DONNELLY BLASTING SERVICES

26 Tamborine St,
Jimboomba Q 4285

p. [redacted]
e. [redacted]

ABN 48 141 953 291

Norfolk Island Regional Council
PO Box 95, Norfolk Island 2899.
New Military Barracks, Kingston, Norfolk Island

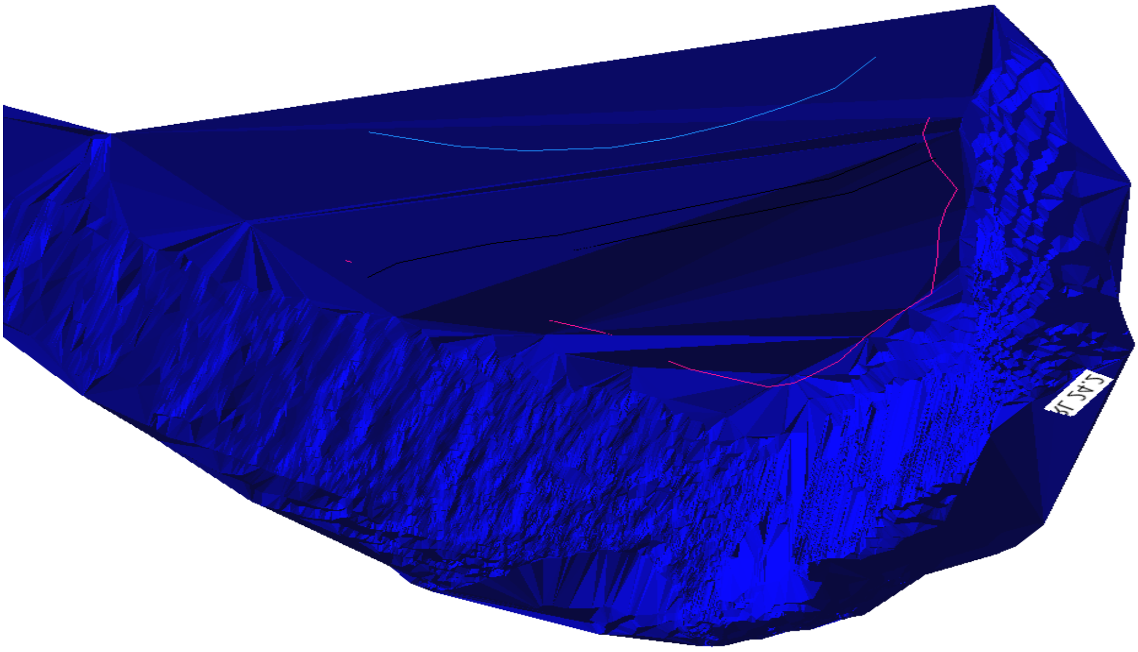
Simon Tuituri
Dear Simon,

Donnelly Blasting Services are pleased to offer Norfolk Island Reginal Council, a working design for drill and blast operations for the proposed cascade quarry on Norfolk Island. Our consultant, [redacted] (QLD Shotfirer Lic: [redacted]), conducted a detailed blast survey to create a model of the blast area including the Blast Face, Blast Bench Surface, and Closest sensitive receivers. Whilst also on the Norfolk Island, research into suitable storage locations for the explosive was also conducted.

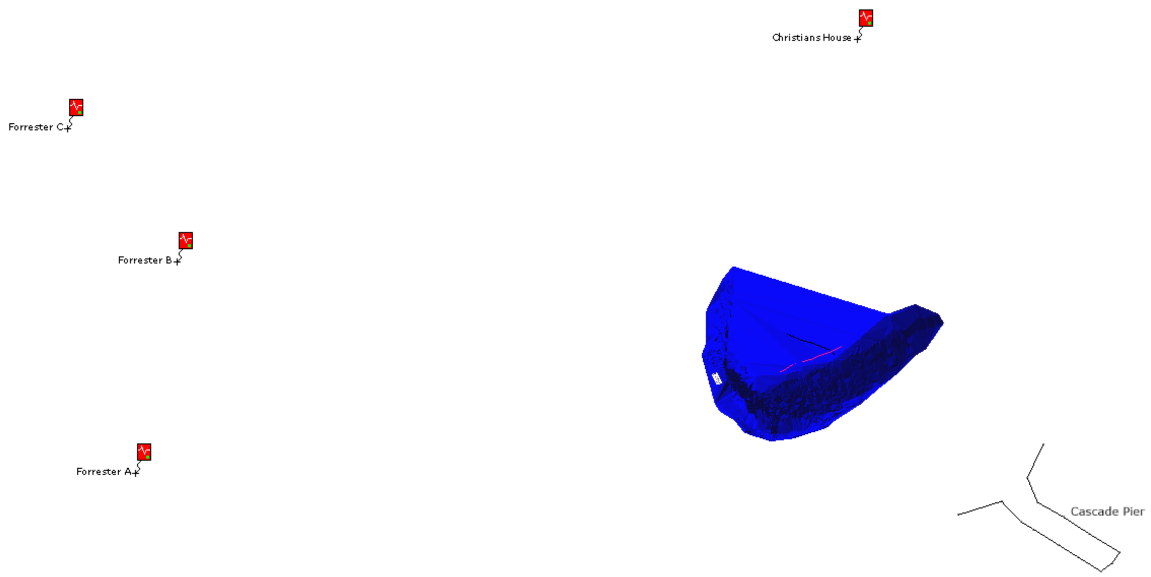
1. 3D Model of Blasting Area

The first major step of the design is survey of the blast area to create an accurate 3D model of the area to be blasted. Some of the information collected during the Survey is the Quarry face, Crest and Toe Line, 2m safety line form the crest for fall protection, the existing wall behind the blast area, and the sensitive receivers (The pier and the [redacted] and [redacted] residences).

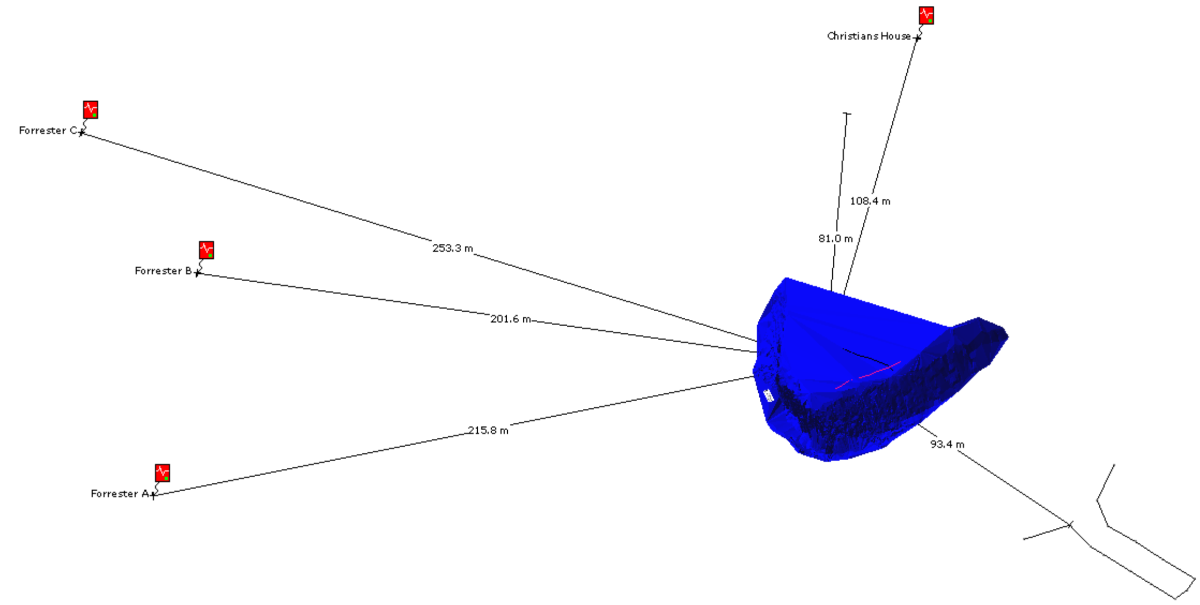
Blast Face Below,



Sensitive Receivers Below,



Distances to Sensitive Receivers,



2. Blast Design

Once the detailed blast design was completed with all the required information, DBS was able to complete a working blast design. Although there are multiple options for explosives to be used in completing the working design, DBS has chosen to use Orica Civec Drive gassed emulsion on the project due to the water resistance properties and the class 5.1 nature of the product for transport and handling, minimising the volume of live explosives required to be transported and storage on the Norfolk Island. With the utilisation of the Civec Drive Product DBS was able to complete the design to be able to blast the whole blast area in 1 blast utilising 2 decks of explosives to minimise the MIC to comply with the Australian Standards AS 2187 Part 2 Appendix J Limits for blasting operations lasting less than 12 months or 10 blasts.

3. Blast Parameters

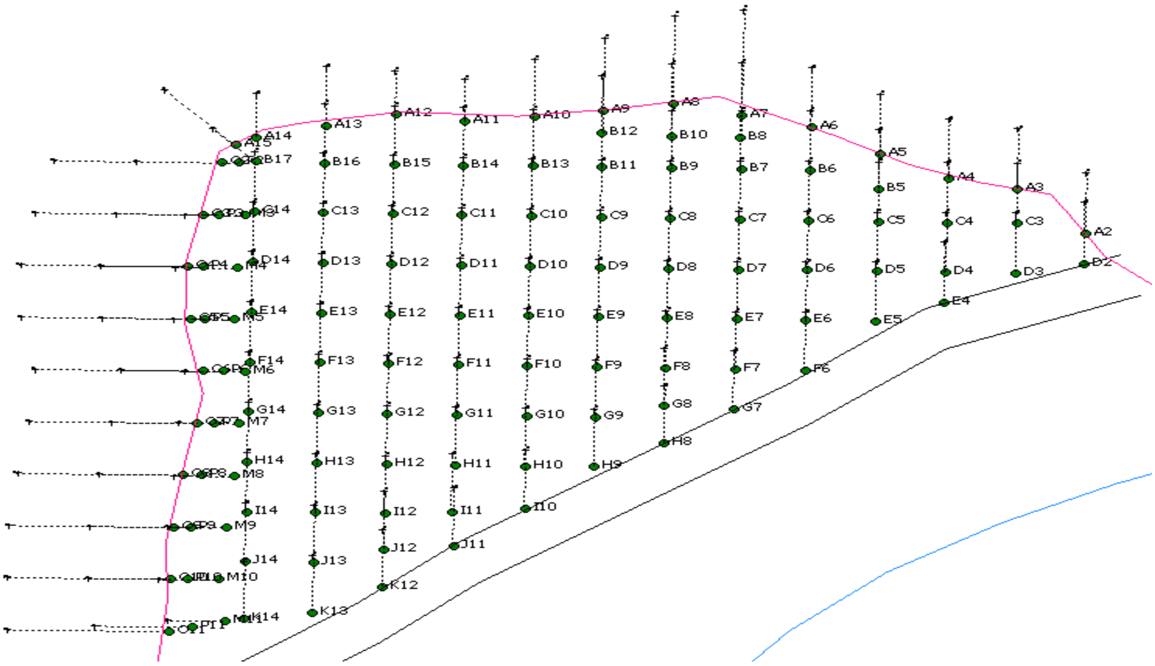
From the detailed site survey, DBS was able to utilise experience on similar projects and Industry best practices to derive the following Blast Parameters.

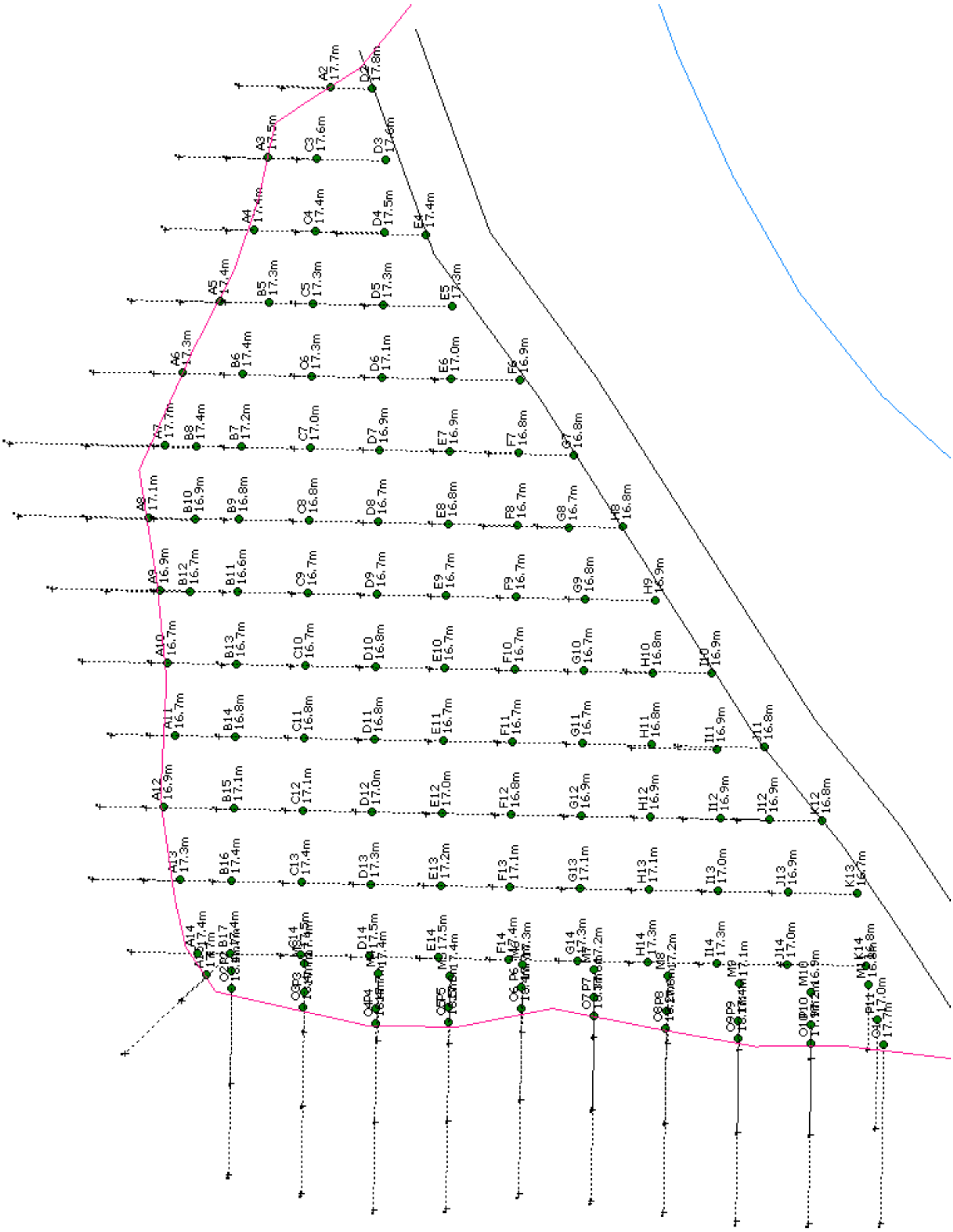
Burden	2.3m	Spacing	2.4m
Front Row Burden	2.7m	Average Depth	16.17m
Hole Diameter	76MM	Stemming Length	2.5 + 1m Air Deck if needed
Total No Holes	128	Drill Meters	2069.9

Total BCM M3	12558.3	Total Bulk Explosives	7168.0 Kgs

The above parameters give a design powder factor of 0.57 Kilograms of explosives per cubic meter of rock which is in line with common practise for blasting highly structured basalt.

Proposed layout of blast holes below,




A2 17.7m
D2 17.8m
A3 17.5m
C3 17.6m
D3 17.6m
A4 17.4m
C4 17.4m
D4 17.5m
E4 17.4m
A5 17.4m
B5 17.3m
C5 17.3m
D5 17.3m
E5 17.3m
A6 17.3m
B6 17.4m
C6 17.3m
D6 17.1m
E6 17.0m
F6 16.9m
A7 17.7m
B8 17.4m
B7 17.2m
C7 17.0m
D7 16.9m
E7 16.9m
F7 16.8m
G7 16.8m
A8 17.1m
B10 16.9m
B9 16.8m
C8 16.8m
D8 16.7m
E8 16.8m
F8 16.7m
G8 16.7m
H8 16.8m
A9 16.9m
B12 16.7m
B11 16.6m
C9 16.7m
D9 16.7m
E9 16.7m
F9 16.7m
G9 16.8m
H9 16.9m
A10 16.7m
B13 16.7m
C10 16.7m
D10 16.8m
E10 16.7m
F10 16.7m
G10 16.7m
H10 16.8m
I10 16.9m
A11 16.7m
B14 16.8m
C11 16.8m
D11 16.8m
E11 16.7m
F11 16.7m
G11 16.7m
H11 16.8m
I11 16.9m
J11 16.8m
A12 16.9m
B15 17.1m
C12 17.1m
D12 17.0m
E12 17.0m
F12 16.8m
G12 16.9m
H12 16.9m
I12 16.9m
J12 16.9m
K12 16.8m
A13 17.3m
B16 17.4m
C13 17.4m
D13 17.3m
E13 17.2m
F13 17.1m
G13 17.1m
H13 17.1m
I13 17.0m
J13 16.9m
K13 16.7m
A14 17.4m
D14 17.5m
E14 17.5m
F14
G14 17.3m
H14 17.3m
I14 17.3m
J14 17.0m
K14 16.8m

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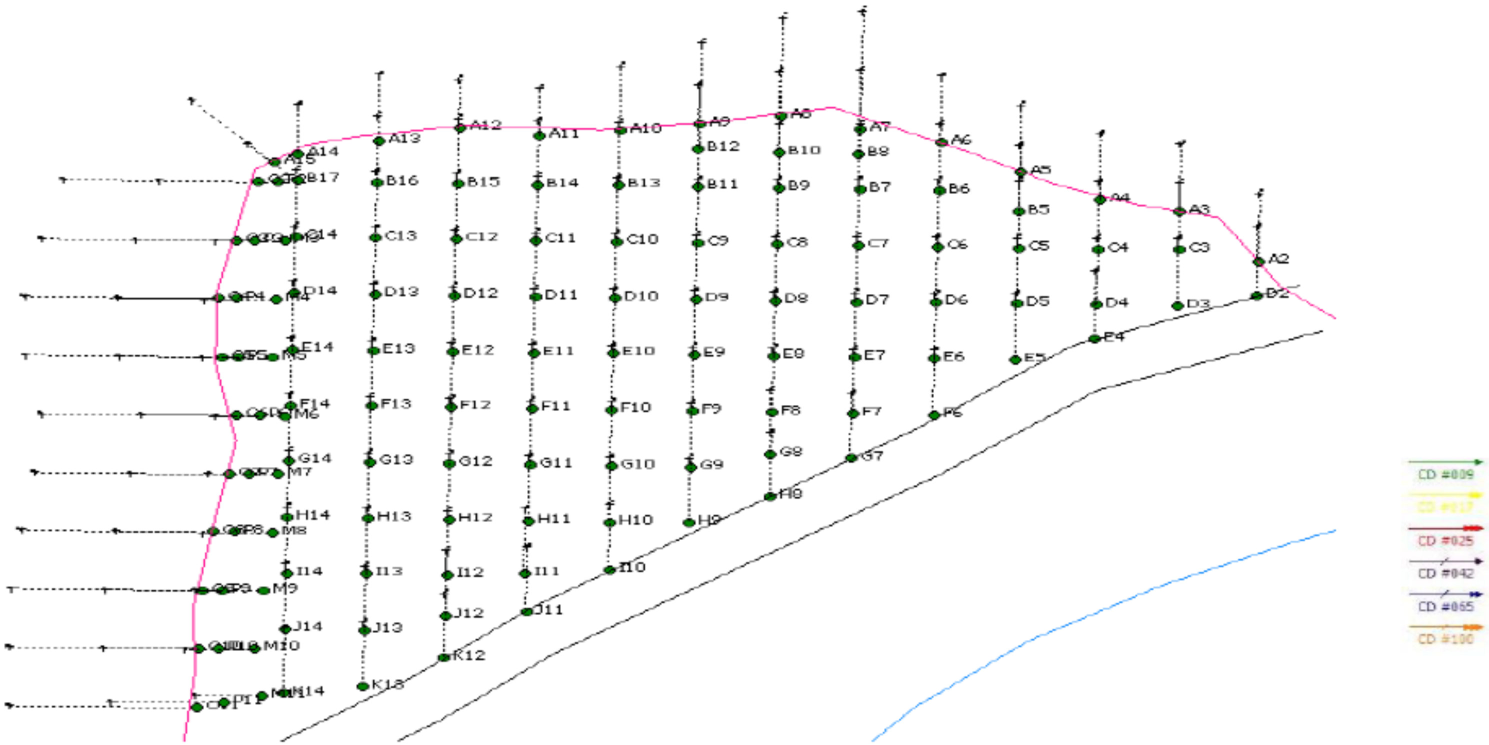
29 Kilmore Drive, Tamborine QLD 4270 Mobile: 0407 597 957 Fax: (07) 55438619 ABN 48 141 953 291

				CUSTOMER NAME	NIRC
				LOCATION	Cascade Quarry
				SHOT No.	NIRC_01
				BENCH No.	RL40
BURDEN	2.3	HOLE DEGREE	10	DATE	29/01/2021
SPACING	2.4	SUBDRILL	0.5	WEATHER	
AV DEPTH	17.19	METERS OF CHARGE		ROCK DENSITY	2.68
TOTAL No. HOLES	128	METERS OF STEMMING		FRONT ROW BURDEN	2.7
TOTAL BCM	12558.33	GROUND VIBRATION	mm/s	TOTAL DRILL METERS	2200.4
ESTIMATED TONNES	33656.31	OVER PRESSURE	dB(lin)	DRILL BIT	76



REMARKS:		SHOTFIRER	
		SHOT FRIER SIGNATURE	
		CUSTOMER SIGNATURE	

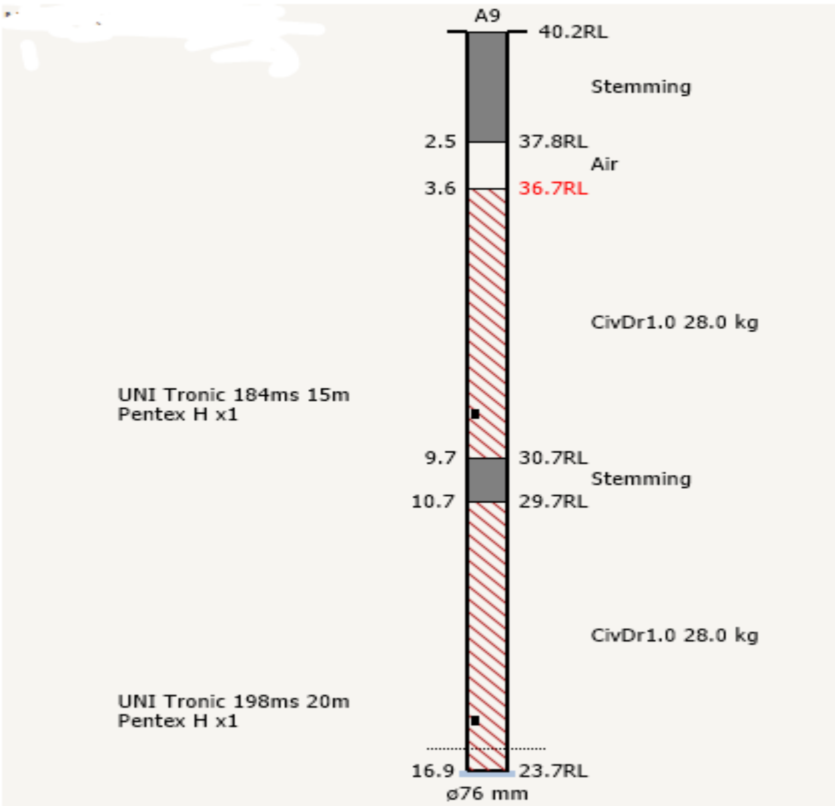
4. Blast Hole Drilling

With the design of the pattern due care must be taken to drill the holes accurately and straight with minimal deviation to ensure that there is no risk of holes dead pressing each other. Once drilling activities are complete, DBS recommends that face holes are Boretraked to ensure compliance with design and all risk of fly rock are mitigated.

5. Blast Hole Loading

By maintaining a high level of housekeeping and quality control following industry best practice, blast holes will be loaded with 2 decks of explosives up to 28kgs per deck of explosives per hole depending on the location within the blast and the drill hole depth. The deck blast hole design allows the holes to be drilled at full depth but the 2 columns of explosives to be initiated at separate timing to minimize the maximum instantaneous charge going off at any point of the blast. Please see attached loading diagram for each hole.

Blast hole loading diagram,



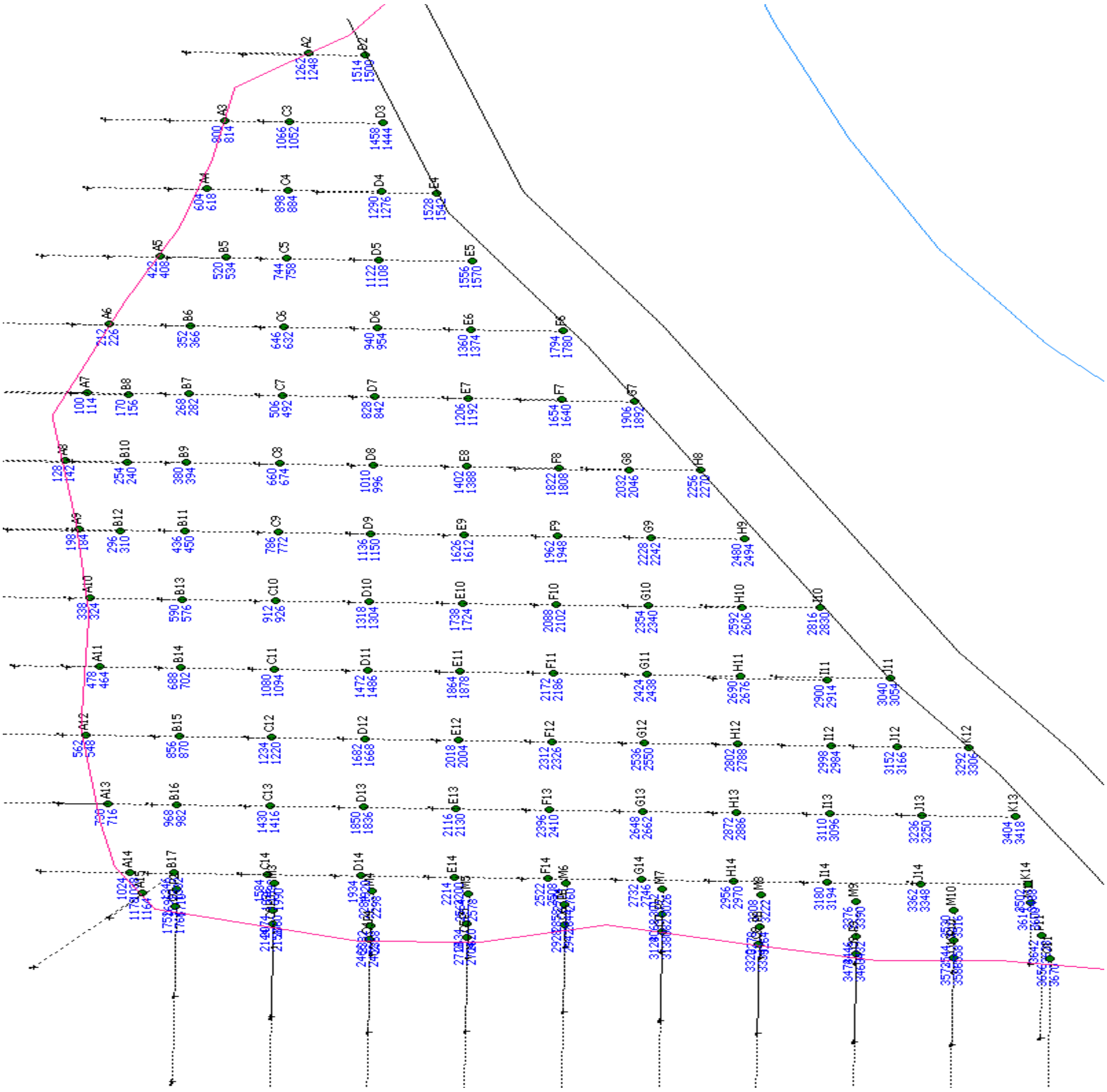
6. Blast Hole Initiation Sequence

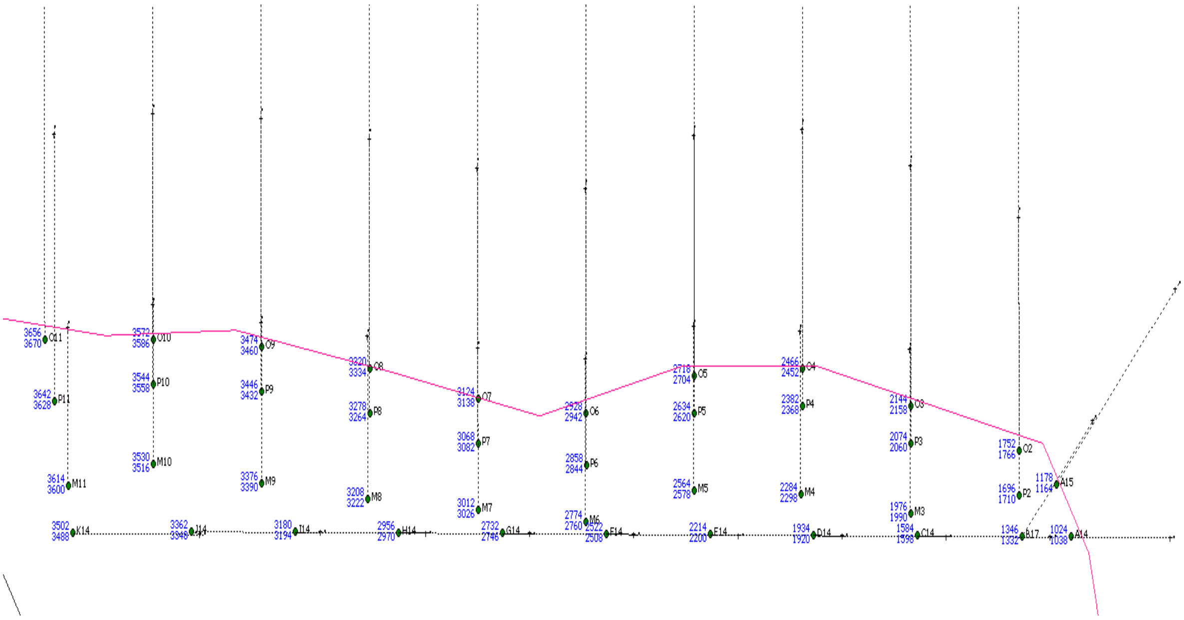
With the use of 2 explosives decks per hole requires careful consideration for timing the blast the ensure that each charge initiates on its own delay at to ensure that adequate timing is allowed between charges to ensure that the arrival time for the vibration at the sensitive receivers does not double up and arrive as 2 charges combined due to the earth's natural transmission frequency.

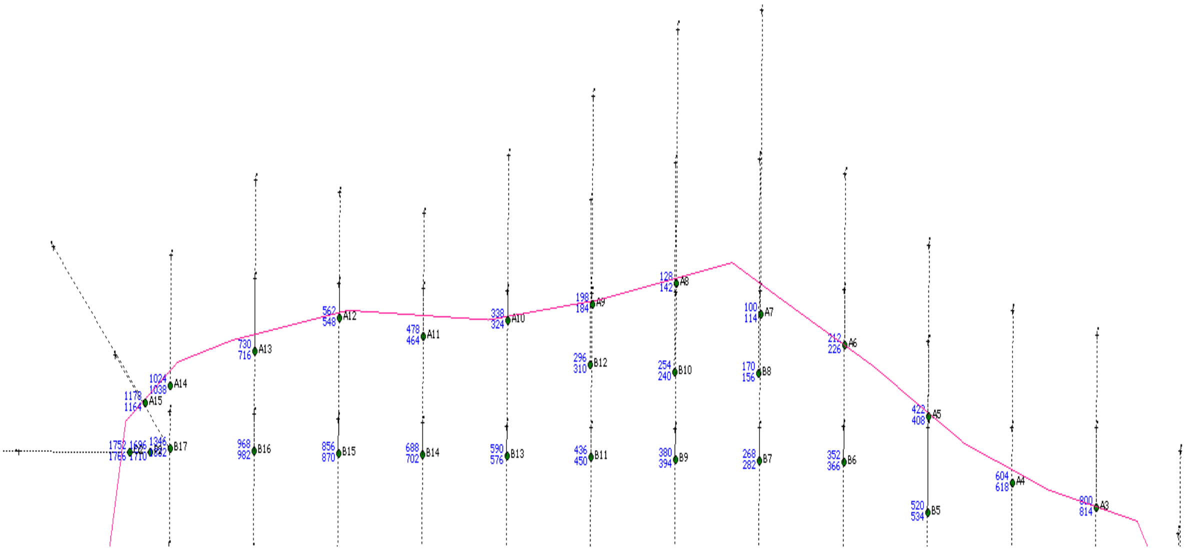
The Top deck on the blast hole must be initiated first to ensure that the bottom charge does not dead press the charge above.

Note the timing design may need to be amended on completion of drilling and post drilling survey and Boretrak results.

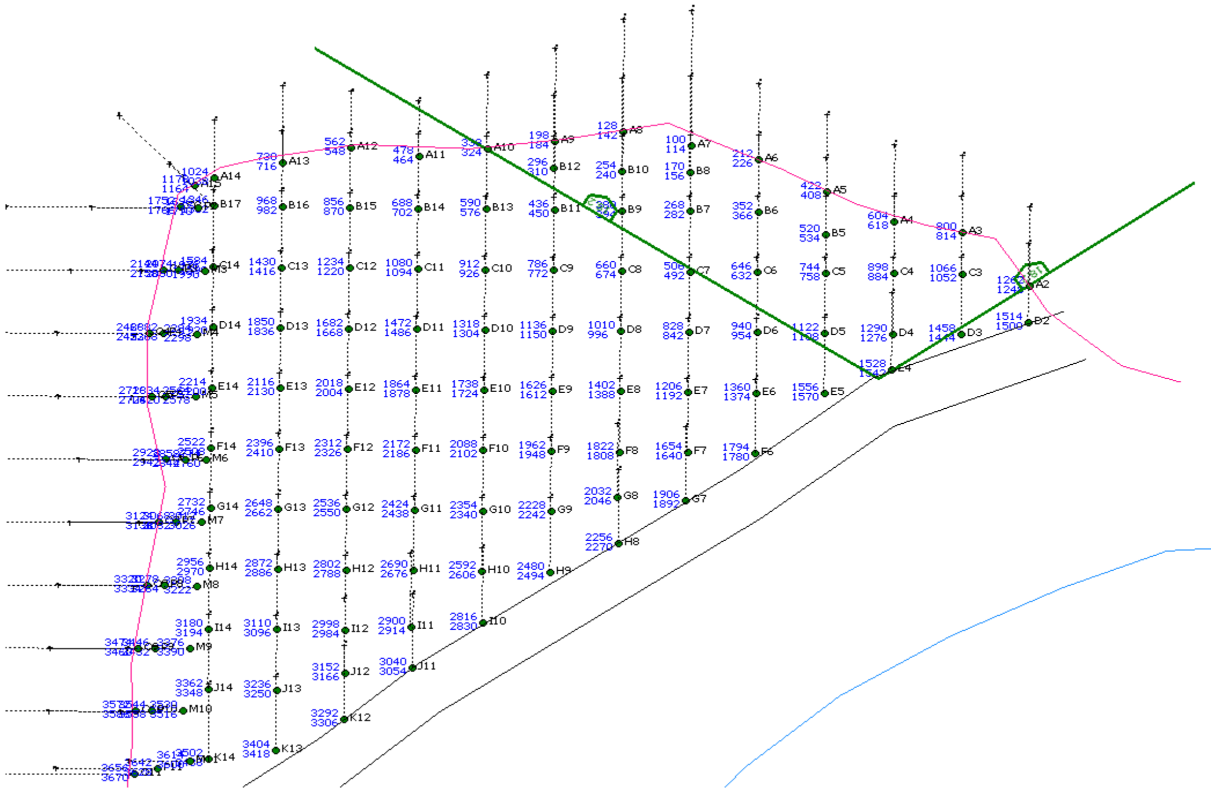
Please see attached plan below for in hole initiation times.







The above timing results in a ground movement to maintain most of the rock on the bench in front of the blast, to minimise the rock that will spill down the face towards the entrance gate.




2.0 m
7.2 m
9.4 m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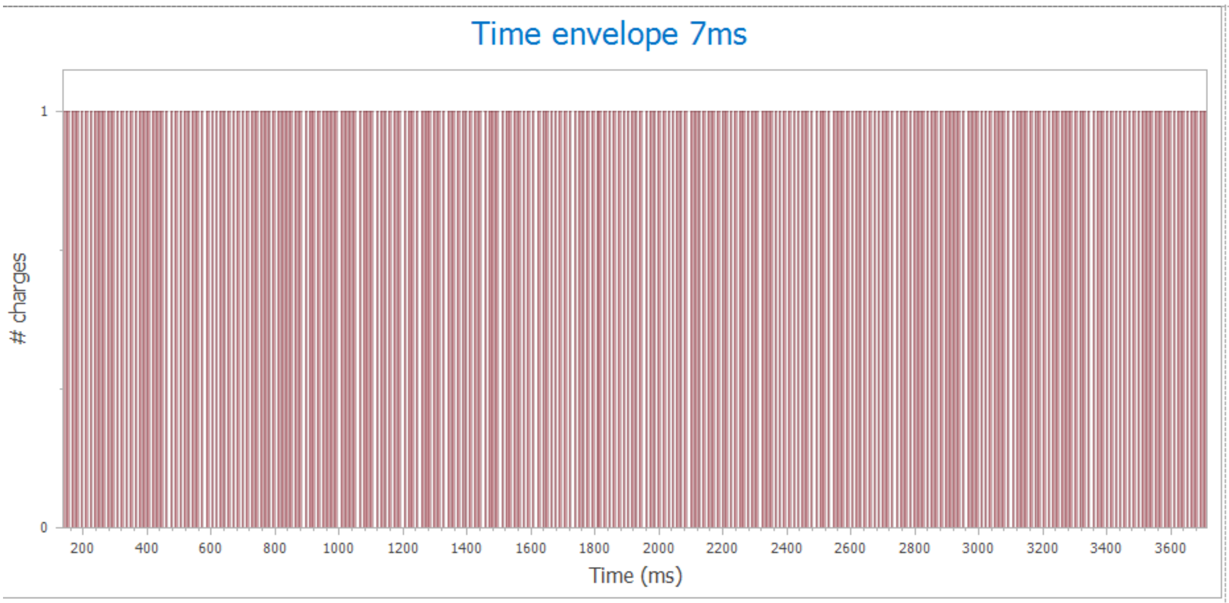
7. Ground Vibration and Air over pressure

By using the 2-deck single charge per delay initiation design the ground vibration and air blast can be controlled successfully to ensure compliance with AS 2187 Part 2 Appendix J limits for Human comfort. Please keep in mind that designs are based on AS2187 coefficients due to no previous records for blasting being able to be produced to calculate site coefficients. With this in mind DBS has chosen to design the blasting to use 75-80% of the allowable limit instead of the common industry practice to use 95% of the allowable limit. (These limits are for Human comfort and the threshold for property damage is substantially Higher)

7.1 Ground Vibration

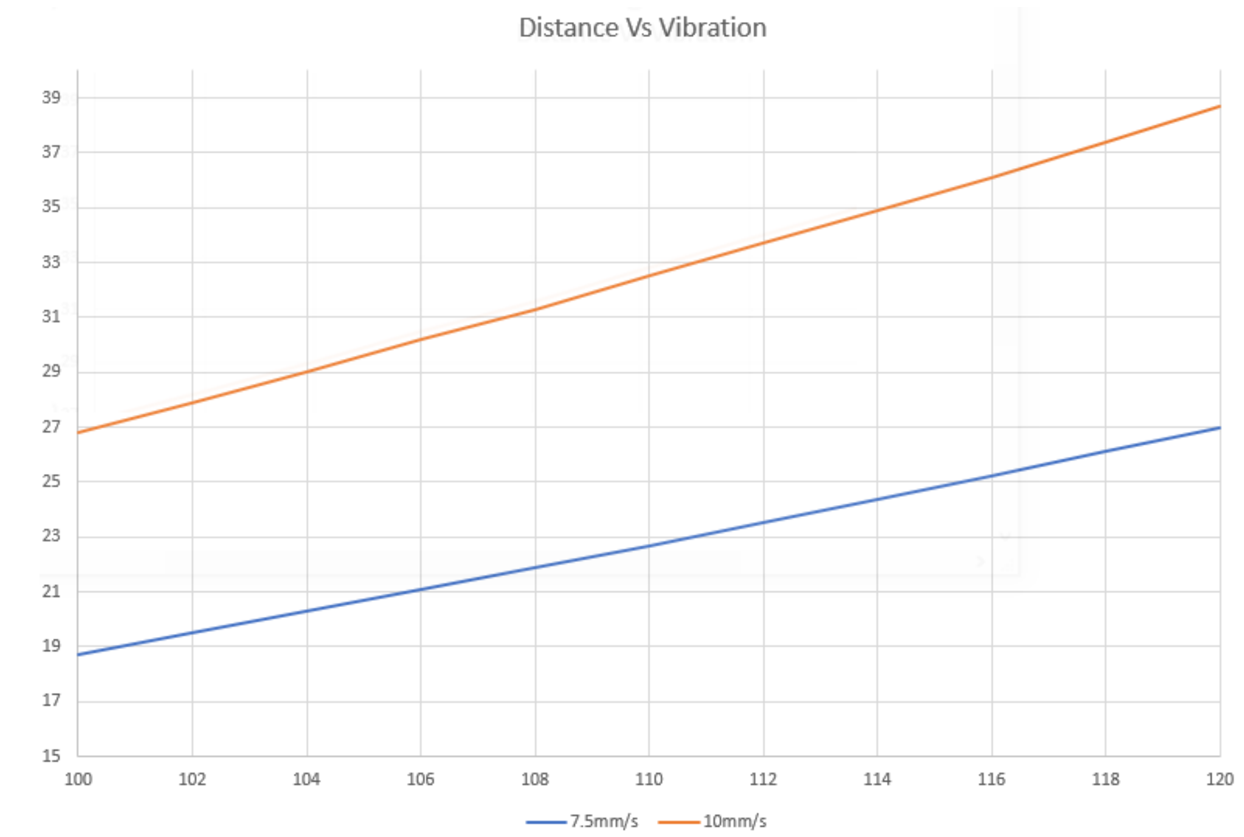
The 2-deck design in each blast hole and with careful loading of the blast holes to ensure that the holes are loaded to the design Kilograms per hole. With the use of electronic detonators and their inherent accuracy of initiation on programmed design, less the 0.03% deviation of actual firing time compared to programmed time means that even at 3600 milliseconds programmed time that the detonator will initiate within 1 millisecond of programmed delay compared to nonelectric detonators which can have a scatter of 8 milliseconds or greater.



7.1.1 [redacted] House @ Portion 5A1

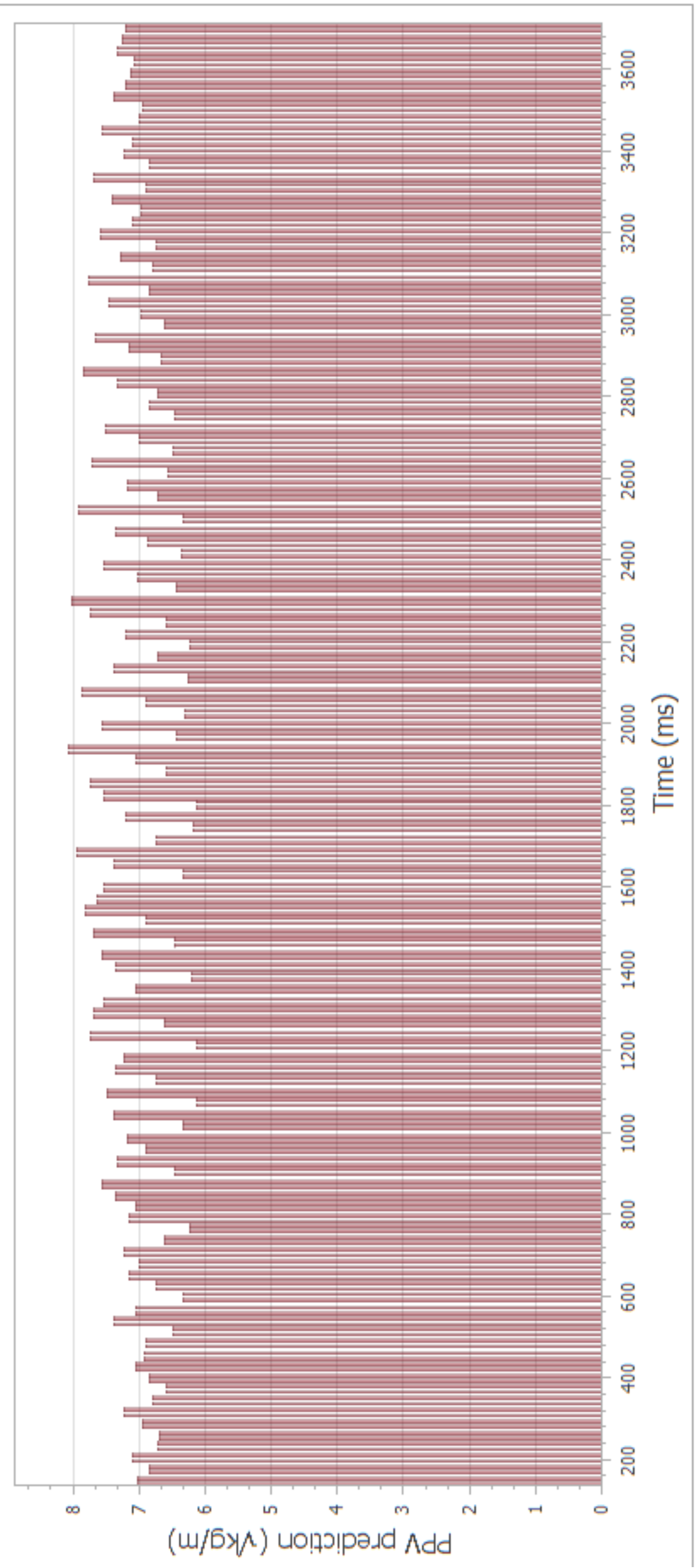
As [redacted] house is the closest house to the blasting area it is the closest sensitive receiver to the blasting area at 108 meters away. The Blast Maximum instantaneous charge has been designed off Australian standard coefficients K and B values of -1.6 and 1160. Below charts represents the Kilograms for explosive per charge VS distance away from the closest sensitive receiver.

$$ppV = K * \left(\frac{D}{\sqrt{W}}\right)^{b}$$



Below Chart represents the ground vibration prediction form each explosive charge loading into the design and simulated firing leaving an approximate 25% buffer off the 10mm/s limit set out in AS 2187 Part 2 Use of explosives. Each red bar represents one charge initiating.

Time envelope 7ms

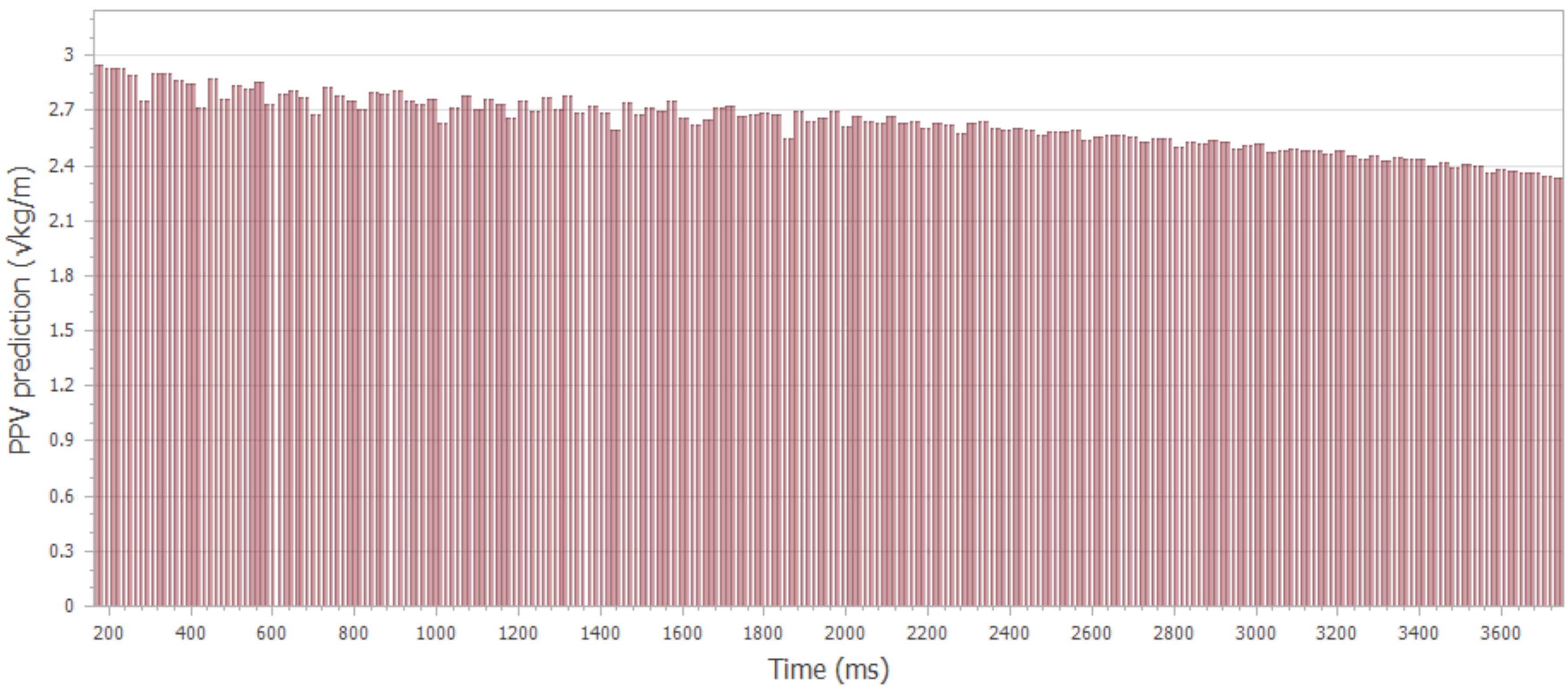


7.1.2 [redacted] @ Portion 1D2

During the site visit and Survey, it was identified that there is 3 houses on [redacted] portion, for calculation purposes all calculations will be based on the closes house/sensitive receiver to the blasting area. The Closest Sensitive receiver on the portion is 201 meters from the blast area (distance calculated is a straight line from point to point however the land distance is longer due to the elevation changes and valley in between the 2 points however for calculation purposes straight line distances will be used) Due to the distance being double the distance to [redacted] sensitive receiver, naturally if ground vibration is controlled a the [redacted] residence it will follow at the [redacted] residences.

Below chart represents simulation firing of the blast, and that the closest blast hole to this sensitive receiver predicts that maximum felt vibration will be less than 30% of the AS 2187 Part 2 limits Peak Particle Velocity of 10mm/s per second.

Time envelope 7ms



7.2 Air Over Pressure

Air Over Pressure is the pressure wave of air from the blast being fired created form the movement of the rock during the blasting procedure, This is measured in Lineal Decibels (DBL) Although it is measured in decibels there is no direct correlation or conversion into acoustic decibels (DBA). The limits set out in Australian Standards AS2187 part 2 Appendix J for blasting operations of less the 20 blast in 12 months is 120 DBL for 95% of blasting with nothing to exceed 125 DBL.

Air Blast is calculated using the following formula below,

$$P = K\left(\frac{D}{\sqrt[3]{Q}}\right)^{a}$$

Below is calculation for the closest sensitive receiver, [redacted] house,

Airblast Analysis		
Nearest Sensitive Receiver	m	108
MIC	kg	28.0
k Factor		100
N Factor		-1.45
Pressure	kPa	0.6
Airblast	**dBL**	**89.0**

With the relative low MIC design for the vibration at the closest sensitive receivers, it will take care of the air overpressure as well. Environmental conditions of the blast day can also influence or effect the air overpressure reading at the monitor due to wind and cloud cover.

7.3 Dilapidation reporting

DBS recommends conducting dilapidation reports on [redacted] and the [redacted] residences, although its entirely at councils discretion. DBS can provide a third party to conduct Dilapidation report and independent blast monitoring if deemed necessary.

8. Transport to and storage on the Island

Due to the nature of the remoteness of Norfolk Island, transport of explosives to the island has taken much consideration to design a blast that is capable not only to be drilled with the available Drill Rig and loaded with Explosives that are capable to be manufactured and pumped into blast holes without complex Mobile manufacturing trucks. All Transport is based on a Roll on/Roll tow behind Brage out of mainland Australia.

8.1 Transport of Class 1 Explosives (Detonators and Boosters)

DBS Proposes to ship the detonators in a suitable magazine meeting AS2187 Part 1 requirements from Brisbane to Norfolk Island, and with boosters will be transports in another suitable magazine. Best scenario is to place these at opposing corners of the barge to separate the 2 classes of explosives as much as practical. Upon completion of the project DBS proposes to leave magazines on the island as infrastructure for future work.

Once the magazines reach the island they would be placed in the Cascade Quarry at a set distance with a bund wall between them and once arrive the access gates to remain locked at all times.

8.2 Transport of class 5.1 Ammonium Nitrate Emulsion (ANE)

DBS Proposes to ship the required ANE over in 7x 1000L IBC's (1300 Kgs each) These IBC can be stored in a shipping container on the barge if required to allow the Councils swing lift crane to come onto the barge and take the whole container to the storage location at the gun club or transport these IBC on a truck with appropriate signage and pack into a shipping container at the gun club.

The storage container will require the correct signage to be fitted for storage.

The storage location of the ANE at the Gun Club will need to ensure that it is greater then 250 meters away from the club house to meet AS2187 Part 1 requirements for a protected works A building.

The ANE loading pump will require compressed air to operate the pump for loading of the blast holes on the blast day.

For any further information please don't hesitate to contact myself or [redacted] for any clarification.

Regards

[redacted]