Hartley Valley Safety Upgrade
ROADS AND MARITIME SERVICES
Blasting assessment
Final
25 March 2014
Project Name
Project no: EN04213
Document title: Hartley Valley Safety Upgrade
Revision: Final
Date: 25 March 2014
Client name: Roads and Maritime Services
Project manager: Vivira Cadungog
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File name: Blasting assessment

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Document history and status

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<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
<th>By</th>
<th>Review</th>
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<td>Final</td>
<td>25/03/2014</td>
<td></td>
<td>S Hughes</td>
<td>Practice review</td>
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<tr>
<td>Final</td>
<td>26/03/2014</td>
<td></td>
<td>A Spinks</td>
<td>Project review</td>
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## Terms and abbreviations

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<th>Definition</th>
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<tr>
<td>Air blast</td>
<td>The airborne shock wave or acoustic transient generated by an explosion.</td>
</tr>
<tr>
<td>Blast, Blasting</td>
<td>The firing of explosive materials for such purposes as breaking rock or other material, moving material, or generating seismic waves.</td>
</tr>
<tr>
<td>dBL</td>
<td>A unit of air overpressure commonly used to measure air blast.</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental impact statement</td>
</tr>
<tr>
<td>Environmental assessment (process)</td>
<td>A specialised part of the decision-making process, where the environmental impact of a development or proposal or activity is considered in detail, together with other aspects of the development</td>
</tr>
<tr>
<td>EPA</td>
<td>NSW Environmental Protection Authority</td>
</tr>
<tr>
<td>ICNG</td>
<td>Interim Construction Noise Guideline (July 2009)</td>
</tr>
<tr>
<td>OEH</td>
<td>Office of Environment and Heritage</td>
</tr>
<tr>
<td>Particle velocity</td>
<td>A measure of the intensity of ground vibration, specifically the velocity of motion of the ground particles as they are excited by the blast wave energy.</td>
</tr>
<tr>
<td>REF</td>
<td>Review of environmental factors</td>
</tr>
<tr>
<td>Roads and Maritime</td>
<td>NSW Roads and Maritime</td>
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</table>
1. Introduction

1.1 Blasting locations

Blasting for the Proposal may be required where retaining walls are located in sections of cutting around Historic Hartley at the following locations:

- Retaining wall 1 - Next to the eastbound carriageway between chainage 25740 and 25850, with a maximum height of about 1.7 metres.
- Retaining wall 2 - Next to the eastbound carriageway between chainage 25917 and 25970, with a maximum height of about 3.6 metres.
- Retaining wall 3 - Next to the eastbound carriageway between chainage 26015 and 26105, with a maximum height of about 2.6 metres.
- Retaining wall 4 - A possible retaining wall about 4.1 metres high would be provided between chainages 26130 and 26220 next to the westbound carriageway.
- Retaining wall 5 - Next to the eastbound carriageway between chainage 26300 and 26500, with a maximum height of about 7.5 metres.

1.2 Receiver identification

Receivers identified as being potentially impacted by the proposal are shown in Figure 1 along with the proposed blasting locations. Receiver identification has been taken from the Noise and Vibration Technical Report, Appendix G, which is included in the REF for the proposal. The closest buildings and receivers are located between about 15 and 170 metres from the proposed blasting activity.

Blasting locations 1, 2 and 3

Blasting locations 3 and 4 are on the opposite side of the alignment from the closest receivers:

- Receiver R134 approximately 143 metres to the retaining wall
- Receiver R139 approximately 173 metres from the nearest point of the retaining wall.

Blasting location 4

The closest receivers are located on the southern side of the alignment and include historic buildings:

- Receiver R145 (Royal Hotel) – retaining wall is located 15 metres from the shed and 40 m from the actual building
- Receiver R143 (St John the Evangelist’s Anglican Church) – about 50 metres from the retaining wall.
- Blasting location 5
- The closest receiver is on the northern side of the alignment adjacent to Kelly Street.
- Receiver R149 (Roads and Maritime owned) – about 40 m from the nearest part of the retaining wall.
HARTLEY VALLEY SAFETY UPGRADE - Figure 1: Potential blasting locations

LEGEND
- The proposal
- Possible retaining wall
- Retaining wall
- Sensitive receiver
- Noise monitoring location

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DATA SOURCES

HARTLEY VALLEY SAFETY UPGRADE
2. Methodology

2.1 Blasting assessment

The blasting assessment is an addendum to the noise and vibration technical paper prepared for the Hartley Valley Safety Upgrade REF. The appropriate guidelines for the proposed construction activities including blasting are presented in the main noise and vibration report working paper however, the blasting criteria have been included here to provide a complete assessment of the proposed blasting locations.

The assessment of blasting impacts during the approval process uses the available project information and typical values for blast parameters taken from AS 2187.2 for the calculation of vibration and air blast overpressure. Based on these preliminary calculations a comparison can be made with the guideline values to determine the potential for impacts from blasting activities at a sensitive receiver. A more detailed analysis of impacts would be undertaken by the blasting contractor once the exact blasting parameters are known.

2.2 Blasting criteria

Impacts from blasting are assessed against separate criteria for both noise and vibration. Impacts transmitted through the atmosphere are termed ‘airborne’ and generally relate to noise more commonly known as ‘air blast’ or ‘overpressure’. Impacts transmitted through the ground, termed ‘ground borne’, relate to vibration. The relevant criteria for noise and vibration for the assessment of potential blasting impacts are taken from:

- **Australian Standard AS2187.2-2006 Explosives – Storage, Transport and Use**
- **ANZEC, 1990, Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration**
- **Roads and Maritime Specification R44, Annexure R44/A6**

Ground borne vibration and air blast overpressure have the potential to impact human amenity and/or buildings and infrastructure when in close proximity to blasting activities. The limits for overpressure and ground vibration from blasting in Australia are taken from the Australian and New Zealand Environment Council (ANZEC) guidelines, which are reflected in the Roads and Maritime R44 Specification. The criteria for Ground borne vibration and air blast overpressure at residential locations are:

- A maximum level for air blast of 115 dB(L), which may be exceeded on up to 5% of the total number of blasts over a 12 month period; however the level should not exceed 120 dB(L) at any time.
- A maximum level for ground vibration of 5 mm/s (PPV). This level may be exceeded up to 5% of the total number of blasts over any period of 12 months but should not exceed 10 mm/s at any time.
- The Roads and Maritime R44 Specification also identifies a maximum level for ground vibration of 2 mm/s (PPV) for a building or monument of historical significance.

These vibration limits have been summarised in **Table 2.1**, indicating the project specific values for human comfort and building damage criteria.

<table>
<thead>
<tr>
<th>Area</th>
<th>Vibration limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airblast overpressure</td>
<td>Not more than 115 dB (Lin) peak for 95% of blasts over 12 months Not to exceed 120 dB (Lin) peak for any blast.</td>
</tr>
<tr>
<td>Blast-induced ground-borne vibration</td>
<td>Must not exceed a peak particle velocity of 5 mm per second for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts; and Must not exceed a peak particle velocity of 10 mm per second for any blast.</td>
</tr>
<tr>
<td>Area</td>
<td>Vibration limit</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td>Must not exceed a peak particle velocity of 2 mm per second for buildings of historical significance.</td>
</tr>
</tbody>
</table>

Hours for blasting will be restricted to the following times for the proposal.

- 9:00 am to 5:00 pm, Mondays to Fridays, inclusive;
- At no time on Saturdays, Sundays or public holidays.
3. Potential impacts

The potential impacts of blasting activities have been considered for the nearest affected receiver locations for each of the retaining walls. An estimate of vibration and air blast levels has been made based on the distance from closest point of the retaining wall to a receiver location. These impacts are assessed individually using the guidance outlined in Section 2 of this report.

As discussed previously, blasting can result in both airborne and ground borne impacts on nearby receivers and can be characterised by the following physical effects.

- **Air-blast overpressure** – A pressure wave is generated by explosive movement of rock and gases at the triggering of a blast and is transmitted through the air. Low frequency pressure waves can rattle fixtures such as windows and cause damage to light structures where exceedances of the criteria are experienced.

- **Ground-borne vibration** – Generated at the moment of the blast and transmitted through the ground. The effects of vibration can be divided into three main categories:
  - Occupants or users of the building are disturbed or inconvenienced
  - The building contents may be affected
  - The integrity of the building or the structure itself may be prejudiced

In order to provide an indication of the risks associated with blasting, a generic assessment that considers the distance to a receiver and different charge sizes has been undertaken. Based on empirical formulae for the propagation of vibration and overpressure, minimum separation distances between the blast site and receivers may be determined.

It is important that the actual buffer distances associated with this project are identified and appropriate measures taken to limit overpressure and vibration to acceptable levels at critical locations. In addition, overly conservative estimates may increase the number of blasts required and can prolong the blast program. Blast charge and blast configurations must therefore be selected to ensure that objectives outlined above are not exceeded while maximising material removal at a site.

The estimated Maximum Instantaneous Charge (MIC) that should result in acceptable overpressure and vibration levels at increasing distances from a blast have been determined using formulae outlined in Australian Standard 2187.2- 2006, and are applicable to free-face blasting in ‘average field conditions’ which are:

Ground-borne vibration as PPV, mm/s:  
\[ V = 1140 \left( \frac{R}{Q^{1/3}} \right)^{-1.6} \]  

Overpressure in kilopascals:  
\[ P = K_a \left( \frac{R}{Q^{1/3}} \right)^{-1.45} \]

Where:

- \( R \) = distance between charge and point of measurement in metres
- \( Q \) = effective charge mass per delay or maximum instantaneous charge in kilograms
- \( K_a \) = site constant between 10 and 100 for confined blasts

3.1 Predicted air blast and vibration

For the proposed blasting locations at Historic Hartley, a maximum instantaneous charge of about 1 to 2 kilograms has been assumed for the initial prediction of impacts. The nominated charges can vary significantly depending on the requirements of intervening geological conditions for each site and therefore these values should be used as a guide only.
The predicted air blast and vibration levels from equations (1) and (2) have been provided for each of the identified receiver locations using the estimated MIC range.

### Table 3.1: Vibration versus maximum charge

<table>
<thead>
<tr>
<th>MIC</th>
<th>Limit PPV mm/s</th>
<th>R134</th>
<th>R139</th>
<th>R143</th>
<th>R145</th>
<th>R149</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.4</td>
<td>0.3</td>
<td>2.2</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.7</td>
<td>0.54</td>
<td>3.8</td>
<td>26</td>
<td>5.4</td>
</tr>
</tbody>
</table>

### Table 3.2: Overpressure versus maximum charge

<table>
<thead>
<tr>
<th>MIC</th>
<th>Limit air blast dB(Lin)</th>
<th>R134</th>
<th>R139</th>
<th>R143</th>
<th>R145</th>
<th>R149</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.4</td>
<td>0.3</td>
<td>2.2</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.7</td>
<td>0.54</td>
<td>3.8</td>
<td>26</td>
<td>5.4</td>
</tr>
</tbody>
</table>

#### 3.2 Discussion of results

The closest structure is the heritage building shed at receiver R145 and the nearest residence is also at R145. The initial prediction of vibration and air blast over pressure indicate that blasting impacts at these nearest locations are likely to significantly exceed the proposal criteria with the estimated MIC values of 1 to 2 kg.

Based on the assumed blasting parameters, the guideline levels at 40 metres for the closest residence would be required an MIC of 0.3 kg. For the heritage shed at R145, an MIC as low as 0.1 kg would be necessary to meet the vibration criterion.

The site specific parameters for blasting are to be determined by the contractor after consideration of the specific site conditions and volumes to be removed. Test monitoring of blasting impacts in accordance with Roads and Maritime R44 Earthworks Specification, must be undertaken prior to commencement of a full blasting program.

The initial monitoring of blast tests will be carried out at a location furthest from the identified receivers in Figure 1 to minimise any impacts from overpressure and vibration. In the event that the measured air blast exceeds the specified limits during this monitoring, additional steps and precautions would be necessary at any subsequent blasting locations, to ensure that the identified criteria for the proposal are not exceeded.

The Vibration and Air Blast Management Plan prepared by the construction contractor will detail how construction vibration and air blast will be managed to ensure that the public, building structures and infrastructure are protected. If required, the Plan will be revised by the construction contractor to maintain vibration and air blast within the specified limits.

Further management measures for blasting are identified in Section 4 of this report.
4. Blasting management measures

Where the contractor is to undertake blasting as part of their construction program, the following blasting management measures would be required to minimise construction impacts at adjacent sensitive receivers:

- Site-specific noise and vibration predictions will be undertaken when the blast designs and geotechnical information are confirmed. Appropriate buffer zones will be identified to ensure that air blast overpressure is limited to acceptable levels (see Section 4.1).

- Blasting vibrations and air blast overpressure will be monitored throughout the project.

- Surveys will be undertaken of all critical properties, before and after blasting activities, to ensure that no damage is occurring to structures located on the property.

- Timing of scheduled blasts with the standard working hours would be considered to ensure minimum impacts on nearby residents.

- Consultation with residents will be considered with regard to the timing of blasting activities.

- A complaints resolution procedure will be implemented so that complaints are thoroughly investigated and blasting activities ceased or modified where appropriate.

4.1 Site specific testing

Site specific testing is necessary to capture the blasting conditions for each new location. To minimise any risk of exceedances of the blasting limits, the Contractor would need to develop a site relationship between peak particle velocity, distance and MIC.

For the first blast, monitors should be set up at about five points at varying distances away from the blasting site. The Maximum Instantaneous Charge for the first test blast should be calculated by halving the estimated maximum charge identified for each location. Half the MIC can be calculated using the following formula.

\[
MIC = 0.5 \times \left( \frac{D}{PPV^{0.625}} \right)^2
\]

Where:

- MIC = Maximum Instantaneous Charge in kilograms
- D = Distance in metres from charge to the point of potential damage
- PPV = limiting peak particle velocity of 2mm/s for buildings of historical significance.

A log-log (base 10) graph of measured peak particle velocity (vertical axis) versus Scaled Distance (horizontal axis) can be plotted for each site where:

\[
Scaled\ distance = \frac{D}{\sqrt{MIC}}
\]

The mean regression line obtained by the least squares method can be developed from the data obtained during the testing phase.

For subsequent blasts, the MIC and other aspects of blast design may be adjusted provided that further ground vibration monitoring and testing is undertaken to ensure that peak particle velocity limits are not exceeded at sensitive receiver locations.