Noise Guidelines – Construction and Maintenance Works

2007
Technical Guidelines: Noise Guidelines – Construction and Maintenance Works

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Text by:
David Pullen, Dipal Sorathia, Paul O’Connell and Evan Styles

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Cover: Clockwise from top left: Rail works undertaken during night time on the Middleborough Road Alliance Project, Girders being placed on one of the bridges on Pakenham Bypass Project, Excavation works on Middleborough Road Alliance Project (Source: VicRoads)
CONTENTS

1. INTRODUCTION 2
2. REGULATORY FRAMEWORK 3
3. NOISE MANAGEMENT FLOW CHART 5
4. NOISE MANAGEMENT OPTIONS 6
5. GUIDANCE ON WORK TIMES AND NOISE MONITORING 7
   5.1 Introduction 7
   5.2 Work Times and Noise Levels 7
      5.2.1 Maintenance Works 7
      5.2.2 Construction Works 7
   5.3 Noise Monitoring Guidance 7
6. ENGAGING KEY STAKEHOLDERS/COMMUNITY 9
   6.1 Community Engagement 9
   6.2 Stakeholder Plan 9
7. REFERENCES 10
8. APPENDIX A – WORKING EXAMPLES 11
   CONSTRUCTION PROJECT 11
   MAINTENANCE PROJECT 12
9. APPENDIX B – TYPICAL NOISE LEVELS 13

GLOSSARY OF TERMS AND ACRONYMS USED IN THIS DOCUMENT

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>EMP</td>
<td>Environmental Management Plan: A plan prepared by VicRoads, prior to the commencement of works, for specific works or areas of environmental and/or cultural heritage significance.</td>
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<tr>
<td>CEMP</td>
<td>Contractor’s Environmental Management Plan</td>
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<tr>
<td>EPA</td>
<td>Environment Protection Authority</td>
</tr>
<tr>
<td>PEPS</td>
<td>Project Environment Protection Strategy: A risk based environmental strategy prepared by VicRoads in consultation with stakeholders during pre-construction, containing a description of the project, the local environment, environmental commitments, action plans and responsibilities.</td>
</tr>
<tr>
<td>SEPP</td>
<td>State Environment Protection Policy</td>
</tr>
<tr>
<td>dB</td>
<td>The measure of sound pressure level (Decibel)</td>
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<tr>
<td>dB(A)</td>
<td>(A) Denotes that the sound pressure level has been “A” weighted so that the scale approximates the response of the human ear. The ear is less sensitive to high and low frequency sounds than it is to sounds in the midrange. Most community noise is measured in “A” weighted decibels.</td>
</tr>
</tbody>
</table>

‘Road works’, ‘Road construction and maintenance works’ and in general ‘works’ These terms refers to all road related construction and maintenance works (e.g. pavement, bridge, noise walls and other road infrastructure).
1. INTRODUCTION

Noise emission from construction and maintenance activities is a sensitive issue to those affected and there are a large number of construction and maintenance projects that are ongoing within the road network throughout Victoria. VicRoads is committed to managing noise from road works and has subsequently developed these Guidelines to provide practical guidance to staff in managing and controlling noise from road construction and maintenance works.

There have been a number of projects where local residents have reported construction, demolition and/or maintenance noise nuisances to the Environment Protection Authority (EPA). In most cases these complaints were related to activities being undertaken outside of normal working hours predominantly because of the need to:

- maintain full traffic capacity on the network during peak demand periods; and/or
- compress the works in a very short period of time and working at night to reduce the overall disruption to the community.

Noise from road works can be harder to manage than from other industries. Personnel managing this issue will likely encounter:

- multiple and varying noise sources;
- difficulties in enclosing noise sources;
- transient (short term & changing) work practices and/or work locations i.e. due to the elongated nature of most road work sites, the work area moves - particularly for periodic maintenance works; and
- stakeholders aggrieved by disturbances.

Purpose/Overview

The main objectives of these guidelines are to assist those involved in construction projects and maintenance activities in understanding:

- the relevant legislation and suggested working hours applicable to these activities;
- the key steps involved in noise management;
- approaches to community engagement; and
- ways to clearly identify and effectively minimise construction noise impacts related to their work.

These guidelines will also be of interest to key stakeholders, community groups and contractors in assisting their understanding of the VicRoads approach to the effective management of noise from road works.

VicRoads engages with a wide range of government agencies and authorities, community groups, businesses and industry on environmental issues. These include the agencies that VicRoads is required to obtain permits and approvals from for certain aspects of works. VicRoads is fully committed to working with key stakeholders in order to deliver the most effective environmental outcomes for the Victorian community.
Legislation for the control of construction and demolition noise is generally the responsibility of State Government and Local Council. In Victoria the EPA and Local Councils are the responsible authorities and should be contacted during the planning stage of a project to obtain the appropriate information about the requirements for construction noise control relevant to the particular project or area (Australian Standard 2436, 1981).

The Environment Protection Act 1970

The Environment Protection Act 1970 (EP Act) provides a legislative framework for the protection of the environment in Victoria. The EP Act stipulates that the EPA is responsible for and to co-ordinate all activities relating to the prevention or control of pollution and noise emissions (volume, intensity and quality). Whilst the State Environment Protection Policy (Control of noise from Commerce, Industry and Trade) exempts construction and demolition noise from its requirements, the EPA may determine that the level of nuisance caused by noise from construction/demolition or maintenance activities are inappropriate and use Sections 13 and 31A to abate the noise from the works. The EPA usually achieves this through the issue of pollution abatement notices and minor works pollution abatement notices. This would normally only happen after the EPA has discussed the issue with VicRoads and/or the Contractor.

Fundamental to the EPA undertaking action to control construction noise, is the unreasonableness of the noise. Noise could be considered unreasonable if it is not consistent with the EPA Environmental Guidelines for Major Construction Sites, Publication 480.

Indicators of unreasonable noise include:

- is very loud compared to the background noise level;
- has a significant impulsive or tonal component;
- occurs during the evening, night-time or early morning period;
- occurs on weekends; or
- all practicable noise abatement has not been undertaken during necessary out-of-hours work.

The Health Act 1958

The Health Act also addresses noise and its impacts on the community. The Health Act applies to “any noise” “which is, or is liable to be, dangerous to health or offensive.” Where, “offensive” means noxious, annoying or injurious to personal comfort.

Noise concerns can be reported to a Council. If Council finds that the noise is a nuisance, then according to the Health Act, the Council must act to reduce the annoyance of the noise. Council can issue a notice to abate the noise. If remedial action to reduce the noise is not undertaken, then fines can be issued or Court actions initiated.

In determining whether a state, condition or activity is a nuisance which is, or is liable to be, dangerous to health or offensive -

a) regard must not be had to the number of persons affected or that may be affected by the state, condition or activity; and
b) regard may be had to the degree of offensiveness of the state, condition or activity.

S.42 of the Health Act prescribes that it is an offence to cause a nuisance; or knowingly allow or suffer a nuisance to exist on or emanate from any land owned or occupied by or in the charge of that person. The penalty is 100 units (As of October 2007, 1 penalty unit = $110.12).

If noise emanating from a project is in accordance with the EPA Guidelines, then action from a Council is less likely.

Not only will the level of noise be assessed, the time of occurrence of the noise will be taken into consideration. Council will most likely consider the noise against the requirements of the EPA’s Guidelines.

EPA Publications / Guidelines

The Environmental Guidelines for Major Construction Sites, Publication 480 and EPA Noise Control Guidelines, TG302/92, have been developed to give some guidance to controlling certain noisy activities including construction and maintenance activities.

Fundamentally these documents direct a Project/Contractor to use best practice equipment and techniques for the work being undertaken, and manage noise impacts by prescribing acceptable working hours.

Suggested measures include:

- Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site.
- Enclose noisy equipment.
- Provide noise attenuation screens, where appropriate.
• All mechanical plant must be silenced by best practical means using current technology.
• Where possible, no truck associated with the work should be left standing with its engine operating in a street adjacent to a residential area.
• Site buildings, access roads and plant should be positioned such that the minimum disturbance occurs to the locality.

There are occasions where it is necessary to work beyond the hours recommended in EPA Guidelines. Exceptions can be made in cases where an activity that has commenced cannot be stopped, such as a concrete pour, and deliveries may need to be made outside normal working hours to avoid a major traffic hazard.

**Australian Standard 2436 – 1981**

The Australian Standard 2436 – 1981 ‘Guide to Noise Control on Construction, Maintenance and Demolition Sites’ provides guidance on noise control generated from construction, maintenance and demolition works and provides guidance in investigation, identification and measurement of noise sources and provides measures to control noise. This standard provides a base framework on methods of sound measurement, project supervision and control of noise.

The relative effectiveness of various forms of noise control for point sources is shown in the table below.

<table>
<thead>
<tr>
<th><strong>CONTROL BY</strong></th>
<th><strong>NOISE REDUCTION dB(A)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>approximately 6 for each doubling of distance</td>
</tr>
<tr>
<td>Screening</td>
<td>maximum 15, normally 7 to 10</td>
</tr>
<tr>
<td>Enclosure</td>
<td>maximum 50, normally 15 to 30</td>
</tr>
<tr>
<td>Silencing</td>
<td>maximum 20, normally 5 to 10</td>
</tr>
<tr>
<td>Substitution by alternative method</td>
<td>maximum 60, normally 15 to 25</td>
</tr>
</tbody>
</table>

(Australian Standard, 1981)

**Occupational Health and Safety (Noise) Regulations 2004**

Occupational Health and Safety (noise) Regulations 2004 address issues related to exposure of employees to noise in the workplace, severity of hearing loss resulting from excessive exposure to noise, and measures of noise control. This regulation also provides requirements for designers, manufactures and suppliers of plant to limit noise emissions from plant and to indicate the sound power level on the plant.
3. **Noise Management Flow Chart**

VicRoads has developed a flow chart that clearly demonstrates tasks required to be completed by VicRoads staff in order to effectively manage noise related to road construction and maintenance works. The flow chart is predominantly focused on construction works; however, elements from the flow chart and noise management options may be of use during maintenance works. The flow chart also shows where further investigation or engagement with the Contractor or key stakeholders is required.

**PLANNING / PRE-CONSTRUCTION**

1. **Complete Environmental Investigations Screening Checklist**
2. **Project Assessment**
   - Avoid working out of hours where possible.
   - Assess likely impacts of works on sensitive receptors.
   - Determine need for future noise monitoring.
3. **Develop Stakeholder Plan**
4. **Stakeholder & Community Engagement**
5. **Developing Project Environmental Protection Statement (PEPS)**
   - Project specific noise requirements
   - Identify key Contract and EMP requirements
   - Works requirements to minimise impacts
6. **Develop Contract**
   - Include project specific requirements

**CONSTRUCTION / MAINTENANCE**

1. **Award of Contract**
2. **Review Contractor’s Environmental Management Plan (CEMP) & Works Plan**
   - Agreed CEMP actions
   - Noise surveillance, audit and incident reporting
   - Corrective and Preventive Action
3. **Make agreed CEMP available to Stakeholders & Community**
4. **Implementation and Auditing**

**STEP 1 Environmental Investigations Screening Checklist:**
Determine the level of noise assessment required for the project by completing the Environmental Investigations Screening Checklist in VicRoads Environmental Management Guidelines Appendix D.

**STEP 2 Project Assessment should include:**
- Justification for the following should be provided and documented for all works not to be carried out within normal working hours.
  - Why are works required outside normal working hours?
  - What are the triggers?
  - Who will be affected?
- Sensitive receptors will vary on different projects and include (but not limited to) local residents, schools, hospitals and local businesses.
- Noise monitoring will not be required on all projects and will depend on sensitive receptors, timing and nature of the works (guidance is provided in Section 5.3 – Noise Monitoring Guidance).

**STEP 3 Stakeholder Plan should identify:**
- Key stakeholders: local residents, local businesses, community groups, Council, EPA and police.
- Engagement methods to be used (guidance provided in Section 6 – Engaging Key Stakeholders/Community).

**STEP 4 PEPS should identify:**
- All noise issues that could be significant to the project.
- Potential impacts on the local communities and stakeholders and ways of minimising or eliminating these impacts (from stakeholder plan).
- Issues that need to be specifically addressed in the contract specification, to ensure the Contractor manages identified risks.
- Processes for further investigating issues and improving mitigation measures during construction (audit, surveillance and incident reporting).
- The scope and frequency of noise monitoring if required.

**STEP 5 Contract documents should address following issues:**
- Details of statutory requirements relevant to the control of noise from works (e.g. permits from Council, EPA notices).
- The need for the contractor to use the best practicable means to minimise noise.
- Include relevant noise limits and noise monitoring methods to be used.

**STEP 6 Review CEMP and Works Plan:**
Review CEMP ensure the contractor has addressed all project specific noise issues identified in the contract.

**STEP 7 Stakeholder & Community Engagement:**
- Demonstrate to local community and stakeholders that key issues identified through the PEPS process are now addressed in CEMP.
- Residents likely to be affected by the works should be notified of the works program and when noise nuisance is likely to occur.
- Establish a contact point for the community i.e. Community Liaison Officer (this could be either VicRoads or Contractor personnel).

**STEP 8 Implementation Monitoring & Auditing:**
- Undertake works in accordance with agreed CEMP.
- Noise monitoring by a VicRoads pre-qualified consultant may assist in the resolution of complaints by identifying problem noise sources.
- Respond to complaints in a timely manner. Provide complainant with information on planned actions and progress towards the resolution of concerns promptly.
4. Noise Management Options

The selection of these options will vary from project to project, depending on complexity and site specific requirements.

**SOURCE CONTROL**

[Sources: All equipment and plant generating noise e.g. trucks, dozers, excavators, pile drivers, rollers, etc.]

**Time Constraints**
- Limit work to daylight hours wherever possible.
- Introduce seasonal limitations (e.g. spring and summer are critical times in residential areas because windows are open at night).
- Avoid noisy works during sensitive time periods (e.g. school examination).
- Combine noisy operations to occur at the same time period at one location. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately.

**Equipments and Plant**
- Select low-noise emitting equipment and plant and establish strict noise emission limits for specific equipment.
- Make sure equipment and plant are fitted with appropriate mufflers (silencers) which meet the manufacturer’s specification and are adequately maintained.
- Design equipment and plant warm-up areas away from noise sensitive areas and reduce prolonged idling of equipment.
- Use rubber-tyred equipment rather than steel-tracked.
- Line haul trucks beds with rubber (4 to 5 inches thick) to reduce impact noise while loading trucks.
- Use equipment and plant fitted with manually adjusting back-up alarms (reversing beepers) or broadband reversing beepers.
- Use equipment and plant with necessary size and power and only have necessary equipment and plant on site.
- Use two-way radios to communicate on site.
- Avoid/minimise use of radio players or use at an acceptable volume.

**Site set-up and Construction methods**
- Re-route truck traffic (deliveries) away from residential areas. If not possible design site access in such a way that delivery trucks move through the site in a circular manner without the need to back-up.
- Use of quieter and less noise emitting methods e.g. bored piles rather than impact-driven piles when piling.
- Educate staff on noise issues in worksite induction training and emphasize on the need to make as little noise as possible.
- Traffic management planning should be undertaken prior to the commencement of works and should involve affected stakeholders.
- Temporary stockpiling areas may remove the need to haul material from the site outside of daylight hours.

**PATH CONTROL**

[Paths: Direct sound, reverberant field, groundborne vibration]

**Noise barriers**
- Consider installing temporary construction noise barriers (walls or curtains).
- Install any permanent noise attenuation that is part of the project as early as possible.

**Other measures**
- Locate equipment and plant behind existing site structures like embankments and storage sheds.
- Enclose (blanket) noisy equipment and plant with suitable material.
- Locate site access roads and noisy plant as far as possible from residential areas.
- Limit plant to necessary size and power as per the requirement of the works.
- For harder materials, blasting over short durations may generate less noise than longer periods of drilling or boring.

**RECEPTOR CONTROL**

[Receptors: All noise sensitive receivers]

- Community engagement, participation and a responsive complaint regime should be part of the noise management plan.
- Provide community with preferred contact routes to the project (e.g. 24 hour hotline).
- Appoint an expert communications officer to liaise with the community and other affected stakeholders.
- Continually update affected stakeholders on the progress and nature of the work.
- Consider temporary relocation of affected residents for the duration of specific noisy activities.
- In extreme cases consider offsite attenuation measures such as upgrading glazing or installing window shutters on affected rooms.

NOTE: The cost of implementing these noise management options is an important budgetary consideration during the planning process.
5. GUIDANCE ON WORK TIMES AND NOISE MONITORING

5.1 Introduction

Permissible noise levels, hours of operation and other regulatory requirements should always be checked with the EPA and the Local Council, during the planning stages of the project and well before the commencement of works.

On occasions where works cannot be carried out during normal hours, it is important to provide the EPA, Local Council and affected communities with:

- justification for the out of hours work;
- a schedule of proposed activities;
- ongoing engagement through the construction process;
- proposed noise mitigation and management measures to ensure reasonable noise impact; and
- contact details of VicRoads and Contractor (e.g. contact details of Community Liaison Officer).

5.2 Work Times and Noise Levels

EPA Guidelines provide a schedule of suggested working hours and noise levels as follows.

5.2.1 Maintenance Works
7:00am to 6:00pm Monday to Saturday
9:00am to 6:00pm Sunday & Public Holidays

5.2.2 Construction Works
(a) Normal working hours
7:00am to 6:00pm Monday to Friday
7:00am to 1:00pm Saturdays

(b) Noise level at any residential premises not to exceed background noise by:
   (i) 10 dB(A) or more for up to 18 months after project commencement.
   (ii) 5 dB(A) or more after 18 months.
   during the hours of:
   6:00pm to 10:00pm Monday to Friday
   1:00pm to 10:00pm Saturdays
   7:00am to 10:00pm Sundays & Public Holidays

(c) Noise should not be above background levels inside any adjacent residence between:
   10:00pm to 7:00am Monday to Sunday

5.3 Noise Monitoring Guidance

Noise monitoring programmes for works will depend significantly on the nature of the works and the sensitivity of the land uses surrounding the intended works. Noise monitoring will not be required for all projects.

Expert advice should be sought when considering what noise monitoring should be undertaken at the planning stage of the project to ensure the monitoring will meet the intended purpose.

Noise monitoring should be done by a VicRoads pre-qualified consultant. A shell brief is included in the VicRoads Environmental Management Toolkit.

In designing a noise monitoring program consideration should be given but not limited to:

- when the monitoring will be undertaken;
- the duration of the monitoring program;
- the type of monitoring equipment required (e.g. hand held monitoring equipment or data loggers); and
- suggested monitoring locations (adjacent to sensitive land user)

There are two types of monitoring methods, background noise monitoring and point source monitoring.

A hand held noise monitoring device used for point source noise monitoring
(Source: EPA Victoria)
Undertaking background noise measurement will:
- provide a baseline condition prior to the start of construction;
- assist in noise attenuation design;
- allow comparison with the hours specified in Section 5.2; and
- provide an indication of the overall impact of the construction works.

Undertaking point source monitoring will:
- provide a means of evaluating / auditing individual noise sources (i.e. plant); and
- identify noise sources that may require additional control.

Point source monitoring is often done with a convenient hand held device (as shown above).

Noise monitoring results can be used to assist with communication with local community and stakeholders in demonstrating how the current noise levels from works compare with the pre-existing conditions.

However, it is important to note that noise nuisance is ultimately subjective and noise measurements alone won’t eradicate the requirement to take actions in resolving community complaints.

Changes to work practices and effective community engagement may often prove more beneficial than noise measurements, when resolving community concerns.
6. ENGAGING KEY STAKEHOLDERS/COMMUNITY

6.1 Community Engagement
A significant challenge for construction and maintenance projects in Victoria is management of noise from a project to avoid impacting on abutting communities, while supporting project milestones and ensuring environmental commitments are achieved.

The approach involves a willingness to use reasonable and feasible noise control methods to mitigate construction noise at the source and to involve the community throughout the project.

Establishing a good working relationship with key stakeholders and community groups is paramount when dealing with works that will affect local and nearby residents.

Local communities provide VicRoads with an additional means of monitoring the effectiveness of project noise management.

Where possible, a preferred contact point (e.g. 24 hour hotline) should be provided to the local community. Consider the use of expert communications officers where construction works have potential for significant impact.

Liaison committees with members of all parties that are involved in the project, or those who will be affected should be considered for projects that have longer durations and are of a complex nature.

Key stakeholders need to be effectively engaged during planning, pre-construction, construction and post construction activities.

6.2 Stakeholder Plan
On all projects we need to plan how we engage with stakeholders through all phases of the project (pre-construction, construction and post construction). A stakeholder plan can be a single page document or quite complex, depending on the project. A stakeholder plan is likely to include some or all of the key communications tools listed in this section. The stakeholder plan should clearly demonstrate how communications and engagement with stakeholders is expected to occur during the project.

The key objectives of the stakeholder plan are to:
• provide a basis for effective two-way communication between the community, stakeholders and VicRoads; and
• identify stakeholder and community issues that will need to be addressed to avoid disputes and project delays.

The plan should be modified during the project to incorporate any additional activities or events that were not anticipated during the planning stage or to improve current processes where necessary.

Key communications tools may include the following:
• **24 hour phone line** – It is important that the community can contact someone (e.g. Community Liaison Officer) while work is occurring and receive advice regarding problems that they may be experiencing.
• **Door knocking** – Where practicable residents living in medium to high risk disruption areas can be engaged and a working relationship established before, works commence and possible disruptions occur.
• **Information Bulletin** – Brochures distributed to local residents, businesses, schools and other stakeholders via a letterbox drop highlighting:
  o specific areas that are likely to be impacted;
  o particulars about the project; and
  o point of contact for information.
• **Website** – A project dedicated website can be established or link created on VicRoads website containing all relevant information, latest updates, contact numbers and email contacts. All printed materials should refer to the website.
• **Community Information Day / Room** – Provide the community with an informal environment to discuss issues of importance to them (e.g. a display at the site office, local community hall and local school notice boards) providing information about current activities on the project, contact details and milestones achieved.
• **Advertisements / Media Releases** – Newspaper advertisements, radio alerts or media releases can be used to make major announcements about the project (e.g. award of contract, start of works, incidents).
• **Site Visits** – Organise site visits for members of the community to observe the work first hand and to meet VicRoads and Contractor personnel working on site. This will help in strengthening the relationship with the community as it helps them appreciate and understand the project.
7. REFERENCES


CONSTRUCTION PROJECT

Project
The level crossing at Middleborough Road in Box Hill caused significant delays to motorists as they use to wait for trains, especially during peak periods. Traffic congestion was largely due to the high volume of trains and cars passing through the area daily. Funding was provided by the Victorian Government to allow the grade separation of the crossing and provide for a pedestrian underpass to improve safety as well as the flow of traffic in the area.

The key component of the project was lowering the Belgrave/Lilydale railway at Middleborough Road. Approximately 1km of track was removed to allow for the excavation works and the new railway line was lowered by up to 6m.

Disruption to the community and the train network strongly influenced the decision to work twenty four hours per day seven days a week for a shorter period, rather than normal working hours over a longer period (18 months of weekend shutdown).

Key Noise Issues
There were residential dwellings north and south of the railway line. Along the railway line dwellings were located within 10m of the construction site boundaries. Over 250 households were affected by construction noise during the night time period. Consequently noise monitoring before and during construction was carried out.

Stakeholder Engagement
Stakeholders engaged during the project included but were not limited to:
- local residents;
- local businesses;
- local school;
- road users and train commuters;
- EPA;
- Local Council;
- police; and
- community groups.

The school adjacent to the work area was less affected as the works were programmed to occur during the Christmas holiday period.

Management of Construction Noise Impacts
The project team prepared a Project Environment Protection Strategy (PEPS) and as a consequence contractual requirements had significant focus on preventing / minimising night time construction noise. Some of the key procedures to reduce noise and disruption to local residents were:

- All site vehicles working night shift were fitted with broadband reversing beepers where practicable.
- Scheduling of potentially noisier works during daylight hours, where possible.
- Modifying work procedures to remove unnecessary noise e.g. hardwiring temporary lighting instead of generators.
- Construction works progressively moved along the corridor in most areas in order to make sure works were not isolated to one location for long periods of time.
- Noise monitoring was undertaken by the project and EPA to identify problem noise sources.
- On-going checks of noise mitigation measures were conducted by the project and on occasions by EPA.
- Local residents relocated at night.

A Communications plan was developed and allowed the project team to:

- Provide the local community with timely and effective information to raise awareness of the project (both the long term benefits and the short term disruptions),
- Engage with local community members and stakeholders to understand their needs and expectations and to take these into account when formulating work plans,
- Provide the community with a 24/7 hotline that was available to raise their concerns and allow feedback.
MAINTENANCE PROJECT

Increasing use of the road network, results in increased maintenance requirements. To prevent disruption to traffic and the broader community, some of this work is done at night. When maintenance works occur at night there is likely to be an impact on those in close proximity to the works.

EPA provides guidance (Noise Control Guidelines TG 302/92) on its expectations of parties carrying out road repair and track maintenance. It is essential that those undertaking VicRoads maintenance works can demonstrate that they are meeting these minimum requirements and that best practice approaches are being adopted.

Failure to demonstrate best practice can lead to intervention and possible enforcement by the EPA.

The South Western Region was undertaking routine asphalt regulation and patching works on Princes Highway West in Geelong and had complaints from a local resident about noise during night works. The delivery manager decided that in this instance he would relocate a badly affected individual for two nights. This in conjunction with good communication and other techniques satisfied the individual affected and the EPA.

Careful planning, consideration of the elements, and implementation of the actions detailed in the Noise Management Flow Chart (Section 3) for future maintenance projects should reduce the level of interventions than that were encountered by the project.
### Typical Noise Levels of Construction Plant Items

(Australian Standard, 1981)

<table>
<thead>
<tr>
<th>PLANT</th>
<th>NOISE LEVEL dB(A)</th>
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<tbody>
<tr>
<td><strong>Compactor</strong></td>
<td>220 kW</td>
</tr>
<tr>
<td><strong>Compressor</strong></td>
<td>25 to 75 kW</td>
</tr>
<tr>
<td><strong>Crane</strong></td>
<td>100 kW</td>
</tr>
<tr>
<td><strong>Dump Truck</strong></td>
<td>10t (lorry mounted)</td>
</tr>
<tr>
<td><strong>Dumper</strong></td>
<td>20t</td>
</tr>
<tr>
<td><strong>Excavator</strong></td>
<td>50 to 75 kW</td>
</tr>
<tr>
<td><strong>Fork Lift Trucks</strong></td>
<td>1t</td>
</tr>
<tr>
<td><strong>Hammer Drill</strong></td>
<td>Hand held</td>
</tr>
<tr>
<td><strong>Loader</strong></td>
<td>100 to 200 kW (tracked)</td>
</tr>
<tr>
<td><strong>Piling</strong></td>
<td>100 to 200 kW (tracked)</td>
</tr>
<tr>
<td><strong>Rock Breaker</strong></td>
<td>2.5t to 5t drop hammer (precast/cased pile)</td>
</tr>
<tr>
<td><strong>Roller</strong></td>
<td>6t internal drop hammer (cased pile)</td>
</tr>
<tr>
<td><strong>Pump</strong></td>
<td>4 kW (diesel)</td>
</tr>
<tr>
<td><strong>Saw</strong></td>
<td>6 kW (petrol)</td>
</tr>
<tr>
<td><strong>Rock Breaker</strong></td>
<td>Pneumatic</td>
</tr>
<tr>
<td><strong>Roller</strong></td>
<td>Vibratory roller</td>
</tr>
<tr>
<td><strong>Saw</strong></td>
<td>Hydraulic</td>
</tr>
<tr>
<td><strong>Saw</strong></td>
<td>Double drum (6 kW)</td>
</tr>
<tr>
<td><strong>Saw</strong></td>
<td>Chain saw</td>
</tr>
<tr>
<td><strong>Saw</strong></td>
<td>Diamond saw (20 kW electric motor)</td>
</tr>
<tr>
<td><strong>Tractor</strong></td>
<td>30 to 50 kW</td>
</tr>
<tr>
<td><strong>Tractor</strong></td>
<td>200 to 300 kW</td>
</tr>
<tr>
<td><strong>Truck</strong></td>
<td>10t</td>
</tr>
<tr>
<td><strong>Truck</strong></td>
<td>20t</td>
</tr>
<tr>
<td><strong>Winch</strong></td>
<td>Pneumatic</td>
</tr>
<tr>
<td><strong>Winch</strong></td>
<td>Electric</td>
</tr>
</tbody>
</table>
Unweighted sound levels and typical noise sources (RTA NSW, 2001)

- **Threshold of pain**: 140 dB
- **Jet engine 25 m away**: 140 dB
- **Jet taking off (100 m away)**: 130 dB
- **Pop group**: 120 dB
- **Pneumatic drill, 7 m away**: 110 dB
- **Heavy truck, 7 m away**: 110 dB
- **Average street traffic at 40 km/h, 7 m away**: 100 dB
- **Business office**: 90 dB
- **Living room**: 80 dB
- **Library**: 70 dB
- **Bedroom**: 60 dB
- **Quiet**: 50 dB
- **Noisy**: 40 dB
- **Moderate**: 30 dB
- **Very noisy**: 20 dB
- **Almost silent**: 0 dB

Sound pressure $10^{-4}$ N/m$^2$ dB