 5.2 Incident reporting and investigation procedures, any accident and incident shall be reported properly.

Key Task	Responsible	Name and Contacts
Assessment of incident severity and initial classification	HEC HSE Manager	<b>D. Y KIM</b> <b>741 1755</b>
Fill-out Notification report	HEC HSE Manager	<b>D. Y KIM</b> <b>741 1755</b>
Designation of Incident Owner and approval	HEC Project Manager	<b>E. M MOON</b> <b>758 4604</b>
Issue Notification report	HEC HSE Manager	<b>D. Y KIM</b> <b>741 1755</b>
Investigation	Incident Owner	
Action plan development	Investigation Team_ E&S team HSE team Construction team Security subcontractor MSS	<b>E&amp;S supervisor</b> <b>Mr. Tanzeel Ahmed</b> <b>770 1464</b> <b>HSE Supervisor</b> <b>Mr. Jonathan Benosi</b> <b>738 2076</b> <b>Security Manager</b> <b>Mr. Peter Tele</b> <b>787 3019</b>
Review and approval of action plan	HEC Project Manager	<b>E. M MOON</b> <b>758 4604</b>
Action plan implementation	Incident Owner	
Confirmation of implementation	HEC HSE Manager	<b>D. Y KIM</b> <b>741 1755</b>
Close-out	HEC Project Manager	<b>E. M MOON</b> <b>758 4604</b>

In case any injured person, emergency contact shall be made as shown in the figure below.



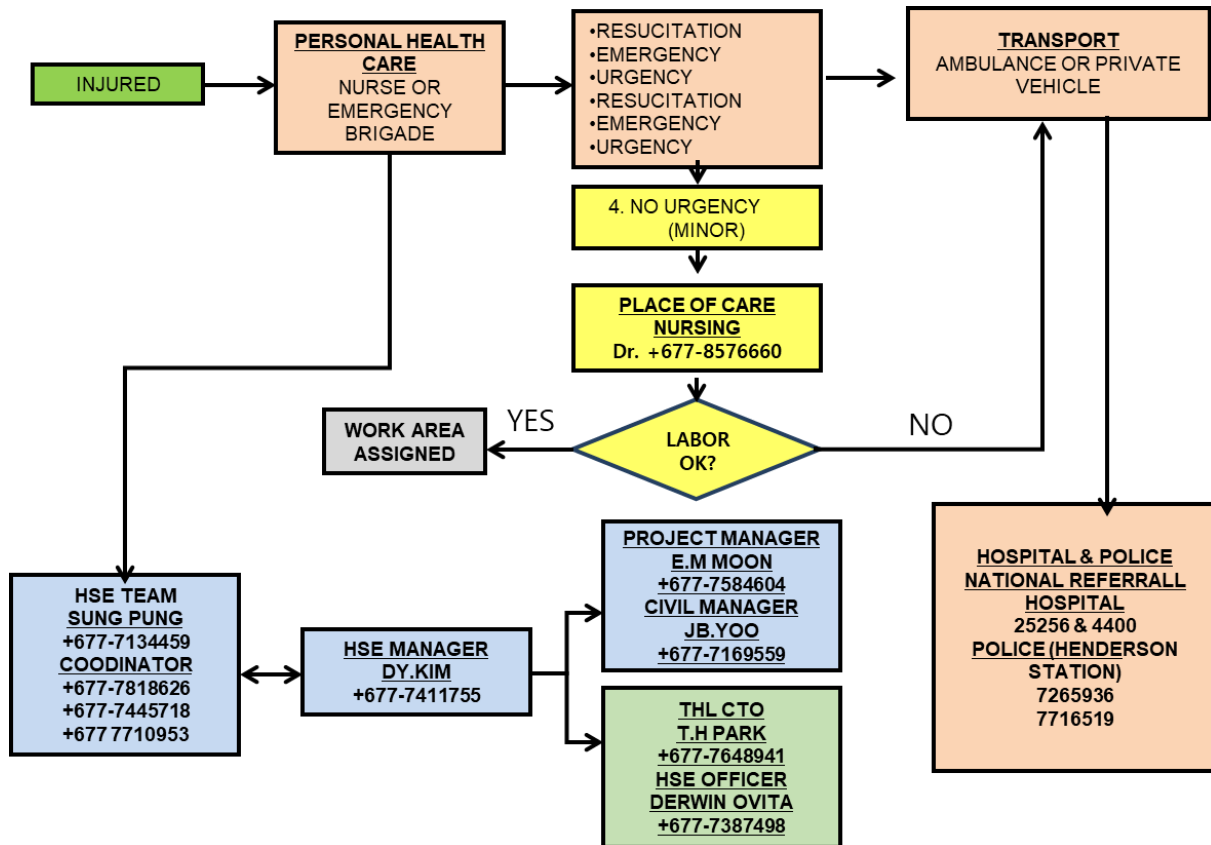


Figure 5. Emergency contact point

## 4 Planning

### 4.1 Safety and Security

All boundary protection is to be in place prior to distributing any explosives onto the shot and commencement of loading. The blast area shall be barricaded by erecting demarcation signs as deemed appropriate by the shotfirer.

The barricades (orange cones/ bollards) shall be located at least 10 meters from either the closest blast holes to be charged or where the explosives are being mixed. Barricades shall also be used on all other sides of shots where it is possible for people or vehicles/plant to access the area.

The red flags, not less than 3' x 2' in size shall be placed on all roads tracks and footpaths leading to the blasting area at a safe distance from the site of blasting having regard to the amount and nature of explosives being used. Further, the notice boards shall be placed with the wording in block capitals, "DANGER BLASTING", and such boards shall not be less than 3' x 2' in size, painted white with red lettering, such lettering to be not less than 4" in height and of appropriate width. The flags and notice boards shall be always removed when their presence may otherwise prevent the safe passage of any person who wished to proceed along any road, track, or footpath.

The positions of intended blast holes shall be marked accurately via Survey and shall be located safely away from butt locations and offset, located for the safety of drilling operations.

### 4.2 Suspension of Blasting

Blasting operations may be suspended by the Employer for any one or more of the following:

- Safety precautions are inadequate
- Ground motion vibration levels exceed specified particle velocity/ frequency limits as specified herein
- New or further damage to existing structures or improvements as a result of blasting;

- d) Blasting methods which in the opinion of the Employer endanger the stability of intact rock outside of the prescribed limits of excavation;
- e) Skilled operators and / or the licensed blasting supervisor is not present;
- f) Failure to comply with blasting notification requirements; or g) Fly rock travels beyond the Project right-of-way.
- g) Suspension of blasting operations shall not relieve the Contractor of his responsibilities under the terms of the Contract.
- h) The Contractor shall not resume blasting operations until modifications have been made to correct the conditions that resulted in the suspension.
- i) The Contractor shall not be entitled to any extension in time, nor to any claim of damage or to excess costs, by reason of any blasting suspension order.

### 4.3 Blast guards - Duties and obligations of a blast guard

The role of a blast guard is essential to the safe firing of explosives. The purpose of the blast guard is to create a physical barrier at all access points to a blast area to ensure no persons can enter the blast exclusion zone during the firing process.



A sign or barricade is NOT sufficient to ensure that no persons are within the area of danger prior to firing. Physical checks and guards are an integral part of any blast clearance process.

All blast guards must be appointed 30 minutes prior to firing time at the blast location, from which each blast guard location will be designated along with any relevant information as to the blast.

The obligation of a blast guard is to work under the direct instructions of the Shotfirer and Security Manager and no other person for the duration of the blast guarding duties. When directed, the blast guard will ensure that on the way to the designated barricade location, that there are no persons within the blast exclusion zone, ensuring that personnel are removed to beyond the barricade point.

Once the blast guard is in position at the barricade point, the access is to be closed. Under **NO** circumstances is any traffic or personnel to venture past this point until clear and confirmed instructions from the Shot firer has been received.

Under **NO** circumstances will the blast guard leave the position until the Shot firer has given the "All Clear" and confirmed with each blast guard that their duties are complete.

If a blast guard barricade has been breached or the blast guard sees personnel within the exclusion zone, the blasting process MUST be stopped. The blast guard will immediately call "*Blast Guard 1 John, to Shotfirer Dwayne. Abort the blast. The blast area has been breached.*" If no response call again.

### 4.4 Pre-Blast Meeting

The purpose of this is to discuss:

- Location of guard sites
- Allocation of guard's location and number Process for the blast clearance plan
- Any exceptional circumstances related to the blast
- From the meeting the authorized persons shall disperse to the allocated positions, checking for personnel on their way. Advising the Shotfirer / Security Manager as to

any machinery and personnel left in the area that you consider could be affected by the blast.

#### 4.5 Establishing the Barricade

Set oncoming vehicle up and park with orange cones/ bollards in a position that blocks the access and is clearly visible to all oncoming traffic. Have your revolving light activated. Ensure you have clear vision of the access and surrounding area.

Remain with your vehicle and two-way communication during the guarding process. Once in position, no traffic or personnel is permitted to pass the barricade location.

#### 4.6 Firing Sequence

The Shotfirer and Security Manager will do a full clearance inspection of the blast zone. Once this has been completed and the Shot firer is satisfied the blast zone is clear, the firing sequence will start.

As part of the blasting plan the contractor shall implement a written “ blasting and warning system ”, describing the audible warning system, signage and procedure which will be used to ensure that all personnel, staff, visitors and all other persons are at a safe distance before blasting takes place. The procedure shall include provisions to “tag out” all workers in the blast area prior to a blast.

**5 Minute Call (Shotfirer) \_ WARNING SIGNAL**(series of long siren blasting, lasting 1min)  
*“Attention all personnel, a blast will be fired in approximately 5 minutes. Blast Guards and Traffic Controllers please be ready to take your positions. All other personnel please maintain radio silence until the blast has been fired and all clear is given unless in the case of an emergency.”*

**Ready to Fire Call (Shotfirer)\_BLAST SIGNAL**  
*“Shotfirer to all Blast Guards, the blast is ready to fire.”*

**Block Access Call (Shotfirer)**  
*“All Blast Guards please block your access.”*

**Check Call (Shotfirer)**  
*“Shotfirer to Blast Guard (number) (name), are you in position?”*

**Check Call Response (Blast Guard)**  
*“This is Blast Guard (number) (name), I am at (location), and my access is blocked.”*

**Traffic Stop Call (Shotfirer)**  
*“Shotfirer to Traffic Controller (number) (name) please block your access, and confirm access is blocked.”*

**Traffic Stop Call Response (Traffic Controller)**  
*“This is Traffic Controller (number) (name), I am at (location), and my access is blocked.”*

**Ten Second Call (Shotfirer)**  
*“Attention all personnel, the blast will be fired in approximately 10 seconds.”*

\*\*\*\*\* **10 Seconds Radio Silence -> “Firing now.”** \*\*\*\*\*

#### 4.7 Shot fired

Once the shot has been fired; Shot firer to announce, “The blast has been fired, radio silence is now lifted, and blast guards please remain in position until the shot is inspected” and the **“all clear”** is given.

Blast guards are to remain in their position until the Shot firer has inspected the blast and cleared the shot. The Shot firer will instruct blast guards.

**NOTE:** The barricade is still in force, no traffic, or personnel to gain access to the blast zone. (This is to allow for the treatment of any misfires found with the possibility of refiring at the time.)

#### 4.8 **Shot Cleared**

Once the shot firer has inspected the blast and is satisfied the shot is clear and free of potential misfires, he will issue the "All Clear". Each blast guard is to respond back the Shot firer the order of their blast guard number to confirm the "*All Clear has been received and blast guard is standing down*"

#### 4.9 **Signs & Markings**

Appropriate warning sign(s) (Danger, Blasting Today, Keep Out) shall be placed on access roads to the blast site. The red flags, not less than 3' x 2' in size shall be placed on all roads tracks and footpaths leading to the blasting area at a safe distance from the site of blasting having regard to the amount and nature of explosives being used. Further, the notice boards shall be placed with the wording in block capitals, "DANGER BLASTING", and such boards shall not be less than 3' x 2' in size, painted white with red lettering, such lettering to be not less than 4" in height and of appropriate width. The flags and notice boards shall be always removed when their presence may otherwise prevent the safe passage of any person who wished to proceed along any road, track or footpath.

The positions of intended blast holes shall be marked accurately and shall be located safely away from butt locations, located for the safety of drilling operations

#### 4.10 **Responsibilities**

The shot firer has overall responsibility encompassing each stage of the blasting operation they shall ensure that the people assigned specific duties are competent for the tasks assigned. The shot firer shall confirm that person's assigned specific duties understand the requirements or activities to be performed

#### 4.11 **General Safety Precautions**

All persons who intend entering the blasting operations shall attend induction training program, comply with the blasting management plan and all work instruction procedures.

#### 4.12 **Special Precautions**

No unauthorized persons to enter a designated blasting area.

#### 4.13 **Design and Layout of Blast Holes**

Blasting Expert shall design the blast sequence and record the details on the blast report worksheet.

The agreed blast pattern shall be laid out.

The burdens and spacing must be measured accurately and marked.

#### 4.14 **Standard Blasting Patterns**

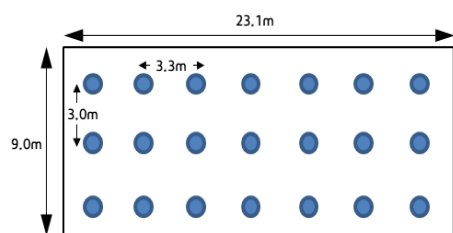
There are 4 standard patterns to be applied for TRHDP blasting. The below table and figures show the details of standard blasting patterns. However, Final pattern and the amount of explosive shall be determined by trial blasting. Blasting areas to determine minimum distances from concrete and grout holes shall be determined by trial blasting considering key factors such as the concrete and grout and standards and relevant research materials.

*Table 4. Standard blasting patterns*

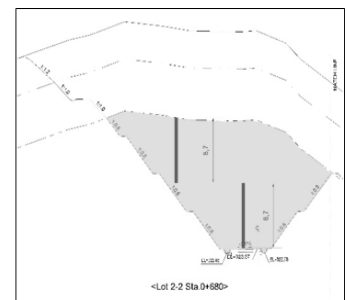
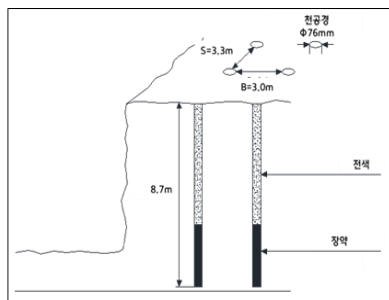
Classification	Large scale blasting	General blasting	Medium scale vibration control blasting	Small scale vibration control blasting
Diameter of drill hole	76mm	76mm	76mm	45mm

Length of drill hole	8.7m	6.2m	3.2m	2.7m
Burden	3.0m	2.4m	1.5m	1.0m
Interval of drill hole	3.3m	2.8m	1.7m	1.5m
Length of explosive	5.50m	3.84m	0.96m	1.20m
Length of stemming	3.20m	2.36m	2.24m	1.50m
Number of hole	22holes/day	32holes/day	62holes/day	74holes/day
Blasting amount	1,800m <sup>3</sup> /day	1,240m <sup>3</sup> /day	480m <sup>3</sup> /day	290m <sup>3</sup> /day

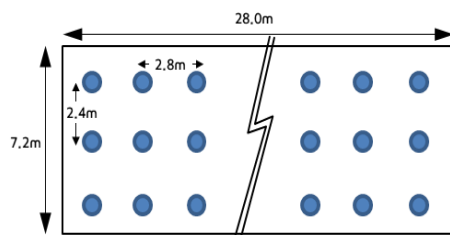
## Large Scale Blasting



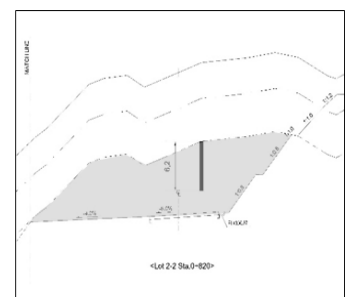
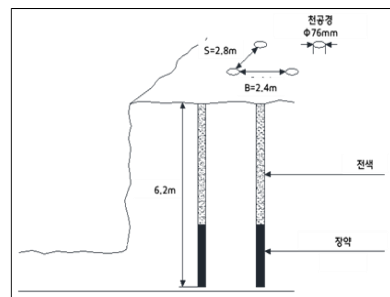
❖ Blasting amount at a time :  $23.1 * 9.0 * 8.7 = 1,800\text{m}^3$



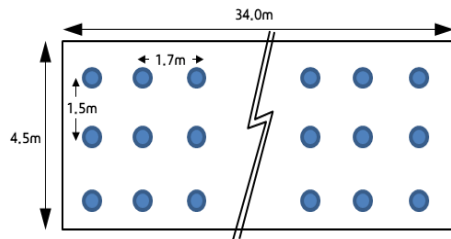
## General Blasting



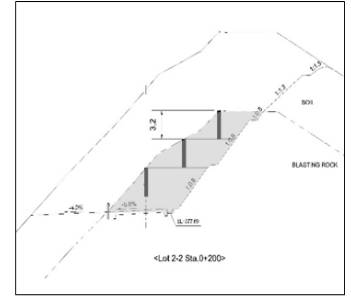
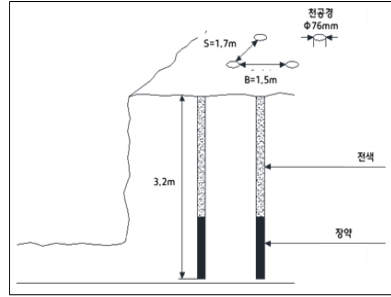
❖ Blasting amount at a time :  $28.0 * 7.2 * 6.2 = 1,240\text{m}^3$



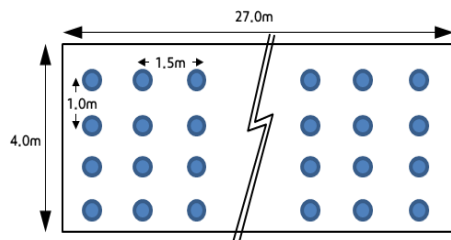
## Medium scale vibration control blasting



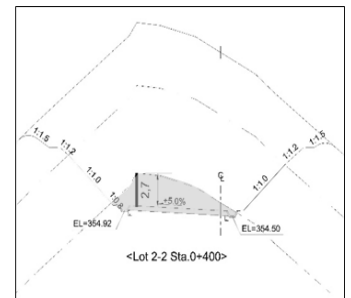
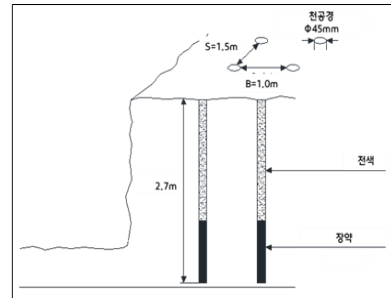
❖ Blasting amount at a time :  $34.0 \times 4.5 \times 3.2 = 480\text{m}^3$



## Small scale vibration control blasting



❖ Blasting amount at a time :  $27.0 \times 4.0 \times 2.7 = 290\text{m}^3$



### 4.15 Detail of blasting

The total blasting amount and subsequently the estimated number of blasting according to the patterns are as follows:

Table 5. Application of blasting patterns

Blasting Pattern	Blasting Amount(m3)	Efficiency (m3/day)	Number of blasting	Remarks
Small scale vibration control blasting	26,915	290	93	Solid Rock
Medium scale vibration control blasting	42,522	480	89	
General blasting	72,522	1,240	59	
Large scale blasting	180,394	1,800	101	
<b>Total</b>	<b>322,359</b>		<b>342</b>	

#### 4.16 Roles and Responsibility

In order to safely control blasting operations a number of key appointments are required as a minimum. Full duties of each role are describe below;

- Explosive supervisor

Explosive supervisor is appointed to organize and supervise all work at blasting site involving the use of explosives. The Explosive supervisor will be appointed by Project Manager.

Key responsibilities;

- To ensure that explosives are handled and used in a manner that is without risk to the health and safety of personnel in the vicinity, and bring anything which may adversely affect this to Project Manager's attention immediately.
- An adequate written blast plan is produced for each blast - prepared by themselves or the Shotfirer. This is evidenced by the Explosive Supervisor signing at least the cover sheet and proposed explosives loading sheets prior to charging operations commencing.
- Making all explosives appointments on site.
- Equipment used for shotfiring is suitable and safe.
- Site conditions are in line with the blast specification before work with explosives begins.
- Explosives are only kept in the approved storage areas unless they are being transported or are being used and accurate records are maintained.
- Implementation of the misfire procedure in conjunction with the Shotfirer.
- Defining the danger zone required. This may be a standard danger zone for blasting, but must be reconsidered for every blast when approving the blasting specification, or if notified of any change during charging notified by the Shotfirer. The extent of the danger zone and position of any safe areas must be notified to the Blast Controller before charging commences and prior to clearing the danger zone in the event of changes in conditions as a result of actual charging.
- Ensuring that risk assessments are in place for all blasting activities, even though they may be assessed by others.

- Shotfirer

Key responsibilities;

- Marking out shots prior to drilling.
- Surveying shots, or ensuring information provided by a separate surveyor is adequate for use preparing the blasting specification.
- To prepare explosives for immediate use.
- Supervising transport of explosives on-site.
- Prepare primers with detonators.
- Charge and stem holes as per the blast plan, or within the allowable variation shown on the specification. They must notify the Explosives Supervisor of any changes outside the allowable variation, or changes to any conditions since the approval of the specification.
- Link, connect or otherwise prepare the initiation system ready for firing.
- Inspect and test the initiation system as appropriate for the type being used.
- Liaise with the Blast Controller to ensure that the danger zone is clear before testing any live initiation system.
- Fire the shot from a safe designated location.
- Carryout post-blast inspections to check for misfires.
- Check that equipment used for shotfiring is suitable and safe and site conditions are in line with the blasting specification before work with explosives begin.
- Maintaining security of explosives and control of the blast site as a restricted area.

- Blast Controller

The Blast controller's primary role is to ensure that the blasting danger zone is clear of personnel, secured against entry from outside, and to communicate directly with the Shotfirer as per the blasting procedure to allow the safe firing of shots without risk to personnel. It is not the role of the Blast controller to determine the extent of the danger zone. The Blast controller does not need blasting experience and could be for instance a construction supervisor.

The blast controller shall be included in the attendance of the public/internal notification.

Key responsibilities;

- To ensure that no person is left in the danger zone once sentries are in position. Only the shotfirer and those personnel with specific duties in the clearance procedure enter the danger zone at this time.
- To only give the instruction to the Shotfirer that they may fire the shot when the danger zone is secure and clear as per the procedure in these rules.
- If anyone gives the STOP, STOP, STOP notice, ensure that the Shotfirer confirms this. If not, repeat the notice until the Shotfirer confirms. Once confirmed, investigate the cause and only recommence the procedure once safe.

- Blast Guard

The primary role of blast guard is to guard a position so as to prevent access to the blasting danger zone from the time they are positioned until relieved by the 'all clear'. Blast guards may have additional roles prior to taking up their position eg. checking an area is clear of personnel then working outwards to the entrance before blocking access to it.

Blast guards will be instructed by the Blast Controller and must only follow instructions from the Blast Controller, or the Shotfirer directly.

Blast guards will be briefed on their specific role for each blast by the Blast Controller. They will be given clear instructions, informing them of their duties and responsibilities and where they must position themselves for the blast.

- Blast guards must ensure that they are in position in sufficient time to clear their area of responsibility, take up position and bar entry to the danger zone.
- Blast guards must ensure that they understand the method of communication.
- Blast guards must be in contact with the Blast Controller and Shotfirer and when asked to do so, report that they are in position and that their area of responsibility is secure, or not.
- Immediately report to the Shotfirer, if at any stage the danger zone is breached, or there is some other matter affecting the safety of the blast. Call **STOP, STOP, STOP** at any time to postpone firing - explanation can be made after.
- Stay in position when the shot is fired and bar all entry to the danger zone until the 'all clear' signal is sounded and you are relieved by the Blast Controller by radio. If in doubt **stay in position** and contact the Blast Controller.

- Drillers

Drillers are responsible for drilling holes as per the blast plan and within limits of allowable variations. They must:

- Report to the Explosive Supervisor should they be unable to drill any shot hole as indicated on the blast plan, or within the allowable variation allowable.
- Ensure that all cavities, obstructions, clay bands, basalt and other geological features that may affect the shot encountered during drilling are recorded on the drill log.
- Securely anchor the drill rig if drilling on steeply inclined ground.
- Do not leave the rig unattended during drilling operations. Lock and isolate the rig when it is



unattended.

- If there is not adequate lighting then all operations will cease during poor visibility and darkness.

## **5 Blast Preparation**

### **5.1 Blast Management Plan**

Prior to the blast preparation process proceeding, the site shall be inspected, and the blast plan shall be reviewed by Employer not less than 30 days to ensure that it is still valid, and any significant variations are identified and assessed.

### **5.2 Access**

Provision should be made for the intended access to and from the blast area to be in a suitable condition under the pre-dominate weather conditions that would be expected during normal blasting operations.

The area around the blast site shall be properly delineated, and exclusion signage displayed.

### **5.3 Pattern Mark out**

Accurate and clear drilling plans. Accurate marking of the positions of intended blast holes. Intended blast holes should be located safely away from butt locations, located for the safety of drilling operations.

### **5.4 Hole diameter**

Blast holes shall be of sufficient diameter as to permit free insertion of the charge without ramming, forcing or removal of cartridge wrapping for packaged products, and of such diameter to ensure when bulk product is being used that fragmentation is optimised.

### **5.5 Pre-drilling examination**

Before drilling commences, the area near the intended blast hole shall be examined for the presence of explosives. If examination reveals explosives are present, they shall be treated as misfires and dealt with according to HEC Misfire procedures.

### **5.6 Drilling**

The area where the shot will be marked out will be communicated by the construction team to the Shotfirer on-site.

The Shotfirer will ensure that:

- The area has been checked as required to ensure that it is safe from face collapse, either on the bench, or from an adjacent bench.
- That the access route to the location is safe and sufficient for drilling equipment and shotfiring /charging vehicles.
- That the ground is sufficiently cleaned off to allow drilling.

The Shotfirer will also check that the proposed blast location, and access to it, is suitable, prior to the shot being marked.

The shot will be marked out by the Shotfirer and a detail blasting plan instruction prepared. The minimum to be marked on the ground will be the hole positions, hole numbers and azimuth markers for front row holes.

For holes marked on a square/rectangular pattern, the azimuth marker for all other rows will be the hole in front. Where this differs an azimuth marker must be provided on the ground. Every effort will be made to avoid geological anomalies, which may give rise to fly rock.

The detail blasting plan shall instruct the driller on hole location, diameter, depth and inclination and azimuth.

The driller shall carry out the drilling instructions. He will record on the drilling record sheet any variations from the intended hole locations and the position and extent of any voids, clay, broken ground, or zones of poorer quality rock identified during the drilling operation. Where there is a need for a substantial departure\* from the instructions given, the driller must refer the matter to the Shotfirer or Explosives Supervisor. (\*If the driller needs to move a hole more than 1m from its original position, or closer to the next hole than the minimums shown in section Blasting Constraints, or where there is any doubt.)

At each blast hole location, the driller will position the drill rig and set the drill mast at the angle specified in the detail blast plan and in the direction of the hole indicator marked on the ground. The mast angle will be re-checked after approximately 2.0 meters of drilling and adjusted as necessary. Blast holes will be numbered sequentially, usually from right to left as the driller approaches the blast pattern from the top.

The rig must be positioned with the tracks perpendicular to the face to keep the rig's centre of gravity as far away from the face as possible. If it is necessary to drill with the rig's tracks parallel to the face a risk assessment will be completed prior to commencement.

As far as is reasonably practical, the front row will be drilled first, starting from any open end, working back through the blast hole pattern.

On completion of drilling, the drilling record sheet will be submitted to the Shotfirer or Explosives Supervisor to enable the blast record to be produced.

Cones must be placed at the entrance to the top of the shot and on the quarry bench below to warn people and prevent access to the blast site by unauthorised personnel.

The Driller shall:

- Report to the Shotfirer or Explosive Supervisor should they be unable to drill any shot hole as per the detail blast plan, or within the allowable variation.
- Report to the Shotfirer or Explosive Supervisor if cavities, caves, holes, whether in-filled by clay or empty, are seen in the face.
- Ensure that all cavities, obstructions, clay bands, faults and other geological features, which may affect the shot encountered during drilling are recorded on the drilling record sheet.
- Ensure that if the shot hole is not to be used for the purpose of the blast, it is in filled with inert incombustible material before any shot is charged.
- Check the hole depth with a tape measure to check the depth is correct and cover if required.

No drilling is permitted adjacent to charged holes where any part of the hole is within 10m of a charged hole without the completion of a specific activity plan and risk assessment for the activity (approved by the Explosive Supervisor). Although permitted, drilling adjacent to charged holes should be avoided wherever possible. Even with the appropriate control measures in place this should normally only be considered during the treatment of misfires.

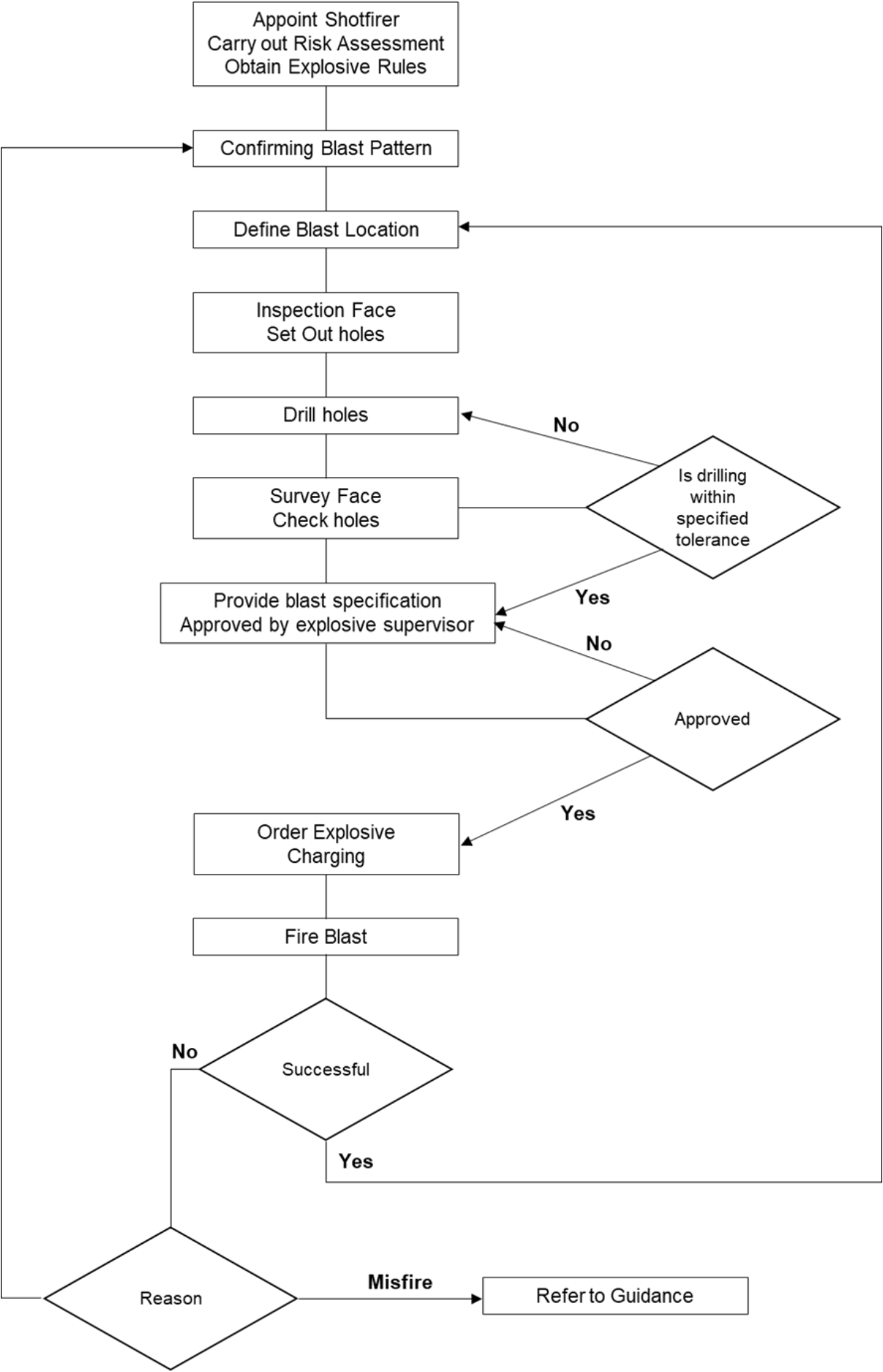
### **5.7 Drilling in cut-offs or butts**

Drilling shall not be carried out in cut-offs or butts. Ensure Drill pattern is offset to previous pattern

### **5.8 Prevention of blast hole blockage**

All drilled holes shall be plugged with a collar cap cone inserted into the collar to prevent the unintentional entry of drill cuttings, surface debris and spoil/ stemming material entering blast holes via the collar.

5.9 Process diagram from Drilling and Blast



## **6 Operations Prior to Charging**

### **6.1 Blast area inspection**

A blast area inspection shall be conducted before loading commences. Any hazards identified as posing an unacceptable risk shall be mitigated.

### **6.2 Environmental conditions**

An assessment of environmental conditions should be made prior to any explosive loading activities. This is especially important for charging and firing to be completed in a limited time, (Operating license conditions).

### **6.3 Precautions at site**

Exclusion zones shall be established around the blast area, taking into consideration vehicle movements, planned maintenance and other non-blasting activities.

Where charging operations are occurring at more than one location, adequate communication shall be maintained between each operation if there is a likelihood of one or more of the locations affecting another.

There shall be no sources of ignition introduced into the blast area other than that which is required to initiate the shot. This shall not preclude the plant required for charging operations. Plant to be used in the blast area shall be assessed for its suitability and unacceptable risks shall be mitigated before it is used.

### **6.4 Blast hole measuring**

The blast holes shall be checked prior to loading for location, depth, diameter, angle, and presence of water.

HEC to provide drilling log for each intended blast site, areas requiring special treatment shall be identified.

- a) Blast holes that contain water.
- b) Blast holes that are to be decked.
- c) The initiation blast hole.
- d) Blast holes that have partially or fully collapsed.
- e) Blast holes that vary from the blast plan.
- f) When variances from the blast management plan are discovered, their effects should be assessed, and any unacceptable risks should be mitigated.

### **6.5 Loading sequence**

Shotfirer/Blasting Expert to co-ordinate loading sequence.

### **6.6 Sleeping loaded shots**

Where a loaded shot is to be 'slept' for period before actual detonation a suitable person must be made responsible for guarding the blast area from un-authorised access.

Persons selected to guard shots must be capable to do so.

Persons allocated to guard shots must have suitable means of communication to alert HEC Shotfirer, HEC HSE Manager and emergency services in the event of an emergency.

Shot firer must record details of when shots are slept and who was allocated to guard the area. A diary note is all that is required.

## **7 Charging**

### **7.1 Safety Precautions**

Before charging commences, un-authorised personnel and machinery not involved with the blasting operations shall be removed from the area.

### **7.2 Precautions at Site**

No work or vehicular activity, other than that associated with the charging operation, shall be performed within proximity of a blast hole or initiation system. All other persons and mobile equipment shall not proceed past exclusion zones, and designated blast guards controlling access.

### **7.3 Blast holes (Cleanliness)**

Blast holes shall be thoroughly cleaned of all loose material before charging, if not charged immediately, blast holes shall be plugged or otherwise protected to prevent debris entering the blast hole.

*Note:* Each blast hole should be examined before insertion of the charge.

### **7.4 Insertion of Charges Loading of Holes with Bulk Explosives(if required)**

- All holes are to be filled to the required load weight or stemming depth.
- Loading the Holes with Bulk Explosives
- Deliver boosters to the site, placing two at the collar of each hole.
- Deliver non-electric downlines to site, placing appropriate detonators at each hole.
- The detonator is threaded into the booster and this unit is now called a “primer”. The primer is now lowered to the bottom of the hole. The remaining non-el tube is wound around a rock or cover with stemming, so ensuring that it does not fall down the hole.
- Drilled holes must be primed before bulk explosive is loaded.

### **7.5 Stemming of Blast Holes**

The stemming of blast holes is an important task and must be administered slowly. The bridging of stemming in a blast hole will result in stemming material ejecting, producing overpressure, fly rock and poor fragmentation.

The stemming material should be crushed aggregate {10mm preferred}. All holes must be stemmed before the surface tie-up starts.

### **7.6 Bulling**

Where blast holes are to be bulled, suitable protective guarding shall be placed in front of the collar of the blast hole to reduce the danger of fly.

## **8 Method of Initiation**

### **8.1 Risk assessment**

The blast must follow the following sequence and the shot firer will:

- Advise the HEC Construction Manager the exact time for the Blast.
- Advise statutory authorities, community etc. (if applicable) of the exact blast time. Clear personnel to a safe place during blasting.

- Place all control points to block access to blast site and close any public roads where necessary.
- Sound the siren to indicate that the blast is imminent and make a final check of the security of the area.
- Verify by radio that all control points are secure. On receipt of the “Area Secure” advice: -
- Run out firing cable device. After checking with Security Manager and Blasting Expert that all visitor / contractor and team members are clear of blasting exclusion zone, this will ensure no mobile plant run over lead in line.

## **8.2 Method of Initiation**

Shotfirer depressed non - electric exploder device or electric det.

To keep safety during charging activity, take measures as belows;

- Prior to charging, any equipment using electricity such as electric water pump, welding machine or etc shall be removed within blasting boundary
- Hold any blasting activity when lightning strikes are forecasted.
- Shorten the last two strands of the electric detonator to the last minute.
- No use of radios or cellphones when handling electric detonators.

## **8.3 Firing**

According to count-down sequence, shot-firer controls firing.

## **8.4 Count-down Sequence**

- Blast controller to shotfirer, the area has been checked and is secure; the shot is now in your control.
- 5 minutes call by shotfirer \_ Warning signal lasting 1 minute
- “Attention all personnel, a blast will be fired in approximately 5 minutes. Blast Guards and Traffic Controllers please be ready to take your positions. All other personnel please maintain radio silence until the blast has been fired and all clear is given unless in the case of an emergency.”
- Shotfirer to all Blast guards/Traffic controller, the blast is ready to fire, “All blast guard and traffic controller please block your access” and then check call to all blast guards.
- Please maintain radio silence until the blast has been fired.
- Ten seconds Call by shotfirer  
Shot firer to all personnel, “Attention all personnel, the blast will be fired in 10 seconds”, 10 seconds radio silence > “Fire now”
- Shot firer to blast controller, the blast has been fired; radio silence is lifted however blast guards are to remain in position while the shot is inspected.

## **8.5 Observation of Blast**

Observation shall only be permitted at a location authorised by the Shotfirer and Blast Crew.

# **9 Post Blast Procedures**

## **9.1 General Safety Considerations**

The Shot firer shall wait at least 5 minutes minimum or until dust and fumes have sufficiently cleared after the shot has been fired before approaching the blast.

## 9.2 Fumes

Blast fumes are a risk factor than must be considered when firing, checking, and calling all clear after firing. Blast fumes are usually NO<sub>x</sub> gases, yellow to red brown to purple in color. Either group of gases determined are detrimental to health and in significant concentrations can be lethal. Several factors can potentially cause fumes including:

- Water resistance properties of explosive product. Improper priming.
- Lack of confinement.
- Excessive sleep time.
- Reaction of explosive with rock.
- Incorrect loading technique and or hose handling.
- Incomplete product reaction or incorrect product formulation.

Shot firers should also be aware of dust or fume clouds after firing and ensure that they and other personnel including blast guards are at sufficient distance that they will not be influenced. If the dust or fume clouds are evident and they are likely to come into significant contact with personnel, then they should retreat a further safe distance and notify the shot firer to ensure the blast area is not compromised. No personnel should enter a blast area until all clear from the shotfirer and all fume and dust cleared. Care should be taken in open pits or underground excavations where dust or fumes may take extra time to dissipate especially on still days or until ventilation can be re-established. In these case`s no personnel should re-enter the area until it has been cleared, whatever the period after firing. Where the blast area can be cleared but fumes are still evident then the site personnel must be informed, and a safe perimeter established until such time as the fumes and dust clear.

## 9.3 Post-Blasting Procedure

The purpose of a post-blast inspection is to ascertain if it is safe for personnel to return to the blast site and for routine operations to resume.

Post blast inspections should include but not be limited to the following:

- a) Whether this is a need for more than one person to return to the shot for the inspection.
- b) Procedures to be adopted if the inspection reveals that the (All Clear) into the exclusion zone cannot be given, including the communications mechanism of the (All Clear) or otherwise.
- c) Determine that oxygen, fumes, and dust are at acceptable levels.
- d) Continuous inspection procedures during the approach to the post-blast site that might identify unusual or abnormal results indicating possible hazards.
- e) Whether there is a need to wash down/ or scale down.
- f) Identifying a misfire or butt and the means of clearly marking misfires or butts.

## 9.4 Site Housekeeping

Prior to exiting, Shotfirer to ensure all explosive product and packaging is removed from site and secured back in the storage magazines. All empty packaging to have labels spray painted out and folded flat

## 9.5 Reporting

Contractor shall submit a record of each blast at least four (4) hours prior to the next scheduled blast. The record shall be prepared in a consistent and concise pre-approved format and include the following:

- a) A plan of the hole spacing, depths and orientation of blast holes and the location of the blast point in relation to Project and nearby features.
- b) Unusual occurrences, including rock falls, unstable ground, ground water problems, work delays, misfires and the location and timing of these occurrences.
- c) A complete description of the blast round as blasted including, but not limited to:
  - I. Date, time and limits of blast by location.
  - II. A comparison of planned versus actual parameters including depths of holes, spacing of holes, number of holes, kilograms of explosive per hole, kilograms of explosives per delay, type of delay, delay periods, total number of delays, method of detonation, type of stemming and length of stemming.
  - III. Description and location(s) of blast matting or other noise and fly rock mitigation methods.
  - IV. Diagram of blast pattern holes indicating holes not drilled, drilled but not loaded, changes in spacing, changes in pattern of delays, changes in loading of holes and burden of round.
  - V. Amount of explosives used by weight and number of cartridges.
  - VI. Total number of delays used and number of holes used for each delay period.
  - VII. An evaluation of the blasting indicating number and percentage of perimeter holes visible after scaling of loose rock, areas of significant over break or tightness and planned adjustment for the next blast.
  - VIII. Peak particle velocity, vibration frequency, and peak overpressure measurements and locations.
  - IX. Method for location and misfire identification, removal/treatment of misfire. Appendix 9. Misfire Handling Procedure should be followed in the event of any type of misfire occurring or being discovered whilst shotfiring operations, inspecting the face or loading the rock pile.



## 10 Resources for Blasting

The workforce and equipment required for blasting works is estimated based on the amount of blasting works and work efficiency as following.

### The average amount of blasting at once

- 1) Total Blasting amount: 321,927m<sup>3</sup>
- 2) Total number of Blasting (Section 4.14): 340
- 3) Average amount of blasting at once:  $321,927/340 = 947\text{m}^3$

### The average amount of blasting per month

- 1) Estimated blasting working days per month: 10days
- 2) Average amount of blasting per month:  $10 * 947 = 9,470\text{m}^3/\text{month}$

### The number of teams required

- 1) Planned time frame for blasting: 12 months
- 2) The number of teams required:  $9,470 * 12 * N = 321,927$

$$N = 3 \text{ Teams}$$

#### 10.1 Workforce


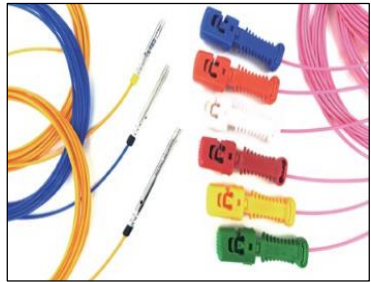
Classification	Job Description	No of Workforce
		Day Shift(08:00~17:00)
Team 1 (For Lot 3 area)	Blasting Expert	1
	Driller	1
	Blasting assistant	3
Team 2 (For Lot 2-2 area)	Blasting Expert/Shot Firer	1
	Driller	1
	Blasting assistant	3
Team 3 (According to rock quality, Team 3 will be allocated as per rock quality of Lot 2 and Lot3) (Blasting expert of team 1 or 2 will cover explosive handling)	Shot firer	1
	Driller	1
	Blasting assistant	3
Total		15

## 10.2 Heavy Equipment

Hydraulic drilling machine will be used for drilling work. Refer to Attachment C. Drilling Machine Specification.

Classification	Heavy Equipment Type	Capacity	Purpose	Quantity
Team 1	Excavator	1.0 m <sup>3</sup>	Loading / Excavation	3
	Dump Truck	15 ton	Transportation	3
	Drilling Machine	JD1000	Drilling	1
Team 2	Excavator	1.0 m <sup>3</sup>	Loading / Excavation	3
	Dump Truck	15 ton	Transportation	3
	Drilling Machine	HCR-910-DS	Drilling	1
Team 3	Excavator	1.0 m <sup>3</sup>	Loading / Excavation	3
	Dump Truck	15 ton	Transportation	3
	Drilling Machine	PowerROC T25	Drilling	1
Total				21

## 10.3 Explosives and detonator

No	Type	Features	Remarks
1	Emulsion Explosives (Refer to Attachment D. Explosive Technical and Safe Data Sheet)	<ul style="list-style-type: none"> <li>• Good waterproof &amp; cold proof</li> <li>• Applicable to tunnel and open pit blasting</li> <li>• Usable for both soft rock and hard rock</li> <li>• Cartridge diameter: 25~65mm</li> <li>• Cartridge length: 250~520mm</li> <li>• Average blast wave velocity: 5,700m/sec</li> <li>• Explosion heat: 880~1,100kcal/kg</li> <li>• Cold proof: -20°C</li> <li>• Water proof: highest resistance</li> </ul>	
2	Non-Electric Detonator (Refer to Attachment E. Detonator Technical and Safe Data Sheet)	<ul style="list-style-type: none"> <li>• Relatively safe because it is not initiated by impacts, friction, leakage current, and static electricity</li> <li>• Silent because it is initiated only inside tube</li> <li>• Good flexibility, wear resistance, and yield strength etc.</li> </ul>	

## 11 Applicable laws and Regulations

As per the Explosives Act, the Contractor has to get 3 compulsory licenses and 1 optional license to store and use the explosive.

- 1) User's License, issued by the Permanent Secretary of Ministry of Infrastructure;
- 2) Dealer's License, issued by the Commissioner of Police;
- 3) Magazine License, issued by the licensing officer; and
- 4) Temporary Storage License, issued by the licensing officer (Optional)



### 11.1 User's License

This License is Issued by the Ministry of Infrastructure (MID) – Permanent Secretary

#### **Procedure**

1. Submit required documents to P.S of MID for endorsement.
2. If approved, then payment of required fees to the ministry of finance.
3. Submit the payment receipt to MID
4. Awarded the User's License

#### **List of Required Documents**

1. Formal request letter seeking permission to obtain User's License
2. Blaster License/Certificate
3. Area of Blasting
4. Quantity of explosives to be used
5. Payment receipt from Ministry of Finance (submitted once the application is approved)

#### **Status**

1. 09/03/20 – Check Application Status with MID.
2. 16/03/20 – Submit the Users' License application
3. 18/03/20 – Collect Approval Letter & Payment of Fees
4. 20/03/20 – Awarded User's License
5. 14/10/20 – Renewal of User's License (License is valid until 22nd March 2022)
6. 11/10/21 – Request for Replacement of Qualification Blaster in the User's License
7. 18/10/21 – The replacement blaster is approved and the renewed license

## **11.2 Dealer's License (Form B) & Magazine License (Form G)**

These two licenses can be permitted only after the completion of construction of Magazine House followed by the inspection and issued by Royal Solomon Islands Police Force – Commissioner.

### **Procedure**

1. Submit required documents to RSIPF Commissioner.
2. Commence the Construction of Magazine House
3. Pre-Survey by EOD Team to correct the progress (before the completion of the construction)
4. Once complete the Magazine House Construction
5. Final Site Inspection of Magazine House by EOD team
6. Officer in Charge of EOD team will write report to RSIPF Commissioner for approval & awarding of Dealer's & Magazine License.
7. Awarded the Dealer's and Magazine License
8. After obtaining the Dealer's & Magazine Licenses, HEC can import Explosives, store and use explosives for construction.

### **List of Required Documents**

1. Formal request letter seeking permission of obtain User's License
2. Copy of User's License
3. Company Registration Certificate
4. Blaster License/Certificate
5. Area of Blasting
6. Quantity of explosives to be used
7. Payment receipt from Ministry of Finance

### **Status**

1. 6/03/2020 - Site visit to RSIPF Magazine site at Hells Point to see how they construct their own magazine & get check list for magazine construction
2. 23/03/20 – Submitted the Dealer's & Magazine License application to RSIPF
3. 24/03/20 – Meeting with RSIPF Officer at Head Quarters regarding the Dealer's & Magazine Licenses application
4. 07/07/2020 – RSIPF sent letter approval to Dealers Magazine Construction Plan
5. 31/08/2021 – Dealers Magazine house is on progress
6. 02/08/2022 – Dealers License(From B) is granted
7. 02/08/2022 – License for a Dealers Explosive Magazine(Form G) is granted

### **11.3 Temporary License for storage of explosives**

According to the Chapter 79, Section 74, (1) Temporary Storage of Explosives of the Explosives Act, A licensing officer may authorize in writing temporary storage by any person of such quantity of explosives not exceeding 200 lbs. in connection with any construction, mining, blasting or other project or purpose, for such period not exceeding six months and subject to the terms and conditions of this regulation and to such other terms and conditions as the licensing officer may in writing specify.

The Contractor proposed that the Temporary Storage of explosive is not applicable to us. Because the quantity of explosives we will be using is more than 200 lbs. and will be used for a period exceeding six months. And Magazine License can be used instead of the Temporary License since we will be operating the Magazine House longer than the period written in Temporary Storage License.

### **11.4 Magazine House**

The Explosives act stated the following:

#### **Section 44- Magazine to be licensed**

Subject to regulation 74 of these Regulations, no explosives shall be kept for sale or stored except in a magazine licensed for that purpose under the provisions of these Regulations, and nothing other than explosives and, in the case of a magazine licensed under the provisions of regulation 47 of these Regulations, detonators, shall be stored in a magazine so licensed.

#### **Section 47-Issue of user's magazine license**

Where the total amount of explosives to be stored in a magazine does not exceed 112 lbs. of explosives other than detonators, nor 200 detonators, the licensing officer may issue to the holder of a valid user's license, upon submission of such plans and information as he may require and upon payment of a fee of one dollar, a magazine license in Form F in the Schedule hereto for a period not exceeding twelve months authorizing the storage of such quantity of detonators and explosives as may be stated therein in the magazine or adit magazine described in the magazine license.

#### **Section 48-Storage of explosives and detonators in user's magazine**

In any magazine licensed under regulation 47 of these regulations, explosives other than detonators and detonators may be kept in the magazine provided that they are separated by a substantial partition, which shall be constructed of 9" \*18" \* 6" concrete hollow block and bonded into the outside walls of the magazine or otherwise constructed in such manner as the licensing officer may in writing authorize.

#### **Section 49- Issue of dealer's magazine license**

Where the total amount of explosives to be stored or kept for sale in a magazine exceeds 112 lbs. of explosives other than detonators and 200 detonators, the licensing officer may issue to the holder of a valid dealer's license upon submission of such plans and information as he may require and upon payment of a fee of two dollars a magazine license in Form G in the Schedule hereto for a period not exceeding twelve months authorizing the storage of such quantity of detonators and explosives as may be stated therein in the magazine described in the license.

#### **Section 50- Separation of detonations and explosives in dealer's magazines**

In a dealer's magazine licensed under regulation 49 of these regulations, explosives other than detonators and detonators shall be stored in separate buildings which shall be not less than 10 yards apart, or such greater distances as the licensing officer may in writing require.

### **Section 53- Distance of magazine from means of ignition**

No magazine shall be authorized to be built within 100 yards of any building or furnace, steam boiler, copra drier, or forge or of anything liable to cause ignition, nor within 50 yards of any road to which the public has access, nor within 10 yards of any overhead power or transmission cable.

### **Section 54- Construction of magazine**

- (1) Subject to any relaxation of the provisions of this paragraph authorized in writing by the licensing officer-
  - (a) Magazine licensed under the provisions of these Regulations shall be substantial buildings adequately secured against unlawful entry, and may be constructed of stone, concrete, brick, timber, corrugated iron or any combination thereof;
  - (b) Every magazine shall be completely lined with wood;
  - (c) There shall be no exposed iron in any magazine;
  - (d) All doors of magazines shall be sheathed with iron on the outside and shall open outwards;
  - (e) Partitions and shelves shall be of timber with all nails and screws countersunk and holes filled
  - (f) If built in the open every magazine shall have a sunroof above its roof, and separated There from with at least twelve inches of air space
- (2) All dealer's magazine shall be surrounded by a mound or bank of loose earth or coral or similar inert material to the height of the eaves or to seven feet whichever shall be the lesser.

Provided that in isolated places, or where the contour of the ground renders it, in the opinion of the licensing officer, unnecessary, he may in writing dispense with mounds or banks, wholly or in part.

- (3) All magazine other than adit shall be provided with and efficient lightning conductor.
- (4) All magazine shall be provided with adequate drainage.

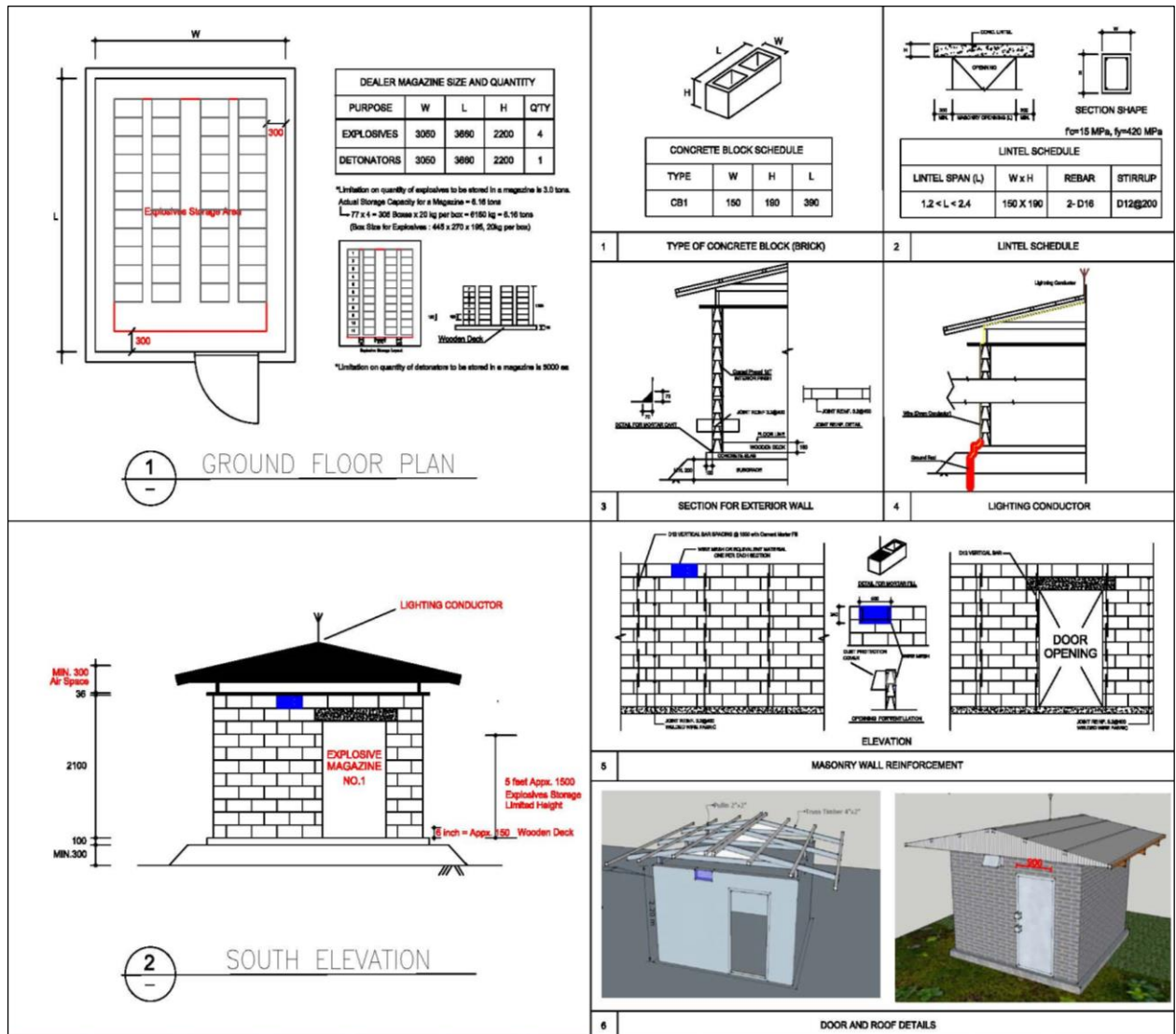
### **Section 56- Construction of magazine floor**

The floor of a magazine shall be of concrete and wooden duck boards easily removable which shall be laid on top of the concrete floor between each row of cases or containers of explosives. All metal screws or nails used in the construction of the duck boards shall be countersunk and the holes filled:

Provided that duck boards need not be provided, if with the approval of the licensing officer, the floor of a user's magazine is made of timber, close-boarded and supported on adequate joists or bearers, and not in contact with the ground, and with all nails or screws countersunk and holes filled.

### 11.4.1 The detailed plan for the construction of Magazine House

According to the above mentioned standard, the Contractor planned to construct Magazine House as per the drawings below:

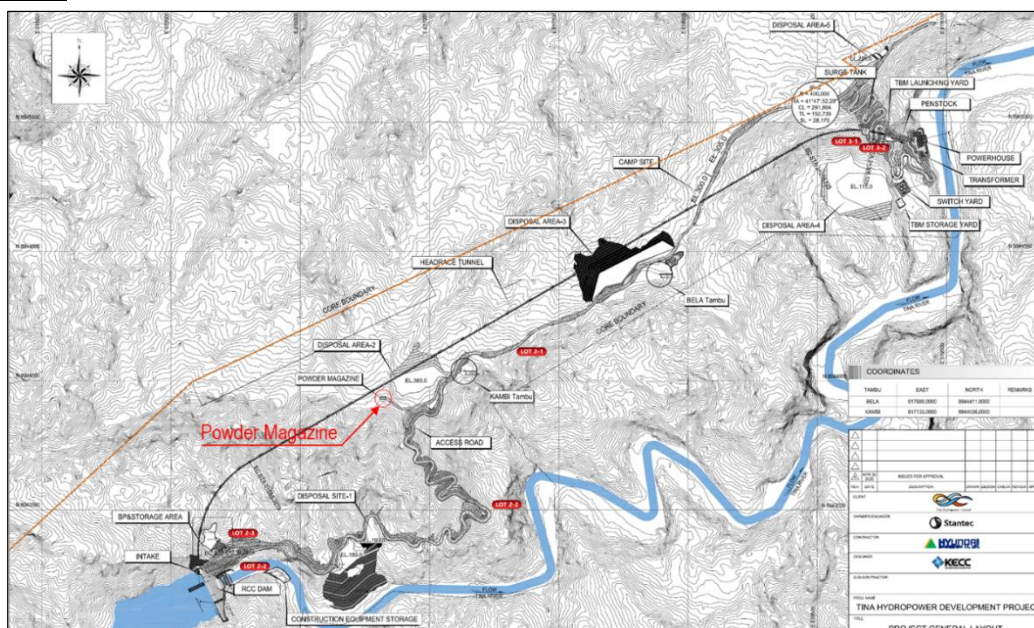


There are 5 magazine houses in magazine site, 4 houses are for explosive and 1 house is for detonator. The maximum quantity of explosive storage in a house is 3 ton, so totally maximum storage quantity of 4 storage is 12 ton. and maximum quantity of detonator storage is 40,000 pcs.

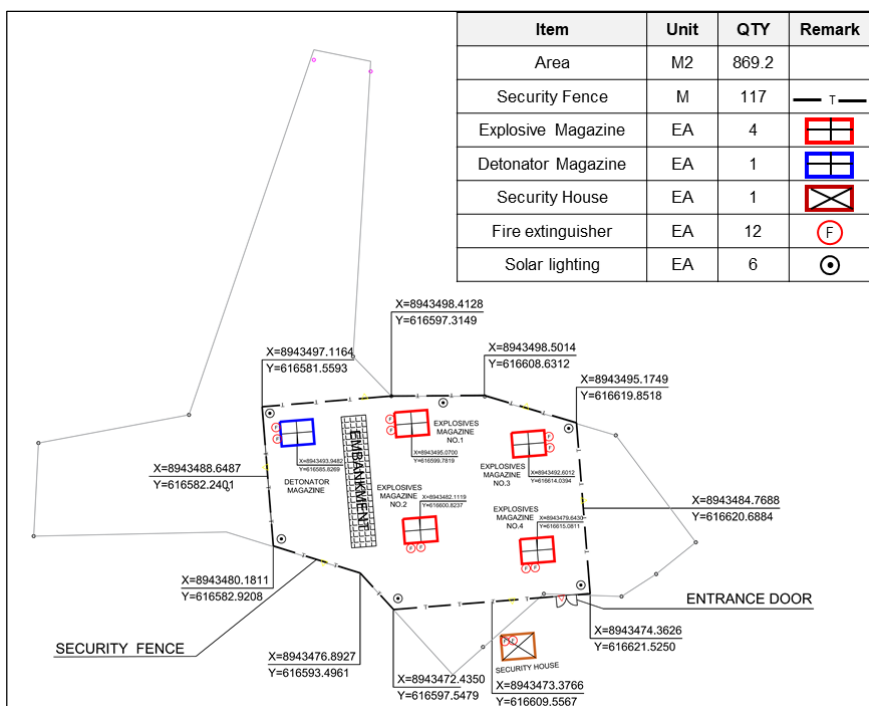
### 11.4.2 Location

The Contractor has selected the premises considering to reduce the adverse impact to the nature. It was already disturbed by logging activities and is not included in the Critical Habitat where the endangered or endemic species lived. Further, that place will need the minimum works for the construction of Magazine House. Thus, the Contractor can avoid to carry out the large scale of excavation, transportation and relocation of the soil.

### Location



## Magazine Layout





## 12 Explosive storage and transportation

### 12.1 Storage

The precaution measures for storage of explosives are as follows;

- a. Nothing other than explosives and, in the case of a magazine licensed, detonators, shall be stored in a magazine so licensed.
- b. No explosives shall be stored within twelve (12) inches of any wall of the magazine.
- c. The bottom row of cases or containers of explosives shall be not less than six (6) inches above the floor of the magazine, and the top row shall be not more than five feet above the floor of the magazine.
- d. The horizontal distance between any two rows of cases or containers of explosives shall be not less than two (2) feet six (6) inches.
- e. Cases or containers of explosives shall be stored in regular layers so that a regular turnover is assured and the cases may be easily inspected.
- f. In cases where it is necessary to open a package containing explosives, it shall be removed to a distance not less than 100 feet from the magazine before being opened.
- g. No tools made of iron or steel shall be taken into or used in any magazine when it contains any explosive.
- h. No smoking nor the ignition of a fire shall be allowed within 100 feet of any explosive magazine.
- i. No material such as charcoal, cotton rags, or waste shall be admitted into any explosives magazine except for immediate use and removal immediately thereafter.
- j. No person shall enter any magazine with boots or shoes having iron or steel nails, nor shall he carry or have about him any fire, matches, or any substance or article likely to cause explosion or fire, nor any steel, iron or grit, or any naked light or lantern.
- k. No electric power cable shall be connected to or conducted into any magazine, nor shall any power cable pass above ground within ten yards of any magazine.
- l. No cultivation, shrubs, grass or woods shall be permitted within a distance of 100 feet from any magazine which shall be marked by a red notice board not less than one (1) foot square on which the words "DANGER EXPLOSIVES" in two (2) inch high white letters shall be displayed.
- m. In cases where it is necessary to open a package containing explosives, it shall be removed to a distance not less than 100 feet from the magazine before being opened.
- n. Care shall be taken to prevent concussion in the storage of explosives in any magazine, and no materials other than explosives shall be allowed in any such magazine.
- o. Whenever it is necessary to repair any explosives magazine, the explosives shall be removed to a distance not less than 100 feet therefrom until the repairs are completed.
- p. An applicant for a magazine license for a dealer's magazine may nominate up to two responsible persons as key-holders, one of whom shall be present at all times when explosives are taken into or issued from the magazine; and the names of such persons shall be entered in the space provided on the dealer's magazine license, otherwise the key-holder shall be the dealer in whose name the license is issued.
- q. Every holder of a magazine license shall report forthwith the loss of the keys of a magazine to the nearest Police Station (Henderson) and to the licensing officer and, until the keys are found or a new lock fitted, a watchman shall be provided by day and

by night.

- r. Every holder of a magazine license shall report forthwith the loss of any explosives or detonators as soon as such loss is discovered to the nearest Police Station and to the licensing officer.
- s. Any loss or deficiency of explosives in a magazine, and any breaking into a magazine whether or not there is any loss or deficiency of explosives shall forthwith be reported to the licensing officer and to the police
- t. The holder of each dealer's license shall cause to be kept in his licensed magazine, books recording the name, address, license number and particulars of persons to whom he disposes of explosives and the quantity and variety of explosives disposed of to such persons
- u. 2 units (ABC type, 3.5kg) of fire extinguisher shall be placed for each explosive magazine and checked the pressure regularly.
- v. Whether stored in the vicinity of the place of use or brought only in such quantities as are required for the day's work, or for immediate use, blasting cartridges and detonators shall be kept in separate locked receptacles not less than six (6) feet apart, and charges shall not be prepared until required for use.
- w. The storage of the blasting material will comply with Solomon regulation of use of explosive.
- x. Transfer of explosive will be registered according to Hazardous Material Management Plan(P13, HMMP)
- y. The storage of explosive material in the on-site magazine will be limited to two months supply. This plan has been changed from the two-week period mentioned in DBMP, C11 to two months. This is because explosive will be imported from South Korea and it is expected to take about two months to book ships and transportation overseas.

## **12.2 Explosive storage security**

- a. 3 security guards 24 hours with 3 shift will be allocated at Magazine site, one is explosive storage-keeper and another 2 are assistant. They are from MSS and especially storage-keeper will be trained by blast expert, and blast expert will keep checking their duty.
- b. Keys to the magazine site will be kept by storage-keeper and blast expert. And keys to the each storage door will be kept by blast expert.
- c. Keeping visitor-log
- d. Immediately reporting any event of magazine site to blast expert and the construction manager
- e. Ensuring that inside of magazine site is kept clean and free from grit at all times.
- f. Keeping the site surrounding the explosive house clear of grass and weed in order to minimize the risk of fire.

## **12.3 A log book will be kept at the magazine to register the movement of explosives(i.e deliverer or user, quantity, date; following Appendix 13. Explosive Log Book Handling**

The precaution measures for handling of explosives are as follows;

- a. Any place used for the loading or unloading of explosives shall be kept clear of other

obstruction while explosives are being unloaded or loaded. Such area shall be shut off and no person or persons other than those actually engaged in the loading or unloading of the explosives shall enter the area except with the authority of a police officer or above the rank of sergeant.

- b. No truck, lorry or other means of conveyance shall be allowed within the area except those actually engaged in the removal of the explosives from area.
- c. The person responsible for discharging or loading the explosives shall cause notices with the words, "DANGER EXPLOSIVES" in at least two (2) inch white lettering on a red background to be posted around the area from which the explosives are being loaded or unloaded,
- d. No smoking shall be allowed within 100 feet of the place where explosives are being loaded or landed, and no person engaged in such loading or landing shall carry matches or any other appliance for producing ignition.

#### 12.4 Transportation

The precaution measures for transportation of explosives are as follows;

- a. If the explosives are not effectively protected from accident by fire from without or from moisture by being conveyed in the interior of a carriage which is enclosed on all sides with wood or metal, they shall be completely covered with tarpaulin or other suitable material so as effectively to protect the explosives against fire and moisture.
- b. Where explosives are conveyed in any motor vehicle, such explosives shall only be so conveyed between the hours of 6.00 a.m. and 6.00 p.m.
- c. Every vehicle when conveying explosives shall carry a red flag at the front and the rear, so affixed as to be clearly visible.
- d. No vehicle while conveying explosives shall exceed a speed of twenty km/hour.
- e. All iron and steel portions of a vehicle which are liable to come in contact with the containers in which the explosives are carried, shall be covered with wood, leather, cloth or other suitable material.
- f. When explosives are being conveyed by vehicle, the vehicle shall be in the charge of a person conversant in the proper handling of explosives who shall be responsible for the loading and unloading of the vehicle for safety in transit and for the due observance of these Regulations.
- g. In addition to the person in charge, every vehicle conveying explosives shall be manned at all times by at least one other person.
- h. A person whilst conveying explosives, or whilst on, in or attending to any carriage containing explosives, or whilst acting as watchman over any explosives, shall not carry matches or other appliance for producing fire, nor shall he smoke.
- i. While the explosives are being conveyed all persons engaged in such conveyance shall observe all due precautions for the prevention of accidents by fire, explosion, or concussion, and for preventing unauthorized persons from having access to the explosives so being conveyed, and shall abstain from any act whatever which tends to cause fire, explosion, or concussion, and is not reasonably necessary for the purpose of the conveyance of such explosives or of any article carried therewith, and for preventing any other person from committing any such act.
- j. Detonators shall not be conveyed in the same carriage as any other explosives.
- k. When cases of explosives are conveyed by carriage, such cases shall be kept flat and secured against friction.

- l. The conveyance of explosives shall proceed with due diligence and without unnecessary delay from the place from which they are being moved to their destination.
- m. Villages and other inhabited places shall be avoided as far as possible
- n. Should it be necessary to halt at any time, this shall be done at a distance of at least 250 yards from the nearest inhabited building, and watch shall be kept over the vehicle.
- o. During a thunderstorm, the vehicle shall be halted at least 250 yards from the nearest inhabited building.
- p. No quantity of explosives exceeding 50 lbs. shall be conveyed through any inhabited area of land outside the area of any port established under the Ports Act except with the approval of the senior police officer in the province and subject to such conditions as he may specify.
- q. If a vehicle is used for conveyance it shall have pneumatic rubber tyres and the axle or axles shall be secured to the vehicle by springs or other shock absorbing device.

### 13 Impacts and Mitigation measures

The blasting works involves exposure to noise, vibration, and dust for both workers, occupants and wildlife close to the site. Impacts on wildlife, communities and workers shall be considered in terms of noise, vibration and dust pollution and safety. Controlled blasting techniques shall be used for the excavation of all materials requiring blasting for removal to minimize overbreak, damage, and fracturing beyond the design lines of the excavation, as well as to prevent damage to existing and newly constructed Project features. The Contractor shall undertake modelling of potential blasting noise levels and check the impact on flora, fauna and communities close by.

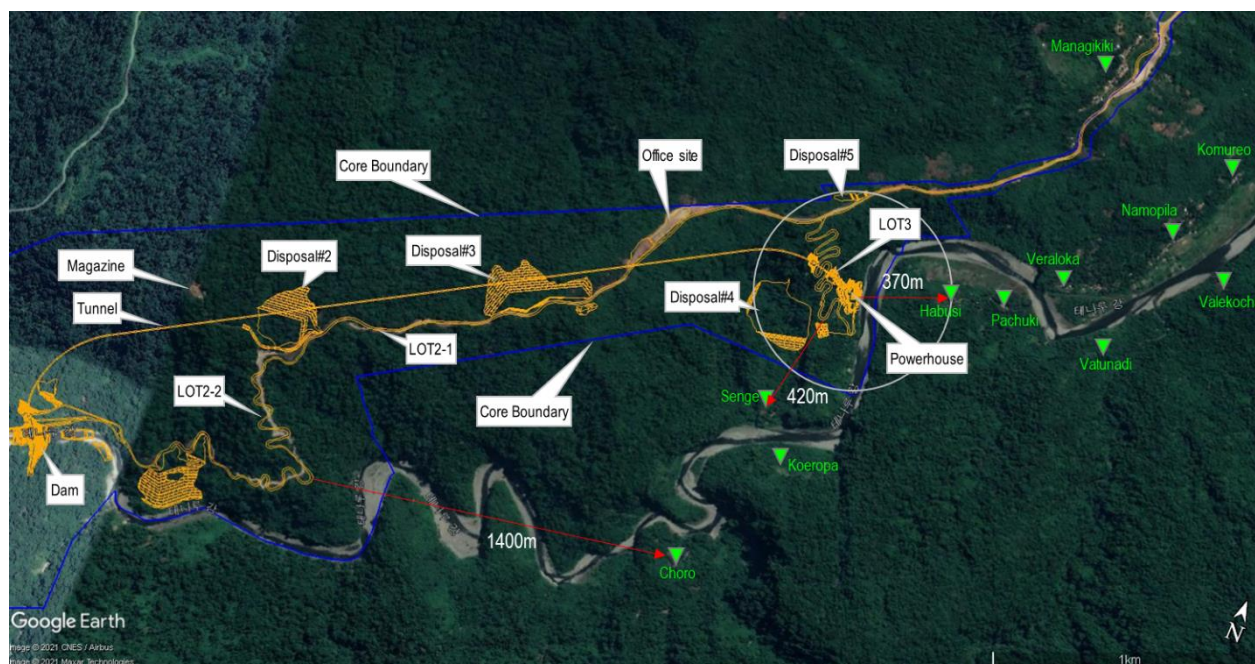
Community awareness program will be provided 1 week prior to blasting activity. The blast controller will co-work with HEC CLOs to conduct face-to face awareness training prior to blasting activity. During awareness training blasting details such as blasting location, blasting schedule, blasting signage, warning alarm, blast guard location and any information regarding blasting activity will be provided. Blasting shall use blasting matts and shall only be undertaken between the hours of 7am and 5pm.

Areas for seismographic monitoring shall be determined considering the surrounding environment, facilities and results from the trial blasting. A seismograph shall be placed at the nearest structure or Permanent Works under construction relative to the blast area (including quarry blasting) to monitor ground motion particle velocity and frequency during each blast.

The maximum allowable peak particle velocity at the nearest structure of Permanent Works under construction shall be as follows and shall comply with USBM blasting vibration level criteria:

Frequency (hertz)	Maximum Peak Particle Velocity (cm / second)
2.5 to 10	1.3
11 to 40	0.13 x frequency
>40	5

Should the Contractor want a relaxation on the above requirements the Contractor shall undertake monitoring during the blast trials and present the results to the Employer with the proposed revised limits.







The below table shows the expected blasting area and distance from surrounding houses.

Item	Blasting area	Surrounding houses and villages
Access road	LOT2-2	1,400m
	LOT3-1	370m

The below table shows the vibration velocity according to the blasting patterns and distance.

No	Blasting Method	Allowable distance by regulatory standards of vibration(cm/sec)					
		0.1	0.2	0.3	0.5	3.0	5.0
1	Low vibration Blasting	Up to 40m	Up to 25m	Up to 20m	Up to 15m	Up to 5m	Up to 3m
2	Precise vibration control blasting	40~80	25~50	20~40	15~30	5~10	3~7
3	Small scale vibration control blasting	80~140	50~90	40~70	30~50	10~17	7~10
4	Medium scale vibration control blasting	140~260	90~170	70~130	50~90	17~30	10~25
5	General Blasting	260~450	170~290	130~220	90~160	30~53	25~40
6	Large scale Blasting	More than 450m	More than 290m	More than 220m	More than 160m	More than 53m	More than 40m

According to the above table, the vibration velocity in the nearest village, Habusi located 360m far from the blasting site, is 0.1(cm/sec) for general blasting and 0.2 for large scale blasting. The regulatory criteria for blasting vibration and noise are shown in the below table.



Item	Cultural Heritage	Building	Store	Factory
Vibration(cm/sec)	0.2	0.3~0.5	1.0	1.0~5.0

Item	Human Being	Animals
Noise(dBA)	75	70

However, the blasting pattern including details of the hole pattern, explosives loading and blasting delays shall be determined considering the surrounding environment, facilities and results from the trial blasting.

### 13.1 Dust

Dust will be generated by drilling and blasting works. To reduce the impact by dust, the below measures will be applied.

No	Activities	Mitigation Measure
1	Drilling	<ul style="list-style-type: none"> <li>•The drilling machine to be adopted for blasting is equipped dust collector which has 4 unit of filter. This dust collector will be able to extract dust during drilling work. In case the dust generated couldn't be controlled (e.g. by strong wind), water spraying will be used.</li> <li>•Dust collector is cleaned every 3~4 day with compressor and exchange every month to keep the functional quality.</li> </ul>  <p><b>Powerful Dust Collector</b> High efficient suction power keeps drilling performance operator's visibility to work without dust.</p> <p>Suction capacity : 24M3/min Number of filter : 4ea</p>
2	Blasting	<ul style="list-style-type: none"> <li>•Blasting mat(tire-mat) to be laid to reduce dust, fly rock and noise. This mat will be prepared 2ea for each Lots.</li> <li>•Blasting mat(tire-mat) will be handled and carried by excavator(crawler type) with wire hooker due to heavy weight and accessibility at blasting site.</li> </ul> 




## 13.2 Noise

The potential species which could be impacted by noise and vibration are described in Table 10-3 (2019 ESIA, p414). For example, Table 10-3 (in the ESIA) states that cuscus could be disturbed by noise & vibration from drilling & blasting, and migration patterns of bats could be temporarily disturbed. Forest-dependent birds “will also be impacted by noise and vibration from machinery works and blasting”. Accordingly, through the additional pre-clearance survey for LOT2/LOT3, sensitive receptor will be identified.

Preclearance survey will be implemented prior to construction of LOT 2 and LOT 3. Sensitive receptors will be identified through preclearance survey report and proper mitigation measure shall be implemented prior to de-vegetation activity.

The pre-clearance survey for fauna will occur at a maximum of 14 and minimum of 7 days prior to blasting. The extent of fauna survey from the blasting area is 500m radius. if there is sensitive fauna location. spotter will be deployed at the location so that spotter can shepherd the sensitive fauna during blasting.

Machinery and shockwaves from blasting may startle river dependent birds and impact amphibians. It is anticipated that the measures in table below will also help to reduce the adverse impact on these identified species.

No	Activities	Mitigation Measure
1	Drilling	<ul style="list-style-type: none"><li>•Use hydraulic drills instead of pneumatic drill.</li><li>•Avoid simultaneous activities that generate vibration such as drill and blasting (where possible) to avoid a cumulative impact.</li><li>•Install noise control baffles to reduce noise levels by up to 10dBA for sensitive receptors.</li></ul>  <p>[noise control baffle]</p> <ul style="list-style-type: none"><li>•Provide appropriate hearing protection (ear plugs, hearing band and muffs) for project personnel working in the vicinity of drilling and blasting works and any construction personnel who request hearing protection.</li></ul>

2	Blasting	<ul style="list-style-type: none"> <li>•Restrict blasting at the dam site or other locations that require blasting to the period 7:00am to 5:00pm</li> <li>•Notify local communities before blasting, in accordance with the protocols outlined in the SECP (P3)</li> <li>•Blasting mat(tire-mat) to be laid to reduce dust, fly rock and noise</li> <li>•Through trial blasting, noise level shall be monitored and evaluated. Optimized blasting pattern and explosive amount shall be determined considering noise and vibration limits.</li> <li>•Workers operating in the blasting area will use hearing protection sufficient to reduce noise by at least 30 dB to a limit of 75 dB (as per Annex B). best protection will be achieved by using a combination of Class 4 and Class 5 hearing protection (e.g. ear buds and over-ear muffs).</li> <li>•The HEC supervisor on duty and at least two of the personnel working in the blasting area (laying charges etc), will wear hearing protection with radio connection (i.e. electronic ear muffs with link to two-way radio system). However, no person shall transmit radio while handling detonators.</li> </ul>
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### 13.3 Vibration

No	Activities	Mitigation Measure
1	Drilling	<ul style="list-style-type: none"> <li>•Use the Wildlife Shepherding Protocol described in the Forest Clearance Plan (FCP; C3) to clear sensitive fauna from the drilling/blasting area before any activities commence and minimize disturbance.</li> <li>•Use hydraulic drills instead of pneumatic drill.</li> </ul>
2	Blasting	<ul style="list-style-type: none"> <li>•Notify affected communities and the Royal Solomon Islands Police Force at least 24 hours in advance of any blasting activities</li> <li>•Through trial blasting, vibration velocity shall be monitored and evaluated. Optimized blasting pattern and explosive amount shall be determined considering noise and vibration limits.</li> <li>•Restrict blasting period from 7:00am to 5:00pm.</li> </ul>

In the case of blasting vibration and noise, there are many differences in the conditions of terrain, features, climate, etc., Thus, a blasting method suitable for the blasting regulation standard shall be determined using the results of trial blasting.

### 13.4 Noise and Vibration monitoring measure

Item	Blasting area	Surrounding houses and villages
Access road	LOT2-2	2,200m
	LOT2-3	2,800m
	LOT3-1	370m

Potential impacts are only expected at Habusi village, approximately 370m from LOT 3 blasting area.



The regulatory criteria for blasting vibration and noise are shown in Table as per C11 DBMP.

### *Regulation of blasting vibration*

Item	Culture Heritage	Building	Store	Factory
Vibration(cm/s)	0.2	0.3 ~ 0.5	1.0	1.0 ~ 5.0

### *Regulation of blasting noise*

Item	Human Being	Animals
Noise(dB)	75	70

Management for blasting vibration and noise are as below;

- In the blasting work, it is judged that there will be no impact on noise and vibration because the villages and houses are located far away.
- The Powerhouse and Access Road Lot 3-1 areas in the closest section are monitored to ensure compliance with regulatory standards using a measurement instrument
- In the case of blasting vibration and noise, there are many differences in the conditions of terrain, features, climate, etc., so it is planned to select a blasting method suitable for the blasting regulation standard through test blasting before blasting.
- Vibration monitoring will be performed from the nearest residence to the blasting, or from the nearest location of permanent concrete works that has already been constructed (i.e. where structures exist that could be affected by vibration), whichever is the closest to the blast site, and whichever is likely to result in the highest peak particle velocity when compared to the limits.

### **Noise and Vibration Measurement instrument**

To illustrate the type of monitoring to be undertaken, the specifications of the measurement instrument which will be used are shown in Table below.

Manufacturer	Photo	Specification
Honglim Ltd., HLS Series Noise and Vibration monitor		<ul style="list-style-type: none"><li>• Display : 4 Line by 20 column</li><li>• A/D Converter : 13 Bit Self Calibrating</li><li>• Frequency Response : Velocity 3-250 Hz</li><li>• Mic Range : 50 to 110db(A), 90 to 140db(Linear)</li><li>• Frequency Response : Mic A-Weighted Fast Response 8 KHz RMS Sound level</li><li>• Resolution : Geophone 0.01mms, Mic 0.1db</li><li>• Data storage : Over 100 Events/USB</li></ul>

Through the trial blasting, noise and vibration monitoring result will be collected to clarify whether the result is within the limit. If the result is over than the limit, the applied blasting pattern, which means adjusting the amount of explosives and depth of drilling hole, shall be adjusted as per blasting expert who has certificate to meet the limit.

## **APPENDIX 1 - BLASTING JOB SAFETY AND RISK ASSESSMENT**

### **Main elements (from AS/NZS ISO 31000:2009)**

- Communicate & Consult
- Establish Context
- Identify Risks
- Analyses Risks
- Evaluate Risks
- Treat Risks
- Monitor & Review

### **Communicate & Consultation Steps:**

- Consider costs, payment and liability for HEC conducting risk assessment.
- Physically visit and “walk” the area of any blasting proposal.
- Convene a meeting in a location with whiteboard / write-up capability.
- Gather a team of persons familiar with the site and blasting objectives.
- Review the objectives of any blasting **proposal**.
- Specify a “typical” blast design that might be anticipated.
- List potential hazards associated with setting up, charging, and firing such a blast.
- Describe the expected environmental and other potential effects of such a blast.
- Locate site plans covering the full potential range of vibrations, air blast, and fly rock.
- Highlight circles of radius around blast site (e.g., 10 m, 50 m, 100 m, 200 m, etc.);
- Identify all equipment, services, and facilities within target ranges.
- Use the assessment sheets provided to identify the hazards, determine the risk and identify the controls associated with each potential target or hazard.
- Document these on the risk management forms.
- Determine whether each hazard can be safely reduced and managed.
- Arrange to draft site-specific operational procedures covering all aspects of the blasting process.
- After completion, have qualified persons review the draft and when completed produce the final operational procedure documentation.
- Ensure every appropriate person on site is familiar with the assessments and the procedures in place to ensure safety.
- Measure and record blast outcomes and effects; and
- Complete summary report after blasting as required by law and site procedures.

### **Context of Risk Assessment**

*When identifying blast-related hazards, HEC considers*

- Regulation requirements
- Other activities in area
- Associated tasks
- Site layout
- Property in non-safety zone
- Internal property damage
- Power lines, underground services
- All weather conditions
- Timing of activity
- Safety equipment needed
- Visitors and contractors
- Uneven surfaces
- Vehicle suitability

- Operator competence
- Delays in charging / firing
- Neighbors
- Traffic/ Speed limits
- Restricted areas / Signs
- Face / ground conditions
- Geology
- Off-spec drilling, lost holes
- Oversize
- Toe
- Back-break
- Air-blast [over pressure], Vibration
- Evacuation areas, Roadblocks

### **Blasting Risk Assessment Table**

$$R \text{ (Risk)} = L \text{ (Likelihood)} \times C \text{ (Consequence)}$$

Likelihood of Occurrence (L)	Potential Consequences (C)					
	5 Notable	10 Significant	15 Highly Significant	20 Serious	25 Very Serious	30 Catastrophic
5 Probable	25	50	75	100	125	150
4 Possible	20	40	60	80	100	120
3 Unlikely	15	30	45	60	75	90
2 Very Unlikely	10	20	30	40	50	60
1 Extremely Rare	5	10	15	20	25	30

### **HEC Internal Hazard Management Table**

Risk	Who Signs Off	Type of Investigation
1-10	Shot firer / Supervisor	Site visit, sign off note in job pack
11-20	TS Blasting Engineer	Site visit, report in job pack
21-50	Snr TS Engineer / Project Manager	Site visit, Risk Report in job pack
Over 50	Must be reduced	Will not accept work with current controls

### **Potential Likelihood**

5	Probable	A common occurrence. The event is expected to occur in most circumstances.
4	Possible	Event will probably mostly occur - known to have happened in similar situations.
3	Unlikely	The event could occur but not expected.
2	Very Unlikely	The event may occasionally occur at some time but rarely
1	Extremely Unlikely	The event may occur only in exceptional circumstances.

### Potential Consequence

	Notable 5	Significant 10	Highly Significant 15	Serious 20	Very Serious 25	Catastrophic 30
<b>Safety &amp; Health</b>	1 Minor Injury	Single MTI	Single LWC or Multiple MTI	Permanent disability or Multiple LWC	Single Fatality	Multiple Fatality
<b>Environment</b>	Very Minor pollution	Minor Local pollution	Evident Pollution local concern	Significant Local pollution	Major Local pollution	Extremely Severe pollution
<b>Reputation and Image</b>	Minor issue 1 complaint	Local issue 10 complaints	Local media 100 complaints	Regional or state media	National media coverage	Headlines, corporate damage
<b>Services / Business Interruption</b>	Minor re-connection required	Minor temporary loss of resource	Short-term supply loss of major resource	Medium term supply loss for major resource	Long term loss of production and/or major resource	Permanent loss of production and/or major resource
<b>Business Liability</b>	>\$5000	>\$50,000	>\$200,000	>\$1m	>\$15m	>\$50m

Blasting Job Safety & Risk Assessment Form							<u>Date: 19/08/2021</u>			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R	
<b><u>Pre-Blast Activities</u></b>										
Blast Supervision	Availability of qualified personnel	5	20	100	Blast date to be confirmed in advance. Shotfirer/Project Manager to be included in notifications. Sourcing Shot firers from multiple plants/confirming blast schedule with Blasting Experts		2	20	40	
Blast Design	Design inadequacy or failure may lead to fly rock/vibration/air blast/misfires/ fume	4	15	60	All blast designs for this project are to be peer reviewed internally within HEC Design to consider geological conditions. Appropriate product selection. QA of manufactured products. Correct priming and loading practices.	Fume scale for observation in <b>Appendix 10</b>	1	15	15	
Site Access	Personnel not inducted or qualified to access site.	5	5	25	All personnel to have attend site induction.		1	5	5	
Manual Handling	Manual handling of boxes of explosives and buckets of stemming may cause injury.	4	10	40	Obey HEC Manual Handling procedures.		1	10	10	
Permits and Notifications	Statutory notifications not submitted. Neighbors unaware of blast – startled neighbours, public reports to local emergency services	5	5	25	Utility owners advised of blasting activity by Security Manager if required. The construction Manager are responsible for notification of neighbours and relevant asset owners.		2	5	10	



Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Transport of explosives and personnel to site	Theft	2	20	40	All IE and HE to be stored under direct supervision of the Shotfirer while on site or in locked explosives vehicle parked in a secure area. All unused IE and HE will be returned to magazine. Security on site if slept overnight. Fatigue management process. DG qualified drivers. Low risk driver training. Licensed explosives transport vehicles.		1	20	20
	Road Accident								
Transport of explosives to site	DG restricted area –traffic violation Wrong quantity of explosives brought to site – project delay	5	5	25	Transport explosives via Dangerous Good route. HEC Shotfirer to confirm the number of holes and depth checked before loading.		2	10	20
Transport of explosives to site	Interaction between Hyundai Engineering Co. Ltd Ute, and other vehicles – collision, fire, explosion	3	25	75	Construction Manager to provide plan for heavyvehicles to access site without causing delay/escorted onto site when required.		1	25	25
Transport of explosives to site	Manual handling of boxes of packaged explosives, narrow uneven access to area making carrying of boxes awkward	3	25	75	Reduce handling by getting explosives Ute as close to the pattern as safely possible or through other mechanical means. Planning path of carrying.		1	25	25
<b>Drill Blast holes</b>									
Mark out holes	Holes marked in wrong place	5	5	25	Mark out conducted by Hyundai Engineering Co. Ltd Personnel according to design. Surveyors to send pick up of as drilled hole collars to BlastingEngineer {if available}. HEC to review as drilled design and adjust loading/timing asrequired.		2	5	10

Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Drill blast holes	Holes drilled in wrong place, wrong depth, and wrong diameter	4	5	20	Refer to Risk Assessment to complete detailed drill logs. Drill surface to be prepared by removing all loose debris, and flattening all undulations/wheel ruts/etc. Dip and bag all holes before loading start to confirm correct depth. All lost holes to be recorded on the blast plan and re-drilled where possible.		2	5	10
	Collars may collapse, holes may become blocked								
Drilling deviation	Damage to drill string/Intersecting holes	4	10	40	Dipping of holes/Bore-tracking where required.		1	15	15
Blast Loading Activities									
Establishing blast area	Access of unauthorized personnel, loss or theft of explosives	4	10	40	Blast area will be demarcated with signs, bollards and flagging as required. No other activities permitted within 10m of blast loading area. Shotfirer or assistant to always supervise blast area once loading commences until blast is cleared. Make blast loading area "No Smoking" for the blast.		2	10	20
	Other activities occurring on site near the blast area								

Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Fly rock within blast clearance area	Damage to excavating equipment	4	15	60	Control stemming heights by measuring stemming quantities and training all blast crew to stem correctly.	Unforeseen geology. Change of conditions (e.g., water). Drilling errors	3	15	45
	Damage to site offices				Scale depth of burial calculations to be considered when designing loading plans. Best practice blast design, peer reviewed. Move all equipment out of clearance area.	Risk of damage from fly rock discussed with and accepted by Construction Manager			
Fly rock outside blast clearance area	Damage to private property, death, or injury to employees or public	2	30	60	No public within project. Control stemming heights by measuring stemming quantities and training all blast crew to stem correctly. Scale depth of burial calculation to be considered when designing loading plans. Follow blast clearance and Traffic Management Plans. Best practice blast design, peer reviewed.	Unforeseen geology  Change of conditions (e.g., water)  Drilling errors/ Geotech Holes	1	30	30

Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Air blast – damage to buildings	Limits: Max 120 dB	3	10	30	Measures designed to control vibration and fly rock will also control air blast. <ul style="list-style-type: none"> <li>• Good stemming</li> <li>• Scaled depth of burial</li> <li>• Limit MIC</li> <li>• Buffer blasting where required to limit face movement and reduce air blast</li> </ul>		1	10	10
Air blast – disturbance to neighboring properties	Complaints from annoyed neighbours. Startle/scare people/animals nearby unaware of the blast.  Unusual noise may generate calls to emergency service	4	10	40	Advise residents/tenants Blasting at planned times, keeping the community aware. Blast warning siren 5 minutes before blast lasting 1 minute . Security Manager/Construction Manager to notify all site personnel of blasting times. Notify police in case of public complaint.	Even these measures may generate complaints – some people will complain even at very low air blast levels.	1	10	10
CONSEQUENTIAL Issues									
Blast dust cloud	Dust from blast causes nuisance or damage to sensitive equipment.	3	10	30	Site dust management procedures to be followed. Limit the amount of loose material on the bench prior to blasting.	The Blast Evaluation may require crusher dust to be placed on blast – may create small amounts of dust.	1	10	10

Blasting Job Safety & Risk Assessment Form						<u>Date: 19/08/2021</u>			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Blast fumes	Fumes from blast may cause annoyance or irritation to nearby public. Fumes may pose a hazard to people on worksite.	3	10	30	Noticeable fume not expected. No personnel to re-enter Project until fume has dispersed. Shotfirer and Blast Guards to notify Blast controller if fume is generated. Blast Controller is to advise personnel to move to a safe location outside the affected area.	NOx information and Fume scale for observation in Appendix 10	1	10	10
Poor rock breakage	Un-diggable, non-productive blast	3	15	45	Agree on risk vs. result outcomes with Construction Manager made aware that fragmentation results are a trade off with fly rock/vibration controls and cost. Proximity to main haul road and other infrastructure limits fragmentation possibilities. Use good blasting practices and design to prevent toe. Dip all holes prior to loading. Redrill blocked holes. Use adequate subdrill. Back-break/under-break could be expected due to geology. Collar rock should be expected through the stemming zone.		2	10	20

Blasting Job Safety & Risk Assessment Form							Date: 19/08/2021		
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Sleeping shots	Product may exceed sleep time Security of shot overnight	5	5	25	Bulk/Packaged explosives will have adequate sleep time. Security Guard from security will be placed on blast overnight when sleeping shot. Guard will be issued written handover instructions as per standard HEC Procedures. Guard will need to be escorted onto site and work under a temporary work permit.		1	5	5
Blasting near structures	Damage from vibration Damage from rock movement Limits apply of 5mm/s for residential areas and 25mm/s for commercial. Specific infrastructure limits detailed in Appendices.	5	25	125	Asset owners to inspect condition of infrastructure before and after blasting if exceedances are expected or recorded.  HEC Blasting Evaluation to allow blast designs to meet all constraints.	Blast Evaluation will be the first blast, appropriate charge weights will be used to test vibration.	2	10	20
Blasting near infrastructure	Damage from blasting vibration outside of set vibration limits.	3	15	45	Precise timing of blast using initiating system and data from Blast Evaluation Peer review regarding vibration limits, MIC limits, and timing design. All stakeholders notified of blasting and results.		3	25	25

Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Blasting adjacent to Haul and Public access Rd	Fly rock or water striking passing cars or public. Rocks or water ejected from unknown, unseen adjacent holes previously drilled (e.g., Geotech holes).	3	25	75	<p>All Geotech holes located and accounted for by Shotfirer/Blasting Expert. All Geotech holes have been stemmed off to prevent ejection. Detailed survey of free face blasts so HEC can design the blast to minimize Fly rock and ejection.</p> <p>If Haul Road and Public access road closures are required. Traffic controllers to manage the adjacent areas to remove public from exposure. Follow Traffic Management Plan.</p>		2	15	30
Blasting in proximity to underground services – gas, electricity	Damage to underground/surface services because of ground vibration or dislocation.	4	25	100	<p>Ensure notification to service provider(s) has been completed. No blasting within 10m of underground services. Reduce charge weights in proximity to services – may require pattern reduction. Design for max PPV of 100mm/s measured directly above the service. Design with reference to driller's logs to ensure any discontinuities in vicinity of service are identified. Design to be reviewed by appropriate Blasting Engineer.</p>		1	25	25

Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Blast result	Failure to achieve desired result.	3	20	60	Blast to be designed in consultation with a cross section of experienced Blasting Personnel and stakeholders. Design to be reviewed by peer group. Calculations to be cross checked.	At all times the safety of public and property must be prioritized above blasting outcomes	1	20	20
Fly rock	Fly rock during Blast Evaluation – ejection through collar.	3	20	60	Adequate stemming decks will be used, and crusher dust/conveyor belt coverings where possible. Fly rock and scale depth of burial calculations to be reviewed. Angle of initiation, firing direction away from road. Blast clearance plan and Traffic Management Plan.	At all times the safety of public and property must be prioritized above blasting outcomes.	1	20	20
<b>Miscellaneous Issues</b>									
Lightning/ Thunderstorm in vicinity while sleeping shot	Lightning may strike shot and initiate part of the blast.	4	10	40	Security Guard on site to follow Siterules.  Check weather forecast before loading commences. Be prepared to cancel shot if storms are forecast Suitable equipment to be on site to manage outcomes of an unplanned initiation		2	5	10

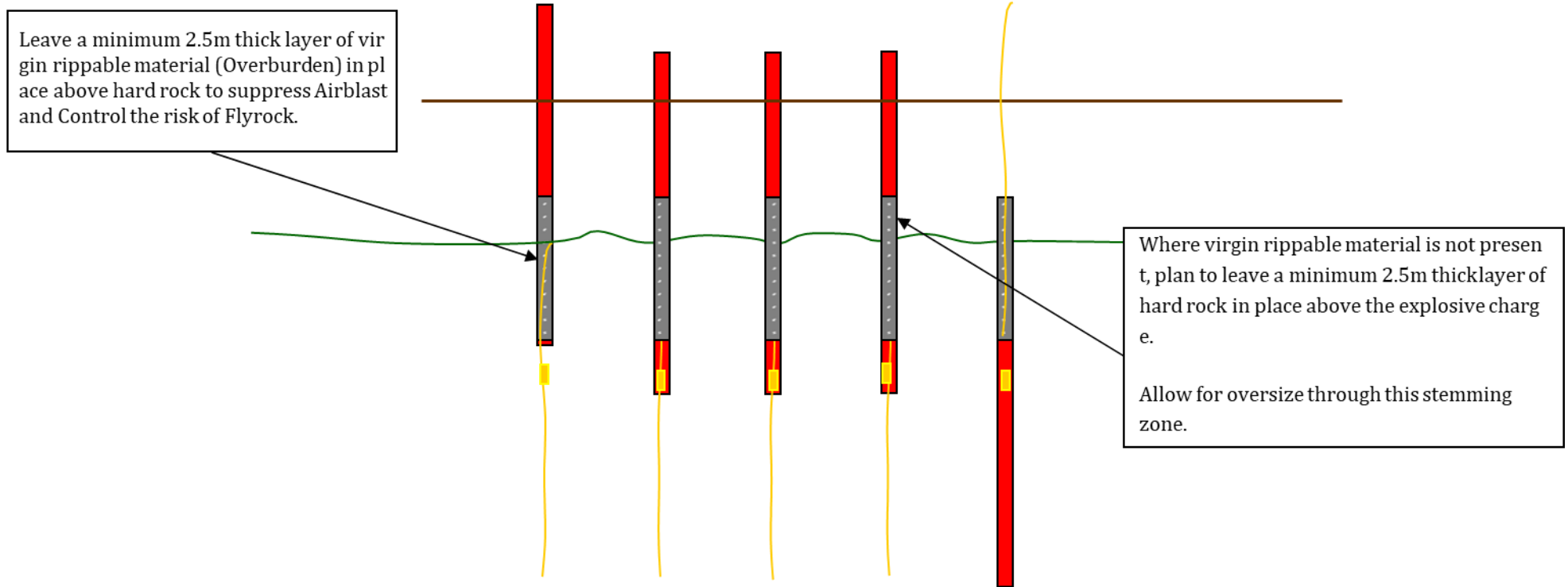


Blasting Job Safety & Risk Assessment Form						<u>Date: 19/08/2021</u>			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Weather/Water/ Lightning	Lightning may occur during loading.	4	10	40	Check weather forecast before loading commences. Be prepared to cancel shot if storms are forecast. Be prepared to stop loading, and clear worksite if lightning storm approaches. Follow blast clearance plans.		2	5	10
Exploration holes/red rills/blocked holes provide escape path to surface	Unidentified exploration holes or other paths will allow gas energy to escape and propel missiles.	4	20	80	Exploration/Geotech-hole locations have been identified/located and stemmed off. All re-drills and blocked holes are to be fully backfilled with stemming material only. If blocked above stemming horizon, extra false burden to be used.		2	10	20
Drilling into underground services	Buried cables, pipes, wires may not be identified prior to drilling.	4	15	60	HEC permit to excavate to be completed. Ensure all underground asset owners have been notified and services into blast area are isolated.	No underground services exist in drilling area.	1	15	15
Slips, trips, falls	Tripping over on uneven ground	2	25	50	Blast area to be cleaned off all loose debris as per bench prep requirements. Eyes on path, review of risk assessment to be used prior to each task.		1	25	25
<u>Post-Blast Activities</u>									

Blasting Job Safety & Risk Assessment Form						Date: 19/08/2021			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Residual Hazard	L	C	R
Misfires	Misfires may remain unidentified in the ground and may not be correctly identified by excavator operator  Recovery of Misfire	3	25	75	Use best practice explosives selection and blast design to reduce the possibility of misfires. Use standard procedures to check for complete initiation after blast. Show excavator operators how to identify explosives – Misfire identification toolbox talk. All blast hole collars must be surveyed to ensure ease of misfire identification. Accurate survey data/drill logs/loading sheets to plot location of misfires.		1	25	25
Check for misfires	Misfires pose a high threat to hand drillers, excavator operator and future users of spoil	3	20	60	Ensure all detonators are installed above grade. Train excavator operator to identify misfires and what to do if found.	HEC to instruct Project operators to identify misfires in the muck pile during excavation	2	10	20
Misfire excavation	Potential misfires in an area that will be excavated from deep fully confined, multiple decked blast.	4	20	80	Survey pickup of all blast hole collars to be completed by Surveyor {if required} and use in conjunction with blast design and hole dipping records to enable recovery of non-detonated explosive. Ensure all detonators are installed above final grade level.		1	25	25
Misfire excavation	Excavation near misfired product - rock hammers, excavators, anchor rigs, working in area	4	25	100	Mark depth of location to misfire. Maintain minimum 2m standoff from misfire. Controlled excavation plan. Toolbox talk the plan with operators		1	25	25



## APPENDIX 2 - STANDARD FLYROCK AND OVERPRESSURE CONTROL (COVER PLAN)

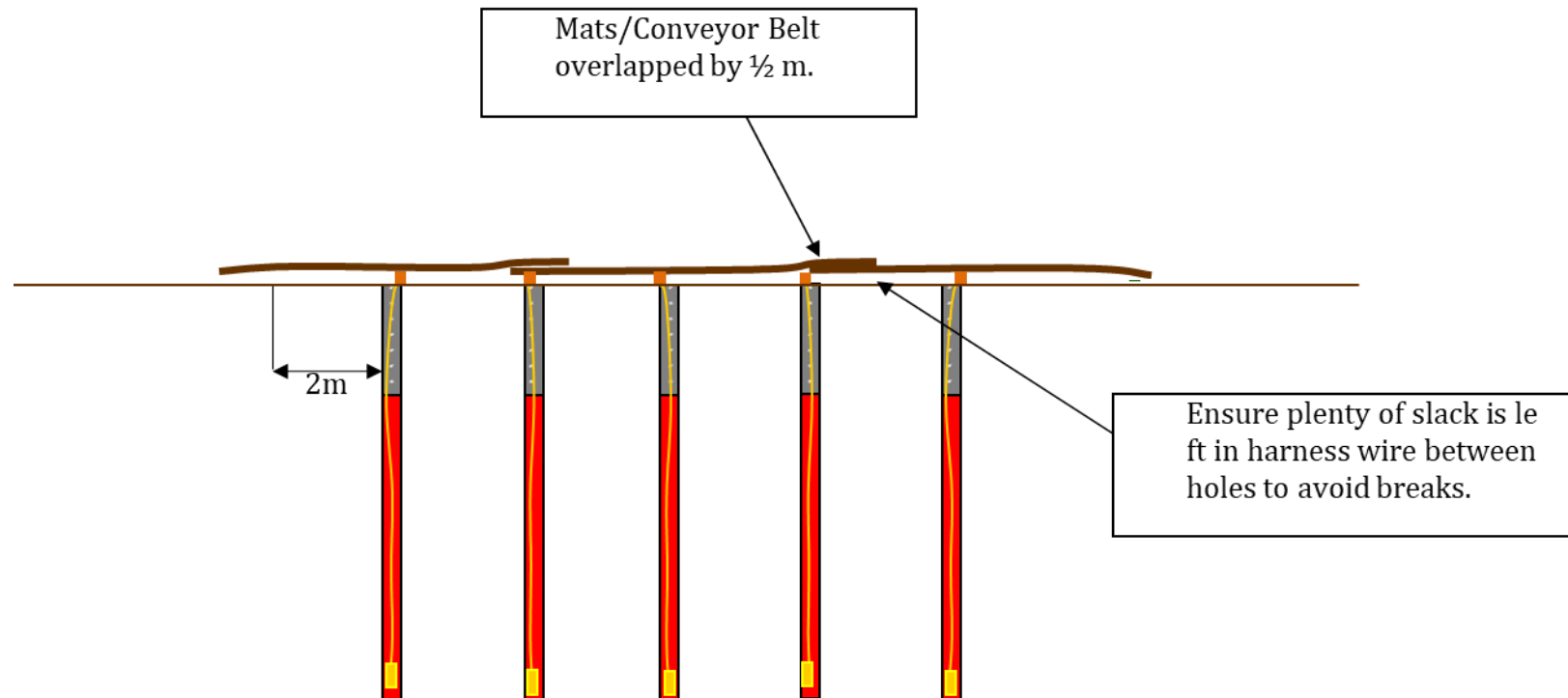


## **SECONDARY COVER PLAN- NOT FOR USE AS PRIMARY METHOD OF FLYROCK CONTROL – MAY BE USED DURING BLAST EVALUATION**

This cover plan will only be used if no other controls can be put in place.

HEC Approval by the relevant Technical Service Engineer and Business Manager is required prior to using this cover plan. This design carries significant cost which must be agreed to by the Customer and HEC Management prior to use.

HEC recommends all overburden is left in place to allow sufficient cover to eliminate the need for this cover plan to be used.



### APPENDIX 3 - PRE-BLAST CHECKLIST

Action	Who	Date Completed	Signature	Comments
<b><u>7 days before</u></b>				
Notify utility owners				
<b><u>1 day before</u></b>				
Notification to RSIPF / IMAS – EOD OIC				Registered mine/standing notification in place
HEC personnel inducted to site	HEC			
Stemming material in place				
Holes identified, dipped and backfilled as required	HEC			
Neighbours notified				
<b><u>Day of the blast</u></b>				
Toolbox Talk to onsite crew	HEC			
Blast guards nominated and briefed	HEC			
Radios charged and checked	HEC			
Establish vibration monitors at preferred locations (if Required)	HEC			
<b><u>30 mins before the blast</u></b>				
Blast guards report to Blast Controller	HEC			
Vibration/Air blast monitors armed if required.	HEC			
Blast video recorder ready	HEC			

## APPENDIX 4 - PERSONNEL LIST

Designation/Role	Name	Responsibility
<b>Main Contractor: Hyundai Engineering Company</b>		
Construction Manager	Mr. J B Yoo	<ul style="list-style-type: none"> <li>• Ensure that blasting is carried out as per the blasting plan and the measures of the Drill and Blast Management plan are rightly implemented.</li> <li>• Liaise with authorities for Drilling and Blasting related licensing and approvals.</li> <li>• ensure relevant employees and subcontractors under their control are aware of their obligations under the Drill and Blast management plan</li> </ul>
HSE Manager	Mr. D Y Kim	<ul style="list-style-type: none"> <li>• Daily inspection of drilling and blasting sites/activities.</li> <li>• Audible signals, such as sirens, whistles, or horns mounted on a vehicle, are used in many operations to caution employees, visitors, and neighbors about a scheduled blasting event. Enough time should be provided to facilitate the orderly evacuation of all personnel, whose presence is not required, from the blast area.</li> <li>• Monitor and assess noise and vibration during drilling and blasting to ensure compliance with the regulation.</li> <li>• Maintain training records and certifications.</li> <li>• Record safety observations, near misses and incidents, reported concerning drilling and blasting.</li> <li>• Liaise with Security Subcontractor for safe transportation of explosives.</li> <li>• Coordinate for weather information and provide required updates to the Blasting Supervisor.</li> </ul>
<b>Drilling and Blasting Personnel shall hold valid licenses and be certified.</b>		
Blasting expert	Mr. Lee Joonhan	<ul style="list-style-type: none"> <li>• Properly handle explosives according to current procedures.</li> <li>• Prevent unauthorized persons from entering the blast site.</li> <li>• Maintain the magazine inventory (including documentation) and cleanliness.</li> </ul>

		<ul style="list-style-type: none"> <li>• Prohibit the entry of unauthorized personnel to the magazine.</li> <li>• Update site blast notification boards.</li> <li>• Conduct a daily visual inspection of the powder magazine area to ensure good housekeeping practices are being followed including removal of weeds or other combustibles and flammables within 50ft.</li> <li>• Perform and document daily visual inspection of all work areas.</li> <li>• Ensure proper placement of barricades and appropriate signage around the blast site.</li> <li>• Provide a blast report with a shot map attached for each blast.</li> </ul>
Shot Firer	Mr. LEE Young Chul Mr. Lee Joonhan	<ul style="list-style-type: none"> <li>• Ensure that before shot firing is carried out there are no persons within or, who can enter the danger zone that is specified in the blast specification.</li> <li>• Check that the shot firing circuit has been correctly connected and, where electric detonators are used, to ensure they are connected correctly, and the shot firing circuit has been tested with a suitable instrument before initiating the blast ensuring its integrity to minimize the risk of a misfire.</li> <li>• Ensure that a warning signal is given and there are no persons inside the designated danger zone.</li> <li>• Ensure that they are in a position of safety when they initiate the blast.</li> <li>• Organize the all-clear signal to be given but shall only allow normal working to resume when he or she is satisfied that it is safe to do so.</li> </ul>
<b>Security Sub-Contractor: Midland Security Services</b>		
Security Manager	Mr. Peter Tele	<ul style="list-style-type: none"> <li>• Providing security during the transportation of the explosives from Magazine House to the Blast area.</li> <li>• Implement Access Control at the blast area by restricting everyone from entering the blast area except the Blast Supervisor and Shot firer /Blast Crew- post guards at the access points to prevent unauthorized entry.</li> <li>• Guards should physically remain at their duty stations until an "all-clear" signal is sounded. The guards must be always attentive to ensure the security of the blast. Blast Guards must be trained and</li> </ul>



		<p>aware of their obligations. Additionally, barricades may be erected with signs in bold letters such as "Explosives in Use, Blasting Area, Do Not Enter" may be posted at all access points.</p> <ul style="list-style-type: none"><li>• Barricade the Blasting area before Blasting Operations</li></ul>
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## **APPENDIX 5 - BLAST CLEARANCE PROCEDURE**

### **1 days+ before the blast**

- HEC Blasting Expert prepares a site layout plan with clearance area marked.

### **Morning of the blast**

- Construction Manager to notify all site personnel of the days blasting activity via a pre-start meeting.

### **30 minutes before the blast**

- All blast guards meet at the nominated meeting point.

### **5 minutes before the blast**

- All personnel not involved in blast to mustering point.
- Blast guards in position.
- 5 MINUTE CALL by Shotfirer on **UHF Channel 20**.
- Shotfirer checks that all sentries and controllers are ready.
- Shotfirer makes final "CHECK CALL" to each nominated blast guard.
- Ten second call by shotfirer  
"Attention all personnel, the blast will be fired in 10 seconds", 10 seconds radio silence > "Fire now"

### **Immediately after the blast**

- Shotfirer notifies Blast Guards to remain in position.
- Shotfirer announces "ALL CLEAR"; and
- Shotfirer asks blast guards to acknowledge all clear and stand down from their position.

## APPENDIX 6 - RADIO PHRASES FOR BLASTING

### **5 Minute Call** (Shotfirer)

*"Attention all personnel, a blast will be fired in approximately 5 minutes. Blast Guards and Traffic Controllers please be ready to take your positions. All other personnel please maintain radio silence until the blast has been fired and all clear is given."*

### **Ready to Fire Call** (Shotfirer)

*"Shotfirer to all Blast Guards, the blast is ready to fire."*

### **Block Access Call** (Shotfirer)

*"All Blast Guards please block your access."*

### **Check Call** (Shotfirer)

*"Shotfirer to Blast Guard (number) (name), are you in position?"*

### **Check Call Response** (Blast Guard)

*"This is Blast Guard (number) (name), I am at (location), and my access is blocked."*

### **Traffic Stop Call** (Shotfirer)

*"Shotfirer to Traffic Controller (number) (name) please block your access, and confirm access is blocked."*

### **Traffic Stop Call Response** (Traffic Controller)

*"This is Traffic Controller (number) (name), I am at (location), and my access is blocked."*

### **Ten Second Call** (Shotfirer)

*"Attention all personnel, the blast will be fired in approximately 10 seconds."*

**\*\*\*\*\* 10 SECONDS RADIO SILENCE – 'FIRING NOW' \*\*\*\*\***

### **Blast Fired Call** (Shotfirer)

*"This is the Shotfirer. The blast has been fired; please remain in position until the blast has been cleared."*

### **All Clear Call** (Shotfirer)

*"This is the Shotfirer. The Blast has been fired and is all clear. Please release the traffic. Blast guards please stand down."*

### **(Acknowledged by each Blast Guard in turn)**

### **Misfire Call** (Shotfirer)

*"Attention all personnel, a misfire has occurred. Blast guards please remain in position and await instructions." (Please maintain radio silence / Radio silence is lifted until further notice). (Traffic Controllers please maintain the traffic block / Traffic Controllers please release the traffic).*

### **Fume Call** (Shotfirer or Blast Controller)

### **To be used if the blast generates visible fumes.**

*"Attention all blast guards, there are blast fumes moving to the (east). Guard (3) please move away from the site and notify people in the area."*

### **Abort Blast Call** (Shotfirer or Blast Guard)

**To be used if the Shotfirer or a Blast Guard becomes aware of an unsafe condition/someone enters the blast area/someone is attempting to enter the blast area.**

*"Attention Shotfirer - This is Blast Guard (number) (Name). Abort the Blast!"*

## APPENDIX 7 - BLAST GUARD INSTRUCTIONS

Blast Controller's Name: \_\_\_\_\_

Radio Channel : **UHF Channel 20**

Your Blast Guard Number: \_\_\_\_\_

Your Blast Guard Name: \_\_\_\_\_

Location: \_\_\_\_\_

### Instructions

1. Take your assigned position 10 minutes before the blast.

If you have been instructed to advise people of the impending blast, commence your clearance. To advise people of the blast you can say:

*"There will be a blast fired on the building site in about 5 minutes. You can hear the warning siren for 1 minute. Blasting will sound like a loud roll of thunder lasting about 2-3 seconds. The blast will be preceded by a 10 seconds call before it is fired."*

2. Block access when instructed by the Shotfirer.

Do not let anyone into the blast area.

Contact the Shotfirer immediately if the blast area is breached or if you see anyone in the area. For example:

*"Blast Guard 1 John, to Shotfirer Dwayne. Abort the blast. The blast area has been breached."*

3. Respond to the Shotfirer's radio calls (Blast Guards only).

If your part of the blast area is secure, respond to the Shotfirer's final blast clearance call using the phrase:

**"This is Blast Guard (number) (name), I am at (location), this access is blocked, And the area is secure."**

4. Maintain your position

Continue to block your access while the blast is fired and after the blast until the "ALL CLEAR" is given. Guards acknowledge the "all clear" in order starting with Blast Guard 1:

**"Guard (1) standing down."**

## APPENDIX 8 - SECURITY GUARD HANDOVER FORM

**Location :** \_\_\_\_\_

**Date:** \_\_\_\_\_

You are required to remain continuously on the blast site until you are relieved by the Shotfirer.

From (time) ..... hrs. on (date) .....

Until (time) ..... hrs on (date) .....

You are not required to enter the blast area.

Upon taking control of the area, you will meet with the HEC Shotfirer who will explain your duties and answer any questions you may have.

### **Contact the undersigned in the event of:**

- An approaching thunderstorm or fire near the blast area.
- Unauthorized access to the blast by anyone except those listed below.
- If the Shotfirer has not arrived on site by the nominated time.

Prevent unauthorized access to the shot by anyone except HEC Personnel.

**NO SMOKING INSIDE THE BLAST AREA.**

### **Contacts (in order of priority)**

Shotfirer

Alternate


I acknowledge and understand the above instructions:

**Signed** .....

Security Guard

**Signed** .....

Shotfirer

**Shot firer must take guard's contact details**

## **APPENDIX 9 - MISFIRE HANDLING PROCEDURES**

Misfires are a fact of life in blasting, so we must always be prepared to deal with them whether they are expected or not. All blasting activities, from design, through to loading and excavating should be undertaken on the assumption that misfires will occur.

The following precautions should be taken at the beginning of every job even if misfires are not expected or have not been found:

- Excavator operators should be trained to identify the explosives being used on site, and told what to do and what NOT to do when a misfire is discovered (covered in Misfire Identification Toolbox Talk as delivered by HEC)
- If HEC does not have a full-time presence on site, the client will be left with contact details for HEC personnel.
- Only a competent legislatively appointed Shotfirer may assess and move misfired products where safe to do so. The blasting manager is to isolate and mark via GPS/survey, and record on dig plans to ensure the area remains secure until the Shotfirer can attend.
- All loading techniques and practices should be documented and consistent, and all variations from the plan must be noted. This information becomes vital in the event of a mass misfire recovery – it is very important to be able to predict the location of the potential misfires in advance; and
- All hole collars should be surveyed in a reproducible co-ordinate system so holes can be re-located after the blast if necessary.

**The procedures required are:**

1. Controlled excavation.
2. Search for and identification of misfired charges.
3. Recovery of misfired charges.
4. Disassembly and preparation of misfired charges for transport; and
5. Storage and transport of misfired charges.

### **Procedure for Controlled Excavation**

Misfired charges are expected to occur at defined relative levels (RLs) within the excavation. The most sensitive part of each charge is the cast booster and the detonator, and these are located at the bottom of each charge. The remainder of the charge comprises emulsion explosive that is considered relatively insensitive in pristine condition and is less sensitive after exposure to shock. It is therefore possible to carefully excavate and expose the top of the misfired charges with negligible risk of premature initiation.

Equipment required:

- Excavator with rock breaker/tine/mud bucket/rock bucket.
- Compressor.
- Blow pipe, water and air hoses.
- Fluro paint, marker pins, survey equipment, tape measure, dewatering (in-pit pump);

and

- PPE: Gloves, hearing protection, safety glasses, raincoat, change of clothes.

**The procedure is as follows:**

1. The HEC Supervisor will provide the expected level (RL) of the top of the charges and review as-loaded details to determine if any holes contain charges above the expected level.
2. Survey control will be established using site survey equipment to allow rapid and repeated measurement of the excavation level at any time.
3. Establish a sump in an area previously cleared of misfires close to the area to be excavated.
4. Excavation to the designated level can proceed carefully. Use the mud bucket to clear the bench of broken rock as far as practical. Then use the blowpipe to clean the bench down. Work from top to bottom (always downhill);
5. As potential misfired collars are exposed, they will be marked, identified, and used to estimate the position of the next expected collar. Offset marks should be used to help the excavator operator maintain clearance from the identified holes; and
6. The bench should be excavated to a relatively level condition across the full width as this will provide safer working conditions for the recovery of the misfired charges in the next step.

**Search for and identification of misfired charges**

Equipment required:

- Water hose, flour paint, marker pins, rotating laser level and staff, tape measure, notebook; and
- PPE: Gloves, hearing protection, safety glasses.

**The procedure is as follows:**

1. As misfired collars are identified, the HEC Shotfirer will use the blowpipe to search for the top of the charge and attempt to clear the charge. If the top of the charge is not evident to the depth of the blowpipe, mark the hole BLUE to indicate it has been treated, and move on. If the top of the charge is evident, but it cannot be removed, mark the hole PINK for further treatment.

**Recovery of Misfired Charges**

Turn off mobile phone and radios when handling misfired electric detonators.

1. The Shotfirer will use water to wash the stemming from within the hole around the charge and remove the charge. Once the charge is removed, the location of the hole and the amount of recovered explosive recorded; and
2. The lead wires of the detonator will be stripped and shorted together.

### **Disassembly and Preparation of misfired charges for Storage and Transport**

Disassembly of the misfired charges will occur as soon as possible after recovery of the misfire from the ground and before the explosives are removed from the shaft.

Equipment required:

- Buckets, water, strainer, pliers, electrical tape; and
- PPE: leather gloves, face shield.

**The procedure is as follows:**

1. The detonator can be pulled from the primer if safe to do so.
2. The misfired charge will be disassembled.
3. Once free of the primer, the detonator lead wires will be shortened, re-stripped and re-shortened. The detonator will then be stored in a separate bucket of sand for later removal to the surface; and The primer can be stored in a bucket of water
4. The water in the bucket containing the misfired booster pieces will be strained to recover all the pieces. The pieces and the cloth will be collected for later disposal by detonation as waste.

### **Storage and Transport**

Equipment required:

- Day boxes, transport labels, vehicle manifest, Category 2 transport vehicle; and
- PPE: normal PPE.

**The procedure is as follows:**

1. Misfired charges will be stored securely under constant supervision of the Shotfirer until they are removed from site and destroyed once an investigation into the reason for the misfire has taken place. Detonators will be stored separately from other explosive components. The Shotfirer will maintain a record of all explosives recovered and removed from site.
2. If HEC does not have a full-time presence on site, the client will be left with contact details for HEC personnel. Only a competent legislatively appointed Shotfirer may assess and move misfired products where safe to do so.
3. Misfired and damaged detonators will be stored and transported in water filled plastic containers to reduce the risk of initiation by electric, impact, friction, or heat sources; and
4. All containers must be labelled for transport with the appropriate name, UN number, Dangerous Goods Class, and quantity in the container.



**HAZARDOUS GOODS LABELS**

**Nonelectric Detonator**

**UN No:** 0360

**Class-primary:** 1.1 B Explosive

**Proper Shipping Name:** DETONATOR ASSEMBLIES, NON-ELECTRIC

**Hazchem Code:** E

**Pentex Boosters (H & PPP Primers)**

**UN No:** 0042

**Class-primary:** 1.1 D Explosive

**Proper Shipping Name:** BOOSTERS

**Hazchem Code:** E

**Ammonium Nitrate Emulsion**

**UN No:** 3375

**Class-primary:** 5.1 Oxidiser

**Proper Shipping Name:** ANE / Fortis

**Hazchem Code:** E

**Surface Delay Detonators**







**UN No:** 0030

**Class-primary:** 1.1 B Explosive

**Proper Shipping Name:** DETONATOR ASSEMBLIES, NON-ELECTRIC

**Hazchem Code:** E

## APPENDIX 10 – BLASTING FUMES (NO<sub>x</sub> GASES)

Level and Action	Typical Appearance	
Level 0 No Fume		
Level 1 Fume Slight orange tinge in post blast dust		
Level 2 Minor Yellow/Orange Fume not significant		
Level 3 Moderate Orange Fume UIR is required		
Level 4 Significant Orange Fume UIR is required		
Level 5 Major Red Fume UIR is required		

Fume concentration can be estimated via visible observation however this is highly subjective and has a high degree of error.

- **Australian Exposure standards**

**NO<sub>2</sub>** : 3ppm TWA, 5ppm (9.4mg/m<sup>3</sup>) STEL

**NO** : 25ppm TWA, 35ppm STEL

TWA : Time-weighted average over 8-hour work day

STEL : Short term exposure limit over 15 minutes

Concentration (ppm NO <sub>2</sub> )	Path Length (NO <sub>2</sub> Cloud thickness) (m)	Expected Appearance
5	50	Pale Yellow
50	10	Yellow
50	20	Orange
50	50	Orange-red
250	10	Orange-red
250	20	Deep red
500	10	Deep red
1000	5	Deep red

## **CONSIDERATIONS**

Post-blast NOx gases need to be considered when establishing exclusion zones and placement of blast guards. The following personnel have been identified as those generally at the greatest risk of exposure to post-blast NOx gases during blasting operations. Consideration should be given to minimizing the numbers of personnel exposed to these situations:

- shotfirers and support personnel may be exposed during the post-blast period by moving back into the general blast area prior to dispersion of the gases.
- shotfirers and support personnel may be exposed during the post-blast inspection of the blast area as the dispersion of the gases can be very localized and continue to leak from under the ground for some time after the blast.
- shotfirers and support personnel may be exposed during the blast guarding process.
- general blast site personnel may be exposed during the dispersion of the NOx gases across a site.
- personnel that gather at areas such as blast guard positions and crib huts, close to the edge of the exclusion zone.

The extent and direction of any post-blast NOx gas plumes should be closely monitored to minimize any adverse impacts and to facilitate appropriate emergency response. It may be useful to increase the size and/or the duration of the exclusion zones in some cases to provide maximum opportunity for any NOx formed to dissipate to normal background levels e.g., downwind of blasting operations.

***Where potential for significant post-blast NOx gases exists, consideration needs to be given to personnel monitors, or gas masks, as an additional safety measure for persons conducting higher risk activities ego post-blast inspections.***

While steps should have been taken to eliminate or minimize the generation of blast generated NOx gases, there may be occasions where potential risk remains. The site blasting procedure must include consideration of areas of risk outside the developed exclusion zone. Such areas will normally be downwind of blasting operations where post-blast gases may drift in concentrations yet to be effectively dissipated. Following such assessments, additional risk control measures may be considered necessary to ensure risk minimization e.g., temporary evacuation of such management zones, deferral of blasting until climate conditions are more favorable.

While persons off site are unlikely to be significantly affected by blast generated NOx gases, communication with neighbours and other potentially impacted parties should be managed to alert them to possible post-blast gas events and to the steps being taken to prevent/minimize any risks presented. Some safety recommendations and guidance to such parties should also be considered.

## **EMERGENCY RESPONSE**

While it is unlikely that exposure to post-blast NOx gases will result in a fatality due to the concentration of the gases in an outdoor, well ventilated surface blasting site, NOx gases must be recognized as a potential health threat and managed accordingly. Generally, NOx plumes generated during blasting will dissipate to background levels in a relatively short time. Dissipation is highly dependent on local atmospheric conditions. However, in cases where a NOx plume does not dissipate and has the potential to result in the exposure to people the following steps must be undertaken:

Persons in the path of a NOx gas plume should;

- not enter the plume
- move away from the path of the plume
- if indoors, close all windows and doors and stay inside
- if in a car, stay inside and use recirculated air conditioning if possible

If a person has been exposed to NOx gases medical attention must be sought as soon as it is safe to do so. The possibility of delayed and life-threatening pulmonary edema dictates that:

- Any person exposed to a visible plume of NO<sub>x</sub>, and/or any person experiencing sudden acute effects of coughing, shortness of breath or irritation of the mucous membranes of the eyes, nose or throat following post-blast NO<sub>x</sub> events must be examined by a medical practitioner without delay, even if no NO<sub>x</sub> smell was noticed or symptoms are mild
- The treating medical practitioner must be informed of the potential NO<sub>x</sub> exposure. The following “Information for treating Medical Staff” should be provided to assist in the conveying of such NO<sub>x</sub> exposure information to the treating medical practitioners.

### **INFORMATION FOR TREATING MEDICAL STAFF**

Those exposed to NO<sub>x</sub> gases should seek immediate medical treatment and consideration should be given to placing those exposed under observation for at least 24 hours after exposure.

To assist medical staff the following guide should be provided

#### **Advice to Medical Staff in the Treatment of Those Who Have Been Exposed to NO<sub>x</sub> Gases.**

The patient may have been exposed to NO<sub>x</sub>. This is a gas usually produced on mines after the use of explosives. NO<sub>x</sub> consists of multiple combinations of nitrogen and oxygen (N<sub>2</sub>O, NO, NO<sub>2</sub>, N<sub>2</sub>O<sub>4</sub>, N<sub>2</sub>O<sub>3</sub>, N<sub>2</sub>O<sub>5</sub>). Nitrogen dioxide (NO<sub>2</sub>) is the principle hazardous nitrous gas. NO<sub>x</sub> irritates the eyes and mucous membranes primarily by dissolving on contact with moisture and forming a mixture of nitric and nitrous acids. But this is not the only mechanism by which injury may occur. Inhalation results in both respiratory tract irritation and pulmonary oedema. High level exposure can cause methaemoglobinaemia. Some people, particularly asthmatics, can experience significant broncospasm at very low concentrations.

The following effects are commonly encountered after NO<sub>x</sub> exposure:

### **ACUTE**

Cough

Shortness of breath

Irritations of the mucous membranes of the eyes, nose and throat

### **SHORT TERM**

Pulmonary oedema which may be delayed for up to 4-12 hours

### **MEDIUM TERM**

- R.A.D.S. (Reactive Airways Dysfunction Syndrome)
- In rare cases bronchiolitis obliterans which may take from 2-6 weeks to appear

### **LONG TERM**

Chronic respiratory insufficiency

High level exposure particularly associated with methemoglobinemia can cause chest pain, cyanosis, and shortness of breath, tachypnea, and tachycardia. Deaths have been reported

after exposure and are usually delayed. Even nonirritant concentrations of NO<sub>x</sub> may cause pulmonary oedema. Symptoms of pulmonary oedema often don't become manifest until a few hours after exposure and are aggravated by physical effort. Prior to transfer to you the patient should have been advised to rest and if any respiratory symptoms were present should have been administered oxygen. The patient will need to be treated symptomatically but as a base line it is suggested that the following investigations are required:

- Spirometry
- Chest x-ray
- Methemoglobin estimation

Because of the risk of delayed onset pulmonary edema, it is recommended that as a precaution the patient be observed for up to 12 hours. As no specific antidote for NO<sub>x</sub> exists, symptoms will have to be treated on their merits.

### **TOXICOLOGY OF NO<sub>x</sub>**

Only one study (CSIRO Australia, 2007) has been found which attempts to quantify the size, concentration and longevity of post-blast gas plumes under realistic conditions pertaining to open cut mining.

However, the toxicology of NO<sub>x</sub> is well understood from controlled medical studies and this knowledge is embodied in exposure limits defined by organizations such as the US Environmental Protection Agency (EPA) and US National Institute for Occupational Safety and Health (NIOSH).

The US EPA has compiled sets of Acute Exposure Guideline Levels (AEGLs) which represent threshold exposure limits for the public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours.

The other relevant standards are known as IDLH levels (Immediately Dangerous to Life and Health) which have been determined by NIOSH. These exposure limits are not considered relevant for public health scenarios but are generally applied when selecting respirators in an industrial situation.

The toxicology of NO<sub>x</sub> is summarized below.

#### **Nitric Oxide (NO)**

Under normal conditions, NO is formed at low levels in the body, and it serves as an important regulator molecule for the human cardiovascular, immune and nervous systems. NO is even used therapeutically for the treatment of several conditions (for example: adult respiratory distress syndrome and frequent pulmonary hypertension in newborns). However nitric oxide can be toxic in larger amounts because it combines with hemoglobin in the blood and prevents its normal oxygen-absorbing function. The toxicology of NO is complicated by the spontaneous formation of NO<sub>2</sub> which has its own adverse effects on the body. Consequently, the toxicity of NO<sub>x</sub> is guided by the levels set for NO<sub>2</sub>.

#### **Nitrogen Dioxide (NO<sub>2</sub>)**

The first toxic effects observed with NO<sub>2</sub> exposure are related to irritation of the airways and eyes. These effects have been studied many times with human volunteers in control environments. Because NO<sub>2</sub> is not very soluble in the moist airways, some gas can reach deep into lungs, causing delayed effects, notably pulmonary oedema (fluid in the lung), which can cause death. Normally, asthmatics or people with chronic lung conditions (e.g., bronchitis) are the individuals most 'at risk' in the general population. As with many toxic substances, the observed effects depend on both the concentrations and duration of exposure (Table 1).

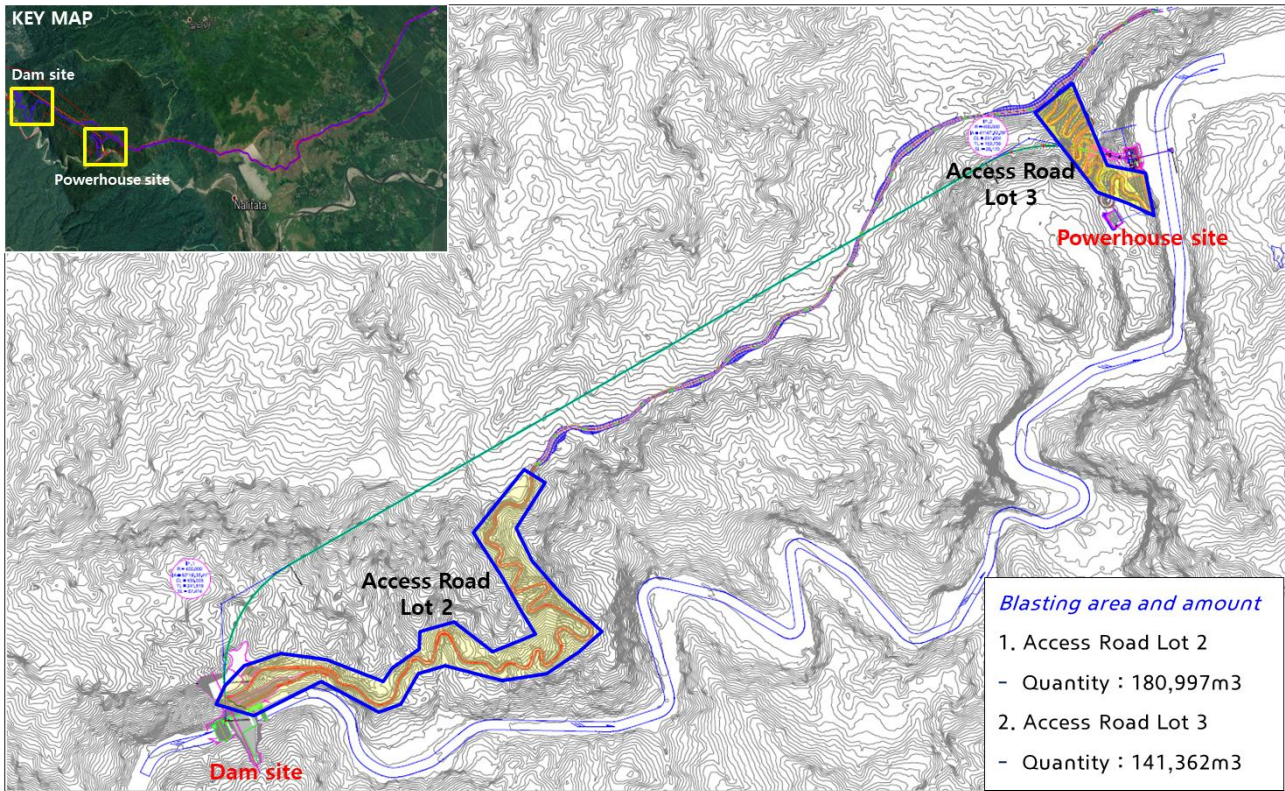
#### **Table 1. Summary of toxic effects verses NO<sub>2</sub> levels**

<b>NO<sub>2</sub> (ppm)</b>	<b>Exposure period</b>	<b>Response in Healthy Adults</b>
0.04-5		Odour threshold
0.3-0.5	2 hr	Decreased lung function, cough and dry throat and mouth.
20	30 min	IDLH level (Immediately Dangerous to Life or Health)*
30	40 min	Tickling sensation in nose and throat
30	70 min	Burning sensations and cough
30	2 hr	Deep chest burning sensations, shortness of breath
80	3-5 min	Chest tightness
90	40 min	Fluid in the lung

IDLH is defined by the US National Institute for Occupational Safety and Health (NIOSH) as the exposure that is “likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment”. The IDLH standard was developed to assist in selecting respirators in a work situation. It should be noted that delayed pulmonary oedema may not be accompanied by any other significant symptoms. This has been considered in the Acute Exposure Guideline Levels (AEGL). It is recommended to consult other authorities (medical) for further advice



APPENDIX 11 - SITE MAP AREA of Operation





## APPENDIX 12 - SHOT PRE- INITIATION CHECK LIST SHEET

### SHOT PRE-INITIATION CHECK LIST SHEET

**SITE:**

**SHOT #:**

**DATE:**

This risk assessment must be completed and signed-off by the shot firer before initiating the shot.

#### **PRE-LOADING:**

1. Do the quantities of explosive devices match the cart note supplied by service provider ?

Yes / No

2. Where a front hole has deviated toward the face, what is the allowable minimum burden before hole loading must be modified?

.....

3. Is the actual burden along the length of each front hole within the allowable minimum burden?

Yes / No

4. If no: record how each hole, with less than the minimum allowable burden, has been loaded to control the fly-rock and overpressure risks?

.....

#### **PRE-INITIATION:**

1. Were any holes overfilled? YES / NO

2. If YES: record for each overfilled hole the action taken to reduce the fly-rock and overpressure risks:

.....

3. Has any Product Slumping Been Noticed? YES / NO

4. If YES: record for each slumped hole the action taken to reduce the fly-rock and overpressure risks:

.....

5. Have any deviations from the blast plant / design been noticed? YES / NO If YES: record the deviations and their effect on fly-rock and overpressure risks:

.....

**BULK EXPLOSIVE AND POWDER FACTOR RECONCILIATION**

	DESIGN	ACTUAL	VARIATION
Bulk Explosive (kg)			
Blast Volume (BCM)			
Powder Factor (kg / BCM)			

1. Is there a variation from design?    YES / NO
2. If YES:    What is the reason for the variation, and is it acceptable?  
.....
3. Is the normal Exclusion Zone (for equipment and personnel) appropriate for the size, orientation and configuration of the actual blast as charged?                      YES / NO
4. Shot video camera –person clear of blasting area?                      YES / NO

**Shot firer to Print Name:** .....    **Signature of Shot firer:** .....

## APPENDIX 13 - EXPLOSIVE LOG BOOK

## SUMMARY OF MAGAZINE TRANSACTIONS

DELIVERER :

LOCATION :

DATE :

USER :

[illegible]

## Appendix 14 – Drill and Blast Log

### Drill and Blast Log

Project Name : Tina River Hydropower Development Project

Date (yyyy-mm-dd)		Time (hh:mm)		<input type="checkbox"/> a.m. <input type="checkbox"/> p.m.		Blast number	
Blast location				Type of material			
Number of rows		Number of holes		Drilling pattern (specify metres or feet)			
				Burden		Spacing	
Depth of holes (specify metres or feet)				Diameter of holes (specify millimetres or inches)			
Maximum number of holes per delay				Maximum explosives weight (specify kg or lbs) (delay of 8 ms or greater)			
Number of decks per hole				Deck separation (specify metres or feet)			
Stemming (specify metres or feet)				Stemming material			
Total weight of explosives (kg or lbs)		Overall rock volume (m <sup>3</sup> or y <sup>3</sup> )		Powder factor (kg/m <sup>3</sup> or lbs/y <sup>3</sup> )			

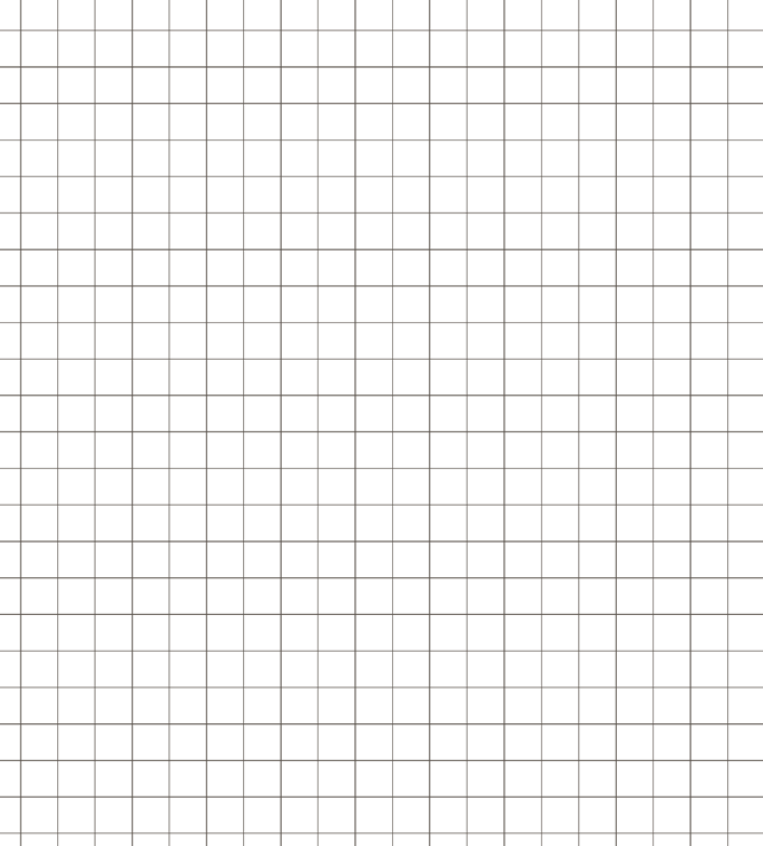
Explosives		Detonator assemblies											
Known name	Qty	Dual delay	Length	Qty	In-hole delay	Length	Qty	Surface delay	Length	Qty	Electric or electronic	Length	Qty

Weather <input type="checkbox"/> Cloudy <input type="checkbox"/> Rain <input type="checkbox"/> Clear <input type="checkbox"/> Snow		Wind direction		<div style="text-align: center;">N   </div>		Wind speed (specify km/h or mph)	
---	--	----------------	--	---	--	----------------------------------	--

Cover protection? <input type="checkbox"/> Yes <input type="checkbox"/> No		Type and size		Blasting mats total used	
---	--	---------------	--	--------------------------	--

Seismograph monitoring location		Calibrated? <input type="checkbox"/> Yes <input type="checkbox"/> No		Type of initiation system	
1. Seismic data		2. Seismic data			
Distance to closest structure		Description of closest structure		Electric cap and circuit test?   Ω <input type="checkbox"/> Yes <input type="checkbox"/> No	
Name of blaster of record (please print)					
Helpers					
1.		3.			
2.		4.			
Signature (blaster of record)					

Show direction of the north, distance to nearest structure (metres/feet), and timing



Check off what you use

**Type A**

☐ Overburden  
☐ Rock  
☐ Stemming  
☐ Main charge  
☐ Primer  
☐ Spacers/Decking  
☐ Main charge  
☐ Primer  
☐ Sub-drilling

**Type B**

☐ Overburden  
☐ Rock  
☐ Stemming  
☐ Main charge  
☐ Primer  
☐ Spacers/Decking  
☐ Main charge  
☐ Primer  
☐ Sub-drilling

Overhang hazards?

☐ Yes ☐ No

Cutoffs?

☐ Yes ☐ No

# Drill and Blast Log

Hole number	Depth (metres or feet)	Burden	Spacing	Stemming	Timing	Explosives (kg or lbs)	Comments (wet, dry, can't load, etc.)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16.							
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32.							
33.							
34.							
35.							
36.							
37.							
38.							
39.							
40.							
41.							
42.							
43.							
44.							
45.							

# Drill and Blast Log

Hole number	Depth (metres or feet)	Burden	Spacing	Stemming	Timing	Explosives (kg or lbs)	Comments (wet, dry, can't load, etc.)
46.							
47.							
48.							
49.							
50.							
51.							
52.							
53.							
54.							
55.							
56.							
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86.							
87.							
88.							
89.							
90.							

**Attachment A. Blast Consultant Resume and Capability Statement**



**Attachment B. Blasting Experts License**

**Attachment C. Drilling Machine Specification**

**Attachment D. Explosive Technical and Safe Data Sheet**

**Attachment E. Detonator Technical and Safe Data Sheet**

**Attachment F. Explosive quantity calculation table**

**Attachment G. Blasting pattern application**

**Attachment H. Letter\_RSIPF to HEC\_RE\_Approval to Dealers Magazine Construction Plan**

**Attachment I. Transportation Flow Chart \_ confirmed by RSIPF**





**Attachment K. Explosive Procument Plan\_HEC**

**Attachment L. Resume of Explosive supervisor and Driller**

**Attachment M. Dealer’s License from RSIPF and GP**