

Road traffic noise management in Queensland through the Element Leadership Process

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ABSTRACT

This paper summarises the contents of the controlled document Element Management Plan. Part 1 (*Elem Mngr 2008*) dealing with Process Description and defines the formal processes for planning investments within a forward program of works for the Road System Manager: Element No 9. Road Traffic Noise Management for the Queensland State Controlled Road Network. The key outcome of this process is to manage road traffic noise to support more liveable communities and minimise negative impacts on the amenity of areas and peoples' quality of life within the road corridor. In general the Element Leader manages the element inventory and condition data base, defines and steers the collection of quality assured data necessary to define element investment needs across the state network and is regularly required to review the medium and long term performance vision for the 'Element'. Traffic noise modelling is essential for the process and requires a number of input parameters for example, Annual Average Daily Traffic (AADT), % commercial vehicles, distances to and elevation of receptors. A more complete description of essential input parameters is given in a Regional Road Traffic Noise Management Strategy (RRTNMS) (*Metro RRTNMS*). Essential physical and acoustical attributes of noise barrier structures required to be inspected and an auditing protocol are given in this Part 1 of the Element Management Plan (EMP). Results of inspections will be entered into a Noise Barrier Database and intervention levels for noise barrier maintenance will also be described.

INTRODUCTION

Element Management Plan. Part 1 is a controlled document that describes the formal processes for planning investments within a forward program of works for the Road System Manager Element No 9: Road Traffic Noise Management for the Queensland State Controlled Network.

A RSM Element is an activity or work item related to the road system that requires resources and/or funding to ensure an appropriate level of service. The 'Elements' were identified during early pilot development work from more than 200 road corridor demands and issues. Each element warrants a state-wide approach to managing its impact on future road system performance and network operation outcomes. There are currently 31 maintenance, preservation and operation elements that ensure the stewardship of the existing network and 10 enhancement elements that improve the extent, capacity or functionality of the road system.

The General Manager (State Wide Planning) and General Manager (Corridor Management and Operations) are the customers for the RSM Elements. They have been delegated accountability for ongoing management of elements on behalf of the Deputy Director-General.

Element Leaders are technical experts chosen for their skills and experience in a given element.

The role of the Element Leader includes:

- Preparing and maintaining the two part Element Management Plans for GM(SWP) and GM(CM&O)
- Collaborating with element stakeholders, including regional and district element managers, Major Projects and RoadTek through Element Reference Groups and other means to ensure that plans reflect and influence element levels of service, current

costs and constraints, understanding of local issues and priorities, and innovative operational practices

- Determination of 20 year, network-wide 'vision' targets for the element aligned with the relevant road system performance outcomes defined by the GM(SWP) and GM(CM&O), and expressed in terms of the element performance measures
- Determination of 5 year performance targets for the element that are aligned with the road system performance milestones
- Driving continual improvement of technical standards relevant to each element and monitor compliance
- Leading and promoting innovation through collaboration, benchmarking, research and development

OBJECTIVES

The objectives of element management are to ensure that:

- Network investment requirements are identified against agreed performance targets and fit-for-purpose technical standards
- Investments are planned consistently across the state-wide road network hierarchy, in accordance with prioritised needs
- Department of Transport and Main Roads (DTMR) achieves best technical and delivery practice for each element through research, benchmarking, innovation, quality and efficiency
- DTMR achieves effective performance from each element through good governance

The key objective of the State-wide Element Plan (Road Traffic Noise Management) is to meet the strategic outcomes of the Roads Connecting Queenslanders (RCQ) strategy document and Main Roads Strategic Plan 2009-2014.

With relevance to road traffic noise management, these outcomes include:

- Environmental management to support environmental conservation through sensible development and use of roads and surrounding land. In terms of noise: trends in community sentiment, benefits from actions that Main Roads takes for noise attenuation measures (for example, noise barriers)
- Ecologically sustainable development to preserve the noise amenity now and for future generations
- Environmental impacts of road traffic noise to be mitigated through an ecologically responsible transport system and changing user behaviours
- Adoption of a road system management focus of building and managing roads within the wider land-use environment and community interest
- Improving level of environmental management of road corridors and stakeholder satisfaction with corridor land management
- Achieving 'Fair Access and Amenity to Support Liveable Communities' by requiring that community amenity should not be compromised by heavy vehicle movements
- Implementing the Road Traffic Noise Management: Code of Practice 2008 (*RTNM Code 2008*) to minimise negative impacts on the amenity of areas and peoples' quality of life

A comparison of typical noise emission levels from different types of transportation are illustrated in Figure 1.

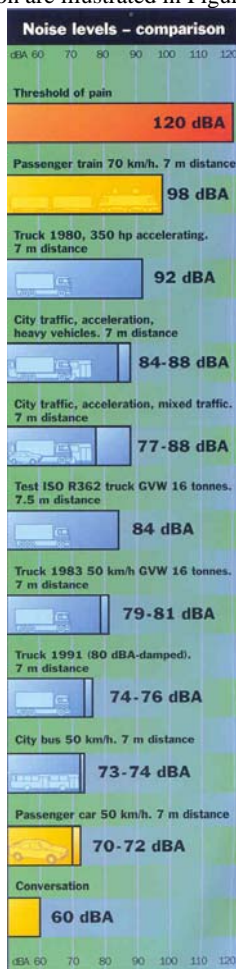


Figure 1. Typical transportation noise emission levels

Source: (Volvo 2000)

- Introduction of the necessary cost effective noise controls across all work activities

- Use of a whole-of-government approach to encourage major freight-generating developments and routes to be located away from residential areas.
- To work in partnership with local government, communities and industry groups to influence the location of residential and industrial developments, shopping centres and schools and take into account Integrated Regional Transport Plans and local government planning schemes
- To minimise noise, amenity and community impacts resulting from construction and maintenance activities on state-controlled roads
- To identify noise treatment (eg. noise barriers) that require remediation or maintenance
- To define a mechanism for categorising inspection of noise barrier condition
- To conduct regular audits of noise barriers to measure effectiveness, both acoustically and structurally and establish a mechanism for managing the outcome of these noise barrier inspections
- DTMR to increase the state-wide level of noise barrier maintenance on state-controlled roads and strive, subject to available funding, to invest in maintenance at the optimum time to maximise whole-of-life performance of the asset and minimise whole-of-life costs
- To define methods of data collection and storage and performance reporting requirements
- To define affordable performance targets for road traffic noise management in the long term (20 years) and for the interim milestone of five years and ten years forward from the base year 2006
- To define the process for planning and funding the five year rolling program of road traffic noise management investments with breakdown into road sets and Regions/district geographical jurisdictions
- To develop a mechanism for ranking priorities in terms of noise treatment for sensitive land use alongside state controlled roads

Integration or objective of the process is to integrate road traffic noise management assets within Region/district asset management systems. This stage of the process will require:

- Definition/quantification of RTNM assets
- Gap analysis of existing asset management systems to determine re. RTNM assets
- Establishment of asset condition assessment criteria for auditing
- Registration and integration of RTNM assets within Region/district asset management systems; and
- Development of RTNM asset training programmes

RTNM ASSET INVENTORY AND AUDIT

The actual extent and condition of the asset inventory and auditing process per Region/district follows the following process:

- Development of asset assessment and intervention levels to determine deficiencies and works prioritisation
- Consultation with Local Governments and community groups to identify asset deficiencies and opportunities for works
- Development of works implementation plans
- The overall processes for the development of the five year rolling noise treatment remediation program includes:

- Identifying residential areas adjacent to state controlled roads where noise levels exceed 68 dB(A) determined as $L_{A10,18h}$
- Developing a mechanism for ranking priorities in terms of noise treatment for residential areas alongside state controlled roads where the above noise criterion is exceeded
- Management and collection of data on noise barriers including condition and inventory

Requirements for Regions/district level program development and delivery will require performance reporting of noise treatment data in:

- Road Traffic Noise Remediation Element Management Reports
- Annual Reports; and
- District Performance Reports

Actual outcomes will then be reviewed through Performance Reports against planned performance.

THE PROCESS SCOPE

The scope of the Element Management Plan is as follows:

- Identifying residential areas adjacent to state controlled roads where noise levels exceed 68 dB(A) determined as $L_{A10,18h}$
- Identifying other sensitive land use areas (schools, medical facilities, open recreational spaces etc) adjacent to state controlled roads where noise levels exceed the appropriate noise criteria as specified in the Road Traffic Noise Management: Code of Practice 2008
- Encouraging implementation of Region/district road traffic noise management strategies as required by the Road Traffic Noise Management: Code of Practice 2008
- Refining RTNM procedures and specifications and developing software packages for these tasks
- Developing a data storage bank for Region/districts information acquired via RTNM staff and consultants (where considered appropriate)
- Developing prioritisation ranking index for establishing priority noise treatment
- Identifying noise barriers that exceed intervention thresholds
- Estimates of cost of noise barrier construction and other noise remediation measures

Various types of noise barrier construction are shown in Figures 2, 3, 4 and 5.



Figure 2. Vegetated Barriers
Source: (Hong Kong EPA 2003)



Figure 3. Absorptive Barrier
Source: (Hong Kong EPA 2003)



Figure 4. Embankment and Freeway
Source: (Hong Kong EPA 2003)



Figure 5. Embankment and Timber Fences
Source: (Hong Kong EPA 2003)

- Development of guidelines, training and reporting of deficiencies for routine maintenance activities associated with noise barriers
- Supporting Regions/districts in data collection (survey/inspection/audit) of noise barrier condition

Out of scope activities include:

- Non-state controlled roads
- Identification of residential locations not exceeding 68 dB(A) $L_{A10,18h}$
- Non-traffic generated noise

- Areas where permitted access preclude the use of noise barriers or mounds
- Public consultation
- Areas where current Main Roads construction projects are underway or where funds have been committed in the Road Implementation Project (RIP) for construction projects. The noise level and noise control treatment in these areas is addressed on a project-by-project basis

PROCESS TIMING

The element planning business cycle and accountability for activities is fully described in Part 1 of the RMS Element Management Plan and includes development of software for traffic noise modelling, model validation in conjunction with sensitive land-use, consultation with Regions/districts to determine asset items/inventory descriptions, definitions, quantifications, registration and assessment criterion (including condition ratings, intervention levels and work prioritisation).

Also included are prioritised RTNM asset works relative to noise exposure for SWP 5 year milestone, implementation of training for Regions/districts staff in the management of RTNM assets, initial consultation with interested stakeholders (local government and community groups etc) to identify key sites and possible projects for upgrading or new works to improve aesthetic and environmental values of the road corridor and ongoing consultation and partnership agreements with stakeholders.

ASSUMPTIONS AND CONSTRAINTS

Assumptions

The development of the road traffic noise management program as described in the document may not be effectively delivered unless the following assumptions are realised.

- Adequate funding is available for the project to achieve the stated outcomes and sufficient trained resources are available to carry out inspections/audits of noise barriers
- Full support and commitment by Regional/District Directors to the project to ensure its successful implementation
- Support is available from Regions/district representatives and relevant officers to develop asset management registers and conduct inventories and audits for in-scope RTNM assets
- Support from Regions/district representatives and relevant officers to consult with stakeholders (local government and community groups) to identify prioritised works and develop cooperative alliances where opportunities exist
- Proactive attitude of stakeholders to engage in joint funded and managed remediation projects, particularly 'main street' and 'town entry' type projects
- The required data fields in supporting systems of ARMIS are populated correctly (for example, location of noise barriers)
- No major changes to the methodology of measurement of road traffic noise in appropriate Australian Standards or the Road Traffic Noise Management: Code of Practice 2008
- Availability of concrete and/or metal panels and/or a disproportionate increase in unit costs (\$/m²)

Costing Assumptions

- Areas where funds have been committed in the Road Implementation Project (RIP) for future construction projects are excluded
- Only areas with access control and treatable with noise barriers are considered. Road segments for which noise barriers are not a viable treatment option are sometimes suitable for resurfacing with low-noise pavement treatments
- All sections of road should undergo detailed noise assessments to determine accurately the future road traffic noise levels and the appropriate mitigation measures to achieve Main Roads' criterion which would allow a more realistic estimation of funding to be performed
- Costing to year 2011 was initially based on the supply and construction of coloured or patterned concrete noise barriers with a maximum height of 4m.

Constraints

- Convincing Regions/districts of value adding benefits of asset management of in-scope items and justification of cost involved in introducing new barrier type materials and securing committed, ongoing participation in SWP Process
- Limited Region/district personnel to conduct required additional activities
- Lack of adequate experience and extent of additional training required for RTNM asset management
- Reticence of stakeholders to commit to joint funded and managed remediation projects
- Difficulties in determining ongoing maintenance responsibilities

DEFINITIONS

AADT	Annual Average of the Daily Traffic volume
TARS	AADT for % heavy vehicles
$L_{A10,18h}$	See Glossary of Road Traffic Noise Management: Code of Practice 2008
AML	Assessed Maintenance Level based on the likelihood and consequence of noise barrier structural failure
Level 1 inspection	A preliminary inspection during which noise barriers are visually assessed, basic noise barrier structural parameters collected and then maintenance requirements categorised as "high", "medium" and "low".
Level 2 inspection	A detailed inspection of noise barriers categorised in a Level 1 inspection as 'likely' to require maintenance. The inspection procedure will follow the Main Roads "Noise Barrier Maintenance Strategy" where a AML is assigned to each noise barrier
Noise Barrier Remediation Plan	A plan developed for noise barriers categorised as AML 1 to 3 to manage the potential risk of failure until remediation is carried out.

Table 1. Definitions

DATA PROCESS DESCRIPTION

Traffic noise modelling will require a number of input parameters for example, AADT, % commercial vehicles and distances to and elevation of receptors. A more complete description of essential input parameters are given in Road Traffic Noise Management Strategies (RTNMS) for the Metropolitan (*Metro RTNMS 2008*) and South Coast Regions (*South RTNMS 2009*).

An example of typical road traffic noise contours adjacent to a state controlled road are presented in Figure 6.

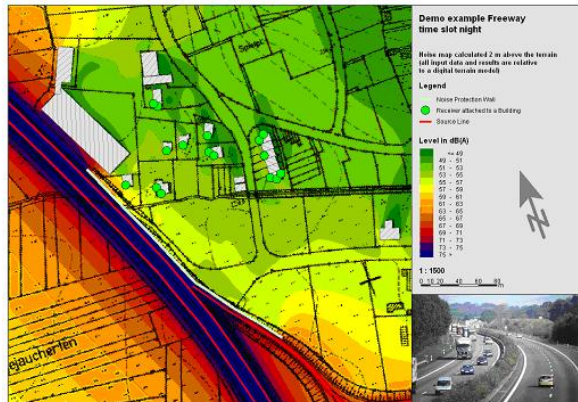


Figure 6. Road traffic noise contours adjacent to a state controlled road
 Source: (GIS Tools 2008)

Essential physical and acoustical attributes of noise barrier structures required to be inspected are given in two Appendices of the EM Plan while results of inspections will be entered into a Noise Barrier Database. Intervention levels for noise barrier maintenance are presented in the Noise Barrier Maintenance Strategy.

DATA USED

Network Asset Condition Data

The asset or activity data classes that are required for this element obtained every 2 to 5 years include traffic noise modelling, auditing of condition of noise barriers and Regional/town 'gateway' noise barrier remediation.

Other Corporate Data

- ARMIS AADT
- TARS
- Australian Bureau of Statistics State population demographics
- MapInfo via Road Information Systems

Responsibility for Data Collection

Collection of data for Network Asset Condition will be the responsibility of the Element Leader and the relevant Region/District representatives and appropriate officers that will be responsible for actual 'on-site' data collection, asset inventories and registration.

The success and scope of data collection will require full and ongoing commitment from relevant Regional/District Directors to support the project, including the probable need to provide training packages to educate district officers on RTNM asset management. The need to either assign dedicated RTNM asset managers, or to integrate RTNM assets within other road asset management systems will have to be determined by Directors in response to the level and scope of items present in each Regions/districts road corridor and level of staff training.

It is anticipated that the following Region/district personnel may be involved in data collection:

- Environmental Officers
- Asset Managers; and
- Maintenance Personnel

Where shortages of available and suitably trained/qualified DTMR staff to successfully collect data occur, external consultants performing on a full service contract for RTNM asset management may be required. RTNM staff will provide training to Region/district personnel and external consultants in data collection procedures.

Other sources of data not requiring intensive on-site survey may include:

- Consultation with Local Governments to yield data on RTNM assets situated in 'main street' and town entry/gateway environs
- Stakeholder and public complaints registers (either within DTMR or LG's) on RTNM assets to identify actual and perceived deficiencies; and
- Public consultation (surveys) to determine public attitudes to condition of current RTNM assets and preferred prioritisation of works. This process may be particularly valuable in the case of 'main street' and 'town entry' type works as a higher degree of community involvement should be engaged to ensure acceptance and ownership by the community.

Network Asset Condition Data Storage

The Element Leader and RTNM staff will provide guidance and training to Regions/districts. RTNM assets are to be registered and incorporated within existing asset management systems (including maintenance manuals). Existing asset management systems will first be required to undergo redevelopment as part of phases of the project for inclusion of identified in-scope RTNM items currently omitted.

Spatial data on the extent of DTMR noise barrier treatments may be stored in databases and MapInfo where required. Appropriate links to these databases are to be included in RTNM asset registers.

Regions/district officers will be responsible for the maintenance, operation and enhancement as required of the RTNM asset management system.

ARMIS will be updated to feature additional noise barrier information, land use categorisation and population density.

Other Input Data (not condition or network data)

The Element Leader and RTNM staff have commenced collecting historical data on noise barrier treatment types, barrier locations and unit costs to use in future cost predictions.

Historical data requirements to be collected/determined yearly for RTNM asset treatments include:

- Current standard industry costs per square meter rates (\$/m²) for RTNM standard works items (determined yearly for cost comparison)
- Estimation of cost loadings (%) experienced in Regions/districts against standard industry rates – including reasons for cost loading; and
- All costs to be labour and GST inclusive

The unit cost of noise barrier construction used in the determination of costings for 2006 was based on coloured and patterned concrete panels (\$350/m²). Departmental costs include planning, engineering, structural and geo-technical design and survey (approximately 25% of contractors' construction costs).

Data quality Management

- Traffic noise exposure forecasts will be updated across the State as improvements are made to RTNMS
- Studies when undertaken by acoustical consultants on behalf of Regions/districts will be reviewed by RTNM staff reporting to the EM to assess quality and accuracy
- Noise barriers will be audited in accordance with DTMR "Noise Barrier Maintenance Strategy" to confirm structural integrity, acoustical performance and level of maintenance required
- Noise barrier inventory data will be largely collected by field surveys

An example of a noise barrier system providing acceptable acoustical performance is presented in Figure 7.



Figure 7. Noise barrier system providing acceptable acoustical performance
Source: (Roberts 2003)

Data output

The format of the data used for Deficiency Analysis and Prioritisation will include: Location of road, location of barrier/s, AADT, % heavy vehicles, gradient of road (%), speed of traffic stream (km/h), distance & relative heights of sensitive noise receptors (m) wrt. road surface, predicted noise

level dB(A) and also include visual inspections and acoustical and structural tests.

DEFICIENCY ANALYSIS AND PRIORITISATION PROCESS DESCRIPTION

The aim of this section is to describe the process to analyse the data and develop a prioritised list of defects business rules, if appropriate which have a current condition worse than the Performance Vision and Performance milestone.

The following will be prioritised:

1. Road traffic noise exposure based on a methodology similar to:

- number of homes in the first and second rows adjacent to state-controlled roads exceeding 68 dB(A)
- degree of exceedance above noise criterion
- cost of noise treatment (single residence or cluster of residences)
- using a Prioritisation Index formula similar to CALTRANS (*FHWA 1995*) formula :

$PI = (AR \times (NL - 68) \times LU) / \text{Barrier cost } (\$1000)$ where:

PI = Priority Index

AR = Achievable Reduction (In order to be considered cost effective, the AR must equal or exceed 5 dB(A))

NL = Measured Noise Level, $LA_{10,18 \text{ hr}}$

LU = Number of Living Units

Example of a residential development having acceptable, façade sound insulation is presented in Figure 8.



Figure 8. Residential development having acceptable façade sound insulation

2. Noise barrier condition

- based on acoustic performance, structural integrity and assessed maintenance level
- using Level 1 or Level 2 categorisation (High, medium and low intervention levels)

The condition will also include the noise barrier location, potential remediation method/s and approximate cost.

SYSTEM OR TOOLS USED

SoundPlan software (incorporating *CoRTN 1998*) and other models permitting $L_{A10,18hr}$ estimations.

MapInfo and GIS databases to support noise modelling.

Laser finders and GPS units for noise barrier surveys.

The primary tool for analysing noise barrier condition along the road network and determining candidates for remediation will be the RTNM database. The source data is extracted from the database and then ranked i.t.o acoustic performance, structural integrity and maintenance level.

DEFICIENCY ANALYSIS AND PRIORITISATION OUTPUT

The output will be a spreadsheet listing all noise barriers requiring remediation under the following headings:

Region/district, Road, Chainage, Road Classification, Noise Barrier ID Number, AML, Possible Remediation Type, Estimate of Remediation Cost.

STATE-WIDE BUDGET ANALYSIS

- Region/district representatives with the assistance of RTNM staff will maintain maintenance activity lists and costings for noise barrier remediation and enter data into the 'Noise Barrier Database'
- Representatives will compile a 'job' in the Noise Barrier Database to rectify defects that impair the original functionality of the structure
- Budget requirements at the structure level or network level will be determined by summing the job estimates.

Breakdown levels for budget needs

The generic level costing of deficiencies will be based on the deficiencies highlighted in the 'Noise Barrier Database'. These deficiencies will show the non-conforming areas by road set and Region/district and will be scheduled into years based on the urgency, quantity of works required and budget allocation. The cost of remedial work will be calculated using the historic unit rates plus an indexed percentage increase for each year in accordance with historic coefficients.

Sensitivity analysis of budget needs

Accuracy of budget predictions will show gradual improvement as experience is gained with time. The initial budget estimates have not been based on factual data since the road traffic noise modelling will be undertaken and progressively improved over the next 5 years.

PROGRAM LEVEL BUDGET ANALYSIS OUTPUT

Element Investment Plan

The Element Investment Plan (EIP) presents the results of the state-wide budget needs analysis according to the defined breakdown levels and sensitivity requirements. A completed EIP Plan for this Element is provided in EMP Part 2 August 2008 and results reflected in RIP (09/10 – 13/14)..

State-wide moderation

When packaging and programming works, Regions/districts will need to consider seasonal issues for example, it will be preferable to carry out remediation work during the 'dry' season.

On a state-wide basis there may be some opportunities to bulk supply materials into single contracts.

The availability of specialist resources, both departmental and consultant, will need to be considered when programming project oriented work on noise barriers.

RoadTek may have an opportunity to become a special provider of inspection services of existing noise barrier remediation works to achieve consistency in this more specialised activity.

PACKAGING AND PROGRAMMING

The EMP Part 1 also documents opportunities for combining work within the same Element to achieve efficiencies in delivery, within a Region, district, group of districts or state-wide.

Once the moderated budgets have been finalised and the Element Leader revised performance predictions accordingly, PD&D will work with districts to develop a program of works.

The output of the Packaging and Programming phase across the network for the Element is a published RIP, undertaken by PD&D. The process details within the individual Element Management Plans are compiled and documented in the RIPA Guidelines. Element Leaders provide a support role to districts and PD&D to ensure that the maximum efficiency and effectiveness is achieved for the allocated funds.

Element and package value tracking

Tracking the planned and actual value of work packages and their component element value proportions (in RIPA) is an important process within the Program Management domain.

As part of the finalisation of the projects, the Regions/districts will be required to report costs to the Element Leader in a format defined by the Element Leader. A link will be required to advise the Element Leader at project completion so that a post construction Level 2 inspection can be carried out to check the success of the remedial works.

Commentary of Efficiency of Element Delivery

The above information will be used to comment on the efficiency of the delivery of the Element in Part 2 (Performance Report).

CONCLUSIONS

The RSM elements were identified by Department of Main Roads during early pilot development work from more than 200 road corridor demands and issues. Element No. 9 Road Traffic Noise Management was identified as warranting a state-wide approach to managing its impact on future road system performance and network operation outcomes.

Element Management Plan Part 1 documents the processes applied or supported by the Element Leader to fulfil the element management task, including performance and prioritisation parameters required for development of Part 2 Plan outputs, data and decision support systems, element deficiency analysis and State-wide budget analysis as agreed by GM(SWP) and GM(CM&O). The process has successfully resulted in a moderated element funding allocation for Element No.9 for five years to Regions and roadsets as agreed by GM(SWP) and GM(CM&O).

DISCLAIMER

- The material presented may be used as a source of information for Element No. 9 Road Traffic Noise Management alone
- The State of Queensland makes no statement, representations or warranties regarding the accuracy or

usefulness of the information for any other use whatsoever

- Any opinions expressed are solely those of the author

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