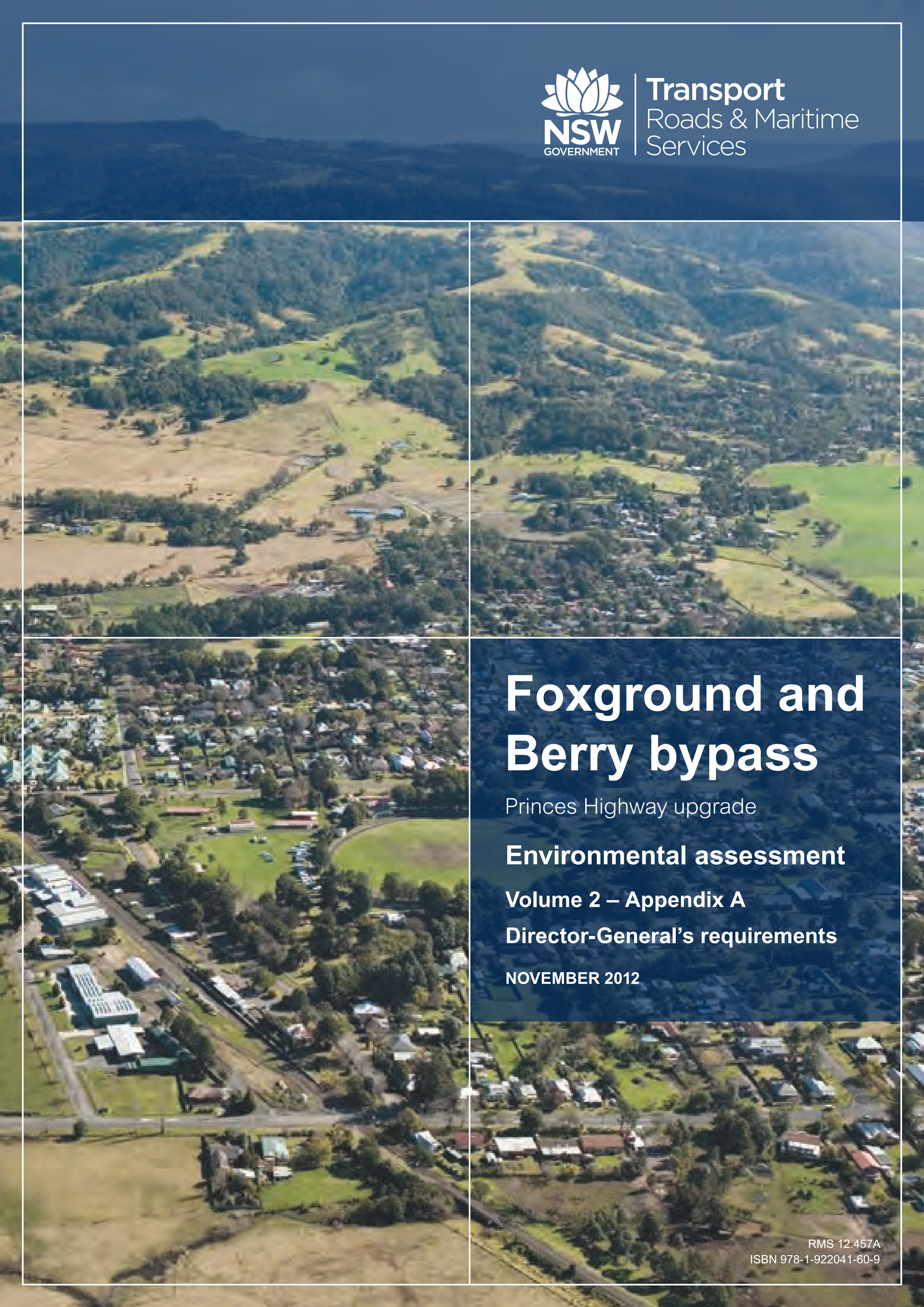

NSW GOVERNMENT
Transport
Roads & Maritime
Services

Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 2 – Appendix A

Director-General's requirements

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NSW GOVERNMENT | Planning

Mr Brad Turner
Regional Manager, Southern
NSW Roads and Traffic Authority
PO Box 477
WOLLONGONG NSW 2520

Our ref: MP 10_0240
File No: 10/17317-2

Dear Mr Turner,

Director-General's Requirements for a Project Application for the Princes Highway Upgrade – Foxground and Berry Bypass (MP 10_0240)

Thank you for your request for Director General's environmental assessment requirements (DGRs) for the above project.

I have attached a copy of the Director General's Requirements (DGRs) for the preparation of an Environmental Assessment for the project. These requirements have been prepared in consultation with relevant government authorities. I have also attached a copy of the government authorities' comments for your information. Please note that the NSW Office of Water have not provided their response. Once received, it will be forwarded to you separately.

The DGRs have been prepared based on the information you have provided to date. Please note that under section 75F(3) of the *Environmental Planning and Assessment Act 1979*, the Director General may alter these requirements at any time. If you do not submit an Environmental Assessment for the project within 2 years, the DGRs will expire.

Prior to exhibiting the Environmental Assessment that you submit for the project, the Department will review the document to determine if it adequately addresses the DGRs. The Department may consult with other relevant government authorities in making this decision. Please provide 3 hard copies and 3 electronic copies of the Environmental Assessment to assist this review.

If the Director General considers that the Environmental Assessment does not adequately address the DGRs, the Director General may require you to revise the Environmental Assessment. Once the Director General is satisfied that the DGRs have been adequately addressed, the Environmental Assessment will be made publicly available for at least 30 days.

If your project is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Department of Sustainability, Environment, Water, Population and Communities.

If you have any enquiries about these requirements, please contact Mr Andrew Beattie on 02 9228 6384 or via e-mail at andrew.beattie@planning.nsw.gov.au.

Yours sincerely

11/2/11

Daniel Keary
Director
Infrastructure Projects
As delegate for the Director General

NSW GOVERNMENT | Planning & Infrastructure

Contact: Andrew Beattie
Phone: (02) 9228 6384
Fax: (02) 9228 6355
Email: andrew.beattie@planning.nsw.gov.au

Our ref.: MP10_0240

Mr Brad Turner
Regional Manager, Southern
Roads and Traffic Authority
PO Box 477
WOLLONGONG NSW 2520

Dear Mr Turner,

Subject: Director-General's Requirements for the Princes Highway Upgrade - Foxground and Berry Bypass (MP10_0240)

I refer to your correspondence received via electronic mail on 16 May 2011 requesting an amendment to the Director General's Requirements (DGRs) for the above project which were issued on 11 February 2011.

The request relates to the "Noise and Vibration" section of the DGRs. In particular, replacing the outgoing *Environmental Criteria for Road Traffic Noise* (EPA 1999) document with the *Road Noise Policy* (DECCW 2011) document, which will become effective on 1 July 2011.

The Department has considered your request and has agreed to the amendment. I have attached a copy of the amended Director-General's Requirements (DGRs) for the preparation of an Environmental Assessment for the project (**Attachment 1**). These DGRs replace those issued on 11 February 2011.

The DGRs have been prepared based on the information you have provided to date. Please note that under section 75F(3) of the *Environmental Planning and Assessment Act 1979*, the Director-General may alter these requirements at any time. If you do not submit an Environmental Assessment for the project within 2 years, the DGRs will expire.

Prior to exhibiting the Environmental Assessment that you submit for the project, the Department will review the document to determine if it adequately addresses the DGRs. The Department may consult with other relevant government authorities in making this decision. Please provide 3 hard copies and 3 electronic copies [1] of the Environmental Assessment to assist this review.

If the Director-General considers that the Environmental Assessment does not adequately address the DGRs, the Director-General may require you to revise the Environmental Assessment. Once the Director-General is satisfied that the DGRs have been adequately addressed, the Environmental Assessment will be made publicly available for at least 30 days.

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[1] File parts must be no greater than 5Mb each. File parts should be logically named and divided.

Your contact officer for this proposal, Andrew Beattie, can be contacted on 9228 6384 or via email at andrew.beattie@planning.nsw.gov.au. Please mark all correspondence regarding the proposal to the attention of the contact officer.

Yours sincerely,

27/5/11

Daniel Keary
Director
Infrastructure Projects

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application number	MP10_0240
Project	Princes Highway Upgrade – Foxground to Berry Bypass
Location	Approximately 11.6 kilometre length of dual carriageway from the junction of Toolijooa Road and the Princes Highway to the junction of Schofields Lane and the Princes Highway, south of Berry in the Kiama and Shoalhaven local government areas.
Proponent	NSW Roads and Traffic Authority
Date issued	27 May 2011
Expiry date	27 May 2013
General requirements	The Environmental Assessment (EA) must include the following: 1. an **executive summary**. 2. a **detailed description** of the Project including: • route alignment and corridor width; • design elements (requirements for bridges, culverts, Level of Service, pedestrian and cyclists, rest areas and service centres, etc); • clear identification of and/or options for the proposed location of ancillary facilities (e.g. compound site, batching plants, etc); • resourcing (e.g. construction material needs, spoil disposal, natural resource consumption including water supply sources); and • potential staging. 3. an **assessment of the key issues**, including an assessment of the worst case and representative impact for each issue for all aspects of the project (including the proposed locations of and/or options for the ancillary facilities) with the following aspects addressed for each key issue (where relevant): • describe the existing environment; • assess the potential impacts of the proposal at both construction and operation stages, in accordance with relevant policies and guidelines. Both direct and indirect impacts must be considered including potential interactions with the existing Princes Highway (as relevant); • identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/ or in developing management/ mitigation measures; and • describe measures to be implemented to avoid, minimise, manage, mitigate, offset and/or monitor the impacts of the project and the residual impacts. 4. a **draft Statement of Commitments (SoC)**. The SoC must incorporate or otherwise capture all measures to avoid, minimise, manage, mitigate, offset and/or monitor impacts identified in the impact assessment sections of the EA and ensure that the wording of the SoC clearly articulates the desired environmental outcome of the commitment. The SoC must be achievable, measurable (with respect to compliance), and time specific, where relevant. 5. **certification** by the author of the Environment Assessment that the information contained in the Assessment is neither false nor misleading.
Key issues	▪ **Strategic Justification –** describe the strategic need, justification and objectives for the project taking into account the aims and objectives of relevant strategic planning and transport policies including the State Plan (2006), the Illawarra Regional Strategy and South Coast Regional Strategy.

- **Project Justification –** assess the alternatives considered (including an assessment of the environmental costs and benefits of the project relative to alternatives), and provide justification for the preferred project taking into consideration the objects of the *Environmental Planning and Assessment Act 1979* and the following:
    - the environmental, social and economic impacts of the project;
    - the suitability of the site; and
    - whether or not the project is in the public interest.

- **Traffic and Transport** - including but not limited to:
    - construction traffic impacts, including identification of construction routes and the nature of existing traffic on these routes, quantification of traffic volumes (including for spoil haulage), potential impacts to regional and local road network (including safety and level of service), and potential disruption to existing public transport services, access/ service lanes to local properties;
    - operational traffic and transport impacts to the local and regional road network, including:
        - changes to access arrangements/ service lanes to local properties;
        - changes to local road connectivity and access and impacts on local traffic arrangements and local road capacity/safety from traffic rerouting and modified access to the upgraded highway, including direct impacts from the replacement of the existing highway that currently passes through Berry. The assessment must take into account potential interactions with local traffic associated with the residential sub-division at Huntingdale Park, Berry (including future growth) and any severance impacts on local connectivity within Berry as a result of the proposed route. Consideration must be given to potential impacts of changed traffic arrangements on local and/or school bus services, access for emergency services and garbage trucks routes;
        - traffic capacity of the proposal and its ability to cater for predicted growth. Consideration should be given to what effect potential major land use changes in the locality may have on the traffic assessment outcomes; and
        - opportunity for the provision of cycle way connections along the highway and to adjoining communities.

- **Noise and Vibration -** including but not limited to:
    - a construction noise and vibration assessment including construction traffic noise, batch plants and blasting impacts. The EA must clearly identify nearest sensitive receptors and assess construction noise/ vibration generated by representative construction scenarios focussing on high noise generating works. Where work hours outside of standard construction hours are proposed, clear justification and detailed assessment of these work hours must be provided including alternatives considered and mitigation measures proposed. The assessment must further consider any cumulative impacts during construction, having regard to any other developments (both existing and approved) in the locality;
    - an operational road traffic noise assessment including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers;
    - the assessment(s) must take into account the following guidelines as relevant: *Interim Construction Noise Guideline* (DECC 2009), *Road Noise Policy (DECCW 2011)*, *Environmental Noise Management Manual* (RTA, 2001), *Assessing Vibration: A Technical Guideline* (DEC, 2006); and *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990).

- **Flora and Fauna -** including but not limited to:
    - an assessment of all project components on flora and fauna and their habitat (both terrestrial and aquatic, as relevant) consistent with the *Draft Guidelines for Threatened Species Assessment* (DEC, 2005). The EA must provide details of the survey methodology employed including survey effort and representativeness for species targeted;
    - specific consideration of impacts to threatened species, populations, ecological communities and/or critical habitat listed under both State and Commonwealth legislation that have been recorded on the site and surrounding land;
    - details on the existing site conditions (both terrestrial and aquatic) and quantity and likelihood of disturbance (including quantifying the worst case extent of impact on the basis of vegetation type and total native vegetation disturbed);
    - as relevant, consideration of weed infestation and edge effects; habitat fragmentation; impacts to wildlife and riparian corridors; impacts to groundwater-dependent communities, riparian and aquatic habitat (including impacts on SEPP 14 wetlands and fish passage);
    - provide details of how flora and fauna impacts would be managed during construction and operation for all project components, including adaptive management and maintenance protocols and monitoring programs; and
    - demonstrate actions to be undertaken to avoid, mitigate or offset impacts associated with the project (all components) consistent with the principles of "improve or maintain". Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project, where offset measures are proposed to address residual impacts.

- **Surface and Ground Water -** including but not limited to:
    - water quality taking into account impacts from both accidents and runoff and considering relevant environmental water quality criteria specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*. The assessment must describe measures to control erosion and sedimentation during construction activities and measures to capture and treat runoff from the site during the operational phase;
    - identify potential risks of the project on groundwater resources including: characterising existing local and regional hydrology; potential risks of drawdown; impacts to groundwater quality; discharge requirements; and implications for groundwater-dependent surface flows (including springs and drinking water catchments), groundwater-dependent ecological communities, and groundwater users;
    - identifying potential impacts of the project on existing flood regimes, consistent with the *Floodplain Development Manual* (Department of Natural Resources, 2005), including impacts to existing receivers and infrastructure and the future development potential of affected land, demonstrating consideration of the changes to rainfall frequency and/or intensity as a result of climate change on the project. The assessment shall demonstrate due consideration of flood risks in the project design; and;
    - waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better.

- **Landscape and Visual Amenity -** including but not limited to:
    - assessment of the visual significance of the area, including the escarpment and ridges and the township of Berry, and impact of the proposed alignment; and
    - design of the project (including noise barriers, retaining walls and

	landscaping) consistent with the existing (and desired) character of affected localities, including consideration of the *Noise Wall Design Guideline* (RTA, 2006). The assessment should also consider highway/street lighting and the potential lightspill impacts on nearby residents. ▪ **Aboriginal and Historic Heritage** – including but not limited to: • an assessment of the project on Aboriginal cultural heritage consistent with the draft *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, July 2005), specifically considering artefacts, potential archaeological deposits and landscape cultural values. The EA must demonstrate effective consultation with indigenous stakeholders during the assessment and in developing mitigation options (including the final recommended measures). The EA must describe the actions that will be taken to avoid, mitigate or offset impacts; and • an assessment of the impact of the project on historic heritage values, in particular impacts on the historic township of Berry. ▪ **Land Use/Property, Social/Economic -** including but not limited to: • directly-affected properties and land uses adjacent to the project, including: impacts to land use viability and future development potential; and property allotment, land sterilisation and severance impacts. • the agricultural sector taking into account the fragmentation and potential loss of agricultural and farm viability including internal and external farm access arrangements both during construction and operation of the project; • local community socio-economic impacts associated with access, land use, property and amenity related changes; • business impacts including the overall viability, profitability, productivity and sustainability of businesses in the township of Berry associated with the changes to route alignment in Berry; and • impacts on recreational fishing access and opportunities in Broughton Creek, Broughton Mill Creek and Bundewallah Creek. **Environmental Risk Analysis –** notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EA.
Consultation	You should undertake an appropriate and justified level of consultation with relevant parties during the preparation of the EA, including: • local, State or Commonwealth government authorities and service providers, including the NSW Office of Environment and Heritage; the NSW Office of Water; the Department of Trade and Investment, Regional Infrastructure and Services; Shoalhaven City Council; Shoalhaven Water and the Council of the Municipality of Kiama; • specialist interest groups including Local Aboriginal Councils; and • the public, including affected landowners. The EA must describe the consultation process, document all community consultation undertaken to date and identify the issues raised (including where these have been addressed in the EA).

NSW GOVERNMENT
Environment, Climate Change & Water

Your reference: DOC11/3638
Our reference: FIL11/518
Contact: Michael Heinze (02) 6229 7002

Attention: Mr Michael Young
Senior Planning Officer
Infrastructure Projects
Department of Planning
GPO Box 39
SYDNEY NSW 2001

PCU019107

31 January 2011

Dear Mr Young

RE: Princes Highway Upgrade - Foxground to Berry Bypass – Director-General's Environmental Assessment Requirements – Section 75F Environmental Planning and Assessment Act 1979

I refer to your letter dated 10 January 2011, requesting the Department of Environment, Climate Change and Water's (DECCW) requirements for the environmental assessment (EA) for the above proposal. DECCW understands that the project application for this proposal will be assessed by the Department of Planning (DoP) under Part 3A of the *Environmental Planning and Assessment Act 1979*.

If approved, the proposal would be a scheduled activity under the *Protection of the Environment Operations Act 1997* and would require an Environment Protection Licence under that Act. The proponent will need to make a separate application to DECCW to obtain this licence if planning consent is given.

DECCW has considered the details of the project and has identified the information it requires to assess the project (**Attachment 1**). The proponent should ensure that the EA is sufficiently comprehensive to enable DECCW to determine the extent of the impact(s) of the proposal. In summary these issues include:

- a clear description of the scope of the project;
- a description of the environmental impacts of the project: sufficient information must be provided to ensure the EA is sufficiently comprehensive to enable DECCW to determine the extent of the impacts of the proposal. In particular, the EA should address requirements of Section 45 of the *Protection of the Environment Operations Act 1997*;
- the impacts of the project on threatened species and their habitat (**Attachment 2**);
- the impacts on endangered ecological communities;
- the impacts of the project on Aboriginal Cultural Heritage values;
- the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts identified above; and
- other broad environment protection or conservation issues of concern in the proposed project.

Department of Planning
Received
3 FEB 2011
Scanning Room

PO Box 622, Queanbeyan NSW 2620
11 Farrer Place, Queanbeyan NSW
Tel: (02) 6229 7002 Fax: (02) 6229 7006
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www.environment.nsw.gov.au

In carrying out the assessment, the proponent should refer to the relevant guidelines as listed in **Attachment 3** and any relevant industry codes of practice and best practice management guidelines.

The proponent should be aware that any commitments made in the EA may be formalised as approval conditions. Consequently pollution control or conservation measures should not be proposed if they are impractical, unrealistic or beyond the financial viability of the development. It is important that all conclusions are supported by adequate data.

DECCW also requests that the applicant is provided with a full unaltered version of DECCW's environmental assessment requirements and guidelines as set out in **Attachments 1-3**.

DECCW requests that 2 hard copies and an electronic copy of the EA are provided for assessment. These documents should be lodged at DECCW's South East Regional Office, 11 Farrer Place, Queanbeyan, NSW 2620.

If you have any queries regarding this matter please contact Mr Michael Heinze on 02 6229 7002.

Yours sincerely

JULIAN THOMPSON
Unit Head – South East Region
<u>Environment Protection and Regulation Group</u>

Attachment 1 – Department of Environment, Climate Change and Water Environmental Assessment Requirements

The environmental assessment must provide sufficient information for DECCW to be able to fully assess the development in so far as the impacts relate to environmental legislation administered by DECCW. The environmental assessment must include a comprehensive description of the construction processes, all discharges and emissions to the environment, an assessment of likely environmental impacts and a comprehensive description of any proposed control measures.

The proposal is scheduled under the *Protection of the Environment Operations Act 1997* and will require the issue of an Environment Protection Licence under that Act. Therefore, the requirements of Section 45 of the *Protection of the Environment Operations Act 1997* must be addressed.

In accordance with the relevant guidelines listed in **Attachment 3**, DECCW requires the following issues to be assessed, quantified and reported on in detail:

- Air issues
- Noise and vibration issues
- Water quality
- Contaminated land
- Waste and chemicals
- Soil contamination
- Threatened species
- Aboriginal cultural heritage
- Cumulative impacts

Air Issues

Dust is the primary air quality concern. Potential emission sources include open exposed areas, drilling and blasting, material processing and handling, loading and un-loading, stockpiles and haulage activities. Details must be provided on proposed dust management strategies for all potential sources of dust.

The environmental assessment must be conducted in accordance with the DECCW publication *"Approved Methods for Modelling and Assessment of Pollutants in New South Wales"*. The environmental assessment must assess PM10 (24-hour and annual average), total suspended particulates and deposited dust impacts.

The environmental assessment must include a cumulative assessment that examines the impacts of the proposal combined with all existing and approved dust generating activities in the area.

Noise and vibration Issues

The environmental assessment should identify all potential noise sources and describe the extent to which noise emissions are likely to impact on any residential and/or other sensitive receivers in the vicinity of the site. The EPA publication *New South Wales Industrial Noise Policy* provides the methodology and assessment criteria applied by the EPA to assess the impacts and to determine project-specific noise planning levels. The environmental assessment should include a noise impact assessment in accordance with this Policy.

The noise impact assessment should take into account the construction phase of the development, clearly specify the proposed hours of operation, and take into account adverse weather conditions including temperature inversions. Sound power levels (measured or estimated) for all plant and equipment should be clearly stated and justified. There should be an assessment of cumulative noise impacts, having regard to any other developments existing and/or approved for the locality. Where adverse noise impacts are predicted, the impact assessment should provide details on proposed noise control measures.

Road transport to and from the premises has the potential to increase disturbance at residential properties along private or public haulage routes. To assess the extent of the impact, the noise impact assessment should identify the transport route(s) to be used, the hours of operation, anticipated traffic movements, and expected increase in noise levels. The publication *Environmental Criteria for Road Traffic Noise* (EPA, 1999) describes the methods generally applied by DECCW to determine noise planning levels for road traffic noise in locations of varying sensitivity.

The method, data and assumptions used to assess the impact of road haulage on residential properties must be fully documented and justified. Where disturbance due to road transport is likely to exceed the recommended criteria, the environmental assessment must describe the measures proposed to mitigate the impacts and the extent to which the measures are likely to be effective in achieving the relevant criteria.

Blast induced vibration effects from the project must also be considered and a thorough assessment must take into account the *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZECC 1990).

Water quality

The environmental outcomes for the project in relation to water should be:

- There is no pollution of waters (including surface and groundwater) during construction or occupation of the site by the final users;
- It is acceptable in terms of the achievement or protection of the River Flow Objectives and Water Quality Objectives.
- The EA should document the measures that will achieve the above outcomes.

The source of water for dust control is a major issue for this proposal. The proponent will need to clearly demonstrate where the water will be sourced from and quantities required for dust control and other activities.

Other water issues include erosion and sediment control during construction activities including pipelines, stormwater runoff control and chemical storage during operation.

If an off-site discharge is proposed for any or all wastewater streams, then the environmental assessment must address potential impacts and demonstrate that the discharges will not prejudice attainment of water quality objectives for the receiving water course. The NSW government has adopted Water Quality Objectives (WQO) for local waterways as part of the Drinking Water Catchments Regional Environment Plan (REP) No. 1 and its' supporting policies and guidelines, as a guide for the assessment of environmental impacts on aquatic ecosystems. These WQOs were developed from community consultation and the Healthy Rivers Commission (HRC) Inquiry into the Hawkesbury Nepean River System.

DECCW expects that this activity can be managed without discharging to waters and it is therefore unlikely that any discharge will be licensed.

The environmental assessment should describe measures for dealing with the following water pollution issues:

- Measures to control erosion and sedimentation during construction activities, Further guidance is available in the guideline *Managing Urban Stormwater - Soils and Construction"*, NSW Landcom, Fourth Edition, March 2004;
- Measures to capture and treat runoff from the site during the operational phase;
- Sealing areas of the site to prevent soil erosion;
- Spillage controls and bunding for materials used onsite.

Contaminated Land

Under the *Contaminated Land Management Act* 1997 there is a responsibility to notify the DECCW of sites that pose a significant risk of harm to human health or the environment.

The environmental assessment must document the management of any land contamination. This includes ensuring that land is not allowed to be put to a use that is inappropriate because of the presence of contamination, and incorporates mechanisms to ensure that:

- planning authorities consider contamination issues when they are making development decisions;
- local councils provide information about land contamination on planning certificates that they issue under section 149 of the *Environmental Planning & Assessment Act 1979*; and

- Land remediation is facilitated and controlled through State Environmental Planning Policy 55 – Remediation of Land (SEPP55).

The following documents should form the basis for the contaminated land assessment for the proposed development:

- Managing Land Contamination: Planning Guidelines - SEPP55 - Remediation of Land, Department of Urban Affairs and Planning and NSW EPA, 1998:
- Contaminated Sites – Guidelines for Consultants Reporting on Contaminated Sites (Environment Protection Authority (EPA) 1997);
- Contaminated Sites – Guidelines on Significant Risk of Harm and Duty to Report (EPA, 1999).

Waste Issues

The environmental assessment should describe all wastes that will be generated by the proposal including, for each of the main waste streams, the process from which it will be generated; its quantity and composition; its classification under the *Protection of the Environment Operations Act 1997*; and the proposed arrangements for dealing with the waste.

Guidance on waste classification and management issues can be obtained from the publication *Waste Classification Guidelines* (DECCW, 2010). The environmental assessment should clearly identify methods of reducing waste volumes and recycling and reusing wherever possible.

The avenues for disposal of industrial/hazardous waste are limited within New South Wales at present and the proponent should detail the likelihood of generation of these wastes and anticipated storage/disposal methods.

The environmental assessment must identify any fuel or chemical storage areas to be established on the site and describe the measures proposed to minimise the potential for leakage or migration of pollutants into the soil, groundwater or surface water systems.

Monitoring Programs

The environmental assessment should specify and assess all monitoring programs for measuring noise, air quality and water quality monitoring during the construction phase and on-going operation of the facility. These monitoring programs should be capable of assessing whether or not the development achieves a satisfactory level of environmental performance. The evaluation should include a detailed description of the monitoring strategies, sample analysis methods and the level of reporting proposed.

Community Consultation

The environmental assessment should outline procedures for responding to breaches of environmental conditions and for reporting these incidents both to regulatory agencies and to the community. This includes complaint handling mechanisms and emergency response procedures.

Impacts of the project on threatened species and their habitat

A number of threatened entities are known to occur or have potential to occur in the Berry area. A complete fauna and flora survey should be conducted and documented in accordance with the draft *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004) and the *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna, Amphibians* (DECC 2009) as it provides the assessment framework for threatened species issues associated with the site. All survey work should be undertaken at the appropriate time of year for each species to maximise the survey results.

The project area may support Endangered Ecological Communities (EECs). Development will need to avoid EECs and provide an appropriate buffer and asset protection zone. The EA must describe what actions will be undertaken to avoid or mitigate impacts caused by the development on all threatened species described at the site. Threatened species that could potentially occur onsite and should be considered include:

- Greater Broad-nosed Bat, Yellow-bellied Sheathtail-bat, Large-eared Pied Bat, Eastern Freetail-bat, Grey-headed Flying-fox, Southern Myotis

- Yellow-bellied Glider, Spotted-tailed Quoll
- Black Bittern
- Gang-gang Cockatoo, Glossy Black-cockatoo, Little Lorikeet
- Varied Sittella, Scarlet Robin
- Masked Owl, Powerful Owl
- Spotted Harrier
- Green and Golden Bell Frog
- Illawarra Greenhood, Leafless Tongue Orchid, Brittle Midge Orchid
- Illawarra Zieria
- Illawarra Socketwood
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Illawarra Subtropical Rainforest in the Sydney Basin Bioregion
- Illawarra Lowlands Grassy Woodlands Grassy Woodland

The above list is not exhaustive and there is potential for a number of other threatened species to occur at the site. See **Attachment 2** for a list of relevant threatened species and associated assessment requirements for this project.

Likely impacts on regionally significant, protected, and threatened species and their habitats need to be assessed, evaluated and reported. The assessment should specifically report on the considerations listed in Step 3 of the Draft *Threatened Species Assessment Guidelines* (DECC and DPI, 2005) as stated below.

- **"Step 3, Involves identifying not only the magnitude and extent of impacts but also the significance of the impacts as related to the conservation importance of the habitat, individuals and population likely to be affected."**

The EA should clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guidelines and describe the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts of the project on threatened species, populations, ecological communities, or their habitats. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after the measures are implemented.

Other vegetation clearing

The EA should clearly outline the extent to which the development footprint will impact on areas of native vegetation. It should also describe the tenure and conservation status of each parcel of land to be affected by the proposal or used as an offset.

Offsetting biodiversity and habitat loss would be required as identified in the threatened species guidelines. There are formulas associated with the "maintain and improve" principle of the Government's vegetation reforms that DECCW considers should apply.

Biodiversity Offset Principles

1. **Impacts must be avoided first by using prevention and mitigation measures**
   Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.

2. **All regulatory requirements must be met**
   Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).

3. **Offsets must never reward ongoing poor performance**
   Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.

4. **Offsets will complement other government programs**
   A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.

5. **Offsets must be underpinned by sound ecological principles**
   They must:

   - include the consideration of structure, function and compositional elements of biodiversity, including threatened species
   - enhance biodiversity at a range of scales
   - consider the conservation status of ecological communities
   - ensure the long-term viability and functionality of biodiversity.

   Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.

6. **Offsets should aim to result in a net improvement in biodiversity over time**
   Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.

   Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.

   Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.

7. **Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs**
   As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.

8. **Offsets should be agreed prior to the impact occurring**
   Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.

9. **Offsets must be quantifiable and the impacts and benefits must be reliably estimated**

   Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include:

   - the area of impact
   - the types of ecological communities and habitat/species affected
   - connectivity with other areas of habitat/corridors
   - the condition of habitat
   - the conservation status and/or scarcity/rarity of ecological communities
   - management actions
   - level of security afforded to the offset site.

The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:

- they protect land with high conservation significance
- management actions have greater benefits for biodiversity
- the offset areas are not isolated or fragmented
- the management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).

Management actions must be deliverable and enforceable.

10. **Offsets must be targeted**
They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.

11. **Offsets must be located appropriately**
Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.

12. **Offsets must be supplementary**
They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.

13. **Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract**
Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.

Biobanking Assessment Methodology – Biodiversity Offsets

Recently adopted by DoP is the DECCW Interim policy on assessing and offsetting biodiversity impacts of Part 3A developments. The policy applies the Biobanking Assessment methodology (BBAM) to set the frame work to applying an appropriate offset to "maintain or improve" biodiversity values.

The question of suitable offsetting often arises in the context of these decisions. This policy seeks to provide a consistent and transparent approach to impact assessment and offsetting for projects assessed under Part 3A of the EP&A Act. This policy also provides the basis for aligning NSW and Commonwealth assessment and offsetting processes by providing an assessment pathway that is likely to satisfy both NSW and federal requirements provided that certain standards are met.

The Biobanking Assessment Methodology is available at: www.environment.nsw.gov.au

Impacts of the project on Aboriginal cultural heritage values

The EA should address and document the information requirements set out in the draft "Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation" involving surveys and consultation with the Aboriginal community.

The EA must identify the nature and extent of impacts on Aboriginal cultural heritage values across the project area.

Should the site be found to have significant Aboriginal cultural heritage values, the EA must describe the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts of the project on Aboriginal cultural heritage values. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

The EA needs to clearly demonstrate that effective community consultation with Aboriginal communities has been undertaken in determining and assessing impacts, developing options and making final recommendations.

The EA should address and document the information requirements set out in the draft *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* involving surveys and consultation with the Aboriginal community.

Identify the nature and extent of impacts on Aboriginal cultural heritage values across the project area. Accordingly, the EA must describe the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts of the project on Aboriginal cultural heritage values. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

The EA needs to clearly demonstrate that effective community consultation with Aboriginal communities has been undertaken in determining and assessing impacts, developing options and making final recommendations.

Attachment 2 - Director General's Environmental Assessment Requirements for the evaluation of impacts on threatened species for the proposed Foxground to Berry Bypass.

INTRODUCTION

The purpose of these Directors General's requirements is to provide the assessment requirements to allow you, as the applicant, to identify the issues pertaining to threatened species, populations, ecological communities or their habitats, and provide appropriate amelioration for adverse impacts resulting from the action and to assist the consent or approval authorities in the assessment of your proposal pursuant to the *Environmental Planning and Assessment Act 1979* (EP&A Act).

DEFINITIONS

The definitions given below are relevant to these requirements:

- **Development** has the same meaning as in the EP&A Act.
- **Activity** has the same meaning as in the EP&A Act.
- **Proposal** is the development, activity or action proposed.
- **Subject Site** means the area directly affected by the proposal.
- **Study Area** means the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as is necessary to take all potential impacts into account.
- **Locality** is the area within a 5km radius of the subject site
- **Subject Species, Populations or Ecological Communities** means those threatened species, populations or ecological communities that are known or considered likely to occur in the study area. The EVALUATION OF IMPACTS is to explicitly consider the impacts of the proposal on each of these entities.
- **Direct Impacts** are those that directly affect habitat and individuals, usually within the footprint of the proposal. They include, but are not limited to, clearing and habitat removal. Consideration must be given to all of the likely direct impacts of the proposed activity or development.
- **Indirect Impacts** occur when project-related actions affect species, populations or ecological communities in a manner other than direct loss, usually beyond the footprint of the proposal. Indirect impacts can include loss of individuals through predation by domestic and/or feral animals, deleterious hydrological changes (including increased runoff and raising or lowering of the water table), erosion, weed invasion, pollution, trampling or other impacts due to increased human activity within or directly adjacent to sensitive habitat areas, altered fire regimes, habitat fragmentation and disruption of wildlife movement corridors. As with direct impacts, consideration must be given to all of the likely indirect impacts of the proposed activity or development.
- **Life Cycle** is the series or stages of reproduction, growth, development, aging and death of an organism.
- **Viable** means the capacity to successfully complete each stage of the life cycle under normal conditions.
- **Risk of Extinction** is the likelihood that the local population of the species or local occurrence of the endangered population or ecological community will become extinct either in the short, medium or long-term as a result of direct or indirect impacts on the viability of that population and includes changes to the ecological function of communities.

- **Local Population** is the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.
  - ➢ The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.
  - ➢ The local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
  - ➢ The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time.

  In cases where multiple populations occur in the study area, each population should be assessed separately.
- **Local Occurrence** means the ecological community that occurs within the study area. However the local occurrence may include adjacent areas if the ecological community on the study area forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the study area can be clearly demonstrated.
- **Composition** means both the plant and animal species present, and the physical structure of the ecological community. Note that while many ecological communities are identified primarily by their vascular plant composition, an ecological community consists of all plants and animals as defined under the *Threatened Species Conservation Act 1995* (TSC Act) that occur in that ecological community.

All other definitions are the same as those contained in the TSC Act.

1 CONTEXTUAL INFORMATION

1.1 Description of proposal, subject site and study area

A full description of the action proposed includes a description of all associated actions. These actions may occur on or off the subject site.

In describing the action proposed, the proportion of the subject site and the study area that will be affected is to be provided, including details of the location of any auxiliary infrastructure and all component parts of the proposal including, but not restricted to (i) roadworks and temporary access and egress routes, (ii) drainage and settling ponds, stockpile areas, diversion banks, vehicle parking areas (iii) changes in surface water flows (iv) utilities such as electricity, drainage, sewage, gas, (v) any actions necessary for fire management, (vi) stockpile areas, (vii) temporary buildings etc.

The type of action proposed shall be detailed, including the timetable for the construction of the proposal. If a staged construction approach is adopted then the timetable shall clearly indicate this.

If subsequent development of adjacent land is proposed by the proponent in the future, including any additional road construction then this shall be identified to the extent that it is known at the time of preparing the Environmental Assessment. If existing structures are to be relocated, this should also be described and assessed.

The vegetation within the study area that is to be retained is to be fully documented, and shown on the relevant plans and maps. The proposed management regimes for such areas are also to be documented.

2. PROVISION OF RELEVANT PLANS AND MAPS

A detailed plan of the *study area* shall be provided at a scale of 1:4000 or finer. This plan shall show the *proposal*, the location and type of vegetation communities present within the *study area*, the full extent of vegetation clearing anticipated, and the scale of the plan. This plan shall also show the location of any key habitat resources for threatened species (e.g. hollow-bearing trees, identified feed trees, potential breeding sites, rock outcrops). Where the general habitat of each *subject species, population or ecological community* within the *study area* can be clearly delineated, this habitat shall be represented on the plan.

Colour aerial photography of the *locality* (or a reproduction of such a photograph) shall be provided. This aerial photograph shall clearly show the *subject site* and the scale of the photograph.

The locations of the *subject species, populations or ecological communities* recorded in any survey conducted for the purposes of the Environmental Assessment shall be represented on a map of the *study area* that shows the *proposal* (preferred scale 1:4000 or finer).

A topographic map of the general *locality* at a scale of 1:25000 is to be provided. This map is to detail the location of the action proposed, landscape features including rivers, swamps, wetlands, any locally significant sites of *subject species, populations or ecological communities*, and areas of high human activity such as townships and major roads. This map shall incorporate the area within a radius of 5km from the subject site. All available historical records are to be included of *subject species, populations of ecological communities* sourced from various databases and other sources are to be included on this map.

2.1 Land tenure information

The land tenure across the *study area* is to be described and any limitations to sampling across the *study area* resulting from this tenure (e.g. denied access to private land) shall be noted.

3 INITIAL ASSESSMENT

3.1 Identifying subject species and populations

For the purposes of this Evaluation of Impacts, the species listed in Table 1 are to be addressed as *subject species*:

Table 1. List of *subject species*.

SPECIES	SCIENTIFIC NAME	STATUS
FAUNA		
Green and Golden Bell Frog	*Litoria aurea*	Endangered
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Vulnerable
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Vulnerable
Large-eared Pied Bat	*Chalinolobus dwyeri*	Vulnerable
Eastern Freetail-bat	*Mormopterus norfolkensis*	Vulnerable
Grey-headed Flying-fox	*Pteropus poliocephalus*	Vulnerable
Southern Myotis	*Myotis macropus*	Vulnerable
Yellow-bellied Glider	*Petaurus australis*	Vulnerable
Spotted-tailed Quoll	*Dasyurus maculatus*	Vulnerable
Black Bittern	*Ixobrychus flavicollis*	Vulnerable
Gang-gang Cockatoo	*Callocephalon fimbriatum*	Vulnerable
Glossy Black-cockatoo	*Calyptorhynchus lathami*	Vulnerable
Little Lorikeet	*Glossopsitta pusilla*	Vulnerable
Varied Sittella	*Daphoenositta chrysoptera*	Vulnerable
Masked Owl	*Tyto novaehollandiae*	Vulnerable
Powerful Owl	*Ninox strenua*	Vulnerable
Scarlet Robin	*Petroica boodang*	Vulnerable

SPECIES	SCIENTIFIC NAME	STATUS
Spotted Harrier	*Circus assimilis*	Vulnerable
FLORA		
Illawarra Greenhood	*Pterostylus gibbosa*	Endangered
Illawarra Zieria	*Zieria granulate*	Endangered
Leafless Tongue Orchid	*Cryptostylis hunteriana*	Vulnerable
Brittle Midge Orchid	*Genoplesium baueri*	Vulnerable
Illawarra Socketwood	*Daphnandra* sp. C Illawarra	Vulnerable
ENDANGERED ECOLOGICAL COMMUNITIES		
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		
Illawarra Subtropical Rainforest in the Sydney Basin Bioregion		
Illawarra Lowlands Grassy Woodlands Grassy Woodland		

One of the roles of the Evaluation of impacts is to determine which species, populations or ecological communities may be utilising, or present, on a development site. The entities to be considered for inclusion in the list of subject species, populations and ecological communities are listed in Table 2. This list is not exhaustive and other entities may also need to be included for assessment on the basis of desktop and habitat analyses and the outcomes of fieldwork.

Table 2. List of other entities for consideration as *subject species, populations or ecological communities.*

SPECIES	SCIENTIFIC NAME	STATUS
FAUNA		
Regent Honeyeater	*Anthochaera phrygia*	Critically Endangered
Swift Parrot	*Lathamus discolour*	Endangered
Eastern Bristlebird	*Dasyornis brachypterus*	Endangered
Stuttering Frog	*Mixophyes balbus*	Endangered
Broad-headed Snake	*Hoplocephalus bungaroides*	Endangered
Australasian Bittern	*Botaurus poiciloptilus*	Endangered
Bush Stone-curlew	*Burhinus grallarius*	Endangered
Southern Brown Bandicoot	*Isoodon obesulus obesulus*	Endangered
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	Vulnerable
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	Vulnerable
Golden-tipped Bat	*Kerivoula papuensis*	Vulnerable
Olive Whistler	*Pachycephala olivacea*	Vulnerable
Pink Robin	*Petroica rodinogaster*	Vulnerable
Eastern Pygmy Possum	*Cercartetus nanus*	Vulnerable
White-footed Dunnart	*Sminthopsis leucopus*	Vulnerable
Flame Robin	*Petroica phoenicea*	Vulnerable
Square-tailed Kite	*Lophoictinia isura*	Vulnerable
Giant Burrowing Frog	*Heleioporus australiacus*	Vulnerable
Littlejohn's Tree Frog	*Litoria littlejohni*	Vulnerable
Rosenberg's Goanna	*Varanus rosenbergi*	Vulnerable

SPECIES	SCIENTIFIC NAME	STATUS
Barking Owl	*Ninox connivens*	Vulnerable
White-fronted Chat	*Epthianura albifrons*	Vulnerable
Sooty Owl	*Tyto tenebricosa*	Vulnerable
Little Eagle	*Hieraaetus morphnoides*	Vulnerable
Koala	*Phascolarctos cinereus*	Vulnerable
FLORA		
Bristly Shield Fern	*Lastreopsis hispida*	Endangered
White-flowered Wax Plant	*Cynanchum elegans*	Endangered
	Solanum celatum	Endangered
Rainforest Cassia	*Senna acclinis*	Endangered
Dwarf Kerrawang	*Rulingia prostrata*	Endangered
Illawarra Irene	*Irenepharsus trypherus*	Endangered
Magenta Lilly Pilly	*Syzygium paniculatum*	Endangered
Nowra Heath Myrtle	*Triplarina nowraensis*	Endangered
Thick Lip Spider Orchid	*Caladenia tessellate*	Endangered
	Genoplesium superbum	Endangered
Warty Zieria	*Zieria tuberculata*	Endangered
Lesser Creeping Fern	*Arthropteris palistoii*	Endangered
Albatross Mallee	*Eucalyptus langleyi*	Vulnerable
Ettrema Mallee	*Eucalyptus sturgissiana*	Vulnerable
Square Raspwort	*Haloragis exalata* subsp. *exalata*	Vulnerable
Netted Bottle Brush	*Callistemon linearifolius*	Vulnerable
	Acacia baueri subsp. *aspera*	Vulnerable
Waterfall Greenhood	*Pterostylis pulchella*	Vulnerable
ENDANGERED ECOLOGICAL COMMUNITIES		
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		
Fresh Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin & South East Corner		

In determining whether the entities listed in Table 2, as well as other entities, should also be addressed as subject species, populations and ecological communities, consideration shall be given to the habitat types present within the study area, recent records of threatened species, populations or ecological communities in the locality and the known distributions of threatened species, populations and ecological communities. This analysis and its conclusion are to be documented in the Evaluation of Impacts.

Databases such as the DECCW Atlas of NSW Wildlife and BioNet, as well as databases held by the Australian Museum and Royal Botanic Gardens, should be consulted to assist in compiling the list of possible entities to be analysed. It should be noted that if the DECCW Atlas is the only database that is referred to, due to data exchange agreements, the data provided by DECCW will only include that for which DECCW is a custodian. In many cases, this may only be a small subset of the data available. Other databases must also be consulted to create a comprehensive list of entities for consideration as subject species, populations or ecological communities.

3.2 Identifying habitats

In describing the *study area*, consideration shall be given to the previous land uses and the effect of these land uses on the *study area*. Relevant historical events may include fire, clearing, logging, slashing, recreational use and agricultural activities.

A description of habitats including such components as the frequency of tree hollows, the presence of wetlands, the density of understorey vegetation, the composition of the ground cover, the soil type and the presence of heath and permanent or ephemeral swamps shall be given. The condition of these habitats within the *study area* shall be discussed, including the prevalence of introduced species. A description of the habitat requirements of threatened species, populations or ecological communities likely to occur in the *study area* shall be provided.

Any areas which may provide habitat connectivity between the *study area* and adjacent areas of likely habitat for *subject species, populations or ecological communities* shall be identified and described.

In defining the *study area*, consideration shall be given to possible *indirect impacts* of the proposed action on species/habitats in and surrounding the *subject site*. These could include impacts arising from altered fire and hydrology regimes, soil erosion or pollution, fencing, habitat fragmentation and disruption of wildlife movement corridors, edge effects, altered light and noise regimes, disturbance of roosting areas or other impacts due to increased use of the area by humans, and the impacts of increased levels of domestic and feral predators.

4 SURVEY

4.1 Requirement to survey

A flora and fauna survey is to be conducted in the *study area*. Targeted surveys shall be conducted for all *subject species, populations and ecological communities* determined in accordance with Section 3. Previous surveys and assessments may be used to assist in addressing this requirement. However, the efficacy of such previous surveys and assessments in meeting this requirement must be described in full. These previous surveys do not negate the need for the additional targeted survey work set out in Appendix 1 of these DGEARs.

Particular attention shall be paid to the timing and climatic conditions for conducting fauna surveys including invertebrates, as many of the *subject species* will only be present or detectable for a few months each year or during certain climatic conditions. Additional advice on these matters should be sought from the DECCW contact officer.

Identification of all species is essential. Identification to genus only is not acceptable. Species of taxonomic uncertainty shall be confirmed by a recognised authority such as the Australian Museum or National Herbarium at the Royal Botanic Gardens, Sydney.

4.2 Documentation of survey effort and technique

Survey technique(s) shall be described and a reference given, where available, outlining the survey technique employed.

Survey site(s) shall be identified on a map with a clear legend. The size, orientation and dimensions of quadrat or length of transect shall be clearly noted for each type of survey technique undertaken. Full AMG grid references for the survey site(s) shall be provided.

DECCW survey proformas are to be used by field staff when applying a range of standard fauna survey techniques. Copies of standard proformas are included in Appendix 2 to these DGEARs. Digital copies of these proformas can be requested from the nominated DECCW contact officer. These proformas shall be used by field staff when undertaking fauna surveys and completed data sheets are to be included as an appendix to the Evaluation of Impacts.

The time invested in each survey technique shall be summarised in the Evaluation of Impacts, based on completed proformas, e.g. number of person hours / transect, duration of call playback, number of nights that traps are set.

It is not sufficient to aggregate all time spent on all survey techniques. Effort must be expressed separately for each survey technique that is applied.

Personnel details including name of surveyor(s), contact phone number, qualifications and experience must be included. The person who identified records (e.g. Anabat, hair tubes, scat analysis) shall also be identified in this manner.

Environmental conditions during the survey shall be noted from the commencement of each survey technique until its completion. These conditions must be documented in the Evaluation of Impacts.

An assessment of the efficacy of each survey regime in detecting each species under the intensity utilised by the study is to be provided. The effect of the season and weather at the time of the field survey shall be considered with respect to the adequacy of survey results. An assessment will also be made of the adequacy of the survey and background information used to assess the likely area of use (home range) for each *subject species, population or ecological community*, and the areas providing habitat connectivity.

A full list of all flora and fauna species recorded during the course of surveys shall be included (such information is indicative of the habitat quality of the site). Completed Atlas of NSW Wildlife cards are to be provided for each threatened species record in any survey conducted for the purposes of the EA. For confidentiality, these cards are not to be included in the Evaluation of Impacts but rather shall accompany the Evaluation of Impacts when supplied to the DECCW.

4.3 Specific survey requirements

Appendix 1 details the specific survey requirements for the *subject species, populations or ecological communities* identified in Table 1 of these DGEARs. These survey requirements can determine the presence of *subject species, populations or ecological communities* known or likely to be in the *study area* and/or can provide contextual information on habitats to allow appropriate assessment of impacts at a broader scale. The flora and fauna survey of the *study area* must include the use of these survey methods.

You are advised that discussions between the consultant(s) engaged to prepare the Evaluation of Impacts and DECCW may be necessary in order to derive an appropriate survey regime for some of these requirements, and to confirm the survey regimes proposed for any additional *subject species, populations and ecological communities* derived by analysis as part of this Evaluation Of Impacts.

5 ASSESSMENT OF LIKELY IMPACTS ON THREATENED SPECIES, POPULATIONS AND ECOLOGICAL COMMUNITIES

For all *subject species, populations and ecological communities*, the Evaluation of Impacts shall describe the following:

a. the location, nature and extent of habitat removal or modification which will result from the action proposed;

b. the likely and potential impact of the removal of habitat. Particular attention shall be given to the loss of:

   i. River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions; Illawarra Subtropical Rainforest in the Sydney Basin Bioregion; and Illawarra Lowlands Grassy Woodlands Grassy Woodland.

   ii. Primary, secondary and important Koala trees.

   iii. the likelihood of and extent of loss of hollow-bearing trees, foraging habitat utilised for breeding, roosting or denning by threatened fauna such as micro-chiropteran bats, Yellow-bellied Gliders, Forest Owls and small woodland birds.

   iv. Similarly, attention is to be given to the likelihood of and extent of loss of food resources and the impact this may have on the *subject species, populations or ecological communities*.

c. Any direct and indirect impacts of the proposal including:

   i. Any potential indirect impact on the viability of breeding/ roosting habitat of micro-bats known to occur in and around the area.

ii. the fragmentation or isolation of *local populations* and/or *local occurrences*, and the increased distance required for the movement of individuals/genetic material between habitat patches.

iii. change in vegetation floristics and structure resulting from edge effects.

iv. altered hydrology regimes (including increased runoff and raising or lowering of the water table).

v. soil erosion and pollution.

vi. disturbance to feeding or nesting/breeding of species.

vii. trampling or other impacts due to increased use of the area by humans.

viii. habitat fragmentation and disruption of wildlife movement corridors and pollination mechanisms.

ix. altered light and noise regimes.

x. the likely contribution of the action proposed to the threatening processes already acting on populations of those *subject species or populations* and occurrences of *subject ecological communities* in the *locality.*

All of the above contextual information (which can be incorporated into Sections 5.1 - 5.5 below) will assist with the assessment of cumulative impacts on the *subject species, populations and ecological communities.*

5.1 Assessment of species likely to be affected

This requirement allows refinement of the list of *subject species or populations* (given the outcome of survey and analysis of likely impacts) in order to identify which threatened species or populations may be affected, and the nature of the impact.

The remaining requirements in this section (5.2 – 5.5) need only be addressed for those threatened species or populations that are likely to be affected by the proposal.

5.2 Discussion of local and regional abundance

5.2.1 Discussion of other known local populations

A discussion of other known *local populations* in the *locality* shall be provided. The long-term security of other habitats shall be examined as part of this discussion. The relative significance of the *subject site* for the *subject species, populations and ecological communities* in the *locality* shall be discussed. It is essential that the Evaluation of Impacts includes some surveys conducted beyond the *study area* to clarify the conservation significance of the *subject site* to the *subject species and populations.*

The need for off-site surveys to provide context to the anticipated impacts of the *proposal* may also be required for other threatened species recorded during the surveys of the *study area* for the Evaluation of impacts.

5.2.2 Discussion of habitat utilisation

An estimate of the number of individuals of each *subject species* utilising the *study area* shall be provided as well as a description of how these individuals use the *study area* (e.g. residents, transients, adults, juveniles, nesting, foraging). A discussion of the significance of these individuals to the viability of the *subject species* in the *locality* shall be provided.

5.2.3 Description of vegetation

The vegetation present within the *study area* and the surface area covered by each vegetation community shall be mapped and described. Reference to the vegetation classification system used (e.g. Specht, Benson, Keith) and to the ecological communities determined as endangered by the NSW Scientific Committee shall be provided. Classification must have regard to both structural and floristic elements.

5.2.4 Discussion of corridors

Particular attention shall be given to identifying movement corridors for *subject species* within the *study area*. The impact of the proposal on these corridors and the resulting impact on the resident *subject species* shall be discussed.

5.3 Assessment of habitat

5.3.1 Description of habitat values

Specific habitat features in the *study area* shall be described and quantified (e.g. frequency and location of stags, hollow bearing trees, culverts, rock shelters, rock outcrops, crevices, caves, drainage lines, soaks, area of ecological communities etc.), as well as the density of understorey vegetation and groundcover.

The condition of the habitat within the *study area* shall be discussed, including the prevalence of introduced species, species of weeds present and an estimate of the total weed cover as a percentage of each vegetation community, whether trampling or grazing is apparent, effects of erosion, prevalence of rubbish dumping, history of resource extraction or logging and proximity to roads. Details of the *study area's* fire history (e.g. frequency, time since last fire, intensity) and the source of fire history (e.g. observation, local records), shall be provided.

5.3.2 Distribution and condition of regional habitats

For the habitats of *subject species and populations* found in the study area, the Evaluation of Impacts shall discuss the distribution and condition of similar habitats in the region. For the *subject ecological communities* found in the study area, the Evaluation of Impacts shall discuss the distribution and condition of these ecological communities in the region. Regional information may be obtained from existing datasets and from other sources.

5.4 Discussion of conservation status

Assessment shall include reference to the threatening processes that are generally accepted by the scientific community as affecting the *subject species, population or ecological community* and which are likely to be caused or exacerbated by the *proposal*. Assessment shall also include reference to any approved or draft recovery plans which may be relevant to the *proposal*. Up-to-date lists and copies of approved and draft recovery plans are available on the DECCW website www.environment.nsw.gov.au by following the links to threatened species.

5.5 Description of feasible alternatives

All feasible alternative location for the wind turbines should be explored taking into account all known constraints.

6 IMPACT AMELIORATION

6.1 Description of ameliorative measures

In accordance with the Draft Guidelines for Threatened Species Assessment objective of Improve or Maintain, the ameliorative measures described for this development should meet the improve or maintain test for biodiversity values.

6.1.1 Long term management strategies

Consideration shall be given to the information contained in approved and draft recovery plans or threat abatement plans for existing taxa, known or likely to occur in the *study area*, and whether any recommendation is applicable to the *proposal*.

The development of long-term management strategies shall be considered to protect areas within the study area which are of particular importance for the *subject species, populations or ecological communities* likely to be affected by the *proposal*. This may include proposals to restore or improve habitat on site where possible. If mitigation is to include rehabilitation of the site, then the rehabilitation strategy shall be detailed.

Any measures proposed to mitigate the effect of the proposal on *local populations* of threatened species and populations and/or *local occurrences* of ecological communities shall be described. The potential effectiveness of any such amelioration in maintaining a viable *local population* and/or *local* *occurrence* in the short, medium and long term shall be discussed (e.g. fauna underpasses, vegetation management).

6.1.2 Compensatory strategies

If significant modification of the *proposal* to minimise impacts on *subject species, populations or ecological communities* is not possible, then compensatory strategies shall be considered. These may include other off-site or local area proposals that contribute to long term conservation of the *subject species, populations or ecological communities*.

The areas proposed to be used for compensatory strategies must be described in full including a detailed description of their biodiversity, tenure and conservation status. These areas should be assessed in accordance with the Principles for the use of biodiversity offsets in NSW, which can be found on the following link on the DECCW significant local populations of *subject species and populations* or significant local occurrences of *subject ecological communities* as determined by the EVALUATION OF IMPACTS should aim to:

i. minimise the impacts by considering all possible alternatives to the *proposal*, such that a significant impact is not likely; and

ii. manage the remaining habitat (if any) to ensure that the *local population* and/or *local occurrence* continues to exist in the long term.

The translocation of *subject species, populations and ecological communities* is only supported by DECCW in specific conservation programs (e.g. recovery planning).

7 ADDITIONAL INFORMATION

7.1 Qualifications and experience

An evaluation of Impacts must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement.

7.2 Licensing matters relating to flora and fauna surveys

Persons conducting flora and fauna surveys must have appropriate licences or approvals under relevant legislation. The relevant legislation and associated licences and approvals that may be required are listed below:

National Parks and Wildlife Act 1974:

- General Licence (Section 120) to harm or obtain protected fauna (this may include threatened fauna).
- Licence to pick protected native plants (Section 131).
- Scientific Licence (Section 132C) to authorise the carrying out of actions for scientific, educational or conservation purposes.

Threatened Species Conservation Act 1995:

- Licence to harm threatened animal species, and/or pick threatened plants and/or damage the habitat of a threatened species (Section 91).

Animal Research Act 1985:

- Animal Research Authority to undertake fauna surveys.

Appendix 1: Survey Requirements for Subject Species - DGEARs for Foxground to Berry Bypass

SPECIES	SURVEY REQUIREMENTS
Eastern False Pipistrelle, Eastern Bentwing-bat, Greater Broad nosed bat, Yellow Bellied Sheathtail-bat, Golden-tipped Bat, Large-eared Pied Bat, Southern Myotis and Eastern Freetail-bat	Surveys using Anabat recorders and stag watching should aim to identify the number and location of roost sites for the subject bats and identify important foraging habitat in the study area and the locality. If required, the DECCW can provide further advice on bat survey techniques to acquire this information. Surveys of the subject site, study area and locality shall be undertaken for hollow-bearing trees, bridges, caves, shafts, and buildings that may provide potential roosting/breeding habitat for microchiropteran bat species. Intensive searches for hollow-bearing trees and other potential roost/breeding habitats shall be undertaken in the subject site and study area. Representative sampling of the locality for hollow-bearing trees shall involve the use of transects in selected locations and the gathering of data in conjunction with ground-truthing for endangered ecological communities. The number of hollow-bearing trees recorded shall be used to provide context to the potential breeding habitat affected by the action proposed.
Grey-headed Flying-fox	Surveys are to be undertaken in potential habitat through the subject site for camp sites. The survey effort must include work to identify any maternity camp sites located within the subject site that may be impacted by the proposal. Surveys are to be undertaken between October – November. One hour surveys on dusk are to be undertaken in a position with a good view of the subject site. Surveys for this species should also be consistent with *DEC 2004, Draft Threatened Biodiversity Survey & Assessment Guidelines for Developments and Activities.*
Yellow-bellied Glider	Map the location of den sites and feed trees within and adjacent to the study area. All trees to be removed or isolated by the development must be assessed to determine if they are being used as den or feed trees. Map the location and size of the areas occupied by Yellow-bellied Glider family groups in the locality. Surveys must consist of stag watching, spotlighting, call play-back and habitat assessment. Spotlighting and call play-back surveys must be undertaken on foot. At each call play-back site, the call of the Yellow-bellied Glider should be played through a megaphone for 5 minutes, followed by at least 10 minutes of listening. An assessment of potential links between habitat on the subject site and habitats in the locality must be conducted particularly identifying routes used by resident Yellow-bellied Gliders within and adjacent to the subject site.

Appendix 1: Survey Requirements for Subject Species - DGEARs for Foxground to Berry Bypass

SPECIES	SURVEY REQUIREMENTS
Spotted tailed Quoll	Live cage traps using platform cat traps 30cmx 30cmx60cm. Trapping should be undertaken from late March over a 10 day period. Drainage lines should be targeted for surveys. Five cage traps per drainage lines should be placed 50 metres apart. Repeat surveys should be undertaken in May using the same methods in March. DECCW supports the use of cameras as a trade-off for cage trapping intensity, however the lower intensity cage trapping should comply with the *DEC 2004, Draft Threatened Biodiversity Survey & Assessment Guidelines for Developments and Activities.* Cameras should be fixed to the ground and installed in suitable habitat. Bait stations consisting of "chicken" should be established prior to camera installation to increase the chance of detecting Spotted-tailed Quolls. Cameras must be installed in the most suitable habitats. Surveys period - March – September.
Eastern Pygmy Possum and White-footed Dunnart	Surveys for these species must be conducted with pitfall traps. Pitfall trapping must be conducted with PVP or buckets with a minimum width of 150mm (at least 40 cm deep) set in clusters of 3 with each pit/trap in a cluster being approximately 10m apart. Drift fences (at least 30cm high) will be used between each pitfall trap and extending 10 beyond the last trap on either end. Each cluster will cover a minimum length of 40 metres. Pitfall traps to be set for a minimum of four nights and repeated through each stratification unit. Pitfall trapping must be conducted for a minimum of two (but preferably three) separate sessions of five consecutive nights. The status of the White-footed Dunnart and Eastern Pygmy Possum in the region is poorly known. If either of these species is found on the subject site, then additional surveys in the locality must be undertaken to determine the significance of the population on the subject site.
Gang Gang Cockatoo and Glossy Black-cockatoo	Undertake diurnal bird surveys across the study area and nesting assessments using a combination of stag-watching and listening for calls of the birds returning to nests in the late afternoon during the known breeding season of each species, to ascertain the locations of any nest sites in the study area. These surveys should target hollow-bearing trees with hollows of suitable size (>10cm diameter) for the species that are to be removed for the proposal or which lie within 50 metres of areas to be disturbed by the proposal. Estimate the availability, condition and security of potential breeding habitat for the species in the locality by ground-truthing existing vegetation mapping datasets.
Little Lorikeet, Olive Whistler, Pink Robin, and Varied Sittella.	Diurnal bird censuses shall be undertaken in the early morning and/or late afternoon within the *subject site* on three occasions each separated by a period of one week. Each census shall comprise observations for birds, including call recognition, for a period of 45 minutes at a minimum of three locations spread across the subject site. Surveys can be undertaken at any time of the year, but shall avoid high-wind and/or rainy days.

Appendix 1: Survey Requirements for Subject Species - DGEARs for Foxground to Berry Bypass

SPECIES	SURVEY REQUIREMENTS
Black Bittern	Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Diurnal surveys to be undertaken in the early morning and/or late afternoon within suitable habitats in the *subject site* on three occasions each separated by a period of one week. Each census shall comprise observations for birds, including call recognition, for a period of 45 minutes at a minimum of three locations spread across the subject site. Diurnal searches for nest/roosting sites to be undertaken through suitable habitat within the study area. Search to be undertaken during the breeding season, from December to March. This species should also be targeted by spotlight survey within foraging habitat; the methodology and survey effort should be consistent with the Threatened Biodiversity Survey and Assessment: guidelines for development and activities (draft 2004).
Masked & Powerful Owl	Nocturnal call playback (one site per 100 ha) with an initial listening period of 10 min then play the call of each subject species separated by at least a 2 minute listening period, then finish with a 10 minute listening period. Identify and map all hollow-bearing trees (potential nest trees) on the subject site and estimate the availability of hollow-bearing trees in the locality. The number of nocturnal call playback surveys should be consistent with *DEC 2004, Draft Threatened Biodiversity Survey & Assessment Guidelines for Developments and Activities*.
Scarlet Robin, Flame Robin	Diurnal bird censuses shall be undertaken in the early morning and/or late afternoon within the *subject site* on three occasions each separated by a period of one week. Each census shall comprise observations for birds, including call recognition, for a period of 45 minutes at a minimum of three locations spread across the subject site. Additional opportunistic bird census shall be employed across the *study area* and *locality* during the course of other surveys for the EA. Surveys should be concentrated on ridges, hills and foothills. Surveys should be between July to January however can be undertaken at any time of the year, but shall avoid high-wind and/or rainy days.
Square-tailed Kite	Diurnal bird surveys across the subject area targeting woodland and forest for nesting sites. Potential nest sites should be surveyed during the July – Feb. Opportunistic surveys should be conducted in the locality given the large home range of the species.
Green and Golden Bell frog	Survey suitable habitat using spotlight/headlamp searches, call playback, diurnal visual searches and dip-netting surveys for tadpoles. Surveys must be conducted on three visits separated by at least two weeks. Small areas of habitat (<0.3 ha) should be surveyed for a minimum of 1 hr for both nocturnal (spotlight and call playback) and diurnal (visual searches and dip-netting) visits (i.e. 1 hr nocturnal survey, 1 hr diurnal survey X 3 visits). Larger areas should be surveyed at a rate of 3 hrs per ha of habitat. September and January but may call through to March in favourable weather. Calling and breeding is stimulated by rainfall.

Appendix 1: Survey Requirements for Subject Species - DGEARs for Foxground to Berry Bypass

SPECIES	SURVEY REQUIREMENTS
Orchids (e.g. *Cryptostylis hunteriana*, *Genoplesium baueri* and *Pterostylis gibbosa*)	These species can only be satisfactorily surveyed when it is flowering, although it is possible for experts to recognise stems of this species at the bud stage. The exact flowering time is unpredictable and the species can flower anytime between early December and mid March. Flowering should be confirmed ate the nearest known site prior to surveys being undertaken. Known Cryptostylis hunteriana sites in the Ulladulla area have been in flower in the week preceding 24 December in 2004-2007. Alternatively, searches of the study area at approximately three weekly intervals over this period could be undertaken. Systematic surveys using evenly spaced transects located about 5m apart through all areas of heath/shrubland and woodland with heath/shrubland understorey must be undertaken. Survey period - Early December and mid March
Illawarra Zieria	Systematic surveys using evenly spaced transects located about 10 metres apart through suitable habitat must be undertaken between the flowering period, spring to early summer.
Illawarra Socketwood	A rainforest tree to 20 metres tall. Occupies rocky hill sides and gullies of the Illawarra lowlands. Systematic surveys using evenly spaced transects located about 10 metres apart through vegetation associated with rainforest and moist Eucalypt forest must be undertaken.
River-Flat Eucalypt Forest, Illawarra Subtropical Rainforest, and Illawarra Lowlands Grassy Woodlands	Surveys shall identify the extent and condition of the ecological communities in the *subject site*, *study area* and *locality*. This shall involve the use of vegetation surveys in the *subject site* and the *study area*. The use of existing datasets held by DECCW in combination with ground-truthing of selected sites within areas mapped by DECCW as the ecological community is recommended for surveys of the *locality*. The sites sampled shall be used to provide context to the ecological community affected by the action proposed. Surveys can be undertaken at any time of the year under varied seasonal conditions. This methodology should apply to other EECs with potential to be impacted by the proposal.

Appendix 2: Examples of suitable survey proformas

DIURNAL HERPETOFAUNA CENSUS SURVEY PROFORMA

Survey Details

Date of survey ________________

Name of surveyor ________________ Contact number ________________

Number of surveyors ________________ ________________

Total effort expressed in person-hours ________________ Total effort expressed in number of rocks/logs rolled ________________

Location Details

Location (including basic habitat) description ________________________________

____

____

____

Map number ________________ Map name ________________

Type of survey, e.g. transect or quadrat ________________ AMG Zone ________________

Active or passive search ________________ Size of survey area (ha) ________________

Survey area
Eastings (6 digits) ________________ Northings (7 digits) ________________

Eastings (6 digits) ________________ Northings (7 digits) ________________

Start time (24hr) ________________ End time (24 hr) ________________

Weather Details

At start of survey, record: Cloud cover* ________________

Wind direction and speed* ________________ Rain* ________________

Temperature (°C) ________________ Moon* ________________

At end of survey, record: ________________________________

Temperature (°C) ________________________________

Comments ________________________________

____

Appendix 2: Examples of suitable survey proformas

Species name (Scientific/Common)	Ob. type*	MH type*	Grid reference (full AMGs i.e. Eastings and Northings)	Accuracy

* See Appendix 3: Standard reporting codes

Appendix 2: Examples of suitable survey proformas

DIURNAL BIRD CENSUS SURVEY PROFORMA

Survey Details

Name of surveyor ________________ Contact number ________________

Number of surveyors ________________ Date of survey ________________

Total effort expressed in person hours ________________ Number of hectares covered or transect or point dimensions ________________

Location Details

Location description ____

Map number ________________ Map name ________________

Full AMG reference(s) for survey site or transect AMG Zone ________________

Start details ________________ Finish details ________________

Easting (6 digits) ________________ Easting (6 digits) ________________

Northing (7 digits) ________________ Northing (7 digits) ________________

Start time (24hr) ________________ End time (24 hr) ________________

Weather Details

At start of survey, record: Cloud cover* ________________

Wind direction and speed* ________________ Rain* ________________

Temperature (°C) ________________ Moon* ________________

At end of survey record: ____

Temperature (°C) ____

Comments ____

Species name	Ob. type*	MH type*	Grid reference (full AMGs)	Accuracy

* See Appendix 3: Standard reporting codes

Appendix 2:Examples of suitable survey pro-formas

Species name	Ob. type*	MH type*	Grid reference (full AMGs)	Accuracy

* See Appendix 3: Standard reporting codes

Appendix 2: Examples of suitable survey proformas

DIURNAL HOLLOW-BEARING TREE CENSUS SURVEY PROFORMA

Survey Details

Date of survey ________________

Name of surveyor ________________ Contact number ________________

Number of surveyors ________________ ________________

Total effort expressed in person-hours ________________

Location Details

Location (including basic habitat) description ________________________________

____

____

____

Map number ________________ Map name ________________

Type of survey, e.g. transect or quadrat ________________ AMG Zone ________________

________________ Size of survey area (ha) ________________

Survey area
Eastings (6 digits) ________________ Northings (7 digits) ________________

Eastings (6 digits) ________________ Northings (7 digits) ________________

Start time (24hr) End time (24 hr) ________________

Appendix 2: Examples of suitable survey proformas

Tree No.	Species (Scientific Name)	Number, sizes and types of hollows *	Grid reference (full AMGs i.e. Eastings and Northings)	Accuracy

* See Appendix 3: Standard reporting codes

Appendix 2: Examples of suitable survey proformas

DIURNAL TERMITE MOUND CENSUS SURVEY PROFORMA

Survey Details

Date of survey ______________

Name of surveyor ______________ Contact number ______________

Number of surveyors ______________ ______________

Total effort expressed in person-hours ______________

Location Details

Location (including basic habitat) description ______________________________

____

____

____

Map number ______________ Map name ______________

Type of survey, e.g. transect or quadrat ______________ AMG Zone ______________

______________ Size of survey area (ha) ______________

Survey area
Eastings (6 digits) ______________ Northings (7 digits) ______________

Eastings (6 digits) ______________ Northings (7 digits) ______________

Start time (24hr) End time (24 hr)

Termite mound no.	Grid reference (full AMGs)	Accuracy

Appendix 2: Examples of suitable survey proformas

Appendix 2: Examples of suitable survey proformas

VERTEBRATE FAUNA SURVEY OPPORTUNISTIC RECORDS

Survey name ____________________ Fauna surveyors ____________________
Surveyor's contact details ____________________ Call analysis ____________________

AMG Zone ____________________

Date	Time	Site #	Easting (full 6 digits)	Northing (full 7 digits)	Species Name	No Ind	Ob. type*	MH* type*	Notes/Field No**

* See over ** Include initials of observer and any other information that will help relocation of site.

Cloud cover. Record cloud cover in eights of sky.

Moon. Record using the following codes. 0=None, 1=1/4 moon, 2=1/2 moon, 3=3/4 moon, 4=full moon.

Wind direction and speed. Record wind direction to nearest cardinal point. Record wind speed using the following codes. 0=calm 1= Light, leaves rustle 2= Moderate, branches move 3=Strong, tops of trees move

Rain. Record using the following codes. 0=none, 1=drizzle - light, 2=drizzle - heavy 3=heavy rain

Sizes of hollows. Record using the following codes. S=Small (1-5cm diameter), M=Medium (5-15cm diameter), L=Large (greater than 15cm diameter).

Types of hollows. Record using the following codes. T=Trunk hollow, B=Branch hollow

Observation type Use the following codes:

O	Observed (sighted)	R	Road kill	F	Tracks, scratching
W	Heard call	D	Dog kill	Z	In raptor/owl pellet
X	In scat	C	Cat kill	M	Miscellaneous
P	Scat	V	Fox kill	E	Nest or roost
T	Trapped or netted	K	Dead	B	Burnt
H	Hair or feathers	S	Shot	Y	Bones or teeth
A	Stranded/beached	I	Fossil/subfossil	N	Not located

MH (microhabitat) type Use the following codes:

AC	Flying above canopy	IB	In burrow	OB	On (beach) sand
BR	In/on bridge	IC	In cave	OL	On log
BU	In building	IG	In grass	OR	On rock
CK	Crevice in rock	IH	In tree hollow	OW	Over water
CL	Crevice in log	IL	In litter	RD	On road
DA	Farm/fire dam	IR	In reeds	TK	On trunk
DT	In dead tree (stag)	IS	In soil	UB	Under bark
EW	Edge of water	IT	In (live) tree	UC	Upper canopy
FC	In/on post or stump	IW	In water	UG	Undergrowth
FL	Flying within canopy	LC	Lower canopy	UL	Under log
GR	On ground	LS	Low shrub	UR	Under rock
HS	High shrub	MC	Mid canopy	UT	Under iron
				WH	Waterhole

Attachment 3 - Guidance Material: Assessing Environmental Impacts

Guidance material

- Protocol for Working with Government Agencies on Major Infrastructure and Development Proposals
- Steps in the Assessment and Approval of Major Projects under Part 3A
- State Significant Sites – guidelines and checklist
- Criteria for declaration of Critical Infrastructure Projects
- What are Major Projects under Part 3A?
- Draft Criteria for Construction Projects under Major Projects SEPP
- Guidelines for Aboriginal Cultural Heritage Impact assessment and Community Consultation
- Guidelines for Threatened Species Assessment
- Assessment into Part 3A of the EP&A Act
- Independent Hearing and Assessment Panels
- Draft Guideline on Publication Notification
- Concept Plan Application Process under Part 3A
- Protocol for working with Councils on matters of Major Infrastructure and Development Proposals
- Assessment Guidelines
- EA procedures (e.g. Statement of Commitments, Community Consultation, etc.)
- Industry Sectors (e.g. mining, chemical industries, roads, marinas, etc.)
- Environmental Issues (e.g. air quality, noise, heritage, biodiversity, etc.)

Assessing Environmental Impacts

Air quality

- Protection of the Environment Operations (Clean Air) Regulation 2002
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW
- Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales
- (Draft) Assessment and Management of Odour from Stationery Sources in NSW
- Action for Air (EPA, 1998)

Noise and vibration

- NSW Industrial Noise Policy (EPA, 1999)
- NSW Environmental Criteria for Road Traffic Noise (EPA, 1999)
- Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990)
- Environmental Noise Control Manual (EPA 1994)
    - Section 19.3 Sleep Arousal Criteria
    - Section 171 Construction Noise Guideline.
- Environmental Noise Management Manual (RTA, 2001)

Water quality

- National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
- NWQMS Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000)
- Healthy Rivers Commission Report into Coastal Lakes and Statement of Joint Intent
- The relevant targets within the State Water Management Outcomes Plan

Wastewater

- National Water Quality Management Strategy: Guidelines for Sewerage Systems - Effluent Management (ARMCANZ/ANZECC 1997)
- National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC 2000)
- Environmental Guidelines for the Utilisation of Treated Effluent by Irrigation (NSW DEC 2004)
- Environment and Health Protection Guidelines: 'Onsite Sewage Management for Single Households', February 1998 (Silver Book)

Stormwater

- Managing Urban Stormwater: Soils and Construction (NSW Landcom, 2004)
- Managing Urban Stormwater: Council Handbook (EPA 1998)
- Managing Urban Stormwater: Source Control (EPA 1998)
- Managing Urban Stormwater: Treatment Techniques (EPA 1998)

Groundwater

- State Groundwater Policy Framework Document (DLWC 1997)
- The NSW State Groundwater Quality Protection Policy (DLWC 1998)
- (Draft) NSW State Groundwater Quantity Management Policy
- NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002)
- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ & ANZECC, 1995)

Contaminated Land

- *Managing Land Contamination: Planning Guidelines - SEPP55 - Remediation of Land* (DUAP and EPA 1998);
- *Contaminated Sites – Guidelines for Consultants Reporting on Contaminated Sites* (EPA 1997);
- *Contaminated Sites – Guidelines on Significant Risk of Harm and Duty to Report* (EPA 1999).

Waste and Chemicals

- Guideline for the Use and Disposal of Biosolids Products (NSW EPA 1997)
- Environmental Guidelines: Solid Waste Landfills (NSW EPA 1996)
- Draft Environmental Guidelines - Industrial Waste Landfilling (April 1998)
- Waste Classification Guidelines (DECCW, 2010)
- Environmental Guidelines: Composting and Related Organics Processing Facilities (July 2004)
- Operations Guidance for Assessing Non-Standard Fuel Proposals – Version 1.2

Soil contamination

- Acid Sulfate Soils Manual (Acid Sulfate Soils Management Advisory Committee, 1998)
- National Strategy for the Management of Coastal Acid Sulfate Soils

Threatened Species

- Guidelines for Threatened Species Assessment;
- The Assessment of Significance: Threatened Species Assessment Guidelines;
- Threatened Biodiversity Survey and Assessment: guidelines for development and activities (draft 2004).
- Recovery Plans (www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans)
- Threat Abatement Plans (www.nationalparks.nsw.gov.au/npws.nsf/Content/Threat+abatement+plans+by+doctype)

- Threatened Species Profiles (www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx)
- Priority Action Statements www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_PAS.aspx

Aboriginal Cultural Heritage

- Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation - Available from Dept of Planning.
- Aboriginal Cultural Heritage Community Consultation Requirements for Proponents (December 2009)

NSW GOVERNMENT | **Office of Water**

14 April 2011

Mr Michael Woodland
Department of Planning
GPO Box 39
SYDNEY NSW 2001

c: Janne Grose
t: 02 4729 8262
f: 02 4729 8141
e: Janne.Grose@water.nsw.gov.au

Our ref : ER21486
Your ref: MP10_0240

Attention: Kylie Seretis

Dear Mr Woodland

MP10_0240 – Princes Highway Upgrade – Foxground and Berry Bypass - Director General Requirements – Kiama and Shoalhaven LGAs

I refer to your letter of 10 January 2011 requesting key issues and assessment requirements from the NSW Office of Water (NOW) for the above project proposal.

NOW's key issues and assessment requirements for the project proposal are outlined in Attachment A and these include:

- the protection of watercourses as stable, natural systems; the protection and enhancement of riparian land and the protection of wetlands;
- water supply and water licensing requirements for the proposal;
- groundwater and groundwater dependent ecosystems.

NOW requests that all referrals from the Department of Planning (DoP) under Part 3A of the *Environmental Planning and Assessment Act 1979* for the project proposal include the following:

- referral **cover letter**; and
- one (1) **hard copy** and one (1) **CD** copy of the Environmental Assessment (EA) report and any other accompanying documentation.

I understand that it is DoP's internal policy to refer digital copies of Applications only, however, this is resulting in the transfer of costs associated with the printing of the EA to NOW. It would be appreciated if the Applicant could be advised of NOW's requirement for a hard copy of the EA and arrange for them to provide it direct to NOW's relevant assessing officer.

Contact Details:

If you require further information please contact Janne Grose on (02) 4729 8262 at the Penrith office.

Yours sincerely

Mark Mignanelli
Manager Major Projects and Assessment

www.water.nsw.gov.au

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ATTACHMENT A

NSW Office of Water Comments

Princes Highway Upgrade – Foxground and Berry Bypass - Director General Requirements

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Protection of Watercourses and Riparian Lands

The Preliminary Environmental Assessment (PEA) indicates that the Princes Highway upgrade crosses a number of creeks including Broughton Creek, Broughton Mill Creek and Bundewallah Creek. The Environmental Assessment (EA) needs to provide details (including scaled plans) on:

- all watercourses and riparian land within the study area and also those outside the study area potentially affected by the proposal including:
  a. the location of all watercourses
  b. top of bank
  c. minimum riparian corridor widths (measured from top of bank) to be protected and enhanced
  d. the footprint of the proposal in relation to the watercourses and riparian areas
  e. photographs at the watercourse crossings looking upstream and downstream and a plan showing the location that the photographs were taken

- potential impacts of the proposal on any watercourses and riparian areas, including areas of disturbance.

- safeguard measures to mitigate impacts, contingency plans for the remediation and rehabilitation of riparian areas in the event of potential adverse impacts and the long term management of the riparian lands.

Riparian land / riparian vegetation

Section 3.1.2 of the PEA indicates that the Illawarra Regional Strategy and the South Coast Regional Strategy apply to Kiama and Shoalhaven LGAs. Both the Illawarra Regional Strategy and the South Coast Regional Strategy outline that the Riparian Corridor Management Study (RCMS) should be used as the assessment approach to identify minimum riparian setback requirements along watercourses.

The EA needs to identify if the proposal is applying the RCMS in accordance with the regional strategies or the NOW Guideline for Controlled Activities to identify minimum riparian setbacks along watercourses potentially affected by the proposal. Riparian setback widths need to be provided in the EA to identify if basins, water quality structures, site compounds, etc are located outside the riparian areas and to identify the riparian areas disturbed by the proposal that require rehabilitation after construction.

Broughton Creek and Broughton Mill Creek are Category 1 watercourses and Bundewallah Creek Bridge is a Category 2 watercourse. The minimum riparian widths for Category 1, Category 2 and Category 3 watercourses are 50 m, 30 m and 10 m respectively each side of the creek (measured from top of bank).

Riparian land disturbed by the proposal should be rehabilitated in a two step process. The primary stage should rapidly stabilise disturbed riparian areas and the second phase should establish a permanent cover of vegetation that reflects the local native species that occur in the vicinity of the site areas.

A Vegetation Management Plan needs to be prepared which provides details on the rehabilitation of riparian land. Details are required on maintenance periods of the riparian land. NOW recommends longer maintenance periods are applied rather than shorter periods as the longer the proponent maintains the riparian vegetation the better, as the vegetation becomes more established. As a minimum the riparian vegetation should be maintained for a minimum period of at least 2 years after final planting.

Watercourse Crossings

The PEA notes a bridge structure is to span Broughton Mill Creek and Bundewallah Creek (see Section 4), the project includes three bridge crossings of Broughton Creek (see Section 6.8.2) and each of the watercourses encountered would require bridges or culverts (see Section 7.2.2).

As noted above, Broughton Creek and Broughton Mill Creek are both Category 1 watercourses and Bundewallah Creek Bridge is a Category 2 watercourse. The NOW supports bridge crossings of these watercourses. At the proposed bridge crossing locations it is recommended:

- the structures are elevated and span the full width of the identified riparian zone.
- the bridge structures are designed to allow sufficient natural light and moisture to penetrate beneath the structures to allow for plant growth and assist in improving riparian connectivity and naturalised stabilisation or the design incorporates options for providing artificial moisture and lighting under the structures.
- the bridge piers or foundations are located outside the bed and banks of the main waterways (this will assist to mitigate future creek stability and maintenance costs).

At crossing locations where culverts are proposed it is recommended:

- box culverts are used instead of piped culverts
- the culverts have naturalised bases
- the design of the culverts consider fish passage and terrestrial fauna movement. Elevated "dry" cells are recommended to encourage terrestrial movement with a combination of recessed "wet" cells to facilitate fish passage.
- the cell size facilitates the movement of woody debris.

If any watercourses are required to be diverted as part of the proposal the EA needs to provide details. Any creek diversion should rehabilitate stable creek channels that emulate natural systems and riparian vegetation.

Works around watercourses should be managed to retain bed and bank stability and prevent erosion. Any stream bank rehabilitation types should be selected by a geomorphologist and the works designed by a river engineer. Areas of disturbance near watercourses should be inspected particularly after major rainfall events to ensure any stabilisation works have been effective. The rehabilitation phase should continue until all areas of disturbance near waterways are identified as stable by an independent suitably qualified certifier.

Construction Compound Sites
The EA needs to provide details if compound sites and other works associated with the proposal are proposed to be located within riparian land. The NOW recommends any construction compound sites are located outside the riparian areas, particularly areas with existing native riparian vegetation. If compound sites are required to be located within riparian land, the sites should be located in areas that have previously been cleared to mitigate further loss of native riparian vegetation.

The EA needs to identify whether riparian vegetation is required to be disturbed or removed as part of the proposal for compound sites/other works etc and provide details on proposed mitigation measures. Any riparian vegetation removed by the proposal should be rehabilitated and revegetated post-construction with plant species representative of the local endemic vegetation communities.

Water quality basins
Section 7.3.3 of the PEA makes reference to sedimentation basins being installed for the construction phase and notes these would be converted to water quality treatment basins for the operational phase. The NOW recommends the EA provides details on the proposed location of basins and that the basins are located outside the riparian areas. If it is not possible to locate the basins outside the riparian areas, it is recommended the basin sites are located in areas previously cleared of native riparian vegetation to mitigate disturbance of vegetation

Surface Water and Groundwater

The PEA has not identified if a water supply is required for the Princes Highway upgrade and the source(s) of the water supply. The EA needs to address any water use and nominate the source(s) of an adequate and secure water supply.

The EA needs to provide sufficient details for the NOW to assess any water licensing requirements under the Water Act 1912, including:

- water supply source(s) for the proposal,
- any proposed surface water extraction, including purpose, location of any existing and proposed pumps or storage ponds/ dams,
- any proposed groundwater extraction,
- volumes of water to be used,
- the function and location of all existing and proposed storages/ponds for the project.

If the proposal includes water management structures/dams, the EA needs to provide details on the following:

- any existing structure/s (date of construction, location, purpose, size and capacity, the legal status/approval for existing structure/s).
- any proposal to change the purpose of existing structure/s.
- if any remedial work is required to maintain the integrity of the existing structure/s.
- the purpose, location and design specifications for any proposed structure/s.
- size and storage capacity of the structure/s.
- calculation of the Maximum Harvestable Right Dam Capacity (MHRDC).

- if the structure/s is affected by flood flows.
- any proposal for shared use, rights and entitlement of the structure/s.
- if the proposed development has the potential to bisect the structure/s.

The NOW's Farm Dams Assessment Guide provides details on Harvestable Rights and the calculation of the Maximum Harvestable Right Dam capacity (MHRDC). Dams capturing up to the harvestable right capacity are not required to be licensed. Harvestable Right dams can be located on hillsides, gullies and minor watercourses that do not have permanently flowing waters and which are first and second order watercourses in accordance with the Strahler system of stream ordering. The Strahler system of stream ordering of watercourses is based on 1:25 000 scale topographic maps. Please refer to: http://www.water.nsw.gov.au/ArticleDocuments/35/trade_farmdams_do_you_need_licence.pdf.aspx.

The Harvestable Right gives landholders the right to capture and use for any purpose 10 % of the average annual runoff from their property. The Harvestable Right has been defined in terms of an equivalent dam capacity called the Maximum Harvestable Right Dam Capacity (MHRDC). The MHRDC is determined by the area of the property (in hectares) and a site-specific run-off factor.

The MHRDC includes the capacity of all existing dams on the property that do not have a current surface water licence. The location and estimated capacity of every dam must be shown. Any capacity of the total of all the dams on the property greater than the MHRDC may require a licence.

There are exemptions for dams related to the Harvestable Right. These include:

- Dams to control or prevent soil erosion;
- Dams to contain effluent and sediment;
- Flood detention basins;
- Dams built for environmental reasons (eg aesthetics, nutrient control, wildlife etc); and
- Dams which don't harvest runoff (eg. turkeys nest dams, ring tanks).

These exemptions are only applicable to the end use of the dam, even if the initial use is one of the above.

Groundwater

NOW is responsible for the management of the groundwater resources. The proposal needs to demonstrate that it is consistent with NSW State groundwater policy, does not impact on groundwater quality or the health of groundwater dependent ecosystems (GDEs).

The EA should consider and provide the following details:

- the predicted highest groundwater table at the site.
- any works likely to intercept, connect with or infiltrate the groundwater sources.

- any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes.
- a description of the flow directions and rates and physical and chemical characteristics of the groundwater source.
- the predicted impacts of any final landform on the groundwater regime.
- the existing groundwater users within the area (including the environment), any potential impacts on these users and safeguard measures to mitigate impacts.
- an assessment of the quality of the groundwater for the local groundwater catchment.
- how the proposed development will not potentially diminish the current quality of groundwater, both in the short and long term.
- Measures for preventing groundwater pollution so that remediation is not required.
- protective measures for any groundwater dependent ecosystems (GDEs).
- proposed methods of the disposal of waste water and approval from the relevant authority.
- the results of any models or predictive tools used.

Where potential impact/s are identified the EA will need to identify limits to the level of impact and contingency measures that would remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on:

- any proposed monitoring programs, including water levels and quality data.
- Reporting procedures for any monitoring program including mechanism for transfer of information.
- An assessment of any groundwater source/aquifer that may be sterilised from future use as a water supply as a consequence of the proposal.
- Identification of any nominal thresholds as to the level of impact beyond which remedial measures or contingency plans would be initiated (this may entail water level triggers or a beneficial use category).
- Description of the remedial measures or contingency plans proposed.
- Any funding assurances covering the anticipated post development maintenance cost, for example on-going groundwater monitoring for the nominated period.

Licensing

It is noted in Section 7.2.2 of the PEA that earthworks associated with the project have the potential to interrupt existing groundwater flows. The EA needs to identify if the proposal is likely to intercept groundwater. Any part of the development that intercepts or uses groundwater may require a water license under Part 5 of the *Water Act 1912*. The NOW will assess the need for a licence when more detailed groundwater assessment information is provided in the EA.

All proposed groundwater works, including bores for the purpose of investigation, extraction, dewatering, testing or monitoring must be identified in the proposal and an approval under relevant water legislation be obtained from NOW prior to their installation.

Groundwater Dependent Ecosystems

The EA should provide details on the presence and distribution of Groundwater Dependent Ecosystems (GDEs) in the vicinity of the study area and:

- demonstrate that the proposed development would maintain natural patterns of groundwater flow and not disrupt groundwater levels that are critical to GDEs;
- identify any potential impacts on GDEs as a result of the proposal including:
  - the effect of the proposal on the recharge to groundwater systems;
  - the potential to adversely affect the water quality of the underlying groundwater system and adjoining groundwater systems in hydraulic connections;
  - the effect on the function of GDEs (habitat, groundwater levels, connectivity); and
- provide safeguard measures for any GDEs.

GDEs are ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater. GDEs represent a vital component of the natural environment and can vary in how they depend on groundwater, from having occasional or no apparent dependence through to being entirely dependent. GDEs occur across both the surface and subsurface landscapes ranging in area from a few metres to many kilometres. Surface and groundwaters are often interlinked and aquatic ecosystems may have a dependence on both.

Ecosystems that can depend on groundwater and that may support threatened or endangered species, communities and populations, include:

- terrestrial vegetation that show seasonal or episodic reliance on groundwater;
- river base flow systems which are aquatic and riparian ecosystems in or adjacent to streams/rivers dependent on the input of groundwater to base flows;
- aquifer and cave ecosystems;
- wetlands;
- estuarine and near-shore marine discharge ecosystems; and
- fauna which directly depend on groundwater as a source of drinking water or live within water which provide a source.

Section 6.8.1 of the PEA notes there are a number of SEPP14 wetlands in the locality and Coomonderry Swamp is to the south of the study area (page 40). The EA should identify and provide detail on the following:

a. any wetlands within the study area (including SEPP14 wetlands) and also those outside the study area potentially affected by the proposal;
b. the footprint of the proposal in relation to the wetlands;
c. buffer setback widths around the wetlands (if applicable).

The EA should identify any potential impact on the wetlands, identify if the wetlands are groundwater dependent, assess the modification to the wetlands hydrologic regime/groundwater recharge and loss/degradation of habitat and provide safeguard measures to protect and minimise impacts on wetlands.

The SEPP 14 wetlands should not be impacted at all, that is no artificial lowering of the water table in a SEPP 14 wetland is the general principle the NOW upholds. Please see the Groundwater Dependent Ecosystem Policy (2000) which can be downloaded off the NOW's web site www.water.nsw.gov.au

The EA needs to supply evidence that there would be no drawdown of significance that would impact the SEPP 14 wetlands. Some pump testing of the aquifer may be required and an assessment of groundwater volumes to be extracted should be determined. Please see a copy of the NOW's pump test standards for the coast attached. The EA needs to demonstrate that excavation below the water table and dewatering will not impact on a sensitive environment like GDEs, and also that there would be negligible interference on neighbouring bores. In addition a Dewatering Management Plan should address disposal of extracted groundwater.

Relevant Policies and Legislation

The following NSW Government legislation and policies implemented by the NOW are applicable to the proposal:

- *Water Management Act 2000*;
- *Water Act 1912*;
- NSW Groundwater Policy Framework Document – General;
- NSW Groundwater Quantity Management Policy;
- NSW Groundwater Quality Protection Policy;
- NSW Groundwater Dependent Ecosystem Policy
- NSW State Rivers and Estuaries Policy
- NSW Wetlands Management Policy
- NSW Farm Dams Policy

End Attachment A
14 April 2011

NSW GOVERNMENT
Industry & Investment

PCU018770

Michael Young
Senior Planning Officer
Infrastructure Projects
NSW Department of Planning
GPO Box 39
SYDNEY NSW 2001

Department of Planning
Received
21 JAN 2011
Scanning Room

Your ref: MP 10_0240

OUT11/554

Attention: Kylie Seretis

Dear Mr Young,

Re: Proposed Princes Highway Upgrade – Foxground and Berry Bypass (MP10_0240) - Section 75F(4) EP&A Act Consultation

I refer to your letter of 10 January 2011, and enclosed Preliminary Assessment report by the Roads and Traffic Authority (RTA) (dated December 2010), requesting Industry & Investment NSW (I&I NSW) key issues and environmental assessment requirements for the above major project application.

This response from I&I NSW provides comments on Fisheries and Agriculture requirements related to this proposal. I&I NSW advises that there are no issues related to Mineral Resources or State Forests.

Issues Related to Fisheries

I&I NSW is responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. To achieve this, the Department ensures that developments comply with the requirements of the *Fisheries Management Act 1994* (namely the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the Act respectively) and the associated *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (1999)*. In addition the Department is responsible for ensuring the sustainable management of commercial and recreational fishing and aquaculture within NSW.

I&I NSW notes that the proposal includes new road crossings of Broughton Creek, Broughton Mill Creek and Bundewallah Creek.

Key Issues

The key issues of concern to I&I NSW in relation to this Major Project development are:

- direct impacts on aquatic environments and key fish habitat (including riparian vegetation, instream aquatic vegetation and large woody debris) from road construction.
- impacts on water quality during all road construction activities and from stormwater runoff and road drainage during the ongoing use of the upgraded highway.
- impacts on recreational fishing access and opportunities in Broughton Creek, Broughton Mill Creek and Bundewallah Creek.

Environmental Assessment Requirements

It is important that the Environmental Assessment (EA) assesses the full extent of potential impacts to the aquatic environment within the development area. Proposed measures to mitigate, rehabilitate or compensate for such impacts are to be detailed in accordance with the Department's Policy and Guidelines referenced above to ensure that there is 'no net loss' of aquatic habitats.

The Department advises that the environmental assessment for the proposed development should consider and provide information on the following specific issues:

- Description of aquatic and riparian environments in the vicinity of the development – particularly extent and condition of riparian vegetation and instream aquatic vegetation, water depth, and permanence of water flow and snags (large woody debris) within the footprint of the proposed highway upgrade.
- Analysis of any interactions of the proposed roadworks with aquatic and riparian environments and predictions of any impacts upon aquatic and riparian environments (including fish and aquatic and riparian vegetation) from the roadworks (both temporary and permanent). This should include assessment of both direct impacts (removal, disturbance, smothering) and indirect impacts (e.g. shading, permanent loss of habitat).
- Description of proposed environmental compensation measures to offset the permanent loss of riparian habitats in Broughton Creek, Broughton Mill Creek and Bundewallah Creek (e.g. funding for aquatic rehabilitation works, such as removal of fish passage barriers, elsewhere in the catchment as recommended by I&I NSW).
- Description of potential impediments to fish passage as a result of the works (e.g. temporary coffer dams, instream bunds or work platforms) and possible mitigation measures to be employed to negate these impacts.
- Predictions of impacts upon water quality of the proposed road development, including in Broughton Creek, Broughton Mill Creek and Bundewallah Creek, both during the construction and operational phases.
- Safeguards to mitigate any impacts upon aquatic species and environments and water quality during construction and operation of the highway upgrade. In particular, provide details on proposed revegetation of riparian areas, proposals for erosion and sediment control (to be incorporated into a Construction Environmental

Management Plan - CEMP) and proposed stormwater and road drainage management measures (e.g. sediment basins). Water quality management for the highway upgrade should be designed to achieve no nett increase in pollutant run-off to Broughton Creek, Broughton Mill Creek and Bundewallah Creek.
- An assessment of any impacts of the proposed development and construction works on recreational fishing in the area, especially in relation to fishing access arrangements (foreshore and boat based).

Issues Related to Agriculture
Most agricultural issues for a highway bypass have been included within the Draft Director General's requirements (23/12/10) attached to your letter.

However, as well as land use viability, development potential, land sterilisation and severance impacts included in the DG requirements, a critical issue that needs to be addressed is farm access.

Infrastructure proposals can result in interruptions to internal or external farm access and to farm services that may affect the efficient operation and sustainability of agricultural businesses. Farm businesses rely on access to road networks for supplies, employees, specialist support services and selling products. Access to infrastructure such as power, communication and water can also be critical for animal welfare and business survival. Reliable, effective access to the road network and services is particularly critical at peak selling or harvesting times and for intensive livestock operations (eg dairies, poultry), horticultural and vegetable enterprises. Internal access to water, pastures, feed storage and farm infrastructure (eg irrigation equipment) can also be vital for animal welfare and sustainable farming. Operating farms often comprise more than one allotment and need to access resources, livestock and crops spread across the holding.

Further information of this issue is available from the I&I NSW land use planning and development web portal: http://www.dpi.nsw.gov.au/environment/landuse-planning/agriculture. The relevant guideline that may assist you is: 'Infrastructure Proposals on Rural Land'.

If you have any queries with regard to agriculture matters please contact Wendy Goodburn on ph 4828 6600 or by email at wendy.goodburn@industry.nsw.gov.au.

Please ensure a copy of the Director-General's Requirements and the subsequent environmental assessment documents provided by the proponent for this major project are provided to I&I NSW for review and further comment. I&I NSW also requests that a copy of this correspondence is provided to the applicant for their information.

If you require any further information, please contact me on 02) 4478 9103.

Yours faithfully

Trevor Daly

Trevor Daly
Fisheries Conservation Manager, South Coast
Aquatic Habitat Protection

17 January 2011

Shoalhaven City Council

City Administrative Centre
Bridge Road, Nowra NSW Australia 2541
Phone: (02) 4429 3111 • Fax: (02) 4422 1816 • DX 5323 Nowra

Address all correspondence to
The General Manager, PO Box 42, Nowra NSW Australia 2541

PCU019226

COUNCIL REFERENCE: 3A11/1000 (D11/22975)
CONTACT PERSON: John Britton
YOUR REF:

2 February 2011

Department of Planning - Major Project Assessments
GPO Box 39
SYDNEY NSW 2001

Department of Planning
Received
7 FEB 2011
Scanning Room

Attention: Mr M Young – Infrastructure Planning

Dear Sir

Princes Highway Upgrade – Foxground and Berry Bypass
Major Project MP10_0240

I refer to the above and provide Council's Key Issues submission for your consideration. The submission provides preliminary comments and Council requests they be conveyed to the proponent at this stage of the project application.

If you need further information about this matter, please contact Council's Part 3A Coordinator, John Britton, on (02) 4429 3432. Please quote Council's reference 3A11/1000.

Yours faithfully

J Britton

John Britton
Part 3A Coordinator

SHOALHAVEN CITY COUNCIL

SUBMISSION TO THE NSW DEPARTMENT OF PLANNING
PART 3A, ENVIRONMENTAL PLANNING & ASSESSMENT ACT, 1979

KEY ISSUES SUBMISSION

MAJOR PROJECT APPLICATION MP 10_0240

PROPERTY: Land within the Shoalhaven local government area. Princes Highway Upgrade – Foxground and Berry Bypass

APPLICANT: Roads and Traffic Authority (RTA)

OWNER: Local and State road authorities and other private landowners

DEPARTMENT OF PLANNING REFERENCE:
MP10_0240 (Project)

COUNCIL REFERENCE: 3A11/1000

Introduction

The project is for the upgrade of the Princes Highway between Foxground and south of Berry. Part of the project is within the Kiama local government area and this Key Issues submission only relates to the project within the Shoalhaven local government area.

Council staff have been included in focus meetings and discussions with the RTA and the Department as the project proposal was prepared. Council has been provided with concept plans by the RTA to assist the Council's understanding of the works. The draft DGRs have been forwarded to Council.

Council's submission highlights additional maters that are requested as part of the DGRs to be satisfied before the public exhibition of the Environmental Assessment Report. These relate to Traffic, Water and Sewer Infrastructure and Consultation matters.

Traffic Planning Matters

(a) Council requests the RTA consider the following as part of the DGR –Traffic and Transport section:

Of particular concern are the following matters:

This project has been subject of ongoing discussions between Council and RTA since project inception, in particular the Berry Bypass and access options for Berry. Council has made a number of resolutions regarding design changes, most of which have now been addressed by RTA however some remain outstanding issues to be resolved.

In addition, now that plans are available for review along the full length of the Highway, other issues have also emerged that are required to be addressed.

At this point in time outstanding issues from observation of the plans RTA have made available include;

(i) The turnaround area proposed to be provided on the old section of Highway adjacent approx CH11150 is at the bottom of the "big dipper" which (being at the bottom of the hill) is a complete inconvenience to motorists who would have to travel down the hill, turnaround, then travel back up the hill to access the Highway. Larger vehicles doing this would impact other traffic as they crawled back up the hill (efficiency concerns and likely adverse safety consequences). This is also avoidable. This situation would not be accepted on the Highway and should not be accepted on what will be a local road when handed over to Council. Refer plan 15 of 50 (of RTA plans). Find attached a sketch prepared by Council Traffic Unit of an alternative arrangement which would be preferred (*"edits to plan 15 of 50.jpg"*)

(ii) The intersection arrangement proposed at Schofields Lane south of Berry is queried. The reason the intersection was moved further to the north years ago (as per the present situation) was to address unacceptable sight distance and the resultant crash history due to location of the crest directly adjacent to (to the south of) the former intersection. RTA have now proposed to move the intersection back to its former location. To do this the crest would either need to be removed completely or alternatively an acceleration lane would need to be provided for traffic exiting Schofield Lane. There are no levels provided on the RTA plans so it is not clear whether they (RTA) have proposed to level the crest to provide good sight distance. This issue needs to be addressed.

(iii) Similar to the issue at Schofields Lane, there are potential sight distance issues at the intersection Tindalls Lane with the new Highway to the north of Berry. An acceleration lane could also be needed at that location for traffic exiting Tindalls Lane to address sight distance concerns. There are no levels provided on the RTA plans so it is not clear exactly what the impact will be, however this issue needs to be addressed.

(iv) Council have been asking for a pedestrian / cyclists overbridge to connect both sides of North Street following the severance the upgraded Highway will create. In response to Council's concerns regarding severance of North Street the RTA have proposed shared path connections to Kangaroo Valley Road and Queen Street and also along the northern side of the Highway connecting back to town under the Highway near Berry Sports complex. These path details have not been shown on the plans made available by RTA, this is to be addressed. If built to RTA standards the northern pathway (which will be in excess of 1km in length just from Rawlings Lane) is likely to cost close to $1M. If included in the Highway upgrade contract a pedestrian overpass could be built for a similar cost and provide a better accessibility solution for pedestrians and cyclists. This should be reconsidered.

(v) Also in relation to the severance of North Street, Council have been asking for a suitable bus and garbage truck turnaround on North Street where the RTA proposes to connect North Street to Rawlings Lane. The RTA has still not addressed this issue. Council and SITA have confirmed there are several properties in North Street (west end) and Rawlings Lane that have a garbage service that will be affected by the RTA proposal. A garbage truck will need to be able to turnaround at the southern end of Rawlings Lane. There are also currently school children in Rawlings Lane that catch the bus in North Street. This bus service will also be affected and Council have requested that the turnaround area be suitable also for school buses. Find attached a sketch prepared by Council Traffic Unit of a suitable turnaround arrangement (*"edits to plan 27 of 50.jpg"*)

(vi) Also in relation to the severance of North Street, there are three (3) properties that will be directly affected by the RTA proposal to provide a cul-de-sac in North Street at the eastern boundary of the Church Lot (Lot 1 DP86897, 80 North Street). Properties 72 North Street, and 74-76 North Street will be affected (immediately to the east of the upgraded Highway). The same sketch prepared by Council Traffic Unit (*"edits to plan 27 of 50.jpg"*) highlights this issue which needs to be addressed. Unless these properties are acquired by RTA they will need to be accessed and serviced.

(vii) There are no provisions in the plans to provide a left turn from Toolijooa Road direct to the Highway at the northern end of Toolijooa Road. The option provided is that motorists travel across the Highway (grade separated junction at Toolijooa Road) and traverse some 6km on the Old section of Highway before rejoining the new Highway at approximately Austral Park Road. This will lead to increased traffic on Toolijooa Road (SCC section) and Beach Road, Tannery Road which have safety issues and are sensitive to even small increases in traffic. This issue may not be so critical based on current levels of traffic on Toolijooa Road however providing direct access to the new Highway will provide some level of protection to Shoalhaven City Council's roads. It is recommended that left turn access be provided at Toolijooa Road on to the Highway, or that at the very least the design demonstrate that a left turn access to the Highway can be provided if necessary to accommodate a development such as service station or other type of development at the Toolijooa Road interchange or along Toolijooa Road, and land acquired at this time to accommodate the left turn out. Traffic can currently turn left out of Toolijooa Road on to the Highway and Council should not accept a reduced level of access that will impact Shoalhaven City Council roads.

(viii) One of the greatest deficiencies in the design (a current outstanding issue) is that RTA have not provided two (2) off ramps to Berry for traffic entering Berry from the south. The current proposal seeks to accommodate all of the traffic entering Berry "through" the residential sub-division at Huntingdale Park, the major residential growth area of Berry. Whilst the off ramp in this location has been planned for as part of the DCP for the area, in Council's view it was never planned for as the "only" entrance to Berry, and Council believes there is a fundamental planning flaw in the RTA proposing this as the only access for Berry from the south due to the adverse traffic and environmental impacts to the residential growth area of Huntingdale Park. It is estimated that at full development there will be no spare environmental capacity to accommodate the Highway traffic entering Berry at this point without an additional exit to Berry further to the north to mitigate the impacts on the residential area. When this occurs Council and the community will not want to have to wait 18 years as has taken the RTA to provide the additional ramps in Kiama to address local traffic impacts. Council have proposed that a northbound exit to Berry be provided at Woodhill Mountain Road. Similarly a southbound access to the Highway should be provided from Woodhill Mountain Road. These measures will ensure the traffic impacts from the off ramp into Huntingdale Park would be kept to minimum possible levels and that as much through traffic as possible would be removed from the Berry town centre which is one of the primary objectives of the Bypass proposal.

Whilst the upgrade proposal in general is supported in principle and should be constructed at the earliest practical time, it is Traffic Unit's view that these outstanding issues are to be addressed by the applicant before Council can support the project to proceed.

Infrastructure

Council requests an additional DGR item be added, named ***"Infrastructure"***

This should require the proponent to (a) accurately identify existing infrastructure such as water, wastewater, sewer, gas, electricity and telephone facilities and services likely to be impacted by the proposal and (b) state the measures to be taken to relocate or otherwise treat to mitigate impacts, including maintaining operations during the constructing works are carried out.

Water and Wastewater

Council's Shoalhaven Water is the water and sewer authority. The proposal will affect critical Shoalhaven Water's water and wastewater assets and the following is requested be included within the DGRs and the proponent advised.

All works in close proximity/or over Shoalhaven Water's assets (including Water Service lines) will require approval by Shoalhaven Water. Shoalhaven Water advises that the minimum horizontal and vertical clearances are to be in accordance with WSA code for water supply and sewerage and where required compliant with Council's Building Over Sewers Policy; therefore works that are required to protect or relocate or augment such services are to be approved by Shoalhaven Water prior to works being undertaken and all works are to be at the developer's expense.

The applicant will be required to submit plans to Shoalhaven Water for determination for the whole extent of the works, the plans are to accurately show all existing Shoalhaven Water infrastructure that may be impacted upon by the proposed road works and associated works.

The applicant will be required to make written application for a Certificate of Compliance, under section 305 of the *Water Management Act 2000*, to Shoalhaven Water after consent has been granted and prior to works commencing.

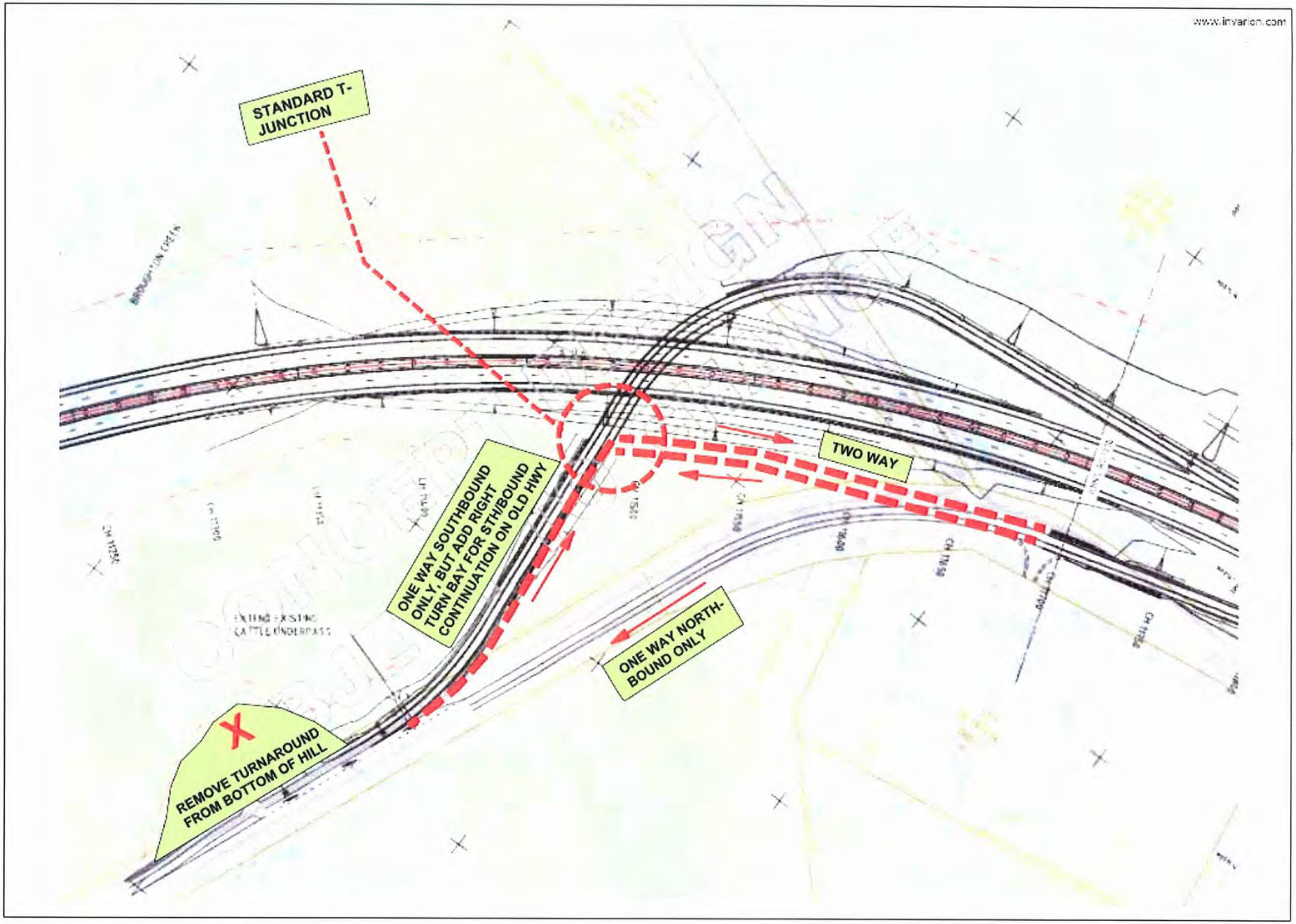
Consultation

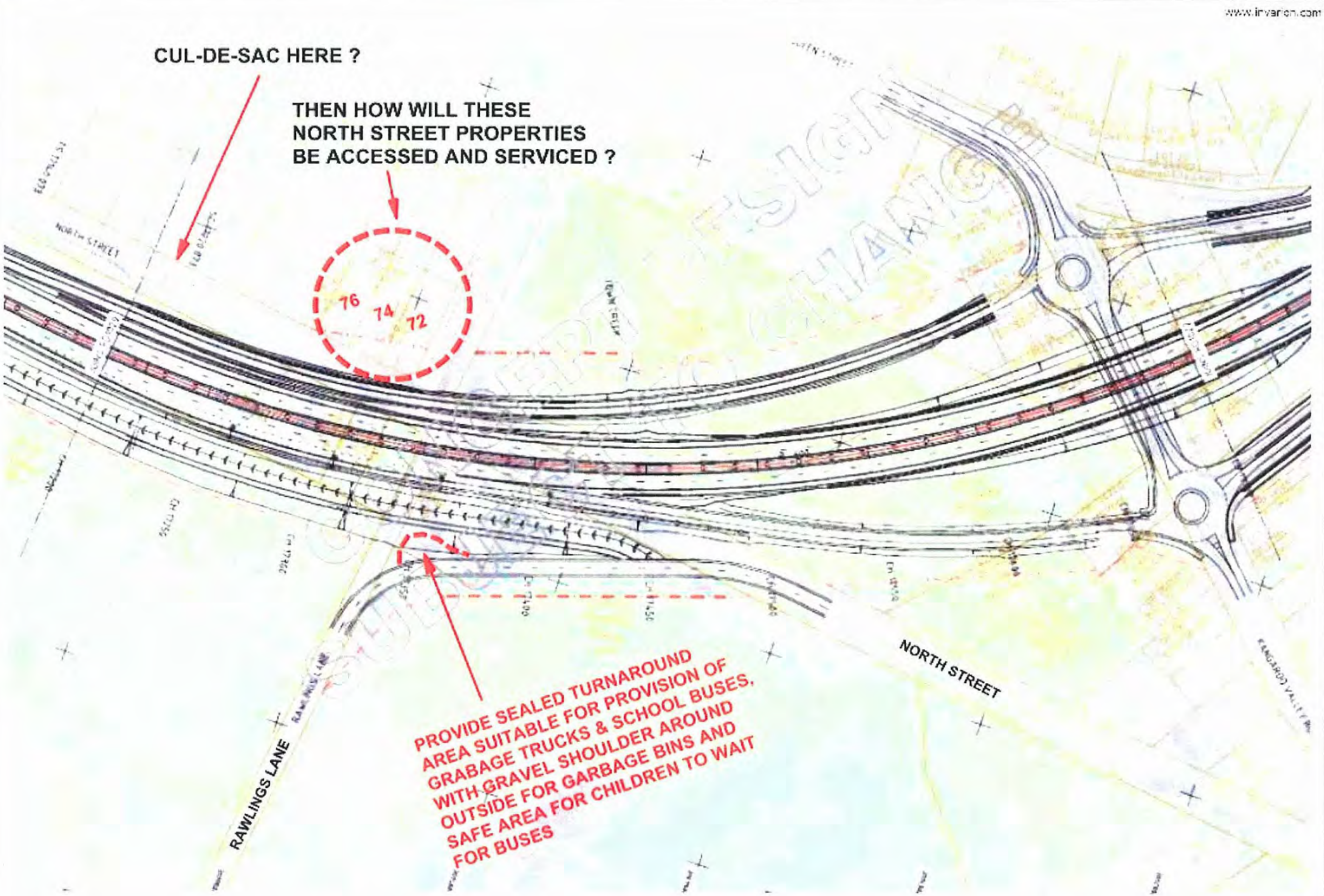
Council requests that Shoalhaven Water be added to the list of agencies the proponent must consult with in the preparation of the studies required by the DGRs.

Conclusion
Council requests the details contained in the submission be favourably considered.

Further information may be obtained by contacting Council's Part 3A Coordinator, John Britton on 02-4429 3432 or britton@shoalhaven.nsw.gov.au

T Fletcher
Director
Development and Environmental Services Group
27 January 2011


www.invarion.com
STANDARD T-JUNCTION
BROUGHTON CREEK
TWO WAY
ONE WAY SOUTHBOUND ONLY, BUT ADD RIGHT TURN BAY FOR STH/BOUND CONTINUATION ON OLD HWY
EXTEND EXISTING CATTLE UNDERPASS
ONE WAY NORTH-BOUND ONLY
X
REMOVE TURNAROUND FROM BOTTOM OF HILL



CUL-DE-SAC HERE ?

THEN HOW WILL THESE
NORTH STREET PROPERTIES
BE ACCESSED AND SERVICED ?

PROVIDE SEALED TURNAROUND
AREA SUITABLE FOR PROVISION OF
GRABAGE TRUCKS & SCHOOL BUSES,
WITH GRAVEL SHOULDER AROUND
OUTSIDE FOR GARBAGE BINS AND
SAFE AREA FOR CHILDREN TO WAIT
FOR BUSES

Andrew Beattie - Fwd: FW: Princes Highway Upgrade - ST.0248

From: Kylie Seretis
To: Andrew Beattie
Date: 2/2/2011 2:48 PM
Subject: Fwd: FW: Princes Highway Upgrade - ST.0248

>>> "Joanne Henry" <joanneh@kiama.nsw.gov.au> 17/01/2011 10:03 >>>

Morning Kylie

Please find following the information as requested by Michael regarding the Princes Highway Upgrade – Berry-Foxground.

Regards

Charmain North

Executive Assistant (Relief)

Engineering and Works
Kiama Municipal Council

P 4232 0483

F 4232 0497

A PO Box 75, Kiama NSW 2533

E joanneh@kiama.nsw.gov.au

W www.kiama.nsw.gov.au

From: Joanne Henry
Sent: Monday, 17 January 2011 9:42 AM
To: 'Michael.Young@planning.nsw.gov.au'
Cc: Records; Bryan Whittaker
Subject: Princes Highway Upgrade - ST.0248

Michael

Thank you for the opportunity to provide comments on the Director Generals Requirements for the Environmental Assessment for the Upgrade of the Princess Highway, Foxground to Berry By-Pass.

The following additional items are considered to be relevant and Council respectfully requests their inclusion in the DGR's

- Air Quality – Both during and after Construction
- Land Acquisition – Minimisation of the acquisition of viable Agricultural land
- Local Property Access – Both during and after construction with consideration of the need for service lanes
- Transfer of redundant highway sections – Road Asset and Safety Audits and/or upgrade prior to transfer to Council
- Local Infrastructure – Impact on the local road and drainage infrastructure both during and after construction. Including detailed traffic modelling of construction phase and post construction conditions and the necessary provision of Traffic Management devices on the local network to accommodate changes.
- Visual Amenity – Highway / Street Lighting and impacts on adjacent residents
- Emergency Access – The provision of adequate turning opportunities for Emergency Service vehicles

Regards

Bryan Whittaker

Director Engineering and Works

Kiama Municipal Council

P 4232 0483

F 4232 0497

A PO Box 75, Kiama NSW 2533

E joanneh@kiama.nsw.gov.au

W www.kiama.nsw.gov.au

Appendix A - DGR checklist

	DGR	Where addressed in the environmental assessment
	1. Executive summary (General requirement *)	
☒	The EA must include an executive summary.	Executive summary
	2. Certification (General requirement*)	
☒	The EA must include certification by the author of the environmental assessment that the information contained in the assessment is neither false nor misleading.	Page iv
	3. Strategic justification (Key issue 1*)	
☒	The EA must describe the strategic need, justification and objectives for the project taking into account the aims and objectives of relevant strategic planning and transport policies including the:	Sections 2.1-2.5 Section 11.1.1
☒	• State Plan (2006).	Section 2.1.2
☒	• Illawarra Regional Strategy.	Section 2.1.2
☒	• South Coast Regional Strategy.	Section 2.1.2
☒	• Other.	Section 2.1.2
	4. Project justification (Key issue 2*)	
☒	The EA must assess:	-
☒	• The alternatives considered.	Chapter 3 Chapter 11
☒	• The environmental costs and benefits of the project relative to alternatives.	Chapter 3 Chapter 11
	5. Description of the project (General requirement*)	
☒	The EA must include a **detailed description** of the project including:	Chapter 4
☒	• Route alignment.	Section 4.2.1
☒	• Corridor width.	Section 4.2.4
☒	• Design elements including:	Section 4.2
☒	– Requirements for bridges.	Section 4.2.7
☒	– Culverts.	Section 4.2.10
☒	– Level of service.	Section 4.2.3 Section 7.1
☒	– Pedestrians.	Section 4.2.17
☒	– Cyclists.	Section 4.2.17
☒	– Rest areas.	Section 4.2.15
☒	– Service centres.	Section 4.2.14
☒	– Other (if required).	Chapter 4 Sections 4.2.2, 4.2.5, 4,2,6, 4.2.8, 4.2.9, 4.2.11, 4.2.12, 4.2.13, 4.2.18 and 4.2.19

	DGR	Where addressed in the environmental assessment
☒	• Clear identification **of and/or options for** the proposed location of **ancillary facilities** including:	Section 4.4.7
☒	– Compound sites.	Section 4.4.7
☒	– Batching plants.	Section 4.4.7
☒	– Other (if required).	Section 4.2.16 Section 4.4.7
☒	• Resourcing including:	-
☒	– Construction material needs.	Section 4.4.4
☒	– Spoil disposal.	Section 4.4.5 Section 8.4
☒	– Natural resource consumption including water supply sources.	Section 4.4.6 Section 8.4
☒	– Other (if required).	-
☒	• Potential staging including:	Section 4.4.10
☒	– Construction.	Section 4.4.10
☒	– Operation.	Section 4.4.10
	6. Consultation (Consultation requirement*)	
☒	An **appropriate and justified level** of consultation must be undertaken with relevant parties during the preparation of the EA, including:	Section 6.2 Table 6-1 Appendix C
☒	• Local government including:	Section 6.2 Appendix C
☒	– Shoalhaven City Council.	Section 6.2 Appendix C
☒	– Council of the Municipality of Kiama.	Section 6.2 Appendix C
☒	• State government including:	Section 6.2 Appendix C
☒	– Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water).	Section 6.2 Appendix C
☒	– Department of Primary Industries (incorporating the former NSW Office of Water, and Industry and Investment NSW – Fisheries and Agriculture).	Section 6.2 Appendix C
☒	• Commonwealth Government.	Section 6.2 Appendix C
☒	• Service providers, including:	Section 6.2 Appendix C
☒	– Shoalhaven Water.	Section 6.2 Appendix C
☒	• Specialist interest groups including Local Aboriginal Land Councils.	Section 6.2 Appendix C
☒	• The public, including affected landowners.	Section 6.2 Appendix C
☒	The EA must describe the consultation process.	Section 6.2
☒	The EA must document all community consultation undertaken to date.	Chapter 6 Appendix C

	DGR	Where addressed in the environmental assessment
☒	The EA must identify the issues raised (including where these have been addressed in the EA).	Chapter 6 Appendix C
☒	The EA must address **all relevant issues raised (including those in the agency letters** accompanying the DGRs).	Chapter 6
	7. Key issues (General requirement*)	
☒	The EA must include an **assessment of the key issues,** including an assessment of the **worst case and representative impact** for each issue for all aspects of the project (including the **proposed locations of and/or options** for the **ancillary facilities**) with the following aspects addressed for **each key issue** (where relevant):	Chapter 7 Technical papers (Appendix D to M)
☒	• Describe the existing environment.	Chapter 7 Technical papers (Appendix D to M)
☒	• Assess the potential impacts of the proposal including:	Chapter 7 Technical papers (Appendix D to M)
☒	– At the construction stage.	Chapter 7 Technical papers (Appendix D to M)
☒	– At the operation stage.	Chapter 7 Technical papers (Appendix D to M)
☒	– In accordance with relevant policies and guidelines.	Chapter 7 Technical papers (Appendix D to M)
☒	– Consider direct impacts including potential interactions with the existing Princes Highway (as relevant).	Chapter 7 Technical papers (Appendix D to M)
☒	– Consider indirect impacts including potential interactions with the existing Princes Highway (as relevant).	Chapter 7 Technical papers (Appendix D to M)
☒	• Identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/or in developing management/mitigation measures.	Chapter 4, Chapter 7 Technical papers (Appendix D to M)
☒	• Describe measures to be implemented to avoid, minimise, manage, mitigate, offset and /or monitor the impacts of the project and the residual impacts.	Chapter 7 Technical papers (Appendix D to M)
	8. Traffic and transport (Key issue 3*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.1 Appendix D
☒	The EA must include an assessment of **Construction traffic** impacts, including but not limited to:	Section 7.1.3 Appendix D 3
☒	• Identification of construction routes and the nature of existing traffic on these routes.	Section 7.1.3 Appendix D
☒	• Quantification of traffic volumes, including:	Section 7.1.3 Appendix D
☒	– Spoil haulage.	Section 7.1.3 Appendix D
☒	– Other	Section 7.1.3 Appendix D

	DGR	Where addressed in the environmental assessment
☒	• Potential impacts to regional and local road network, including:	Section 7.1.3 Appendix D
☒	– Safety.	Section 7.1.3 Appendix D
☒	– Level of service	Section 7.1.3 Appendix D
☒	– Other	Section 7.1.3 Appendix D
☒	• Potential disruption to existing:	-
☒	– Public transport services.	Section 7.1.3 Appendix D
☒	– Access/service lanes to local properties.	Section 7.1.3 Appendix D
☒	The EA must include an assessment of **Operational traffic and transport** impacts to the **local and regional road network** including but not limited to:	Section 7.1.3 Appendix D
☒	• Changes to access arrangements/service lanes to local properties.	Section 7.1.3 Appendix D
☒	• Changes to local road connectivity and access.	Section 7.1.3 Appendix D
☒	• Assessment of impacts (including direct impacts from the replacement of the existing highway that currently passes through Berry) on:	Section 7.1.3 Appendix D
☒	– Local traffic arrangements.	Section 7.1.3 Appendix D
☒	– Local road capacity	Section 7.1.3 Appendix D
☒	– Safety from traffic rerouting	Section 7.1.3 Appendix D
☒	– Modified access to the upgraded highway	Section 7.1.3 Appendix D
☒	• The assessment must take into account:	-
☒	– Potential interactions with local traffic associated with the residential sub-division at Huntingdale Park, Berry (including future growth).	Section 7.1.3 Appendix D
☒	– Any severance impacts on local connectivity within Berry as a result of the proposed route.	Section 7.1.3 Appendix D
☒	• Consideration must be given to potential impacts of changed traffic arrangements on:	-
☒	– Local and/or school bus services.	Section 7.1.3 Appendix D
☒	– Access for emergency services.	Section 7.1.3 Appendix D
☒	– Garbage truck routes.	Section 7.1.3 Appendix D
☒	• Traffic capacity of the proposal and its ability to cater for predicted growth.	Chapter 4 Section 7.1.3 Appendix D
☒	• What effect potential major land use changes in the locality may have on the traffic assessment outcomes.	Section 7.1.3 Appendix D

	DGR	Where addressed in the environmental assessment
☒	- Opportunity for the provision of cycle way connections along the highway and to adjoining communities.	Section 7.1.2 Appendix D
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.1 Appendix D
	9. Noise and vibration (Key issue 4*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.2 Appendix E
☒	The EA must include a **construction noise and vibration assessment,** including but not limited to:	Section 7.2 Appendix E
	- Assessment of:	-
☒	– Construction traffic noise.	Section 7.2.4 Appendix E
☒	– Batch plants.	Section 7.2.4 Appendix E
☒	– Blasting impacts.	Section 7.2.4 Appendix E
☒	- The EA (Construction noise and vibration assessment), must:	-
☒	– Clearly identify nearest sensitive receptors.	Section 7.2.4 Appendix E
☒	– Assess construction noise/vibration generated by representative construction scenarios focusing on high noise generating works.	Section 7.2.4 Appendix E
☒	- Where **work hours** outside **of standard construction hours** are proposed, provide:	-
☒	– clear justification;	Section 7.2.4 Appendix E
☒	– detailed assessment of the proposed work hours, including:	Section 7.2.4 Appendix E
☒	▪ Alternatives considered	Section 7.2.4 Appendix E
☒	▪ Mitigation measures proposed.	Section 7.2.5 Appendix E
☒	- The assessment must further consider **any cumulative impacts during construction**, having regard to any other developments (both existing and approved) in the locality.	Section 7.2.4 Appendix E
☒	The EA must include an **operational road traffic noise assessment** including but not limited to:	Section 7.2 Appendix E
☒	- Consideration of local meteorological conditions (as relevant).	Section 7.2.4 Appendix E
☒	- Any additional reflective noise impacts from proposed noise mitigation barriers.	Section 7.2.4 Appendix E
☒	The **Construction and Operational Noise and Vibration** assessments must take into account the following guidelines as relevant:	-
☒	- Interim Construction Noise Guideline (DECC 2009).	Section 7.2 Appendix E
☒	- Environmental Criteria for Road Traffic Noise (EPA 1999).	Section 7.2 Appendix E

	DGR	Where addressed in the environmental assessment
☒	- Environmental Noise Management Manual (RTA 2001).	Section 7.2 Appendix E
☒	- Assessing Vibration: A Technical Guideline (DEC 2006).	Section 7.2 Appendix E
☒	- Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990).	Section 7.2 Appendix E
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.2 Appendix E
	10. Flora and fauna (Key issue 5*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.3 Appendix F Appendix G
☒	The EA must include a Flora and Fauna (terrestrial and aquatic) assessment, including:	Section 7.3 Appendix F Appendix G
☒	- An assessment that is consistent with the Draft Guidelines for Threatened Species Assessment (DEC 2005).	Section 7.3 Appendix F Appendix G
☒	- Details of the survey methodology employed including survey effort and representativeness for species targeted.	Section 7.3.1 Appendix F Appendix G
☒	- An assessment of all project components on:	-
☒	– Terrestrial flora and their habitats.	Section 7.3 Appendix F Appendix G
☒	– Terrestrial fauna and their habitats.	Section 7.3 Appendix F Appendix G
☒	– Aquatic flora and their habitats.	Section 7.3 Appendix F Appendix G
☒	– Aquatic fauna and their habitats.	Section 7.3 Appendix F Appendix G
☒	- Specific consideration of impacts to threatened species, populations, ecological communities and/or critical habitat (terrestrial and aquatic) listed under both State and Commonwealth legislation that have been recorded on the site and surrounding land.	Section 7.3.3 Appendix F Appendix G
☒	- Details on the existing site conditions (both terrestrial and aquatic) and quantity and likelihood of disturbance (including quantifying the worst case extent of impact on the basis of vegetation type and total native vegetation disturbed).	Section 7.3.2 Appendix F Appendix G
☒	- As relevant, consideration of:	-
☒	– Weed infestation.	Section 7.3.3 Appendix F Appendix G
☒	– Edge effects.	Section 7.3.3 Appendix F Appendix G

	DGR	Where addressed in the environmental assessment
☒	– Habitat fragmentation.	Section 7.3.3 Appendix F Appendix G
☒	– Impacts to wildlife and riparian corridors.	Section 7.3.3 Appendix F and G
☒	– Impacts to groundwater-dependent communities	Section 7.3.3 Appendix F Appendix G
☒	– Impacts to riparian areas	Section 7.3.3 Appendix F Appendix G
☒	– Impacts aquatic habitat	Section 7.3.3 Appendix F Appendix G
☒	– Impacts on SEPP 14 wetlands	Section 7.3.3 Appendix F Appendix G
☒	– Impacts on fish passage	Section 7.3.3 Appendix F Appendix G
☒	• Details of how:	-
☒	– Flora impacts would be managed during construction for all project components, including adaptive management and maintenance protocols and monitoring programs.	Section 7.3.4 Appendix F Appendix G
☒	– Fauna impacts would be managed during construction for all project components, including adaptive management and maintenance protocols and monitoring programs.	Section 7.3.4 Appendix F Appendix G
☒	– Flora impacts would be managed during operation for all project components, including adaptive management and maintenance protocols and monitoring programs.	Section 7.3.4 Appendix F and G
☒	– Fauna impacts would be managed during operation for all project components, including adaptive management and maintenance protocols and monitoring programs.	Section 7.3.4 Appendix F Appendix G
☒	• Demonstrate actions to be undertaken to avoid, mitigate or offset impacts associated with the project (all components) consistent with the principles of “improve or maintain”. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project, where offset measures are proposed to address residual impacts.	Section 7.3.4 Appendix F Appendix G
☒	• An assessment of **waterways to be modified** as a result of the project, including:	Section 7.3.3 Section 7.3.4 Section 7.4. Appendix G Appendix H
☒	– Ecological impacts.	Section 7.3.3 Section 7.3.4 Section 7.4. Appendix G Appendix H

	DGR	Where addressed in the environmental assessment
☒	– Hydrological impacts.	Section 7.3.3 Section 7.3.4 Section 7.4. Appendix G Appendix H
☒	– Geomorphic impacts (as relevant).	Section 7.3.3 Section 7.3.4 Section 7.4. Appendix G Appendix H
☒	– Measures to rehabilitate the waterways to pre-construction conditions or better.	Section 7.3.3 Section 7.3.4 Section 7.4. Appendix G Appendix H
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.3 Appendix F Appendix G
	11. Surface and groundwater (Key issue 6*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.4 Appendix H
☒	The EA must include an assessment of impacts to **Surface water quality** including but not limited to:	Section 7.4 Appendix H
☒	• The assessment must take into account:	-
☒	– Impacts from accidents.	Section 7.4.3 Appendix H
☒	– Impacts from runoff.	Section 7.4.3 Appendix H
☒	– Relevant environmental water quality criteria specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000.	Section 7.4.3 Appendix H
☒	• The assessment must describe:	-
☒	– Measures to control erosion and sedimentation during construction activities.	Section 7.4.4 Appendix H
☒	– Measures to capture and treat runoff from the site during the operational phase.	Section 7.4.4 Appendix H
☒	The EA must identify potential risks of the project on **groundwater resources** including:	Section 7.3 Section 7.4 Appendix G Appendix H
☒	• Characterising existing local and regional hydrology.	Section 7.4.2 Appendix H
☒	• Potential risks of drawdown.	Section 7.4.3 Appendix H
☒	• Impacts to groundwater quality.	Section 7.3.3 Section 7.4.3 Appendix G Appendix H
☒	• Discharge requirements.	Section 7.4.3 Section 7.4.5 Appendix H

	DGR	Where addressed in the environmental assessment
☒	• Implications for groundwater-dependent surface flows (including springs and drinking water catchments), groundwater-dependent ecological communities and groundwater users.	Section 7.3.3 Section 7.4.3 Appendix G Appendix H
☒	The EA must include an assessment of **waterways to be modified** as a result of the project, including:	Section 7.3 Section 7.4 Appendix G Appendix H
☒	• Ecological impacts.	Section 7.3.3 Section 7.3.4 Section 7.4.3 Section 7.5.4 Appendix G Appendix H
☒	• Hydrological impacts.	Section 7.3.3 Section 7.3.4 Section 7.4.3 Section 7.5.4 Appendix G Appendix H
☒	• Geomorphic impacts (as relevant).	Section 7.3.3 Section 7.3.4 Section 7.4.3 Section 7.5.4 Appendix G Appendix H
☒	• Measures to rehabilitate the waterways to pre-construction conditions or better.	Section 7.3.3 Section 7.3.4 Section 7.4.3 Section 7.5.4 Appendix G Appendix H
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.4 Appendix H
	12. Flooding (Key issue 6*)	
☒	The EA must identify potential impacts of the project on **existing flood regimes**, consistent with the Floodplain Development Manual (Department of Natural Resources 2005), including:	Section 7.5 Appendix H
☒	• Impacts to existing receivers and infrastructure.	Section 7.5.3 Appendix H
☒	• The future development potential of affected land.	Section 7.5.3 Appendix H
☒	• Demonstration of consideration of the changes to rainfall frequency and/or intensity as a result of climate change on the project.	Section 7.5.3 Appendix H
☒	• Demonstrate due consideration of flood risks in the project design.	Section 7.5 Appendix H
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.5 Appendix H

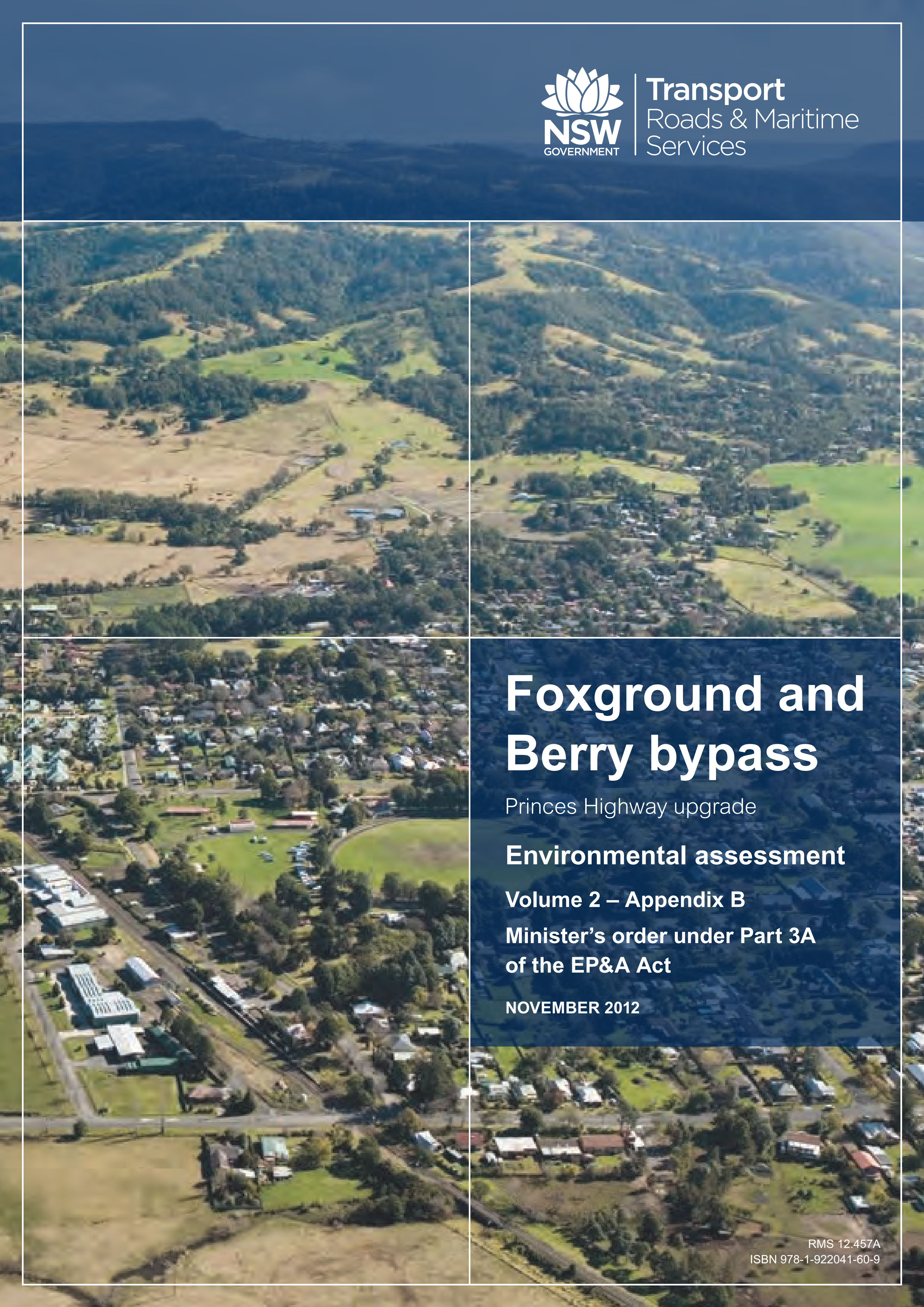
	DGR	Where addressed in the environmental assessment
	13. Landscape and visual amenity (Key issue 7*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.6 Appendix I
☒	The EA must include an assessment of **Landscape and visual amenity** impacts including but not limited to:	Section 7.6 Appendix I
☒	• Assessment of the visual significance of the area, including:	Section 7.6 Appendix I
☒	– The escarpment and ridges.	Section 7.6.2 Section 7.6.3 Appendix I
☒	– The township of Berry.	Section 7.6.2 Section 7.6.3 Appendix I
☒	– The impact of the proposed alignment.	Section 7.6.2 Section 7.6.3 Appendix I
☒	• Design of the project (including noise barriers, retaining walls and landscaping) consistent with the existing (and desired) character of affected localities, including consideration of:	Section 7.6 Appendix I
☒	– The Noise Wall Design Guideline (RTA 2006).	Section 7.6.3 Section 7.6.4 Appendix I
☒	– Highway/street lighting and the potential light spill impacts on nearby residents.	Section 7.6.3 Section 7.6.4 Appendix I
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.6 Appendix I
	14. Aboriginal cultural heritage (Key issue 8*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.7 Appendix J
☒	An assessment of the project on **Aboriginal cultural heritage** including but not limited to:	Section 7.7 Appendix J
☒	• The assessment is consistent with the draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, July 2005).	Section 7.7 Appendix J
☒	• Specifically considers:	-
☒	– Artefacts.	Section 7.7.2 Section 7.7.3 Appendix J
☒	– Potential archaeological deposits.	Section 7.7.2 Section 7.7.3 Appendix J
☒	– Landscape cultural values.	Section7.7.2 Section 7.7.3 Appendix J
☒	The EA (and the Aboriginal cultural heritage assessment) must demonstrate **effective consultation** with indigenous stakeholders:	-
☒	• During the assessment.	Chapter 6 Section 7.7 Appendix C Appendix J

	DGR	Where addressed in the environmental assessment
☒	- In developing mitigation options (including the final recommended measures).	Chapter 6 Section 7.7 Appendix C Appendix J
☒	The EA must describe the actions that will be taken to avoid, mitigate or offset impacts.	Section 7.7.4 Appendix J
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.7 Appendix J
	15. Non-Aboriginal heritage (historic heritage) (Key issue 8*)	
☒	Addresses the relevant general requirements for key issues (section 7 above).	Section 7.8 Appendix K
☒	The EA must include an assessment of the impact of the project on **historic heritage values** including but not limited to:	Section 7.8 Appendix K
☒	- Impacts on the historic township of Berry.	Section 7.8.3 Appendix K
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.8 Appendix K
	16. Land use and property (Key issue 9*)	
☒	Address of the relevant general requirements for key issues (section 7 above).	Section 7.9 Section 7.10 Appendix L Appendix M
☒	The EA must include an assessment of impacts of the project on land use and property including:	Section 7.9.2 Section 7.10 Appendix L Appendix M
☒	Directly-affected properties and land uses adjacent to the project, including:	Section 7.9.2 Section 7.10 Appendix M
☒	Impacts to land use viability.	Section 7.9.2 Section 7.10 Appendix M
☒	Impacts to future development potential.	Section 7.9.2 Section 7.10 Appendix M
☒	Property allotment impacts.	Section 7.9.2 Section 7.10 Appendix M
☒	Land sterilisation impacts.	Section 7.9.2 Section 7.10 Appendix M
☒	Severance impacts.	Section 7.9.2 Section 7.10 Appendix M
☒	The agricultural sector including:	Section 7.9.2 Section 7.10 Appendix M
☒	Internal and external farm access arrangements during construction of the project.	Section 7.9.2 Section 7.10 Appendix M

	DGR	Where addressed in the environmental assessment
☒	Internal and external farm access arrangements during operation of the project.	Section 7.9.2 Section 7.10 Appendix M
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.9 Section 7.10 Appendix L Appendix M
	17. Socio-economic (Key issue 9*)	
☒	Address of the relevant general requirements for key issues (section 7 above).	Section 7.9 Section 7.10 Appendix L Appendix M
☒	An assessment of the **socio-economic impacts** of the project including but not limited to:	Section 7.9 Section 7.10 Appendix L Appendix M
☒	• The agricultural sector taking into account the fragmentation and potential loss of agricultural and farm viability including internal and external farm access arrangements:	Section 7.9.2 Section 7.10.3 Appendix L Appendix M
☒	• Local community socio-economic impacts associated with changes to:	-
☒	– Access.	Section 7.9.2 Section 7.10.3 Appendix L Appendix M
☒	– Land use.	Section 7.9.2 Section 7.10.3 Appendix M
☒	– Property.	Section 7.9.2 Section 7.10.3 Appendix M
☒	– Amenity.	Section 7.9.2 Section 7.10.3 Appendix M
☒	• Business impacts including:	Section 7.10.3 Appendix M
☒	– The overall viability of businesses in the township of Berry associated with the changes to route alignment in Berry.	Section 7.10.3 Appendix M
☒	– The overall profitability of businesses in the township of Berry associated with the changes to route alignment in Berry.	Section 7.10.3 Appendix M
☒	– The overall productivity of businesses in the township of Berry associated with the changes to route alignment in Berry.	Section 7.10.3 Appendix M
☒	– The overall sustainability of businesses in the township of Berry associated with the changes to route alignment in Berry.	Section 7.10.3 Appendix M

	DGR	Where addressed in the environmental assessment
☒	• Impacts on recreational fishing access and opportunities in:	Section 7.10.3 Appendix M
☒	– Broughton Creek.	Section 7.10.3 Appendix M
☒	– Broughton Mill Creek.	Section 7.10.3 Appendix M
☒	– Bundewallah Creek.	Section 7.10.3 Appendix M
☒	This section of the EA must address all relevant issues raised in agency letters accompanying the DGRs or through other consultation activities (see section 6 above).	Section 7.9 Section 7.10 Appendix L Appendix M
	18. Environmental risk analysis (Key Issue 10*)	
☒	The EA must include an environmental risk analysis to identify potential environmental impacts associated with:	Section 9
☒	• Construction of the project.	Section 9.2
☒	• Operation of the project.	Section 9.2
☒	• Proposed mitigation measures.	Section 9.2
☒	• Potentially significant residual environmental impacts after the application of proposed mitigation measures.	Section 9.2
☒	Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EA.	Chapter 7 Chapter 9
	19. Draft Statement of Commitments (General Requirement*)	
☒	The EA must include a draft Statement of Commitments (SoC).	Chapter 10
☒	The SoC must incorporate or otherwise capture all measures to (for the impacts of the project and the residual impacts):	Chapter 10
☒	• Avoid.	Chapter 10
☒	• Minimise, manage, mitigate.	Chapter 10
☒	• Offset.	Chapter 10
☒	• Monitor	Chapter 10
	20. Justification and conclusion (Key issue 2*)	
☒	Provide justification for the preferred project taking into consideration the objects of the *Environmental Planning and Assessment Act 1979* **and** the following:	Section 11.1.2
☒	• The environmental impacts of the project.	Section 11.1.1
☒	• The social impacts of the project.	Section 11.1.1
☒	• The economic impacts of the project.	Section 11.1.1
☒	• The suitability of the site.	Section 11.1.1
☒	• Whether or not the project is in the public interest.	Section 11.1.1

** This checklist has the same structure as the Foxground and Berry bypass environmental assessment. The location of each section in the original DGR document is indicated in brackets.*



NSW GOVERNMENT
Transport
Roads & Maritime
Services

Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 2 – Appendix B

Minister's order under Part 3A of the EP&A Act

NOVEMBER 2012

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COMPANION ANIMALS REGULATION 2008

ORDER

Organisations Approved by the Chief Executive, Local Government under Clause 16(d) of the Companion Animals Regulation 2008

PURSUANT to Clause 16(d) of the Companion Animals Regulation 2008, the organisation listed in Schedule 1 is hereby approved, subject to the conditions contained in Schedule 2.

SCHEDULE 1

Name of Organisation	*Address of Organisation*	*Name of Contact Officer for Organisation*
No Kill Pet Rescue.	71 Darvall Road, West Ryde NSW 2114.	Ms Nora ALEXANIAN.

SCHEDULE 2

1. The exemption under clause 16(d) of the Companion Animals Regulation 2008 from the requirements of section 9 of the Companion Animals Act 1998 only applies to an animal in the custody of an organisation listed in Schedule 1 if the organisation is holding that animal for the sole purpose of re-housing the animal with a new owner.
2. The exemption under clause 16(d) of the Companion Animals Regulation 2008 from the requirements of section 9 of the Companion Animals Act 1998 only applies to an animal in the custody of an organisation listed in Schedule 1 if the organisation maintains appropriate records that show compliance with the Companion Animals Act 1998, Companion Animals Regulation 2008 and the Guidelines for Approval to be an Organisation Exempt from Companion Animal Registration under clause 16(d) of the Companion Animals Regulation 2008.
3. The exemption under clause 16(d) of the Companion Animals Regulation 2008 from the requirements of section 9 of the Companion Animals Act 1998 only applies to an animal in the custody of an organisation listed in Schedule 1 if the organisation maintains a register that is made available to the relevant local council and the Division of Local Government, Department of Premier and Cabinet as requested. The Register must list the names of all carers involved in the rehoming of animals and the locations of all animals received under the exemption while in the custody of the organisation.
4. The exemption under clause 16(d) of the Companion Animals Regulation 2008 from the requirements of section 9 of the Companion Animals Act 1998 expires five years from the date of this order, unless revoked or varied at an earlier time.

Dated: 7 September 2010.

ROSS WOODWARD,
Chief Executive,
Local Government,
Delegate of the Director General,
Department of Premier and Cabinet

ELECTRICITY SUPPLY ACT 1995

Electricity Supply (General) Regulation 2001

Accredited Service Provider scheme

IN accordance with clause 88 (1) of the Electricity Supply (General) Regulation 2001, I, Paul Gerard Lynch, M.P., Minister for Energy, make the following Order to take effect from 20 September 2010:

- The scheme titled Accredited Service Provider (ASP) scheme for contestable services in electricity as described in the NSW Code of Practice: Contestable Works is recognised as an accreditation scheme for the purposes of the Regulation; and
- Industry & Investment NSW is recognised as the accrediting agency in relation to that scheme.

Dated at Sydney, this 2nd day of September 2010.

PAUL LYNCH, M.P.,
Minister for Energy

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

Order Declaring Development to be a Project Under Part 3A

I, the Minister for Planning, in pursuance of section 75B (1) of the Environmental Planning and Assessment Act 1979 (the Act), do, by this Order declare that the development described in Schedule 1 is a project to which Part 3A of the Act applies.

In my opinion, the development described in Schedule 1 is of Regional environmental planning significance.

Dated, this 27th day of August 2010.

TONY KELLY, M.L.C.,
Minister for Planning,
Sydney

SCHEDULE 1

Development for the purposes of widening and realigning the Princes Highway, located within the Kiama and Shoalhaven local government areas, extending from approximately the junction of Toolijooa Road and the Princes Highway for approximately 11.6 kilometres to approximately the junction of Schofields Lane and the Princes Highway including a bypass of Berry, to achieve four lanes of divided carriageway ('the Project').

The development includes all associated or ancillary works, activities, uses, structures, or facilities for the purposes of the Project, including (but not limited to) the following:

(a) Construction and associated demolition works and operation (excluding maintenance) of the Project;
(b) Access for construction and operation of the Project, including access for pedestrians, public transport and vehicles;
(c) Environmental management and pollution control for the Project;
(d) Associated interchanges, intersections, bridges, overpasses, ramps, service roads and road modifications for the Project;
(e) Any changes to the route of the existing carriageway or road for the Project;

(f) Any realignment, modification, demolition, or replacement of the existing carriageway or road for the Project; and

(g) Any winning or obtaining of extractive material as part of the construction work for the Project.

The development does not include: utility adjustments and relocations; and preliminary works (such as surveys, test drilling, test excavations, preliminary geotechnical investigations, contamination investigations, utility identification and location and pavement investigations) associated with the design and/or environmental assessment of the Project occurring prior to the commencement of construction.

GEOGRAPHICAL NAMES ACT 1966

PURSUANT to the provisions of section 10 of the Geographical Names Act 1966, the Geographical Names Board has this day assigned the name 'Bathurst Town Square' for an historic area bounded by William, Russell, George and Howick Streets in Bathurst.

The position and the extent for this feature is recorded and shown within the Geographical Names Register of New South Wales. This information can be accessed through the Board's Web Site at www.gnb.nsw.gov.au.

WARWICK WATKINS, AM,
Chairperson

Geographical Names Board,
PO Box 143, Bathurst NSW 2795.

GEOGRAPHICAL NAMES ACT 1966

PURSUANT to the provisions of section 14 and section 10 of the Geographical Names Act 1966, the Geographical Names Board has this day discontinued the name 'The Overflow' and in its place assigned the name 'Cathy Freeman Park' for a reserve bounded on the north by Grand Parade, on the east by Showground Road, on the south by the westerly extension of Murray Rose Avenue and on the west by Olympic Boulevard at Sydney Olympic Park.

The position and the extent for this feature is recorded and shown within the Geographical Names Register of New South Wales. This information can be accessed through the Board's Web Site at www.gnb.nsw.gov.au.

WARWICK WATKINS, AM,
Chairperson

Geographical Names Board,
PO Box 143, Bathurst NSW 2795.

LEGAL PROFESSION ADMISSION RULES 2005

Third Schedule – Amendments

	Fee until 30/9/2010 $	*Fee from 1/10/2010 $*
Student Registration Application	180	180
Rule 67 Application	60	60
Student Course Application	60	60
Rule 71 review	60	60
Academic Transcript	50	50
Interview with Examiner	100	110
Examination	140	150
Additional fees examination in unscheduled location in a single examination period, where permitted:		
NSW first subject / additional subject	200/150	250/150
Elsewhere in Australia first subject / addition subject	300/200	350/200
Overseas first subject / addition subject	500/350	600/350
Section 26 Application	300	300
Academic Exemptions Application	200	200
Legal Practical Training Exempt.	200	200
Admission Application	400	400
Re-Admission Application	950	950
Certificate of Admission	50	50
Original Diplomas/Certificates	120	120
Other Application/Certificate	50	50
Late Fee Admission	100	100
Late Application-Other	60	60
Dishonored Cheque Fee	35	35
Photocopying – up to two pages	1	1
Duplicate Receipts	10	10
For services not listed in the schedule	50	50

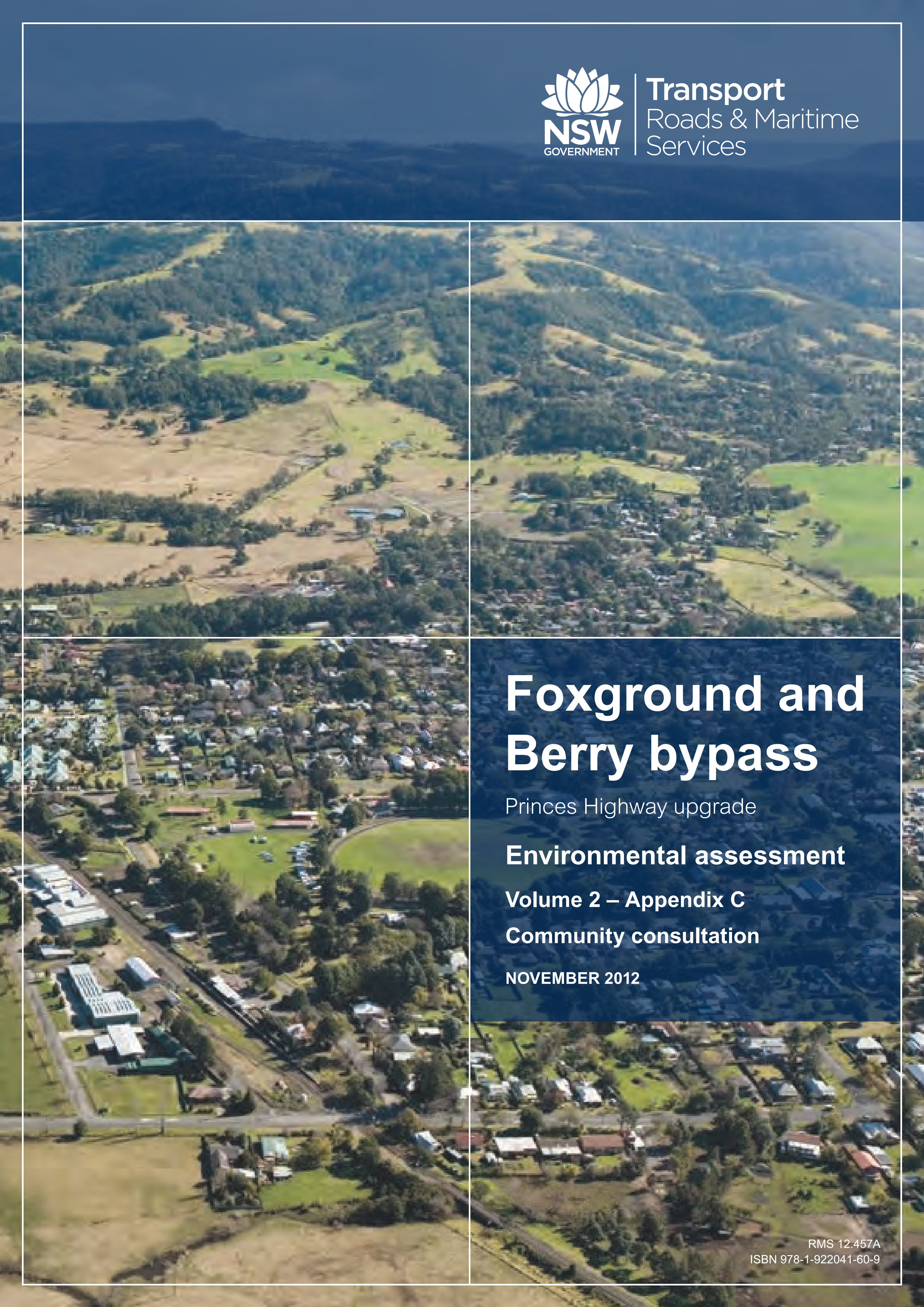
NATIONAL PARKS AND WILDLIFE ACT 1974

I, LISA CORBYN, Director General of the Department of Environment, Climate Change and Water, in accordance with section 87(6) of the National Parks and Wildlife Act 1974, set the following minimum standards for requirements specified in the regulations or in a code of practice adopted or prescribed by the regulations under section 87(3) of the National Parks and Wildlife Act 1974.

Date signed: 3 September 2010.

LISA CORBYN,
Director General

Transport
Roads & Maritime
Services



Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 2 – Appendix C

Community consultation

NOVEMBER 2012

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Appendix C – Consultation

The purpose of this appendix is to provide supporting information and further detail on community / stakeholder engagement and consultation activities undertaken for the project from March 2006 when route options were being considered to the exhibition of this environmental assessment. This appendix should be read in conjunction with Chapter 6.

1.0 Consultation activities

As detailed in Chapter 6, the project engagement program has proactively informed and involved stakeholders and community members at each stage of the project. By maximising public access to information and feedback channels, the engagement approach aimed to increase awareness and understanding of the project and encourage participation in consultation activities. The following tables C-1 to C-13 provide an overview of stakeholder and community consultation to date.

Table C-1 Details of consultation activities for project familiarisation and route options development

Project familiarisation and route options development
March 2006 to August 2007

- The distribution of community updates in March 2006, September 2006, January 2007, April 2007 and July 2007.
- Community workshops were held at:
  - Berry School of Arts, 3 May 2006 (6pm-8.30pm).
  - Gerringong Town Hall, 4 May 2006 (6pm-8.30pm).
  - Bomaderry RSL, 9 May 2006 (6pm-8.30pm).
- Information stands were held at:
  - Queen Street, Berry, 6 May 2006 (10am-1pm).
  - Fern Street, Gerringong, 13 May 2006 (10am-1pm).
  - 63 Meroo Street, Bomaderry, 20 May 2006 (10am-1pm).
- A planning focus meeting with representatives from various agencies and stakeholder groups was held on 29 September 2006.
- Property access letters for field investigations were sent in January 2007.
- Community workshops were held at:
  - Berry School of Arts, 20 February 2007 (6pm-8.30pm).
  - Gerringong Town Hall, 21 February 2007 (6pm-8.30pm).
  - Bomaderry Community Hall, 22 February 2007 (6pm-8.30pm).
- An interest group workshop was held at the Berry School of Arts on 19 April 2007.
- Individual meetings with local councils, local Aboriginal representatives, Chamber of Commerce, and other local community and business interest groups.
- Establishment of the project office in Berry in July 2007.
- Specialist information sessions held at the Berry Agricultural Pavilion on 11 August 2007 (11am-1.15pm and 1.45pm-4pm).
- Establishment of the 1800 free call number.
- Establishment of the project email address.
- Establishment of the project web page.

Table C-2 Details of consultation activities for route options display

Route options display **November 2007 to July 2008**
• Courtesy phone contact with potentially directly affected landowners one day prior to the public announcement of the shortlisted options. • Media announcement of shortlisted options. • Advertisements placed in local papers during week commencing 26 November 2007. • Community update booklet distributed to about 14,000 properties in the study area. Included reply paid feedback form for the route options. • Mail-out conducted during the week commencing 26 November 2007 to potentially affected property owners. • Correspondence during the week commencing 26 November 2007 to stakeholders registered to receive project updates. • Individual meetings held with potentially directly affected landowners. • Group meetings held with potentially directly affected landowners. • Unstaffed displays located at Kiama Municipal Council, Shoalhaven City Council, Kiama Fair and Nowra Fair from 26 November 2007 to 29 February 2008. • Mail-out in January 2008 to all residents within the study area and on the registered project mailing list advising dates, times and location of consultation activities. • Advertisements were placed in local newspapers during the week commencing 7 January 2008. • Community information sessions, including 3D animated drive throughs of each route option, were held at: - Gerringong Town Hall, 2 February 2008 (10am-3pm). - Berry School of Arts, 9 February 2008 (10am-3pm). - Bomaderry Community Hall, 16 February 2008 (10am-3pm). • Targeted focus group workshops were held at the Berry School of Arts on: - Agriculture workshop, 20 February 2008 (10am-12.30pm). - Business workshop, 20 February 2008 (6pm-8.30pm). - Environment workshop, 21 February 2008 (6pm-8.30pm). - Community workshop, 22 February 2008 (10am-12.30pm). - General community workshop, 23 February 2008 (10am-12.30pm). (With the exception of the general community workshop, attendance at all workshops was by invitation). • Berry project office staffed with project team members and displaying a topographical model of the study area and options. The office was open from Monday 26 November 2007 to Friday 21 December 2007 (Monday to Friday 8.30am-4pm) and from 10 January 2008 to 29 February 2008 (Thursday and Friday 8.30am-4pm). • Project website including a facility to complete a project feedback form online. • Toll free community information line. • Route options value management workshop held with key stakeholders and community members in Gerringong on 14 May 2008 to 16 May 2008. • Five property owner meetings held with potentially directly affected property owners along the modified 'Orange' route. • Project update mail-out in June 2008 to all residents within the study area and on the registered project mailing list.

Table C-3 Details of consultation activities for access options display

Access options display **October 2008 to December 2008**
• Courtesy phone contact with potentially directly affected landowners one day prior to the public announcement of the shortlisted options. • Media announcement of the access options. • Advertisements were placed in local papers during week commencing 13 October 2008. • Community update booklet distributed to about 14,000 properties in the study area, including reply paid feedback forms for the Berry access options. • Staffed displays were held at: - Berry project office, Monday to Friday from 13 October 2008 to 31 October 2008 (9am-4pm) and Saturday 18 October 2008 (10am-1pm). - Gerringong Town Hall, Monday to Friday from 13 October 2008 to 17 October 2008 (9am-4pm). - Saint George's Anglican Church, Gerringong, Saturday 18 October 2008 (10am-1pm). • Community information sessions were held at: - Berry Agricultural Pavilion, 22 October 2008 (5pm-8pm) and Saturday 25 October 2008 (9am-12pm). - Gerringong Town Hall, 23 October 2008 (5pm-8pm). - Gerringong School Hall, 25 October 2008 (1pm-4pm). • Mail-out conducted during the week commencing 13 October 2008 to potentially directly affected property owners. • Correspondence during the week commencing 13 October 2008 to stakeholders registered to receive project updates. • Individual meetings held with potentially directly affected landowners. • Unstaffed displays located at Kiama Municipal Council, Shoalhaven City Council and the Kiama Library from 13 October 2008 to 13 November 2008. • Project website including a facility to complete a project feedback form online. • Toll free community information line. • Access value management workshop held with key stakeholders and community members in Nowra on 18 November 2008 to 19 November 2008.

Table C-4 Details of consultation activities for finalised preferred option and access arrangements announcement

Finalised preferred option and access arrangements announcement **June 2009**
• Courtesy phone contact with potentially directly affected landowners one day prior to the public announcement of the shortlisted options. • Media announcement of the finalised preferred option and access arrangements. • Community update booklet distributed to about 14,000 properties in the study area. • A staffed display with maps of the preferred option and 3D animations of the access arrangements was held at the Berry project office Monday to Friday from 15 June 2009 to 26 June 2009 (9am-4pm) and Saturday, 20 June 2009 (10am-2pm). • Correspondence during the week commencing 15 June 2009 to stakeholders registered to receive project updates. • Individual meetings held with potentially directly affected landowners. • Unstaffed displays at Kiama Municipal Council, Kiama Library and a shop front in Belinda Street, Gerringong from 15 June 2009 to 26 June 2009. • Project website included facility to complete a feedback form online. • Toll free community information line.

Table C-5 Details of consultation activities for recreational fishing in Broughton Creek, Broughton Mill Creek and Bundewallah Creek

Recreational fishing **May 2011 to June 2011**
• Letter sent to 13 recreational fishing clubs located in, and in the vicinity of, the study area requesting information on access and opportunities for recreational fishing in Broughton Creek, Broughton Mill Creek and Bundewallah Creek. • Meeting held on 17 June 2011 with the Gerringong Hotel Fishing Club.

Table C-6 Details of consultation activities for extended working hours construction noise consultation

Extended working hours construction noise consultation **September 2011**
• A total of 58 properties from Toolijooa Road to the northern Berry interchange were identified as being potentially impacted by construction noise. • Nine properties were RMS owned and existing tenants were contacted by the leasing agent. One tenant contacted the project team to request a meeting. • For the remaining 49 privately owned properties, 44 telephone calls were made, with letters sent to five properties with no telephone number listed. Letters were sent to all 49 private property owners. • A total of 37 of the property owners contacted requested an interview with the project team. Interviews were held during September 2011 and January 2012.

Table C-7 Details of consultation activities for Berry bypass revised alignment

Berry bypass revised alignment **September 2011 to January 2012**
Consultation activities for the Berry bypass revised alignment were undertaken from 11 August to 14 December 2011 and aimed to provide information about the Berry bypass option review process and subsequent public display period for the revised alignment. • Community review group meetings were held on: - 24 August 2011. - 07 September 2011. - 21 September 2011. - 12 October 2011. - 26 October 2011. - 16 November 2011. - 30 November 2011. • Community review group meeting statements published on the project website: - Meeting statement one - 25 August 2011. - Meeting statement two - 9 September 2011. - Meeting statement three - 22 September 2011. - Meeting statement four - 13 October 2011. - Meeting statement five - 27 October 2011. - Meeting statement six - 17 November 2011. - Meeting statement seven - 1 December 2011. • Newspaper advertisement of community review group meeting statements published in the South Coast Register: - 31 August 2011. - 14 September 2011. - 28 September 2011. - 19 October 2011. - 2 November 2011. - 23 November 2011. - 7 December 2011. • Newspaper advertisement of community review group meeting statements published in the Berry Town Crier: - October 2011 edition. - November 2011 edition. • Telephone calls to 38 residents along North Street to offer interviews with the project team to discuss the revised alignment. • Distribution of approximately 3500 ‘letters to the householder’ on 11 September 2011 to inform Berry residents of the Berry bypass option review and process. • Distribution of approximately 200 ‘letters to the householder’ on 8 November 2011 to residents of the North Street precinct regarding a proposed series of urban design workshops. • Incoming emails were received via the dedicated project email address. • Project update emails were sent to approximately 400 stakeholders registered on the project database. • The project website was updated regularly with the bypass review updates. • Publication and distribution of 3500 community updates on 1 December 2011 announcing details of the community meeting and the revised Berry bypass alignment.

Berry bypass revised alignment
September 2011 to January 2012

- Distribution of 80 ‘letters to the householder’ on 1 December 2011 to residents of Huntingdale Park Road and surrounds regarding the proposed changes to Huntingdale Park Road.
- Telephone calls on 30 November 2011 to 17 residents of Huntingdale Park Road and Kangaroo Valley Road to advise of alignment announcement, public display and offer a meeting with the project team.
- Public display of the revised alignment at the Berry project office from 1 December 2011 to 14 December 2011 at the following times:
  - 10am to 5pm Monday to Friday (extended to 8pm on 7 December).
  - 10am to 2pm Saturdays.

  Members of the project team were available at the project office to discuss the project with the community.
- Newspaper advertisements announcing the community meeting were placed in the South Coast Register, Nowra News and the December issue of Berry Town Crier.
- Radio advertising on I98FM, 96.5FM, 2STAM and FM between 1 December 2011 and 6 December 2011.
- Electronic message signs were placed at the northern and southern ends of Berry to advertise the date, time and location of the community meeting.
- Community meeting opened by Local MP Gareth Ward on 6 December 2011 at the Berry School of Arts from 6.30pm to 8.30pm.
- Incoming emails were received via the dedicated project email address.
- Calls received on the 1800 project information line.
- Project update emails were sent to approximately 400 stakeholders registered on the project database.
- The project website was updated to include details of the revised alignment, community meeting and public display period.
- Community update January 2012 to announce the preferred alignment and Berry (south) interchange posted to project website.
- Email alert to announce publication of the *Berry bypass alignment issues report,* January 2012.
- Email alerts to registered stakeholders.
- Project website updates.

Table C-8 Community working groups

Foxground and Berry bypass northern alignment community working groups January 2012 to August 2012
• Working group meeting expression of interest advertisements placed in the Berry Town Crier, South Coast Register, in the Berry project office and on the project website. • Email invitations sent to stakeholders registered to receive project updates requesting community members to register their interest in attending the first working group meeting. • First working group meeting was held 8 February 2012 at which four separate community working groups were formed: - Berry bridge and northern interchange working group. - North Street precinct working group. - Austral Park Road interchange and heavy vehicle rest area working group. - Kangaroo Valley Road interchange and Victoria Street working group. • A total of 13 community working group meetings were held between February 2012 and August 2012. • Wildlife crossing meeting and site visit held with local residents and members of the Austral Park Road interchange and heavy vehicle rest area working group. • Notes of meetings, presentation material and handouts published on the project website as part of the weekly website updates. • *Berry bridge and northern interchange urban design summary report* (80% issue) published on the project website for community comment. • *North Street precinct urban design summary report* (80% issue) published on project website for community comment. • *Kangaroo Valley Road interchange and Victoria Street precinct urban design summary report* (80% issue) given to working group members for comment and then published on the project website • Monthly updates detailing working group discussions in the Berry Town Crier. • Calls received on the 1800 project information line.

Table C-9 Southern Berry bypass costing review

Foxground and Berry bypass southern Berry bypass costing review February 2012 to July 2012
• Courtesy telephone calls during week commencing 6 February 2012 to potentially directly affected property owners along both the northern and southern alignments. • Property access phone calls for field investigations were conducted February 2012. • Electronic message signs were placed at the northern and southern ends of Berry to advertise the date, time and location of community Q&A sessions and also to direct people to the project information line and website. • Community Q&A sessions also advertised on the project website and in the Berry project office. • Four community Q&A sessions held during the review process: - 16 February 2012. - 1 March 2012. - 19 March 2012. - 30 April 2012. • Distribution of householder letter during week commencing 28 May 2012. • Six individual stakeholder meetings held to discuss the suggested southern alignment. • Weekly project website updates during the review process, including latest technical investigation group minutes of meeting, factsheets, alignment drawings and an issues, actions and outcomes register. • Monthly updates in the Berry Town Crier. • Distribution of householder letter during week commencing 25 June 2012. • Media announcement of the NSW Government's decision on the preferred option. • Courtesy telephone calls during week commencing 25 June 2012 to potentially directly affected property owners along both the northern and southern alignments. • Email updates during week commencing 25 June 2012 to stakeholders registered to receive project updates. • Individual meetings offered to potentially directly affected property owners and stakeholders. • Three community members requested meetings which were held with representatives of the technical investigation group and independent review team. • Project office opened following NSW Government's announcement and for extended hours 10am to 5pm from Tuesday 25 June to Friday 29 June 2012. Staffed by members of the project team, the technical investigation group and the independent review team. • Advertisements for the Q&A session in the South Coast Register week commencing 25 June 2012. • Bypass decision community Q&A session held 3 July 2012 (6.30pm to 8.30pm). • RMS report on route feasibility comparative cost estimates, June 2012 published on the project website. • Addendum to RMS report on route feasibility comparative cost estimates, June 2012 published on the project website. • External review of RMS findings, June 2012 (independent review team report) published on the project website. • Incoming emails received via dedicated project email address. • Calls received on the 1800 project information line.

Table C-10 Community updates and householder letters

2006	
March 2006	Community update at the commencement of project and community consultation process.
September 2006	Community update detailed process and steps for selecting a preferred route.
2007	
January 2007	Community update introduced the activities planned for identifying route options and selecting a preferred route.
April 2007	Community update identified the specialist studies to be undertaken.
July 2007	Community update detailed project objectives and constraints and provided an update on the progress of the specialist studies.
November 2007	Community update detailed route options and the route options display activities.
2008	
June 2008	Letter to the householder explained route options community submissions, peer review of route options and Value Management Workshop processes.
September 2008	Letter to the householder described the North Street corridor amendment resulting from discussions with Shoalhaven City Council and the community.
October 2008	Community update with preferred option update and Gerringong and Berry access options.
2009	
March 2009	Letter to the householder with project update.
June 2009	Community update with preferred option and Gerringong and Berry access options finalised.
November 2009	Community update with arrangements for local road and property access.
2010	
December 2010	Community update design improvements to Berry access arrangements following discussions with Shoalhaven City Council and the community.
2011	
May 2011	Community update with project update and an overview of the environmental assessment process.
September 2011	Letter to the householder advising the then RTA (now RMS) review of the Berry bypass preferred option alignment.
November 2011	Letter to the householder to residents of North Street precinct regarding urban design.
December 2011	Community update advertising the community meeting and detailing the revised Berry bypass alignment.
December 2011	Letter to the householder to residents of Huntingdale Park Estate and surrounds advising proposed changes to the Kangaroo Valley Road intersection.
December 2011	Letter to the householder to residents of north Berry detailing the purpose of the white poles erected by RMS on the northern side of North and George streets.

2012	
January 2012	Community update announcing RMS revisions to the alignment and the design of the Berry bypass.
May 2012	Letter to the householder explaining what information will be included in the *RMS report on route feasibility comparative cost estimate*.
June 2012	Letter to the householder detailing Berry bypass costing review announcement.

Table C-11 Dates of meetings with government agencies

2006
Planning focus meeting held 26 September 2006 in Wollongong. This meeting was attended by representatives of key government agencies, local councils, utility companies and the emergency services.
2008
Three day route options value management workshop held 14 to 16 May 2008 in Gerringong. The workshop was attended by representatives from the former NSW Department of Planning (now Department of Infrastructure and Planning (DP&I), the former NSW Department of Environment and Conservation (DEC) (now Office of Environment and Heritage (OEH), the NSW Department of Primary Industries (now part of the Department of Trade and Investment, Regional Infrastructure and Services (DTIRISI)) and the emergency services.
Two day access value management workshop held 18 November 2008 to 19 November 2008 in Nowra. The workshop was attended by representatives from the former DEC (now OEH).
Emergency Services meeting held 11 December 2008 in Kiama. The meeting was attended by representatives from the Illawarra Emergency Management Division, Rural Fire Services, NSW Ambulance Services, Kiama State Emergency Services and the NSW Police Force.
2010
Agency information workshop held on 30 July 2010 in Berry. This doubled as the planning focus meeting for the project. The workshop was attended by representatives from the Department of Environment, Climate Change and Water (DECCW) (now OEH and EPA), the DP&I, Shoalhaven City Council and Kiama Municipal Council.
2011
Meeting held with OEH, NSW Office of Water and Southern Rivers CMA on 1 November 2011.
2012
Meeting held with DP&I on 3 July 2012.
Meeting held with OEH (Heritage Branch) 2 August 2012
Meeting held with DP&I on 16 August
Discussion with DPI(Fisheries) 21 August 2012

The meetings in Table C-12 were held with representatives from Kiama Municipal Council and Shoalhaven City Council to assist the project team to better understand the requirements and key issues that need to be considered for the project.

Table C-12 Dates of meetings with local government

2007
Berry flood meeting held with the Department of Natural Resources and Shoalhaven City Council, 6 March 2007. Meeting with Kiama Municipal Council, 19 April 2007. Meeting with Shoalhaven City Council, 20 April 2007. Meeting with Kiama Municipal Council, 14 March 2008. Meeting with Shoalhaven City Council, 14 March 2008.
2008
Route options value management workshop held 14 May 2008 to 16 May 2008, attended by representatives from Kiama Municipal Council and Shoalhaven City Council. Access value management workshop held 18 November 2008 to 19 November 2008, attended by representatives from Kiama Municipal Council and Shoalhaven City Council.
2009
Meeting with Kiama Municipal Council, 14 December 2009.
2010
Meeting with Shoalhaven City Council, 21 April 2010.
2011
Meeting with Shoalhaven City Council, 17 June 2011. Meeting with Kiama Municipal Council, 03 August 2011. Meeting with Shoalhaven City Council, 03 August 2011. Meeting with Shoalhaven River Natural Resources and Floodplain Management Committee, 24 August 2011. Meeting with Shoalhaven City Council, Floodplain risk management process, 29 November 2011.
2012
Meeting with Shoalhaven City Council and Berry Alliance, traffic and transport meeting, 1 May 2012.

Table C-13 Dates of meetings with interest groups

2006
Rotary Club of Berry-Gerringong, 14 September 2006
2007
Toolijooa/Harley Hill Protection Group, 19 April 2007. Probus Club of Shoalhaven, 7 May 2007. Toolijooa/Harley Hill Protection Group, 7 May 2007. Kiama and Shoalhaven Bicycle Users Groups, 8 May 2007. Berry Chamber of Commerce, 29 May 2007. Berry Rural Co-operative Society (dairy farmers), 8 June 2007. Toolijooa/Harley Hill Protection Group/Kiama Greens representative, 8 June 2007. Local Real Estate Agency briefing, 19 November 2007. Berry Alliance, 17 December 2007.
2008
Berry Alliance, 7 February 2008. PHocus Group, 11 January 2008. Probus Club of Shoalhaven, 12 February 2008. Berry Rural Co-operative Society/South Coast Dairy, 13 February 2008. Australian Steel Mill Services, 3 March 2008. RailCorp, 18 June 2008. Berry Southern Option Supporters and Fair Process Alliance, 24 July 2008. Local Real Estate Agency briefing, 16 October 2008. Kiama Bicycle Users Group, 20 October 2008. Meeting with Berry Public School Principal, 11 November 2008. Emergency Services Briefing, 11 December 2008.
2009
Dairy Transporters and Bus Company workshop, 9 March 2009. Shoalhaven Floodplain Management Committee meeting, 30 April 2009. Berry Alliance, 5 May 2009. Berry Equestrian Club and Shoalhaven City Council, 22 July 2009. Huntingdale Park Residents, 3 September 2009. Huntingdale Park Residents, 26 October 2009. Berry Alliance, 15 December 2009. Huntingdale Park Residents, 15 December 2009.
2010
Berry Alliance, 13 May 2010. Berry Alliance, 19 November 2010.
2011
Site visit with utility providers, 11 February 2011. North Street Corridor Amenity Group, 18 March 2011. Berry Alliance, 28 April 2011. Berry Alliance, 13 May 2011. Gerringong Hotel Fishing Club, 17 June 2011. Berry Landcare, 15 July 2011.

2011
Berry Alliance, 15 July 2011.
Berry Landcare and Southern Rivers CMA, 12 August 2011.
Shoalhaven River Natural Resources & Floodplain Management Committee, 24 August 2011.
Better Options for Berry (BOB), 7 October 2011.
Better Options for Berry (BOB), 21 October 2011.
Better Options for Berry (BOB), 26 October 2011.
Berry District Historical Society, 26 October 2011.
Berry Landcare and Southern Rovers CMA, 11 November 2011.
2012
Berry P&C, Arbour Retirement Village and Shoalhaven City Council, 19 January 2012.
Meeting with Shoalhaven City Council and Berry Alliance, traffic and transport meeting, 1 May 2012.

2.0 Aboriginal community consultation

Consultation and liaison with the Aboriginal community and the Illawarra, Jerringa and Nowra Local Aboriginal Land Councils commenced at the beginning of the project planning phase. On 23 June 2006, RMS called for registrations of interest from the local Aboriginal groups to participate in the consultation program through advertisements in the following newspapers:

- Koori Mail.
- Deadly Vibe.
- Berry Town Crier.
- Illawarra Mercury.
- South Coast Register.
- Illawarra Advertiser.

An Aboriginal Focus group (AFG) has been formed to provide a forum to bring together the registered Aboriginal stakeholders to discuss the scope of the project and the cultural heritage assessment process. The aim of the focus group was to identify Aboriginal cultural issues at an early stage of the project. The group facilitates ongoing community involvement throughout the life of the project, ensuring appropriate care and control of Aboriginal artefacts identified during the Aboriginal heritage investigations and to provide for comment on all aspects of the Aboriginal heritage management.

The initial meetings of the AFG were held in Nowra on 21 July 2006 and Wollongong on 24 July 2006.

To ensure the best approach to Aboriginal participation in the consultation process, the AFG and project team undertook the following:

- Met the then DECCW (now OEH) requirements for consultation with Aboriginal community stakeholders regarding the application of section 87 (preliminary research) permit and/or section 90 (consent to destroy) permit.
- Provided information on the scope, timing and reasons for the project.
- Informed Aboriginal community stakeholders of the NSW Government *Aboriginal Affairs 10 year policy ("Two ways together" policy*), *Interim Guidelines for Aboriginal Community Consultation* (DEC, 2005) and *Aboriginal Cultural Heritage Requirements for Proponents* (DECCW 2010) for the applications under sections 87 and 90 of the *National Parks and Wildlife Act 1974* and Aboriginal participation in construction.
- Provided a connection to RMS Aboriginal program and genuine training and realistic employment for local Aboriginal people.
- Provided information about the current knowledge of Aboriginal cultural values and archaeological investigations to date.
- Enabled Aboriginal community input into the design and methodology for the Aboriginal cultural and archaeological assessment.
- Enabled Aboriginal community stakeholders to contribute to the development of Aboriginal heritage management recommendations.
- Discussed the process of engagement of Aboriginal stakeholders to assist in the Aboriginal cultural assessment and archaeological assessment.
- Discussed the care and control of Aboriginal artefacts identified during the Aboriginal heritage investigations.

- Provided archaeological and project standards to identify and preserve traditional Aboriginal sites.
- Provided comment on all aspects of the Aboriginal heritage management.

A terms of reference was prepared by the AFG in order to capture the following ongoing consultation objectives:

- To work collaboratively with RMS and all stakeholders for the benefit of Aboriginal cultural heritage and the project.
- To facilitate processes for improved communication and flow of information between all stakeholders.
- To respectfully acknowledge the traditional land, law and customs of the traditional owners/custodians.
- To acknowledge the diversity of our Aboriginal community and their contributions to the process.

The terms of reference note that the AFG is not a decision making body and there is no requirement to reach a consensus amongst members on issues discussed. There is likely to be a diversity of viewpoints expressed on a number of issues. RMS has considered and will continue to consider all viewpoints.

AFG meetings have generally been conducted quarterly and additionally as required at project milestones. The content of the meetings has varied depending on project development and pertinent issues at the time. Meetings attended by representatives from registered Aboriginal groups throughout the project include:

- Illawarra Local Aboriginal Land Council AFG meeting #1, 16 February 2007.
- Nowra and Jerrinja Local Aboriginal Land Councils AFG meeting #2, 8 March 2007.
- Illawarra Local Aboriginal Land Council AFG meeting #3, 20 April 2007.
- AFG meeting #4, 18 May 2007.
- AFG meeting #5, 7 August 2007.
- AFG meeting #6, 3 December 2007.
- AFG meeting #7, 29 February 2008.
- AFG meeting #8, 27 May 2008.
- AFG site walkover, 23 June 2008.
- AFG meeting #9, 21 October 2008.
- AFG meeting #10, 21 April 2009.
- AFG site walkover, 17 June 2009.
- AFG meeting #11, 17 November 2009.
- AFG meeting #12, 28 July 2010.
- AFG meeting #13, 19 November 2010.
- AFG meeting #14, 24 February 2011.
- AFG meeting #15, 14 July 2011.
- AFG Meeting #16, 10 November 2011.

Liaison with the local Aboriginal community was also undertaken in the form of cultural knowledge holder interviews as part of the cultural values study for the broader Princes Highway upgrade program (*Gerringong to Bomaderry Aboriginal Cultural Values*, Navin Officer Heritage Consultants 2009). Within the open forum of the AFG meetings, discussions were held with a selection of the local community nominated by the AFG, as the most appropriate to provide cultural knowledge about the project area. The AFG forum also facilitated the nominations of who should attend a study area site walkover and a bus trip during the option selection process to identify potential Aboriginal cultural heritage issues.

3.0 Feedback data management

The consultation strategy has provided a diverse range of tools to provide opportunities for the public to be informed and involved in the project and access the project team. The list of consultation tools outlined in Chapter 6 demonstrates that the program has utilised a wide variety of two-way communication mediums that have provided information to community members and enabled the study team to consult with and involve the community as relevant. **Table C-12** details the methods and participation levels of communication with the community and stakeholders.

Table C-14 Methods of communication with community and stakeholders since 2007

	G2B	FBB	GU and BBU
Project info line (1800 number) incoming	160	534	370
Project info line outgoing	34	1011	736
Email incoming	58	423	115
Email outgoing	23	334	81
Letters incoming	6	42	20
Letter outgoing	68	77	95
Submissions received during the submissions periods (incoming)	876	701	616
Community info sessions	16	6	8
Stakeholder meetings	37	47	13
Property owner interviews	-	323	330
Project office visits	4500+	-	-
Community updates to the study area	11	7	5

G2B - Gerringong to Bomaderry upgrade
FBB - Foxground and Berry bypass
GU - Gerringong upgrade
BBU - Berry to Bomaderry upgrade

Project telephone and email address

The project has established and administered a 1800 number (1800 506 976) and email address, foxgroundandberrybypass@rms.nsw.gov.au to provide the community and stakeholders with a central reference point for contact on all project matters. The number and email address is published on all printed project communication material and the website.

The project's community relations team facilitates responses to community and stakeholder enquiries via email and telephone.

Project website

The project website (www.rms.nsw.gov.au/fbb) provides up to date information about the project. It includes a home page, latest news, an overview of the project, key project related documentation and contact details.

Stakeholder database

All stakeholder content and activity for the project is managed via a secure database namely *Consultation Manager.*

By tracking and recording incoming feedback and project team responses, the team is able to effectively distribute communication updates to all stakeholders. All enquiries, comments and complaints received by telephone, email, or letter are entered into the database with details of events such as information sessions, meetings, displays and issues raised at each of these events.

Project office

A permanent shop front was opened to provide community members and stakeholders with information. The project office is located at Broughton Court, 3/113 Queen Street, Berry. During staffed information displays, the project office is generally opened from 10am-5pm Monday to Friday. During the remainder of the year it is staffed every Friday from 10am-5pm or by appointment if required.

Since opening, over 4500 individuals have visited the project office.

Potentially directly affected landowner consultation

The project team has met with both potentially directly affected landowners and individuals who have requested one-on-one interviews at each key stage of the project. Potentially directly affected landowners are identified as those with properties impacted by potential total or partial property acquisition.

Table C-15 Landowner consultation

Date	Activity	Total
January 2008 to February 2008	Business owner interviews held during the route options display period.	22
November 2007 to February 2008	Property owner interviews held during the route options display period.	100
May 2008	Property owner interviews conducted following North Street corridor amendment announcement.	4
October 2008 to November 2008	Property owner interviews during preferred option and access options display period.	69
June 2009	Property owner interviews during preferred option finalisation and preferred access options display period.	24
July 2009 to present	Property interviews during the development of the concept design and environmental assessment.	104

Key stakeholders

The community/stakeholder interest groups, service providers, local businesses/business groups and government agencies/services that have been consulted during the project are identified in **Table C-16**.

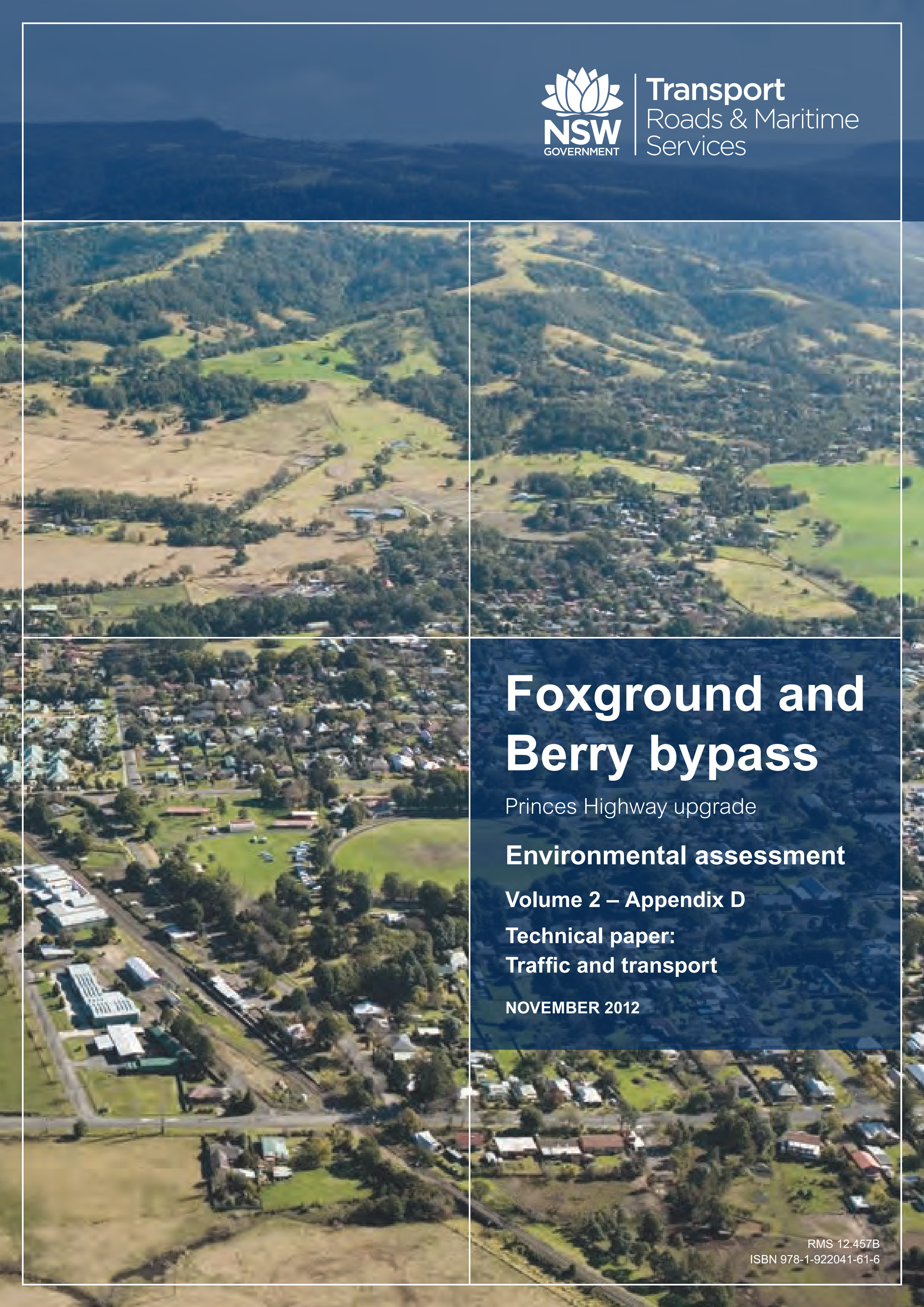
Table C-16 Key stakeholders

Interest groups	
Berry Pre-school	Camp Quality
Berry Public School	Country Women Association NSW – Kiama and Berry
Bomaderry Pre-school	Fair Process Alliance
Bomaderry Public School	Foxground Landcare
Bomaderry High School	Frog's Hollow Bomaderry Bushcare Group
Gerringong Pre-school	Gerringong All Sports
Gerringong Public School	Gerringong and District Historical Society
Kiama High School	Gerringong Hotel Fishing Club
Sts. Peter and Paul Catholic School	Gerringong Senior Citizens
Apex Club of Berry	Gerroa Environmental Protection Society
Archer Fishing Club	Gerroa Boat Fisherman's Club
Association of Independent Retirees	Hazel Berry and David Berry Parks Management Committee
Australian Red Cross Society – Berry/Bolong/Bomaderry	Huntingdale Park Residents Group
Australian Conservation Foundation	Jamberoo Fishing Club
Berry Alliance	Kangaroo Valley Amateur Fishing Club
Berry Bowling Club	Kiama Amateur Fishing Club
Berry Bushcare Group	Kiama Art Society
Berry and District Garden Club	Kiama and Shoalhaven Bicycle Users Groups
Berry Equestrian Club	Kiama Bowling and Recreation Club
Berry Fishing Club	Kiama Golf Club
Berry and District Historical Society	Kiama Harbour Boat Owners Association Inc.
Berry Landcare	Kiama Meals on Wheels
Berry Masonic Retirement Village	Kiama Pony Club
Berry Meals on Wheels	Kiama Show Society
Better Options for Berry (BoB)	Kiama Tourism/Visitors Centre
Bomaderry Bowling Club	Kiama Walkabouts
Bomaderry and District Senior Citizens Club	Liberal Party of Australia
Bomaderry Rotary Club	Lioness Club of Shoalhaven
Bomaderry RSL Club	Lions Club of Bomaderry

Interest groups	
Berry Southern Option Supporters	Lions Club of Gerringong
Bomaderry RSL Fishing Club	Mayflower Retirement Village
Berry Pony Club	North Street Corridor Amenity Group
Berry Show Society	Probus Club of Shoalhaven
Nowra/Bomaderry Meals on Wheels	Riverland Fishing Club
Kiama Council South Precinct	Rotary Club of Berry-Gerringong
Kiama Game Fishing Club	Shoalhaven Heads Bowling and Recreation Club
Kiama Greens	Shoalhaven Ex-Servicemen’s Fishing Club
Nowra Sport Fishing Club	Toolijooa/Harley Hill Protection Group
PHocus	Werri Beach/Gerringong Garden Club
Probus Club of Berry	Western Road Access People
Probus Club of Gerringong	Zonta Club of Berry
Probus Club of Gerroa	
Service providers	
Accommodation South Coast Association	Mornington Waters Pty Ltd
Berry Bus Service and Coach Hire	Nowra Coach and Premier Motor Service
Care South	NRMA
David Berry Hospital	Premier Illawarra Bus Company
Defence Housing Authority	RailCorp
Gerringong Bus Service	NSW Private Forestry Association
Integral Energy Australia	Shoalbus
Jemena – Eastern Gas Pipeline	Shoalhaven Community Transport Service Inc.
Kennedy Bus Service	St. Johns Ambulance – Kiama Division
Kiama Coachlines	Shoalhaven Community Transport Service Inc.
Kiama Taxi Cabs and Hire Car Service	Telstra Corporation
L.B.J. Tours Bus Company	
Businesses/business groups	
Australian Trucking Association	Cleary Bros. Pty Ltd
Berry Bon Bon	Cronin Investments Pty Ltd
Berry Boutique Motel	Crooked River Winery
Berry Bulk Haulage	Ecology Partners Pty Ltd
Berry Chamber of Commerce	Ellard Limousines
Berry Dairy Farmers	Emporium Food Company
Berry Newsagency	Gerringong Dairy Farmers
Berry Pharmacy	Gerringong Pharmacy
Berry Rural Co-operative Society	Great Southern Hotel

Businesses/business groups	
Berry Service Centre	Gourmet on Broughton Cafe
Bomaderry Chamber of Commerce	Harcourts Berry
Broughton Bush Pty Ltd	Hedgehogs Coffee Shop
Blue Regent Lodge Pty Ltd	Hitchcocks Haulage
Budawang Design Systems Pty Ltd	Huntingdale Park Development Pty Ltd
Bangalee Motel	The Ice Creamery
Independent Local Transporters	NSW Farmers Association Dairy Committee
Ivy Mount Pty Ltd	Our Bookshop
KB Pearce Pty Ltd	Park Medical Practice
Kiama and Gerringong Chamber of Commerce	Pomona Vale Pty Ltd
Lazumba, Berry Country Rooster	Raine & Horne Pty Ltd
LEAP Disbursement Management	Raycolleen Pty Ltd
Manildra Flour Mills	Reeves Transport
Martin Bros. (Orange) Pty Ltd	Roselea Vineyard
McColl's Transport	Roymao No. 2 Pty Ltd
McGrathnical (Huntingdale Park)	Shell Service Station, Berry
Mirrabrook Alpacas Pty	Shoalhaven Auto Electrical
Moontara Pty Ltd	Smash Repair Centre
Mosal Pty Ltd	South Coast Dairy
Nowra Dairy Farmers	The Treat Factory
Nowra Trucking Group	Whitewash Development Pty Ltd
Government agencies/services	
Berry Fire Services	NSW Fire Brigade (Southern Region)
Broughton Vale/Berry Rural Fire Service	NSW Land Housing Corporation
OEH	NSW Member for Gilmore
DP&I	NSW Member for Kiama
DTIRIS	NSW Office of Water
Illawarra Aboriginal Corporation CDEP	NSW Police Service – Kiama Command
Illawarra Local Aboriginal Council	NSW Police Service – Shoalhaven Command
Illawarra Regional Development Board	NSW Rural Fire Service
Jerrinja Local Aboriginal Land Council	NSW South Coast Electorate Committee
Kiama Ambulance Service	NSW State Rescue Board
Kiama Hospital and Community Health Service	Rural Lands Protection Board
Kiama Municipal Council	Shoalhaven City Council
Kiama Shellharbour Rural Fire Service	Shoalhaven City Hospital
Kiama State Emergency Services	Shoalhaven City State Emergency Service

Government agencies/services	
Nowra Local Aboriginal Land Council	South East Australian Transport Strategy Inc
NSW Ambulance Service	Sydney Water Corporation
NSW Department of Communities, Sport and Recreation	EPA



NSW GOVERNMENT

Transport
Roads & Maritime
Services

Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 2 – Appendix D

Technical paper: Traffic and transport

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Foxground and Berry bypass

Prepared for

Roads and Maritime Services

Prepared by

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November 2012

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Executive summary

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* for the upgrade of 11.6 kilometres of the Princes Highway, to achieve a four lane divided highway (two lanes in each direction) highway with median separation between Toolijooa Road north of Foxground and Schofields Lane, south of Berry (the project). The project would include bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

The outcomes of the Foxground and Berry bypass preliminary environmental investigations indicate that traffic and transport is one of the key environmental issues for the project. Key issues are those that may have moderate or high impacts (actual or perceived) and a detailed assessment is necessary to determine the level of potential impacts and to develop appropriate measures to mitigate and manage the impacts. This report details and summarises the Traffic and Transport Assessment undertaken as part of the environmental assessment of the Foxground and Berry bypass.

Existing traffic and transport environment

Between 1990 and 2010, annual average daily traffic (AADT) on the Princes Highway north of Rose Valley Road increased by an average of over 400 vehicles per year; equating to a linear growth rate of around 3.2 per cent per annum. More recently, between 2007 and 2010, daily traffic volumes increased by 2097 vehicles; which equates to an average linear growth rate of around 3.6 per cent per annum.

North of Berry, surveys showed traffic on the Princes Highway to be around 10,150 vehicles per day, with 8700 vehicles using the alternative ‘Sandtrack’ route. This equates to a 54 per cent / 46 per cent split of traffic using the Princes Highway / ’Sandtrack’. South of Berry, the AADT is 12,575 vehicles on the Princes Highway compared to 6650 using the ‘Sandtrack’. At these locations, the bias of traffic is more heavily weighted towards the Princes Highway, with 65 per cent of the total using the highway, compared to 35 per cent using the ‘Sandtrack’.

Overall, origin-destination (O-D) surveys indicate that during a typical day, non-stopping through traffic contributes around 80 per cent of total traffic travelling through Berry on the Princes Highway. During the 100th highest hour peak periods (eg holiday periods or morning and afternoon peak periods), traffic volumes are higher and travel patterns vary. As a result, through traffic fluctuates considerably between 50-75 per cent of total traffic.

Local and regional bus and coach services utilise the Princes Highway in the project area, although the number of routes and frequency of services available to the general public are limited.

Existing road network performance

The section of the Princes Highway between Toolijooa Road and Schofields Lane has a poor crash record in comparison to connecting sections of the Princes Highway and other major highways in NSW. Between 1 July 2003 and 30 September 2010 a total of 118 crashes were recorded on the Princes Highway, including three fatal and 61 injury crashes. On the alternative ‘Sandtrack’ route, five fatal and 81 injury crashes occurred during the same period.

The results of the travel time analysis indicates that the Princes Highway currently has an average travel time of around 14-15 minutes within the project area between Toolijooa Road and Schofields Lane. The equivalent route via the ‘Sandtrack’ is shorter in length and operates at a higher average speed, taking less than eight minutes on average. Although the ‘Sandtrack’ is significantly quicker in terms of travel time within the project area, traffic modelling shows that within the traffic impact footprint (between Gerringong and Bomaderry), the routes are comparable in both length and travel time. Between these towns the Princes Highway is around 33.2 kilometres long with a travel time of around 32-33 minutes, while the ‘Sandtrack’ is around 32.4 kilometres long with a travel time of around 30 minutes.

The Princes Highway both north and south of Berry currently operates with a midblock level of service (LoS) D during typical AM peak and PM peak periods, while the alternative ‘Sandtrack’ route is currently operating at LoS C for both periods. The analysis indicates that during the 100th highest hour (eg holiday periods or morning and afternoon peak periods), the operational performance of the Princes Highway deteriorates to an unacceptable LoS E at most locations and the ‘Sandtrack’ operates at LoS D.

Future conditions without the project

Analysis indicates that midblock locations on the Princes Highway in the project area would operate at an unacceptable LoS E or LoS F for all peak periods in the absence of the project, should traffic continue to grow at current rates. This compares to LoS D during AM and PM peak hours and LoS E during 100th peak hours at present.

Paramics modelling shows that as well as significant traffic delays at intersections, traffic queuing back to adjacent intersections may also become an issue, further diminishing the performance of the local road network in Berry. The results of the modelling undertaken illustrate that the performance of local roads and intersections in Berry would deteriorate based on the predicted increase in traffic; if the current road network remains unchanged.

Travel times throughout the project area would increase as the level of traffic and congestion grows on the existing road network. In the west of the project area, intersection delays in Berry would significantly increase, especially during the peak periods.

The forecast growth in traffic on the existing road network within the traffic impact footprint would result in a considerable increase in the total number and cost of crashes occurring. Assuming current crash rates and costs remain constant, the total number and cost of crashes would increase by 78 per cent by the design year of 2037.

Traffic impact assessment - construction

The performance analysis for the worst-case construction scenario indicates that midblock locations on the Princes Highway would operate at LoS E during both the 100th highest hour northbound and southbound scenarios. Average travel speeds on the Princes Highway would be expected to drop to around 50 kilometres per hour or less. Key factors contributing to this deterioration include the expected increase in traffic, speed restrictions, and the prevention of overtaking through construction zones in the project area. The analysis indicates that despite a poor LoS and low travel speeds during peak hours, the Princes Highway does have the capacity to accommodate worst-case traffic volumes during construction.

The results show the roadway LoS on the ‘Sandtrack’ would remain relatively unchanged despite a reduction in traffic (with traffic expected to transfer to the Princes Highway in the worst-case scenario), operating at LoS C during the 100th highest hour northbound period, and deteriorating to LoS D during the busier 100th highest hour southbound period.

In summary, it can be concluded that due largely to the offline construction of the Berry bypass, the local road network and intersections in Berry would still perform adequately during both the most-likely and worst-case construction scenarios; without the provision of additional temporary traffic management measures.

Traffic impact assessment - operational

On the Princes Highway south of Berry (Victoria Street), the AADT is expected to grow by around 16,000 vehicles between 2017 and 2037. This increase includes a predicted transfer of traffic from the ‘Sandtrack’ due to improved traffic efficiency, road safety and travel time savings on the upgraded highway.

In 2037, the bypass of Berry would accommodate around 28,000 vehicles per day, which equates to an average annual growth of around 750 vehicles from 2017 and constitutes 86 per cent of the AADT on the highway south of Victoria Street.

The split between the Princes Highway and the ‘Sandtrack’ traffic is estimated to change from 55 per cent / 45 per cent to the north of Berry (60 per cent / 40 per cent to the south) in 2009 to 84 per cent / 16 per cent in 2037 (87 per cent / 13 per cent to the south), with the majority of traffic switching from the ‘Sandtrack’ in favour of the Princes Highway by 2037.

The predicted midblock LoS for all highway locations and scenarios falls within the Concept Design Criteria set out for the project, which states that the project must perform at LoS C (represents optimum free flow conditions) or better for the 100th highest hour (holiday peak hour) in its design year of 2037.

Victoria Street currently intersects with the Princes Highway at the southern extent of Berry adjacent to Mark Radium Park; allowing for all turning movements between the two roads. Under the project, various treatments could occur at this intersection, which would change the volume and distribution of traffic on local roads; particularly along and between Victoria Street and Queen Street.

The local road traffic impacts for each Victoria Street option would vary depending on location, with the magnitude varying for each option. However, for all options, the predicted traffic volumes in 2037 would not significantly change the residential nature of the local road network in Berry.

RMS is required to present one option for the purpose of the environmental assessment and has moved forward with Victoria Street closed in the concept design. Nonetheless, RMS is able to deliver any of the Victoria Street design options through the project, and will continue discussions and encourage feedback and submissions through the environmental assessment display period to finalise the design.

Paramics modelling shows that intersection approach roads in Berry, including the two grade-separated interchanges, would operate at LoS A in the 2037 design year and experience negligible congestion or delay; as the bypass of Berry would remove large volumes of through-traffic from the centre of town. In addition, sensitivity analysis shows that a second northbound off-ramp in Berry is not required to accommodate projected traffic volumes and is therefore not being provided as a project design feature.

The project would create a shorter travel time on the Princes Highway than the ‘Sandtrack’ in the project area in the future, with estimated travel time savings of over seven minutes on the Princes Highway between Toolijooa Road and Schofields Lane. It is estimated that average travel times along the ‘Sandtrack’ would remain roughly constant at around 7.5 minutes.

Once a central median and safety barriers are installed, local roads and accesses in rural areas would be provided with left turn in and left turn out only facilities. Low daily volumes of traffic, which would previously have turned right from, or into a minor road, would be required to travel to the nearest u-turn facility to make a safe right hand turn to proceed in the desired direction. This would inconvenience some local traffic as it would require additional travel when compared to existing arrangements.

The proposed highway upgrades are expected to significantly improve road safety, along and adjacent to the project. In summary, the project could be expected to significantly reduce the frequency and severity of crashes occurring on the Princes Highway in the project area for existing users. It would also provide an alternative with a higher level of safety than experienced by current users of the ‘Sandtrack’. This would both increase the level of road safety for highway users and reduce the cost attributable to crashes that occur across the traffic impact footprint.

Bus travel times would also be improved. The project would enable higher safe travel speeds on the Princes Highway, while intersection delays in Berry would reduce as a result of fewer vehicles travelling through the town. A reduction of traffic on the ‘Sandtrack’ would also benefit travel times for buses using this alternative route.

Management of impacts - construction

A traffic management plan (TMP) would be prepared as part of the construction environmental management plan. The TMP would be submitted in stages to reflect the progress of work and would include signage requirements (eg temporary speed restrictions, changes to the road environment, traffic management controls deployed); lane allocation and restrictions during periods of online construction (eg linemarking and temporary barriers); traffic control devices such as temporary traffic signals; and a local and regional communications strategy. This would include methods to provide advanced notice of any major or prolonged impacts (eg leaflets and local media), and real-time information regarding current impacts (eg variable message signs and radio traffic news).

Management of impacts - operational

Traffic levels and operational performance would be monitored following construction, particularly during peak periods, to check whether the road network is performing as expected. Traffic monitoring would be undertaken on the Princes Highway and key local roads in Berry including the bypass, on- and off- ramps, Kangaroo Valley Road and Queen Street. Traffic volumes would be assessed against those predicted. The performance of climbing lanes provided by the project would be similarly monitored. A comparison of actual versus modelled performance of the road network in this way would identify any significant differences at an early stage. As a result, revised traffic forecasting would be undertaken and the adjusted traffic predictions would be input to the Paramics modelling to re-assess the future operational performance of the project and plan in advance of any major impacts occurring.

Within Berry changes to the existing road network raised concerns by the community, with the potential to reduce amenity for pedestrians and cyclists. This would include pedestrians and cyclists re-routed from North Street following its severance by the Berry bypass.

Suitable pedestrian and cyclist arrangements are proposed according to relevant guidelines to ensure that safe access would be maintained following construction of the project.

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Glossary of terms and abbreviations

Term	Meaning
100th highest hour	A 100th highest hour of traffic volume is either derived or factored from a year of hourly (ranked 100 of 8760 hours) traffic count data and represents a true period of peak traffic demand; in which to base the operational analysis of the concept design.
100SB	100th highest hour southbound peak period that reflects traffic patterns in the project area recorded on Thursday 21 April 2011 (southbound peak holiday direction).
100NB	100th highest hour northbound peak period that reflects traffic patterns in the project area recorded on Tuesday 26 April 2011 (northbound peak holiday direction).
A	
AM peak period	Unless otherwise stated, this refers to vehicle trips arriving at their destination between 6.31am–9.30am on a weekday.
Arterial roads	The main or trunk roads of the State road network.
AADT	Average annual daily traffic The total volume of traffic passing a roadside observation point over a period of a year, divided by the number of days per year. It is calculated from mechanically obtained axle counts.
ATC	Automatic traffic count (ATC)
B	
Base case	Also known as “Do nothing” case. Used in evaluating projects to compare the cost and benefit of the existing road (the base case) with another or a number of other projects or options.
BBU	Berry to Bomaderry upgrade
C	
Capacity	The nominal maximum number of vehicles that can travel along a road in a given time.
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes.
Chainage	Any point on a control line selected to provide more detailed information about the cross-section or any other feature mentioned in the drawings. Also known as a station.
Climbing lane	An auxiliary lane, usually on a long upgrade, primarily for the use of slow moving vehicles. Differs from overtaking lanes as linemarking does not initially direct all traffic to the left hand side of the road.
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility, and provide a basis for estimating and to determine further investigations needed for detailed design.
CEMP	Construction environmental management plan. A plan used to manage environmental impacts during construction of the project. It is a synthesis of all proposed mitigation, management and monitoring actions, set to a timeline with defined responsibilities and follow up actions.

Term	Meaning
D	
Degree of saturation	The ratio of the traffic volume entering an intersection to the total capacity of the intersection in a specific period.
DEH	Department of Environment and Heritage
Design traffic	The cumulative traffic count expressed in terms of equivalent standard axles, predicted to use a road over the structural design life of the pavement. An hourly volume used to determine the geometric layout of the road which takes into account the variations in volume at various times of the day and the maximum turning volumes at intersections.
Design year	The predicted year in which the design traffic would be reached.
Detour	An alternative route, using existing roads, made available to traffic during temporary closure of a road.
Dir	Direction
Divided road	A road with a separate carriageway for each direction of travel created by placing a physical obstruction (eg central median and safety barrier) between the opposing traffic directions.
Do nothing	No upgrade of the Princes Highway between Gerringong and Bomaderry. This represents the consequence of no action environmental assessment measure.
Do minimum	Construction of only the Gerringong upgrade and Foxground and Berry bypass. This represents the operational impacts environmental assessment measure.
Do something	Construction of the full Gerringong to Bomaderry Princes Highway upgrade. This represents the operational impacts environmental assessment measure.
DPI	NSW Department of Primary Industries
Driveway	A defined area for vehicles to travel between a carriageway and a property adjacent or near to the road.
DGRs	Director-General’s requirements. Requirements and specifications for an environmental assessment prepared by the Director-General of the Department of Planning under section 75F of the *Environmental Planning & Assessment Act 1979*.
E	
Environment	All aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings (from EP&A Act).
EP&A Act	*Environmental Planning and Assessment Act 1979*
F	
Footpath	The paved area in a footway.
Footprint	The extent of the impact that a development in plan view makes on the land.
Footway	An area open to the public designated for the movement of pedestrians or has one of its main uses for pedestrians.

Term	Meaning
Foxground bends	The existing section of the Princes Highway between Toolijooa Road and Austral Park Road.
Freeways	Fast, high volume, access controlled roads or large scale that primarily link regional hubs and cities usually with grade separated intersections and without traffic lights.
FBB	Foxground and Berry bypass (the project).
G	
Grade separation	The separation of road, rail or other transport modes, so that crossing movements at intersections are at different levels.
GU	Gerringong upgrade
H	
Haul road	A designated road, often temporary, used for moving materials (often used when new infrastructure is being constructed).
Horizontal and vertical geometry	Winding (horizontal) and undulating (vertical) sections of the existing Princes Highway.
h	Hour
ha	Hectare/s.
HV	Heavy vehicle, which is classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System.
I	
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Interchange	An intersection of two or more roads that typically uses grade separation, and one or more ramps, to permit traffic on at least one carriageway to pass through the junction without directly crossing any other traffic stream.
Intersection at-grade	An intersection where carriageways cross at a common level.
J	
Junction	A place where two or more roads meet.
K	
km/h	Kilometres per hour.
L	
Local road	A road or street used primarily for access to abutting properties.
LGA	Local government area.
LoS	Level of service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
LV	Light vehicle, which is less than five tonnes gross, in accordance with the Austroads Vehicle Classification System.

Term	Meaning
M	
Median	The central reservation which separates carriageways from traffic travelling in the opposite direction.
Midblock	A general location on the Princes Highway or local roads between two intersections.
Mode	A type or method of transport movement – including for the road corridor: cars, buses, bikes and pedestrians.
Modal split	Proportion of the transport task which is carried by the various carriers (ie road, rail, ferry, bike, pedestrian).
MVKT	Million vehicle kilometres travelled.
N	
NB	Northbound.
O	
O-D	Origin-Destination
Overtaking lane	An auxiliary lane provided to allow for slower vehicles to be overtaken. Line marked so that all traffic is initially directed into the left hand lane with the inner lane being used to overtake.
P	
PAMP	Pedestrian Access and Mobility Plan
PM peak period	Unless otherwise stated, this refers to vehicle trips arriving at their destination between 3.01pm–6pm on a weekday.
Project area	The Princes Highway and adjacent area (local land use and road network) between the junctions with Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry).
Private vehicle	Includes all motorised vehicles such as cars, 4WDs, vans, motorbikes, motor scooters, utes and trucks.
Public transport	Includes train, bus (government and private) and ferry (government and private).
Q	
-	-
R	
RMS	NSW Roads and Maritime Services (formerly NSW Roads and Traffic Authority (RTA)).
Road furniture	A general term covering all signs, street lights and protective devices for the control, guidance and safety of traffic and convenience of road users.
Road reserve	A legally defined area of land within which facilities such as roads, footpaths and associated features may be constructed for public travel.
Roadside	The area from the edge of the carriageway to the boundary of the road reserve.
Roundabout	An intersection where all traffic travels in one direction clockwise around a central island.
RTA	NSW Roads and Traffic Authority.

Term	Meaning
S	
Safe intersection sight distances	The minimum sight distance which should be available from vehicles on legs of an intersection.
Safety ramp	A short trafficable spur road usually with a steep upgrade, provided for emergency use by vehicles on steep downgrades.
'Sandtrack'	An alternative route to the winding, hilly section of Princes Highway between Gerringong and Bomaderry (via Fern Street, Crooked River Road, Gerroa Road and Bolong Road).
Shared path	A pathway used for both cyclists and pedestrians, usually located on the side of the road.
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement.
Side track	A track to take traffic while a road is temporarily closed for construction or maintenance activities.
Sight distance	The distance measured along the carriageway over which objects of defined height are visible to a driver whose eyes are at a specified height above the pavement surface level.
Slip lane	A lane providing for left turning vehicles allowing them to avoid stopping at an intersection.
s	Seconds.
SB	Southbound.
T	
Tie-in	Location where an existing road (Princes Highway) joins with a new road (Berry bypass).
TMP	Traffic Management Plan
Traffic impact footprint	The regional and local road network between Gerringong and Bomaderry bounded by the Princes Highway and 'Sandtrack' routes.
U	
Underpass	A grade separation where the subject carriageway passes under an intersecting carriageway (or railway). A tunnel constructed for the use of pedestrians, cyclists, fauna and/or stock under the carriageway.
Urban design	The process and product of designing human settlements, and their supporting infrastructure, in urban and rural environments.
V	
Veh	Vehicle.
Veh/h	Vehicle per hour.
VKT	Vehicle kilometres travelled.
W, X, Y, Z	

1 Introduction

1.1 Background

1.1.1 Project overview

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the upgrade of 11.6 kilometres of the Princes Highway, to achieve a four lane divided highway (two lanes in each direction) highway with median separation between Toolijooa Road north of Foxground and Schofields Lane, south of Berry (the project). The project would include bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

Further details on the project description and objectives are included in Chapter 6.

1.2 Director-General's requirements – traffic and transport

The outcomes of the Foxground and Berry bypass preliminary environmental investigations indicate that traffic and transport is one of the key environmental issues for the project. Key issues are those that may have moderate or high impacts (actual or perceived) and a detailed assessment is necessary to determine the level of potential impacts and to develop appropriate measures to mitigate and manage the impacts.

For each key issue, the Department of Planning and Infrastructure has issued a list of Director-General requirements (DGRs) that inform the environmental assessment. **Table 1.1** displays the DGRs that are specific to traffic and transport; and also provides a cross reference to the relevant section(s) of this report which address these requirements.

In addition, four agency letters, which accompany the DGRs, were issued by Shoalhaven City Council, Kiama Municipal Council, Office of Environment and Heritage (OEH, formerly the Department of Environment, Climate Change and Water (DECCW)) and Department of Primary Industries (DPI, formerly Industry and Investment NSW). Specifically, the Shoalhaven City Council letter included a request to justify the proposed access arrangements to Berry from the Princes Highway northbound, which has been addressed in Section 7.2.2 of this report.

Table 1.1: Traffic and transport DGR checklist

Director-General's Requirements (DGRs)	Section addressed
Key issues (General requirements)	
The EA must include an **assessment of the key issues**, including an assessment of the **worst case and representative impact** for each issue for all aspects of the project (**including the proposed locations of and/or options** for the **ancillary facilities**) with the following aspects addressed for **each key issue** (where relevant):	
• Describe the existing environment.	Chapter 2 Chapter 3
• Assess the potential impacts of the proposal including: – At the construction stage. – At the operation stage. – In accordance with relevant policies and guidelines. – Consider direct impacts including potential interactions with the existing Princes Highway (as relevant). – Consider indirect impacts including potential interactions with the existing Princes Highway (as relevant).	Chapter 7
• Identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/or in developing management/mitigation measures.	Chapter 4
• Describe measures to be implemented to avoid, minimise, manage, mitigate, offset and / or monitor the impacts of the project and the residual impacts.	Chapter 8
Traffic and transport	
Addresses the relevant general requirements for key issues (above).	
The EA must include an assessment of **construction traffic** impacts, including but not limited to:	
• Identification of construction routes and the nature of existing traffic on these routes.	Section 7.1.2
• Quantification of traffic volumes, including: – Spoil haulage. – Other.	Section 7.1.2
• Potential impacts to regional and local road network, including: – Safety. – Level of service. – Other.	Section 7.1.3 Section 7.1.4 Section 7.1.5
• Potential disruption to existing: – Public transport services. – Access/service lanes to local properties.	Section 7.1.3

Director-General's Requirements (DGRs)	Section addressed
The EA must include an assessment of **operational traffic and transport** impacts to the **local and regional road network** including but not limited to:	
• Changes to access arrangements / service lanes to local properties.	Section 7.2.5
• Changes to local road connectivity and access.	Section 7.2.2 Section 7.2.5 Section 7.2.6
• Assessment of impacts (including direct impacts from the replacement of the existing highway that currently passes through Berry) on: – Local traffic arrangements. – Local road capacity. – Safety from traffic rerouting. – Modified access to the upgraded highway.	Section 7.2
• The assessment must take into account: – Potential interactions with local traffic associated with the residential sub-division at Huntingdale Park, Berry (including future growth). – Any severance impacts on local connectivity within Berry as a result of the proposed route.	Section 7.2.2 Section 7.2.5 Section 7.2.6
• Consideration must be given to potential impacts of changed traffic arrangements on: – Local and / or school bus services. – Access for emergency services. – Garbage truck routes.	Section 7.2.6 Section 7.2.8 Section 7.2.9
• Traffic capacity of the proposal and its ability to cater for predicted growth.	Section 7.2.1 Section 7.2.2
• What effect potential major land use changes in the locality may have on the traffic assessment outcomes.	Chapter 4 Section 7.2
• Opportunity for the provision of cycle way connections along the highway and to adjoining communities.	Section 7.2.9 Section 8.2

1.3 Objectives of the traffic and transport assessment

The objective of this traffic and transport assessment is to address the DGRs by reporting existing and future conditions in terms of:

- Traffic volumes for the Princes Highway between the junctions with Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry), including the predicted transfer of traffic to the project from the alternative ‘Sandtrack’ route. In addition, future traffic volumes would also be reported for key local roads in the project area, including the predicted reduction in traffic volumes on Queen Street due to the Berry bypass.
- Level of service (LoS) at key intersections, interchanges and roadway locations.
- Construction impacts, including the potential impacts on the road network between Gerringong and Bomaderry. These impacts include the effects of traffic diverting along the ‘Sandtrack’ route to avoid the construction zone.
- Operational impacts of the project on road users including motorists, public transport, freight, pedestrians and cyclists; on the local (within Berry) and regional (Princes Highway) road networks.
- Travel speeds and travel time analysis.
- Road safety analysis.

More specifically, the assessment includes the following objectives:

- Develop detailed strategic and microsimulation traffic models encompassing the project and the local and regional road networks.
- Assess the construction traffic impacts including route identification, number, frequency and size of construction related vehicles, the nature of existing traffic, and the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project.
- Determine the operational traffic impacts including an assessment of existing local and regional traffic volumes and traffic patterns against forecast volumes and potential changes to traffic patterns associated with the project and public transport impacts.
- Recommend traffic and transport mitigation measures.

1.4 Structure of the report

This report has been structured into the following chapters:

- Chapter 2 provides an overview of the existing traffic and transport conditions, including a description of the route, details of public transport frequency and patronage, a review of walking and cycling routes and a summary of daily and peak period traffic patterns.
- Chapter 3 includes a summary of the operational performance of the existing Princes Highway in terms of midblock and intersection level of service, travel time analysis and a review of historical crash data.
- Chapter 4 documents the traffic modelling methodology which has been adopted to predict future traffic volumes for the project and key local roads in the traffic impact footprint.
- Chapter 5 provides details of the traffic impact assessment that was undertaken to determine the operational performance of the Princes Highway without the upgrade, which is referred to as the consequence of no action ‘Do nothing’ option.
- Chapter 6 includes an overview of the project concept design.
- Chapter 7 of this report provides details of the operational impact assessment that was completed for both construction and operational staging scenarios.
- Chapter 8 includes management measures that have been developed to mitigate the impacts of the traffic and transport issues.

2 Existing traffic and transport environment

This chapter outlines the existing traffic and transport environment within the traffic impact footprint. All data presented in this chapter represents the base or existing conditions and is based on the latest publicly available information or was specifically sourced for the project between 2009 and 2011.

2.1 Route description

The Princes Highway is the main north-south regional road corridor between Sydney, the Illawarra and through the south coast of NSW to Victoria. It is an important corridor for the following purposes:

- Commuter route between Sydney, Wollongong and Nowra.
- Local route for residents of surrounding smaller towns and rural residences.
- Major tourist route for key destinations including Gerringong, Berry, Nowra and the south coast, resulting in high volumes of peak period traffic on weekends and holiday periods.
- Important freight and bus route, particularly for the south coast and far south coast where there are no rail services.

In the project area the Princes Highway is a road of both local and regional importance. It provides the primary route for regional traffic travelling to, from, or through the project area. It also serves as a key route for traffic travelling on the local road network within Berry, and between Berry and surrounding towns and residences. Outside Berry, the highway intersects with key local roads including Toolijooa Road, Foxground Road, Austral Park Road, and Tindalls Lane.

Within Berry the highway intersects with Kangaroo Valley Road, Tannery Road, and Prince Alfred Street, which provide access to both local residences and wider regional destinations. In the town, the highway also intersects with numerous other local roads such as Victoria Street, Alexandra Street and Albert Street, providing access to residences, businesses, and other local areas and facilities.

In the wider traffic impact footprint, the ‘Sandtrack’ fulfils a similar role to the Princes Highway as a road of both local and regional importance. This route is commonly used by regional traffic to bypass the project area to the north; it also intersects with numerous local roads and therefore provides a key element of the road network to local residents and businesses within the traffic impact footprint.

The project would involve widening and realigning of 11.6 kilometres of the Princes Highway between the junctions with Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry); located within the Kiama and Shoalhaven local government areas (LGAs).

Figure 2.1 highlights the ‘project area’ and also shows key roads that encompass the ‘traffic impact footprint’ between Gerringong and Bomaderry.

The existing highway is a two lane single carriageway and the horizontal and vertical geometry requires upgrading to meet current design safety and traffic efficiency requirements; particularly in the winding and undulating sections near Toolijooa Ridge and through the ‘Foxground bends’ and Broughton Village. The highway has two short overtaking lanes for southbound traffic only, several junctions with local rural roads and many uncontrolled private accesses. The Princes Highway passes through Berry and becomes Queen Street from about Tannery Road to Kangaroo Valley Road. This results in highway traffic, including heavy vehicles, travelling through the town centre.

Figure 2.1: **Project area and traffic impact footprint**

(Source: AECOM)

Currently, the Princes Highway has various posted speed limits between Toolijooa Road and Schofields Lane ranging from 80 kilometres per hour on the section north of the Broughton Creek crossing, then 90 kilometres per hour to the northern edge of Berry, reducing to 50 kilometres per hour through the town and increasing to 100 kilometres per hour on the southern section south of Berry.

Existing major heavy vehicle rest areas on the Princes Highway within and surrounding the project area are limited. In the southbound direction, the north Kiama (Nungarry) rest area has recently been upgraded to provide parking for 7 heavy vehicles and associated facilities; and is located around 15 kilometres north of the project area. In the northbound direction, the Clive Bissell rest area provides the closest major facilities to the north, at around 50 kilometres from the project area. The Bewong rest area provides facilities for northbound traffic around 50 kilometres south of the project area. The RMS Strategy for Major Heavy Vehicle Rest Areas on Key Rural Freight Routes in NSW indicates that both the Clive Bissell and Bewong rest areas require upgrading to fill a gap in rest area facilities on the Princes Highway.

Figure 2.1 also shows the ‘Sandtrack’, which is an alternative route for light vehicles between Gerringong and Bomaderry via Fern Street, Crooked River Road, Gerroa Road and Bolong Road; enabling motorists to avoid the winding, hilly sections of the Princes Highway between these two towns. As a consequence, many private vehicles use this route to avoid delays behind slow moving heavy vehicles (which are prevented from using the ‘Sandtrack’ by a five tonne load limit). The ‘Sandtrack’ is slightly shorter than the highway and has a posted speed limit of 90 kilometres per hour or 100 kilometres per hour for much of its length between Gerringong and Bomaderry.

2.2 Modes of travel

2.2.1 Private vehicles

Berry is about a two and a half hour drive from Sydney and typically it takes an additional 15 minutes to drive further south to Bomaderry. The town is located about half way between Gerringong and Bomaderry, with Foxground and Broughton Village roughly half way between Gerringong and Berry. Private vehicles are the predominant mode of transport in the project area, which is reflected by higher than average vehicle ownership in the Kiama and Shoalhaven LGAs. The average vehicle ownership per household in Kiama and Shoalhaven is 1.73 and 1.69 respectively, compared to an average of 1.47 in the Sydney greater metropolitan area.

The *NSW Transport Data Centre, 2007 Household Travel Survey Summary Report, 2009 Release* provides details of the mode share of average weekday travel demand made from each LGA in NSW. Travel mode shares for the Kiama and Shoalhaven LGAs in comparison to the Sydney greater metropolitan area are shown in **Table 2.1**.

Findings from the household travel survey show that around 85 per cent of total trips on a typical weekday made in Kiama and Shoalhaven are car-based, compared to an average of 72 per cent in the Sydney greater metropolitan area.

Table 2.1: Average weekday travel mode share for Kiama/Shoalhaven LGAs (2007)

Local government area	Private vehicle			Rail passenger	Bus passenger	Walk only	Other modes
	Driver	Passenger	Total				
Kiama	59 %	24 %	83 %	1 %	4 %	9 %	3 %
Shoalhaven	59 %	27 %	86 %	1 %	2 %	10 %	1 %
Sydney greater metropolitan area	50 %	22 %	72 %	4 %	5 %	17 %	2 %

(Source: NSW Transport Data Centre - 2007 Household Travel Survey Summary Report, 2009 Release)

2.3 Public transport services

2.3.1 Bus services

Although the project area is serviced by bus routes the frequency of services is limited, resulting in a low bus passenger mode share when compared to other forms of travel. **Table 2.1** shows that bus passengers represent between two per cent and four per cent of the mode share of average weekday travel demand generated from the Shoalhaven and Kiama LGAs respectively.

Local and regional bus and coach services utilise the Princes Highway in the project area. School services transporting students between Gerringong, Berry and Bomaderry frequent the route during term time, although patronage figures provided by local bus operators indicate that only around 20 students typically use these services on a daily basis.

Premier Motor Service provides two daily bus services in each direction between Sydney and Melbourne via Kiama, Gerringong and Nowra using the Princes Highway in the project area. This is a service typically used by passengers travelling long distances/interstate, rather than a service for local residents. Premier Motor Service also provides a school service between Bomaderry and Toolijooa Road along the Princes Highway in the project area.

Private operator Shoal Bus offers services to and through Berry, as shown in **Figure 2.2**. Service 705 extends from Werri Beach in the north east of Gerringong to Berry via the 'Sandtrack' and Beach Road; and then on to Bomaderry and Nowra via the Princes Highway. Shoal Bus users can change services at Berry and Bomaderry to access other areas further south. For instance, the service from Shoalhaven Heads to Berry (SB), or service 735 from Bomaderry/Nowra to travel further south towards St Georges Basin.

Shoal Bus service 705 operates a minimum of two services per day on weekdays, although an additional two 'Shoal Shopper' services operate on Tuesday and Friday, bringing the total services on these days to four. The timetable for this service depends primarily on school holiday schedules, although there is a minimum of one morning and one afternoon service. Two services operate between Berry and Nowra on the weekend with one service in the morning and another in the afternoon.

The primary stops for service 705 are located in Gerringong, Berry and Nowra, with additional stops for all stop routes at Werri Beach, Gerroa and Shoalhaven Hospital. The express service travelling between Gerringong and Nowra typically takes between 30 and 45 minutes, while all stop services can take in excess of one hour.

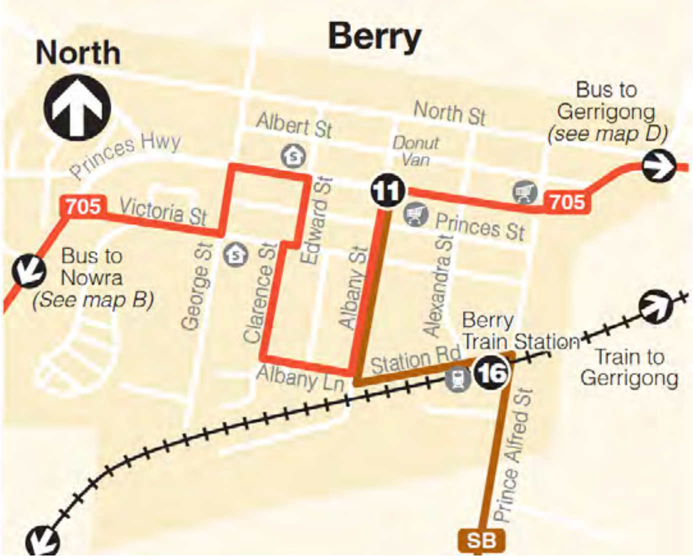

Figure 2.2: **Shoal Bus scheduled service routes to Berry**

(Source: www.shoalbus.com.au)

Several school-specific buses and coaches also use the Princes Highway and local roads in the project area. Shoal Bus school service SB operates between Berry and Shoalhaven Heads via Prince Alfred Street and Coolangatta Road. Two services operate on a typical weekday with one service operating in the morning and the other in the afternoon. Only one service is provided on Saturday, with no service on Sundays or Public Holidays. The primary stops for service SB are located in Berry at the 'Donut Van' via Albany Street, Berry Train Station and Shoalhaven Heads (Heads Bowling Club). On a typical weekday, the travel time between Berry and Shoalhaven Heads is about 30 minutes in the morning and 15 minutes in the afternoon.

In addition, Shoal Bus operates two weekday school-specific services which travel from the locality of Gerringong to Nowra and Bomaderry through the project area during the morning pick-up and afternoon drop-off periods. One service operates from Gerringong, travelling down the 'Sandtrack' (Gerroa Road), before heading across from the 'Sandtrack' to Berry via Beach Road; and then further south to Bomaderry via the Princes Highway. The other service commences in the Foxground area and travels south along the Princes Highway through Berry and on to Nowra. This service has informal pick-up and drop-off locations, stopping at property accesses in rural areas along the Princes Highway where children reside, as well as at numerous intersections between the Princes Highway and local roads in the project area.

2.3.2 Rail services

Table 2.1 shows that rail passengers represent one per cent of average weekday travel mode share in the project area, partly due to the south coast line terminating at Bomaderry, north of the Shoalhaven River. The south coast rail line links Sydney, Wollongong and North Nowra/Bomaderry. There is a station serving the project area located in Berry. North Nowra/Bomaderry Station is located to the south of Berry, while Gerringong is the nearest station to the north. As there are no direct services from Berry to Sydney, passengers are required to change trains at Wollongong, Dapto or Kiama.

There are 18 services in each direction stopping at Berry during weekdays, with 14 services in each direction during the weekends. Services operate about once every hour during morning and afternoon peak hours through the week. There are train services every two hours during the inter-peak period between 9.30am–3pm.

Indicative travel times for rail services between the project area and surrounding areas are shown in **Table 2.2**. Rail travel between Bomaderry and Berry, and Gerringong and Berry takes about 10 minutes. Rail travel between Berry and Wollongong takes around 70 minutes, while travel between Wollongong and Sydney takes between 90 and 105 minutes.

Table 2.2: Rail travel times to / from project area (Berry) and surrounding areas

Approximate travel time (minutes)		**To**				
		Berry	Bomaderry (Nowra)	Gerringong	Wollongong	Sydney
From	Berry	-	10	10	70	>160
	Bomaderry (Nowra)	10	-	20	80	>170
	Gerringong	10	20	-	60	>150
	Wollongong	70	80	60	-	>90
	Sydney	>160	>170	>150	>90	-

(Source: CityRail South Coast Line Train Timetables, (RailCorp, September 2011))

RailCorp publishes annual NSW station entry and exit statistics. The latest data was released in 2010 and is contained in *A Compendium of CityRail Travel Statistics, Sixth Edition, June 2010*.

Table 2.3 displays the 2009 average weekday station entries and exits between 6am–6.30pm and also the total passenger throughput over the corresponding 24 hour period. All three stations at Gerringong, Berry and Bomaderry show a similar tidal profile; in that the majority of passengers depart from the station in the AM peak and arrive back at the station during the PM peak. The table also shows that daily and peak period passenger demand at these stations is low, particularly at Gerringong and Berry which have only 70 entries and exits on a typical 24 hour period.

Table 2.3: 2009 average weekday station entries and exits

Train station	**AM peak 6am–9.30am**		**Inter peak 9.30am–3pm**		**PM peak 3pm–6.30pm**		**24 hours**	
	In	**Out**	**In**	**Out**	**In**	**Out**	**In**	**Out**
Bomaderry (Nowra)	140	30	80	100	80	140	340	340
Berry	30	10	10	20	20	30	70	70
Gerringong	40	0	10	20	10	40	70	70
Wollongong	680	540	620	570	760	700	2320	2320

(Source: A compendium of CityRail Travel Statistics, Sixth Edition (RailCorp, June 2010))

2.3.3 Walking and cycling

External to Berry, there are no footways along the Princes Highway within the project area and very few pedestrians travel along this route. Shoulders and verges provide a means for pedestrians to travel along the Princes Highway; however the speed of traffic on this route combined with significant travel distances to nearby towns (eg Gerringong and Berry) result in very low pedestrian flows.

Footways are provided in Berry between Woodhill Mountain Road and Kangaroo Valley Road to service local shops and businesses on Queen Street. Residential streets in the town have either one-sided, partial or no footways.

The results of pedestrian crossing surveys of Queen Street (Princes Highway) in the main commercial precinct of Berry, between Alexandra Street and Prince Alfred Street, are shown in **Table 2.4**. In addition the results of pedestrian demand surveys undertaken on Friday 1 June and Saturday 2 June 2012 are also shown. The latter surveys were undertaken on North Street, at the intersection with Rawlings Lane, and Kangaroo Valley Road, at the intersection with Huntingdale Park Road. These locations were surveyed as during consultation the community identified these routes as particularly significant pedestrian connections within the town.

Table 2.4: Pedestrian and cyclist survey results – Berry

Location	Approach	Total pedestrian and cyclist demand			
		Fri 2 June 2012: 7am-10am	Fri 2 June 2012: 2pm-5pm	Sat 2 June 2012: 10am-2pm	Sun 14 Aug 2002: 11am-3pm
North Street | Rawlings Lane | George Street Intersection	North Street westbound	7	8	8	-
	George Street	1	1	2	-
	North Street eastbound	7	7	10	-
	Rawlings Lane	1	0	2	-
	Total	**16**	**16**	**22**	**-**
Kangaroo Valley Road | Huntingdale Park Road Intersection	Kangaroo Valley Road westbound	5	24	4	-
	Huntingdale Park Road	4	6	3	-
	Kangaroo Valley Road eastbound	11	8	3	-
	Total	**20**	**38**	**10**	**-**
Queen Street between Alexandra Street and Prince Alfred Street	**Total – Queen Street crossings**	**-**	**-**	**-**	**3953**

(Source: AECOM, June 2012; AECOM, based on RMS Southern Region Traffic Survey Data, Aug 2002)

The results of these surveys show substantial pedestrian activity in the vicinity of Queen Street between Alexandra Street and Prince Alfred Street, with demand generated by the commercial development in this area. Pedestrian volumes on North Street and Kangaroo Valley Road are significantly lower, with these routes providing connections for pedestrian and cyclist movements over longer distances to and from residential areas to the north and west of the town.

There are no formal cycle specific facilities in Berry, but Shoalhaven Council does promote various cycle routes to and from Berry utilising the Princes Highway and other local and regional roads (for example Berry to Seven Mile Beach via the Princes Highway, Tannery Road and Beach Road, and Berry to Kangaroo Valley via Berry Mountain).

A proposed 1400 kilometre coastal cycleway stretching from the Queensland border, through NSW to the Victorian border includes a section within the study area that follows the route of the 'Sandtrack'. This connects to the Berry to Seven Mile Beach route described above. The purpose of the cycleway program is to deliver more sustainable transport choices, increase tourism, provide better coastal recreation access and grow bicycle-tourism industries. It is largely funded by RMS and implemented by local government, and has already resulted in over 330 kilometres of the route being constructed, or committed to, in the form of shared pedestrian/cycle paths or on-road cycle lanes along local streets. There are opportunities for Shoalhaven and Kiama Councils to apply for grants to improve the route for cyclists.

In the surrounding area, an off-road cycle route linking Gerringong and Gerroa along Fern Street was completed in 2000 and a six kilometre walking track between Kiama and Gerringong along the coast was opened in October 2009.

2.4 Existing traffic volumes and patterns

2.4.1 Introduction

This section provides details of vehicular traffic flows that have been recorded within the traffic impact footprint. In addition to annual average daily traffic (AADT), average AM peak, PM peak and 100th highest hour traffic volumes are reported to show the fluctuation in traffic demand for different time period scenarios.

As the Princes Highway (in the project area) is in a rural area and is a major route for tourism with significant peak period traffic during school holidays, it is not necessarily appropriate to focus the analysis of existing conditions on typical weekday morning and evening peak periods. Therefore, further analysis was carried out to identify the true periods of peak demand and found that these usually occurred on the first evening of a holiday period southbound and the last afternoon of a holiday period northbound during a Public Holiday weekend or other holiday period.

Since it is not economical to design to a level of operational road capacity that is required only for a few hours per year, a design hour must be selected upon which to base design analysis. The design hour is usually chosen between the 30th and 100th highest hour of the year, with the 100th highest hour selected to assess carriageway and access operational performance measures for the project.

Historic data recorded at locations within the traffic impact footprint shows that traffic volumes typically reach 100th highest hour levels during the Easter period. Therefore in order to quantify the magnitude and change in traffic patterns associated with 100th highest hour volumes, traffic surveys were undertaken during the Easter and Anzac Day 2011 public holiday weekend (Thursday 21 April – Tuesday 26 April 2011) at two locations on the Princes Highway to the north and south of Berry.

Analysis of the survey data showed that the traffic volumes peaked in the southbound direction on the Thursday evening (preceding Good Friday) and then in the northbound direction on the Tuesday afternoon (ANZAC day). Traffic volumes recorded during the southbound peak period represented 12.6 per cent of the AADT and 11.6 per cent of the AADT in the northbound direction; compared to around seven per cent and nine per cent of the AADT during the AM peak and PM peak respectively. Due to the significant directional variations of peak holiday traffic demand in the traffic impact footprint, it was determined that existing and future conditions of the highway would be assessed for two 100th highest hour peak scenarios.

Therefore the following time periods have been selected to report existing traffic flows within the traffic impact footprint:

- Annual Average Daily Traffic (AADT).
- Average one hour AM peak (7am–11am).
- Average one hour PM peak (3pm–7pm).
- 100th highest single hour (100th highest hour) traffic volumes, which have been reported for two sub-scenarios:
  - 100SB: 100th highest hour southbound peak period that reflects traffic patterns in the project area recorded on Thursday 21 April 2011 (southbound peak holiday direction).
  - 100NB: 100th highest hour northbound peak period that reflects traffic patterns in the project area recorded on Tuesday 26 April 2011 (northbound peak holiday direction).

2.4.2 Annual traffic growth

Table 2.5 shows AADT and linear growth rates recorded at RMS' permanent automatic traffic count (ATC) site 7.800 on the Princes Highway north of Rose Valley Road. Between 1990 and 2010, AADT on the highway increased by an average of over 400 vehicles per year; equating to a linear growth rate of around 3.2 per cent per annum. More recently, between 2007 and 2010, daily traffic volumes increased by 2097 vehicles; which equates to an average linear growth rate of around 3.6 per cent per annum.

Table 2.5: AADT traffic growth summary (1990–2010)

Location:	**Site 7.800: Princes Highway, north of Rose Valley Road**		
Year	**AADT**	**Growth rate**	
		Period	**Average annual growth (%)**
1990	12,944	-	-
1994	14,791	1990 – 1994	3.6%
1997	15,711	1994 – 1997	2.1%
2000	17,753	1997 – 2000	4.3%
2002	18,960	2000 – 2002	3.4%
2004	19,371	2002 – 2004	1.1%
2006	18,731	2004 – 2006	-1.7%
2008	19,675	2006 – 2008	2.5%
2010	21,300	2008 - 2010	4.1%
-	**-**	**1990 - 2010**	**3.2%**

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Although this location is north of the project, it is indicative of the continuous level of traffic growth on the Princes Highway corridor through the project area.

2.4.3 Seasonal variation in traffic volumes

The RMS' permanent ATC site 7.800 has also been used to perform seasonal traffic variation analysis. The changes in annual traffic volumes over two historical years (2009-2010) are shown in **Figure 2.3.**

Figure 2.3. shows that traffic flows are highest during major holiday periods, including the school holidays at Christmas, Easter, and Labour Day in October. Traffic volumes peak to over 26,000 vehicles per day during the Christmas holidays, which equates to around 20 per cent more vehicles in comparison to the AADT at this location.

Seasonality factors have been used to scale surveyed traffic volumes in order to estimate annual traffic volumes from temporary traffic surveys. The objective is to factor the average daily traffic (ADT) flow from a given survey period to the annual average daily traffic (AADT) flow for the corresponding year, resulting in a seasonality factor. A seasonality factor of 1.126 has been calculated to convert the May/June 2009 survey data and 1.138 to convert April/May 2011 survey data; to reflect the AADT for each year.

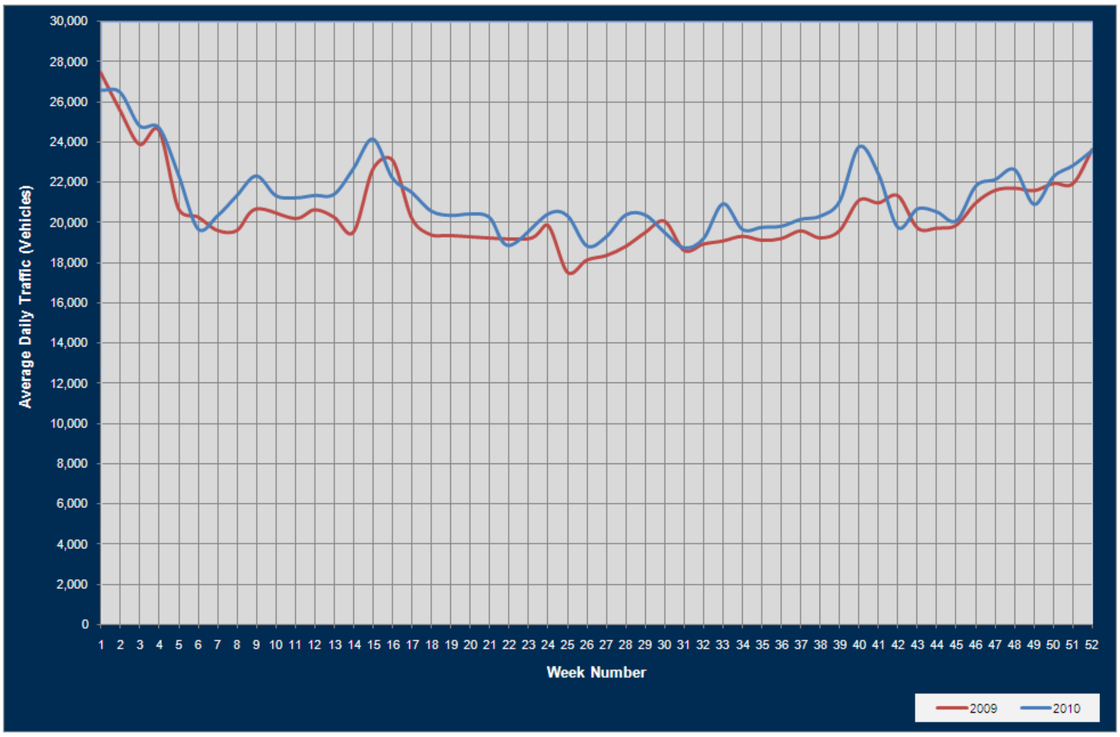

Figure 2.3: **Seasonal variations in average daily traffic (2009-2010)**

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

2.4.4 Daily and peak period traffic volumes

RMS commissioned traffic surveys in May/June 2009 and April/May 2011 to measure traffic volumes at other key locations on the Princes Highway and the adjacent 'Sandtrack' route in the traffic impact footprint.

A series of ATC tubes were located on the Princes Highway north of Tannery Road and south of Victoria Street and on the 'Sandtrack' south of Belinda Street and south of the Beach Road intersection, as shown in **Figure 2.4**. A summary of the average peak and daily traffic volumes (seasonally adjusted) are displayed in **Table 2.6**.

Table 2.6 shows that the highest daily volume of traffic in the traffic impact footprint is on the Princes Highway north of Rose Valley Road with an AADT of 21,300 vehicles. South of Gerringong, the combined AADT on the Princes Highway (north of Tannery Road) and on the ‘Sandtrack’ (south of Belinda Street) is 18,850 vehicles suggesting a net loss of traffic of around 2450 vehicles to Gerringong and villages adjacent to the highway between Gerringong and Berry, via local roads and accesses.

North of Berry, surveys showed traffic on the Princes Highway to be around 10,150 vehicles per day, with 8700 vehicles using the alternative ‘Sandtrack’ route. This equates to a 54 per cent / 46 per cent split of traffic using the Princes Highway / ‘Sandtrack’. South of Berry, the AADT is 12,575 vehicles on the Princes Highway compared to 6650 using the ‘Sandtrack’. At these locations, the bias of traffic is more heavily weighted towards the Princes Highway, with 65 per cent of the total, compared to 35 per cent using the ‘Sandtrack’.

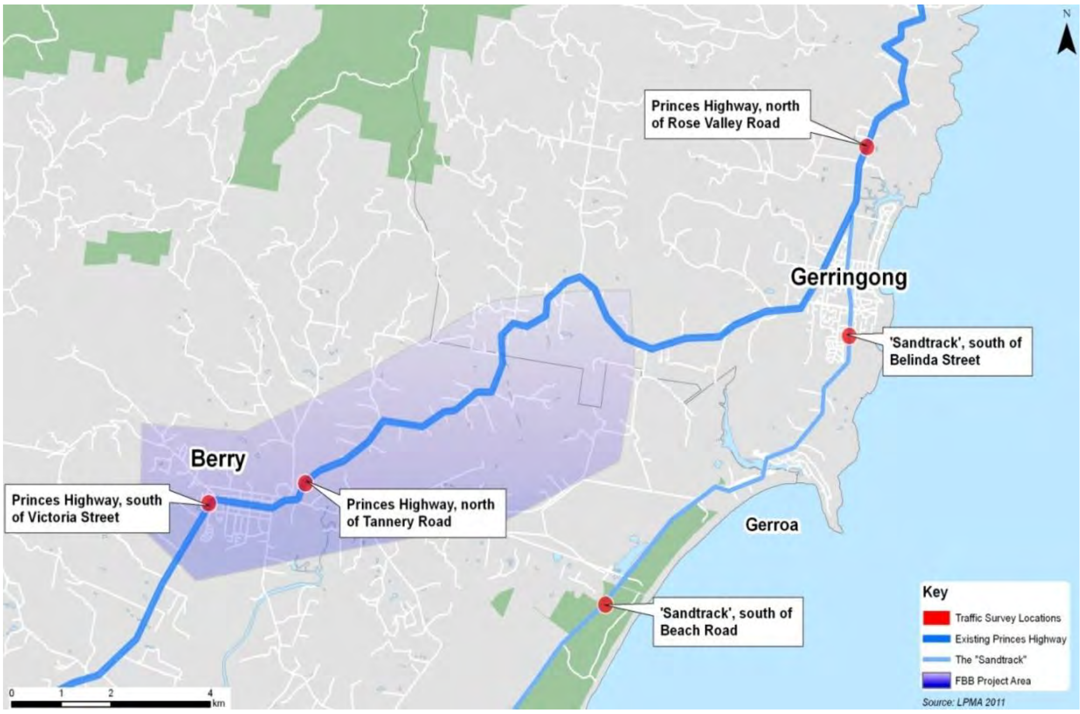

Figure 2.4: **Traffic survey locations**
(Source: AECOM)

The higher traffic volumes on the Princes Highway to the south of Berry compared to the north indicates that a higher proportion of traffic arriving or departing from Berry travels to or from the south of the town. The volumes also highlight the difference in heavy vehicle traffic between the two competing routes. Heavy vehicles constitute eight per cent of the AADT on the Princes Highway north of Gerringong, increasing to around 12 per cent and 13 per cent to the south and north of Berry respectively. In comparison, heavy vehicles on the ‘Sandtrack’ represent between three and four per cent of the AADT along the length of this alternative route due to the five tonne vehicle load limit in place.

The 100th highest hour factors of 12.6 per cent and 11.6 per cent recorded on the Princes Highway north and south of Berry were applied to the AADT for the other count locations to synthesise respective 100 northbound (NB) hour and 100 southbound (SB) hour traffic flows for the two ‘Sandtrack’ locations and the Princes Highway north of Rose Valley Road. The resultant traffic volumes are provided in **Table 2.6**, showing that each location has a substantial increase in 100th highest hour traffic volumes when compared to the corresponding AM peak and PM peak periods.

Table 2.6: Daily and peak period traffic volume summary (2009-2011)

Location	Year	Two-way traffic flows					
		AM peak (veh/h)	PM peak (veh/h)	100NB* peak (veh/h)	100SB* peak (veh/h)	AADT	
						Flow (veh/day)	% heavy veh
Princes Highway, north of Rose Valley Road	2010	1525	1800	2470	2680	21,300	8 %
Princes Highway, north of Tannery Road	2011	730	875	1185	1275	10,755	13 %
Princes Highway, south of Victoria Street	2011	930	1090	1250	1475	13,400	12 %
‘Sandtrack’, south of Belinda Street	2009	620	760	1010	1100	8700	3 %
‘Sandtrack’, south of Beach Road	2009	450	590	770	840	6650	4 %
Victoria Street, east of Princes Highway	2012	215	190	170	245	2170	4%
Kangaroo Valley Road, north of North Street	2011	115	140	155	140	1485	5%
Tannery Road, east of Pulman Street	2011	130	165	125	95	1680	5%
Prince Alfred Street, south of Queen Street	2011	-	-	155	220	-	-
Woodhill Mt. Road, north of North Street	2011	80	100	90	110	970	6%

NB – northbound, SB - Southbound
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Surveys were also conducted on other roads of regional and local significance within the project area, with the results included in **Table 2.6**. ATC tube surveys undertaken during 2011 and 2012 were used to capture AM peak, PM peak and AADT traffic volumes on Victoria Street, Kangaroo Valley Road, Tannery Road, and Woodhill Mountain Road; these surveys augmented the 100NB and 100SB hour volumes captured during the Easter 2011 origin-destination (O-D) surveys.

Kangaroo Valley Road, Tannery Road and Prince Alfred Street provide both local and regional connectivity within and around the project area. The results in **Table 2.6** indicate that both local and regional traffic demand using these routes is low when compared to the Princes Highway and the ‘Sandtrack’. As an example, the recorded AADT of 1485 on Kangaroo Valley Road is equivalent to around 12 per cent of the 13,400 daily vehicles recorded on the intersecting section of the Princes Highway. Although these roads provide important links for residents and businesses within and surrounding the project area, they are only used by a small proportion of vehicles travelling to, from, and within the project area.

2.4.5 Weekday and daily traffic profiles

The 2010 average weekly directional and combined traffic profiles recorded at RMS' permanent ATC site 7.800 are shown in **Figure 2.5**. The profile clearly shows a significant increase in southbound traffic on Friday afternoons and Saturday mornings, and an increase in northbound traffic on Sunday afternoons. This illustrates the significant amount of recreational travel present in the area, with many road users making weekend trips to the south coast of NSW from Sydney and Wollongong.
As a result, the probability of congestion and delays is typically higher during weekend peak hours than AM peak and PM peak hours through the week.

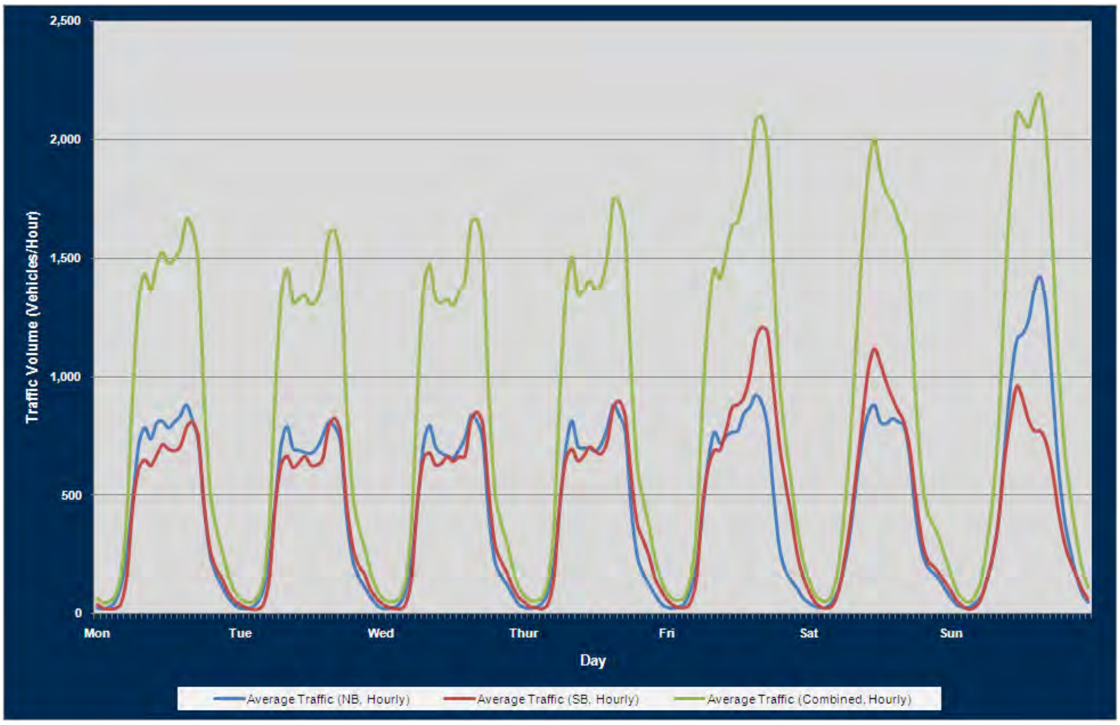

Figure 2.5: Average weekly traffic profile: Site 7.800, Princes Highway north of Rose Valley Road (2010)

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Daily traffic volume profiles for the surveyed Princes Highway and 'Sandtrack' locations listed in **Table 2.6** are shown in **Figure 2.6** to **Figure 2.10**.

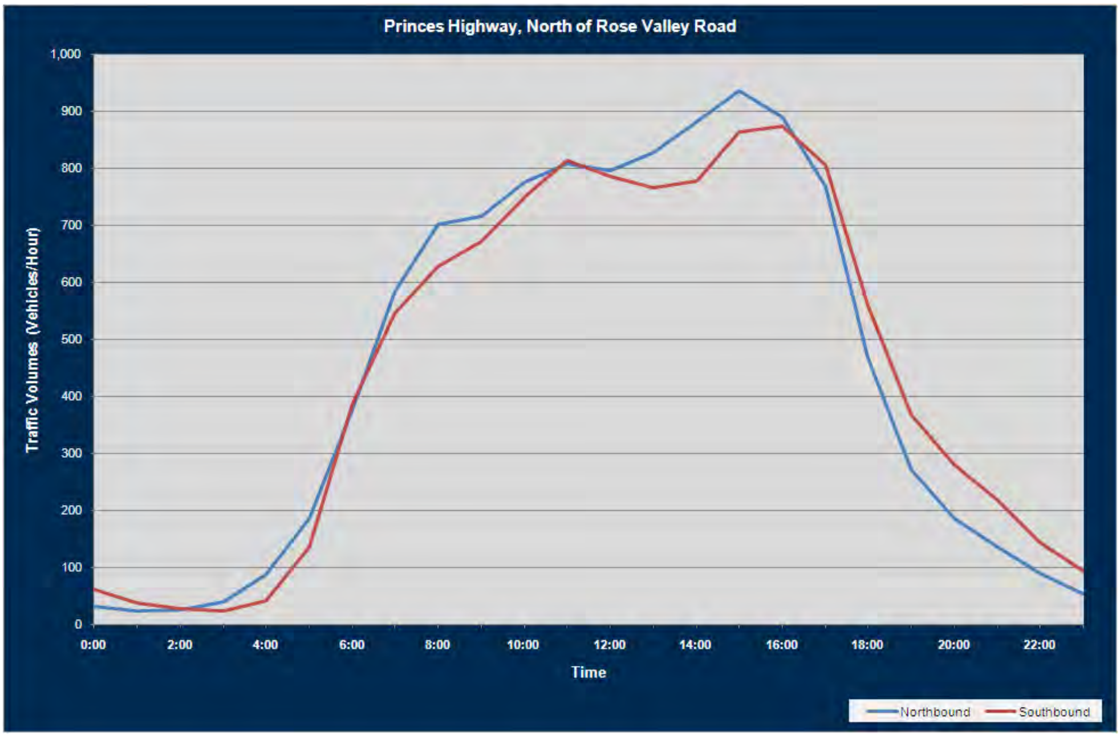

Figure 2.6: **Average daily traffic profile: Princes highway north of Rose Valley Road (2010)**
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

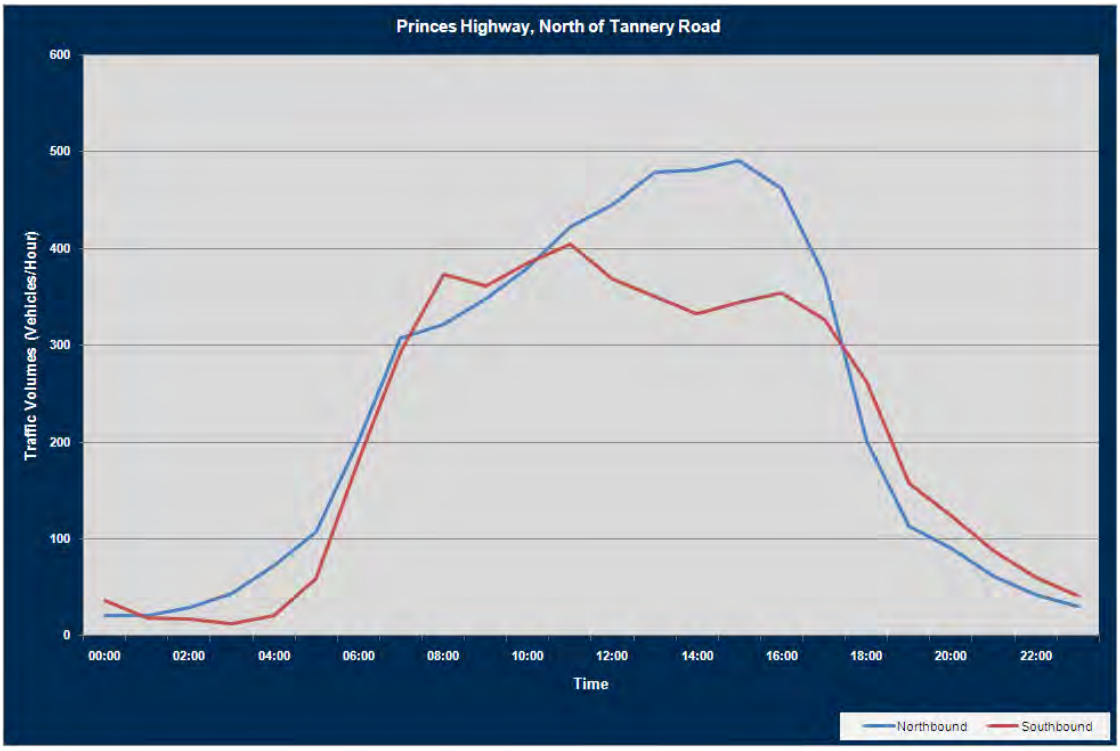

Figure 2.7: **Average daily traffic profile: Princes Highway north of Tannery Road (2011)**
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Figure 2.8: **Average daily traffic profile: Princes Highway south of Victoria Street (2011)**

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

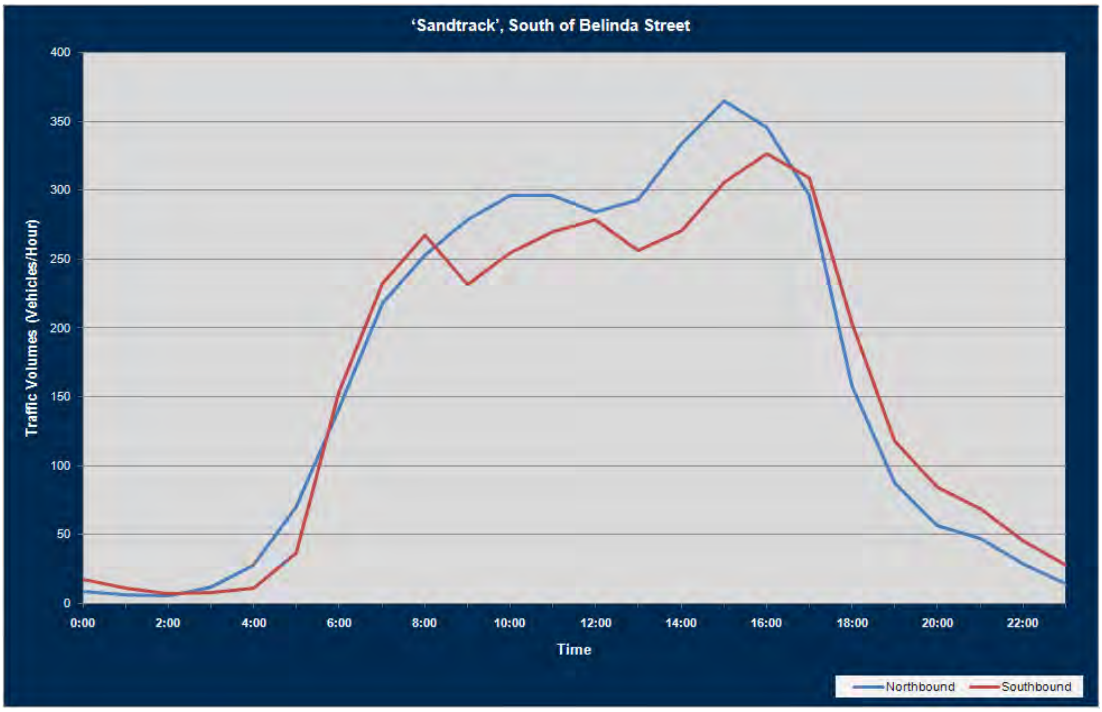

Figure 2.9: **Average daily traffic profile: 'Sandtrack', south of Belinda Street (2009)**

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

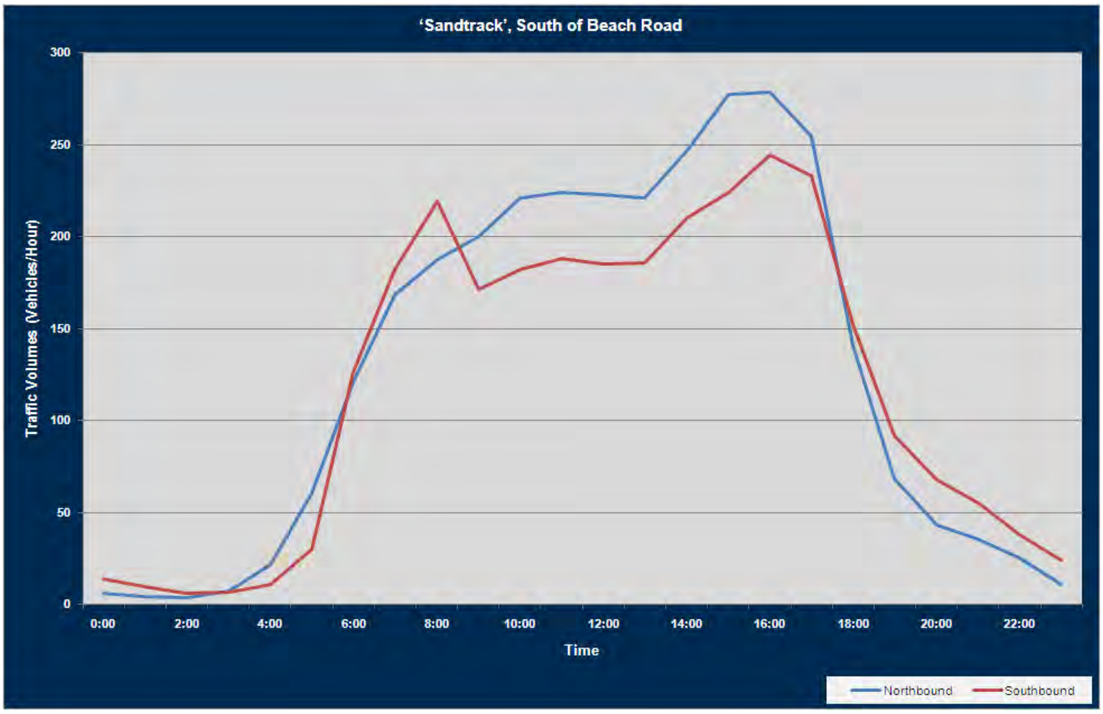

Figure 2.10: Average daily traffic profile: 'Sandtrack', south of Beach Road (2009)

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

The profiles for all of the survey sites (shown in **Figure 2.6**, **Figure 2.7**, **Figure 2.8**, **Figure 2.9** and **Figure 2.10**) show a steady increase in traffic throughout the day, peaking at around 3pm–4pm before subsiding in the early evening. Traffic volumes tend to grow gradually throughout the morning and into the afternoon; there is however a small peak in morning southbound traffic north of Berry on the Princes Highway, and south of Berry on both the Princes Highway (south of Victoria Street) and the 'Sandtrack' (south of Beach Road).

The general traffic patterns in the project area are dissimilar to denser urban areas, which generally peak early in the morning with commuter traffic, subsiding in the inter-peak period, before growing again to a peak in the afternoon. The early afternoon peak (3pm) suggests a significant level of after school pickup and resultant social and commercial activity in the area.

2.4.6 Berry traffic patterns

One of the key objectives of the project is to provide significant beneficial environmental effects for Berry town centre. At present, large volumes of through traffic, including heavy vehicles, are required to travel through the town increasing congestion, reducing road safety, and diminishing general amenity.

The project would offer substantial benefit to Berry town centre with the construction of the Berry bypass. Through traffic would use the bypass, avoiding potential delays and traffic conflicts in the town. Stopping traffic and traffic accessing local roads would enter Berry via grade-separated interchanges to the north and south of town, and would benefit from significantly reduced traffic conflicts and congestion in the town centre, especially during peak hours.

Surveys were undertaken to assess current traffic patterns within and surrounding Berry. The O-D surveys were used to help analyse the potential benefits and impacts of the Berry bypass. It also represents a key component of the traffic data required to complete traffic modelling (see Chapter 4).

Preliminary strategic O-D survey (2007)

During preliminary planning of the project in 2007, a strategic O-D survey was undertaken between Gerringong and Bomaderry within the traffic impact footprint to record traffic movements, and in particular gauge the proportions of through and stopping traffic. The survey was undertaken between 7am-9am and 2pm-6pm on Thursday 15 February 2007, at survey stations shown in **Figure 2.11**.

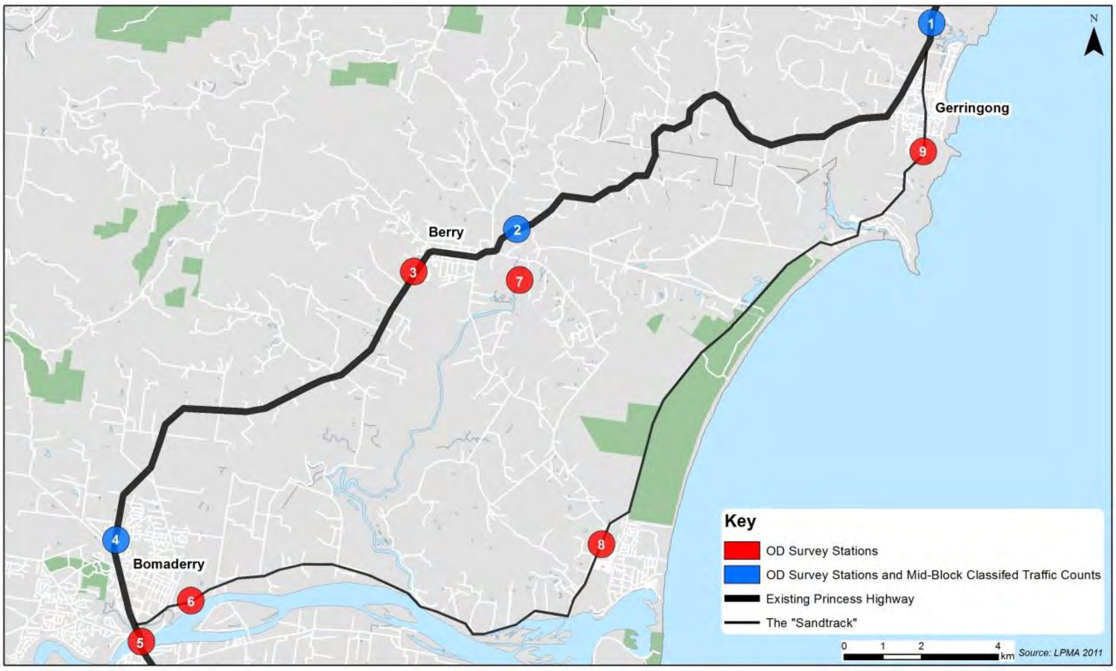

Figure 2.11: 2007 O-D survey station locations

(Source: Gerringong to Bomaderry Princes Highway upgrade–Preliminary Traffic Assessment Report, AECOM 2007)

A summary of the data collected, indicating the proportions of through and stopping traffic within the traffic impact footprint is shown in **Table 2.7**. The survey data indicates that through traffic comprised over 80 per cent of vehicles travelling between the extents of the traffic impact footprint on a typical weekday.

Table 2.7: Through and stopping traffic proportions (7am-9am and 2pm-6pm, average weekday)

Origin	Destination	Route	Sample size (all vehicles)	Through traffic (%)	Stopping traffic (%)
Station 5: South of Bomaderry	Station 1: North of Gerringong	Princes Highway (Northbound)	914	82 %	18 %
		The 'Sandtrack' (Northbound)	544	83 %	17 %
Station 1: North of Gerringong	Station 5: South of Bomaderry	Princes Highway (Southbound)	889	82 %	18 %
		The 'Sandtrack' (Southbound)	613	85 %	15 %

(Source: Gerringong to Bomaderry Princes Highway Upgrade – Preliminary Traffic Assessment Report, AECOM 2007)

Table 2.7 indicates the proportions of through and stopping traffic travelling within the traffic impact footprint from the north of Gerringong, south of Bomaderry, or between both points. Within the traffic impact footprint, local trips with origins and / or destinations in Bomaderry, Berry, and Gerringong would also influence the proportion of through traffic travelling on the Princes Highway through Berry. Although the 2007 survey suggests that over 80 per cent of traffic travels through the traffic impact footprint without stopping on a typical weekday, it is noted that the equivalent proportion travelling through Berry would also be influenced by the trip patterns of local traffic generated within the project area and traffic impact footprint.

Gerringong to Bomaderry sub-area TRACKS modelling (2010)

Outputs of the Gerringong to Bomaderry sub-area TRACKS model, developed by Gabites Porter Consultants (see Section 4.2.2) provided a representation of trip patterns in the project area. The model forecasts average daily traffic which was used to estimate daily through and stopping traffic proportions on the Princes Highway in Berry. The results estimate that presently around 70 per cent of total northbound traffic and 75 per cent of total southbound traffic on the Princes Highway travels through Berry without stopping. This indicates that local traffic generated and travelling within the traffic impact footprint lowers the proportion of through traffic in Berry, when compared to the proportion of through traffic travelling between the extents of the traffic impact footprint indicated by the 2007 O-D survey.

100th highest hour O-D surveys (Easter & Anzac Day 2011)

As noted in Section 2.4.4, traffic in Berry town centre is highest during holiday and other recreational peak periods, with the volume and distribution of traffic varying significantly from a typical weekday. For this reason, a comprehensive set of surveys, including O-D surveys, were undertaken during the Easter and Anzac Day 2011 public holiday weekend (Thursday 21 April – Tuesday 26 April 2011). The data collected during this period was used to develop detailed O-D matrices used as input to the Paramics microsimulation modelling (see Section 4.3) and also to develop and validate other forecast data used during the analysis of 100th highest hour traffic impacts and road network performance.

Within the project area, southbound traffic significantly increases at the start of a holiday period (100th southbound peak period) while northbound traffic experiences a similar peak at the end of a holiday period (100th northbound peak period). Therefore, O-D surveys were undertaken during both peak periods during the Easter and Anzac Day 2011 public holiday weekend; 3pm-7pm on Thursday 21 April and 10am-2pm on Tuesday 26 April. These surveys captured vehicle classified movements between the following locations:

- Princes Highway, south of Victoria Street.
- Queen Street (Princes Highway), west of Alexandra Street.
- Princes Highway, north of Tannery Road.
- Kangaroo Valley Road, north of North Street.
- Tannery Road, east of Pulman Street.
- Prince Alfred Street, south of Station Road.
- Woodhill Mountain Road, north of North Street.

The following additional surveys were also undertaken to develop further understanding of traffic movements within Berry and validate O-D survey data:

- Intersection turning counts (vehicle classified) at three key locations:
  - Queen Street (Princes Highway) and Kangaroo Valley Road.
  - Queen Street (Princes Highway) and Albert Street.
  - Queen Street (Princes Highway) and Woodhill Mountain Road.
- Midblock tube counts (vehicle classified) at two key locations (used to validate the integrity of the O-D survey):
  - Princes Highway, south of Victoria Street.
  - Princes Highway, north of Tannery Road.

Table 2.8 shows the travel times recorded during the 100th highest hour peak period O-D surveys for the dominant movements through Berry on the Princes Highway (Queen Street). As an example, during the 100th northbound peak period, traffic travelling southbound on the Princes Highway between Tannery Road and Victoria Street took an average of 8:31 minutes, with the quickest trip between these points recorded at 2:24 minutes. The 85th percentile bracket however shows that 85 per cent of all trips recorded between these locations took less than 6:30 minutes; the average of 8:31 minutes is skewed by travel times in excess of one hour (stopping traffic).

Because of this, 85th percentile values have been used to differentiate stopping and non-stopping traffic. Both movement combinations and travel times have been used to estimate potential bypass traffic. In this example, traffic travelling southbound on the Princes Highway between Tannery Road and Victoria Street in less than 6:30 minutes is assumed to be through traffic and potential bypass users. It is assumed that traffic with longer travel times than this would stop in Berry.

The travel time results also highlight that during the 100th northbound peak period, average northbound travel times between the locations shown were close to 15:00 minutes; the 85th percentile value between 20:00-22:00 minutes. This indicates that during this period heavy congestion and delays were experienced on the road network through Berry, exemplifying the current impact of traffic in the town during the busiest peak periods. **Figure 2.12** and **Figure 2.13** illustrate the distribution of recorded travel times through Berry during the 100th northbound and 100th southbound peak periods respectively.

Table 2.8: Princes Highway travel times through Berry (100th highest hour peak periods)

Origin	Destination	Direction	Minimum (mm:ss)	Average (mm:ss)	85th percentile (mm:ss)
100th northbound peak period					
Princes Highway, north of Tannery Road	Princes Highway, south of Victoria Street	Southbound	02:24	08:31	06:00-06:30
Princes Highway, south of Victoria Street	Princes Highway, north of Tannery Road	Northbound	03:02	14:44	20:00-22:00
100th southbound peak period					
Princes Highway, north of Tannery Road	Princes Highway, south of Victoria Street	Southbound	02:48	06:08	05:30-06:00
Princes Highway, south of Victoria Street	Princes Highway, north of Tannery Road	Northbound	02:40	05:44	04:00-04:30

(Source: AECOM)

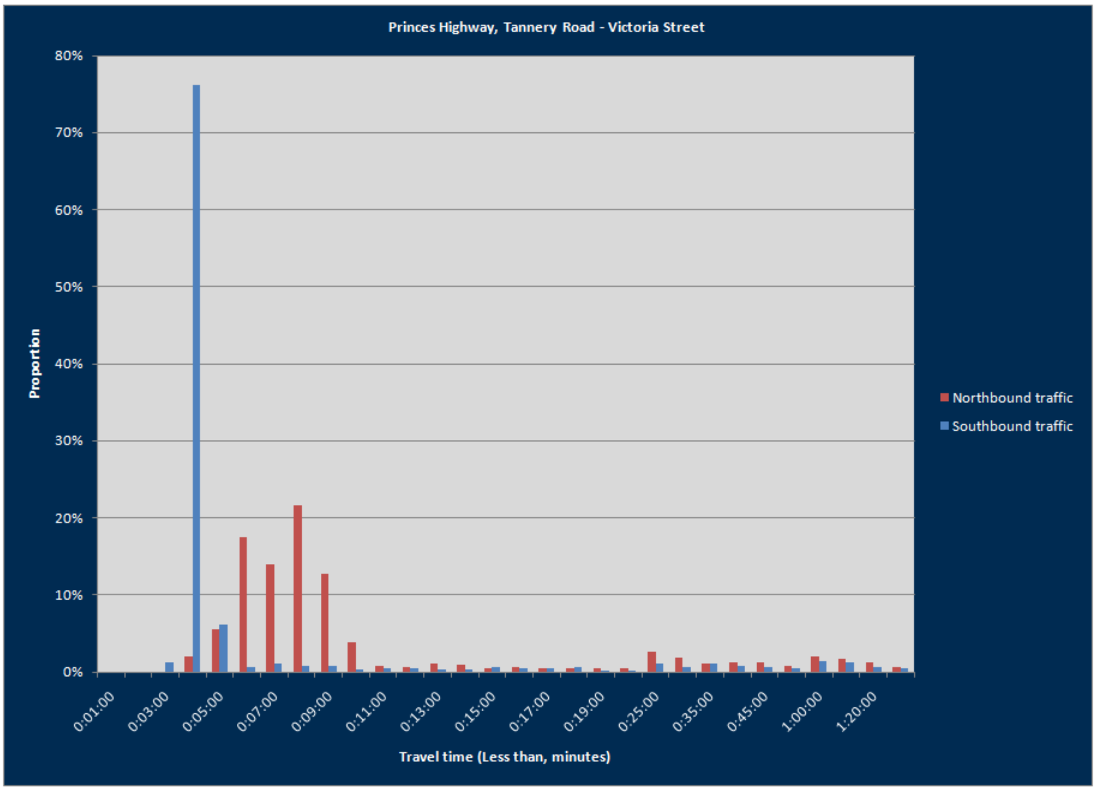

Figure 2.12: Princes Highway travel times through Berry (Distribution, 100th northbound peak period)

(Source: AECOM)

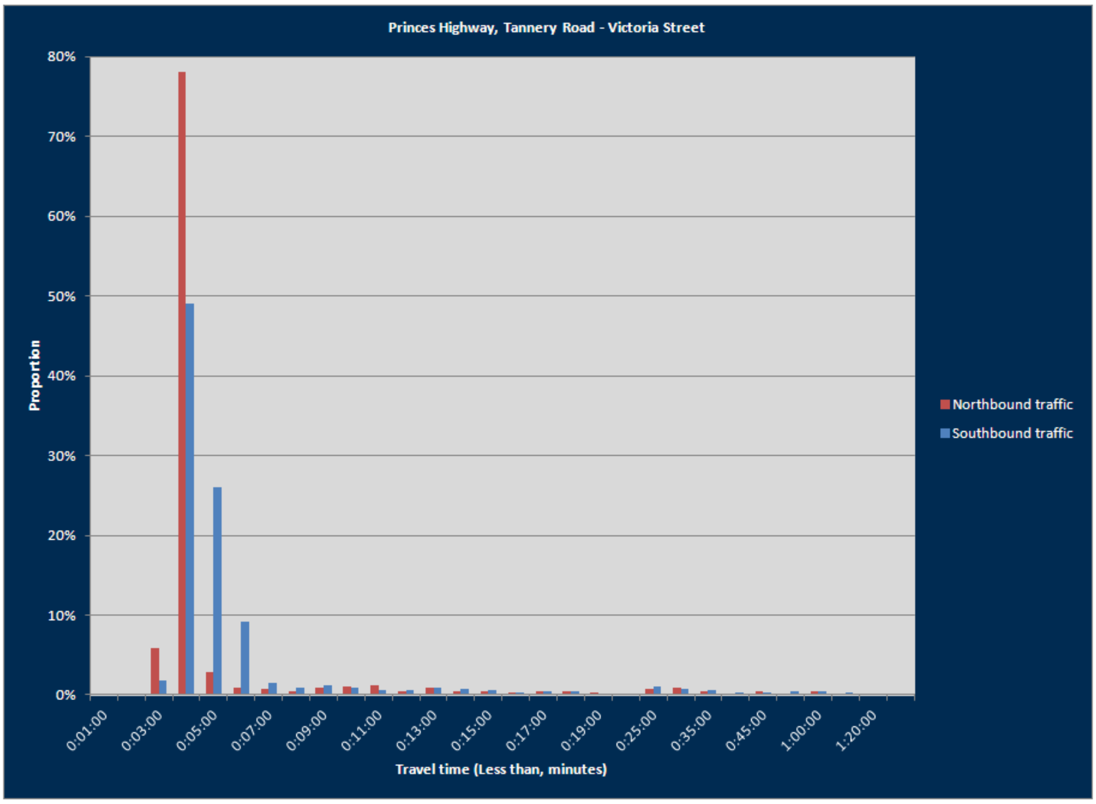

Figure 2.13: Princes Highway travel times through Berry (Distribution, 100th southbound peak period)

(Source: AECOM)

Through traffic proportions derived from the O-D surveys are summarised in **Table 2.9**, showing the proportion of traffic on the Princes Highway that currently travels non-stop through Berry during 100th highest hour peak periods. As discussed, non-stopping through traffic has been estimated based on the traffic movement recorded, as well as the time taken to complete the movement.

Table 2.9: Berry through traffic proportions (100th highest hour peak periods)

Location	Direction	100NB* peak			100SB* peak		
		Sample size (veh)	Potential bypass traffic		Sample size (veh)	Potential bypass traffic	
			Veh	%		Veh	%
Princes Highway, north of Tannery Road	Southbound	1097	753	69 %	2569	1988	77 %
Princes Highway, south of Victoria Street	Northbound	3453	2206	64 %	1800	951	53 %

*NB – northbound, SB - southbound
(Source: AECOM)

The results show that non-stopping through traffic varies significantly by direction and time period during the 100th highest hour peak periods. During both peak periods, a greater proportion of through traffic was present in the southbound direction; around 70 per cent of total traffic during the 100th northbound peak period, and closer to 80 per cent of total traffic during the 100th southbound peak period. In the northbound direction through traffic was estimated at between 50-65 per cent for the 100th southbound and 100th northbound peak periods respectively.

Overall, the O-D surveys indicate that during a typical day, non-stopping through traffic contributes around 80 per cent of total traffic travelling through Berry on the Princes Highway. During the 100th highest hour periods traffic volumes are higher and travel patterns vary. As a result, through traffic fluctuates considerably between 50-75 per cent of total traffic. The variations of both traffic volumes and patterns during varying peak periods have been considered in this traffic and transport assessment.

Victoria Street O-D surveys (2012)

Victoria Street provides access to and from local areas in the south of Berry, and is also used as a ‘through’ route providing a connection between the Princes Highway in the west and Prince Alfred Street in the east. Recent traffic surveys indicate that at its western end, Victoria Street currently carries around 2200 vehicles per day on average throughout the year (see Section 2.4.4).

To determine existing traffic patterns and volumes during typical weekday and weekend peak hours, O-D surveys were undertaken on Thursday 3 May, Friday 4 May, and Sunday 6 May 2012.

The O-D surveys captured the time, registration, and movements of all vehicles turning into and out of Victoria Street at both the eastern and western ends. The raw data was then processed and analysed: through movements involved a matching number plate recorded at both ends of Victoria Street within a specified travel time; non-through movements involved a number plate recorded at only one end of Victoria Street, or matched number plates but with an extended time period between them.

A summary of the results captured by these surveys is shown in **Table 2.10**. During typical weekday peak times, approximately 20 per cent of total vehicles at the western end of Victoria Street were generated by ‘through’ movements, with vehicles travelling to or from Prince Alfred Street at its eastern end. Sunday 6 May was the day of Berry Country Fair; as a result the proportion of ‘through’ traffic using Victoria Street dropped to 9 per cent, with significantly higher volumes of traffic using Victoria Street to access the Berry Showground and surrounding areas.

Table 2.10: Victoria Street O-D survey results

Movement	Victoria Street western end, all vehicles (2-way)				
	Thu 3 May 2012:		Fri 4 May 2012:		Sun 6 May 2012:
	8am-10am	3pm-6pm	8am-10am	3pm-6pm	10am-1pm
Total (Vehicles)	263	500	313	495	1342
Through (Vehicles)	59	97	62	94	116
Through (% Total)	**22 %**	**19 %**	**20 %**	**19 %**	**9 %**

(Source: AECOM, based on RTA (now RMS) Southern Region Traffic Survey Data)

3 Existing road network performance

Chapter 2 described the magnitude and patterns of existing traffic and transport demand in the traffic impact footprint. In this chapter, peak period demands are combined with the road and intersection capacity to assess the operational performance of the existing Princes Highway and the surrounding local road network.

The assessment uses the following performance indicators:

- Average travel speeds and times.
- Road safety and incidence of traffic crashes.
- Operational assessment of roadways (midblocks) and intersections based on average delay and level of service (LoS), which is described further in Section 3.3.

3.1 Traffic crashes

The Princes Highway between Toolijooa Road and Schofields Lane has a poor crash record in comparison to connecting sections of the Princes Highway and other major highways in NSW. In the northern-most part of the project area between Toolijooa Road and Austral Park Road, where the existing Princes Highway has a substandard horizontal and vertical road alignment, the crash history is particularly poor; as two of the three fatal crashes, and almost half of all crashes in the project area occurred on this section. Between 1 July 2003 and 30 September 2010 a total of 118 crashes were recorded on the Princes Highway, including three fatal and 61 injury crashes. On the alternative 'Sandtrack' route five fatal and 81 injury crashes occurred during the same period. **Table 3.1** shows the crash history for this period, detailing the section where they occurred.

Table 3.1: Crash history (1 July 2003 to 30 September 2010)

Section from	Section to	Section length (km)	Total crashes	Fatal crashes	Injury crashes	Tow-away crashes
Project area						
Toolijooa Road	Austral Park Road	5.7	50	2	25	23
Austral Park Road	Woodhill Mountain Road, Berry	4.3	34	1	16	17
Woodhill Mountain Road, Berry	Schofields Lane	2.6	34	0	20	14
Traffic impact footprint						
Princes Highway: Toolijooa Road - Schofields Lane		12.6	118	3	61	54
The 'Sandtrack': Gerringong - Bomaderry		28.9	203	5	81	117

(Source: AECOM, based on RMS Southern Region Crash Data)

Crash severity indices provide an assessment of road safety based on the type and number of crashes occurring on a route. Fatal, injury and tow-away crashes carry different weightings; they are determined independently of absolute traffic volumes, and calculated to establish the average level of severity of crashes that occur. **Table 3.2** shows crash severity indices and **Figure 3.1** illustrates the formula used to calculate these indices.

Crash Severity Index =
*[(No. of fatal crashes * 3.0) + (No. of injury crashes * 1.5) + (No. of non-injury crashes)] / Total no. of crashes*

Figure 3.1: Crash severity index calculation

(Source: RMS Southern Region)

The average crash severity index on the Princes Highway in the project area is 1.31, with the section between Toolijooa Road and Austral Park Road the highest at 1.33. By comparison the average crash severity index of all crashes reported on all roads open to the public across NSW between 2003 – 2010 was 1.24[1], indicating the Princes Highway historically has a higher than average proportion of fatal and injury crashes in the project area.

Table 3.2: Crash severity indices (1 July 2003 to 30 September 2010)

Section from	Section to	Crash severity index
Project area		
Toolijooa Road	Austral Park Road	1.33
Austral Park Road	Woodhill Mountain Road, Berry	1.29
Woodhill Mountain Road, Berry	Schofields Lane	1.29
Traffic impact footprint		
Princes Highway: Toolijooa Road - Schofields Lane		1.31
The ‘Sandtrack’: Gerringong - Bomaderry		1.25
New South Wales average (2003 – 2010)		1.24

(Source: AECOM, based on RMS Southern Region Crash Data)

Crash rates per 100 million vehicle kilometres travelled (100MVKM) are shown in **Table 3.3**. These crash rates are calculated using the volume of traffic and distance travelled along a route, therefore offering a measure of risk per kilometre travelled. The formula used to calculate this rate is shown in **Figure 3.2**.

Crash rate per 100 MVKM =
*(Total no. of crashes * 100,000,000) / (No. of years * 365 * Length (km) * AADT)*

Figure 3.2: Crash rate per 100 million vehicle kilometres calculation

(Source: RMS Southern Region)

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[1] Calculated using crash data provided by *Road traffic crashes in New South Wales 2009*, RTA, and the Crash Severity Index formula presented in Figure 3.3.

Table 3.3 shows the average fatality rate on the Princes Highway (Toolijooa Road – Schofields Lane) is 0.8 per 100MVKM in the project area. The latest available RMS data (for the 12-month period ending June 2012) shows an average fatality rate across NSW of 0.6 per 100MVKM, indicating that this section of the existing highway historically has over 30 per cent more fatalities per kilometre travelled than the NSW average for reported crashes on all roads open to the public. The alternative 'Sandtrack' route between Gerringong and Bomaderry has a fatality rate of 0.7 per 100MVKM.

Table 3.3: Crash rates per 100MVKM (2011)

Section from	Section to	Section length (km)	2011 ADT (veh)	Crash rate per 100MVKM			
				Total	Fatal	Injury	Tow-away
Project area							
Toolijooa Road	Austral Park Road	5.7	10,755	30.8	1.2	15.4	14.2
Austral Park Road	Woodhill Mountain Road, Berry	4.3	10,755	27.8	0.8	13.1	13.9
Woodhill Mountain Road, Berry	Schofields Lane	2.6	12,077	40.9	0.0	24.1	16.8
Traffic impact footprint							
Princes Highway: Toolijooa Road - Schofields Lane		12.6	-	32.1	0.8	16.6	14.7
The 'Sandtrack': Gerringong - Bomaderry		28.9	-	29.9	0.7	12.0	17.3
New South Wales average (July 2011 – June 2012)		-	-	-	0.6	31.0	-

(Source: AECOM, based on RMS Southern Region Crash Data, NSW Crash Data Monthly Bulletin, June 2012)

Table 3.4 provides details of the crash costs for sections of the Princes Highway and the 'Sandtrack' within the traffic impact footprint. Average crash costs based on definitions for coding accidents (DCA), have been provided by RMS*' Economic Analysis Manual (Economic Parameters for 2009),* and can be used in conjunction with crash frequency data to estimate the overall cost of crashes over a period. The crash costs presented in this report are based on a 'willingness to pay' approach; willingness to pay values for road safety reflect the accumulated value the NSW community is willing to pay or forgo in exchange for a reduction in the probability of crash related injuries and road accident deaths on NSW roads.

Table 3.4: Total and average annual crash costs (1 July 2003 to 30 September 2010)

Section from	Section to	Section length (km)	Total cost (July 2003 - Sept 2010)		Average annual cost (July 2003 - Sept 2010)	
			Total cost ($M)	Cost per km ($M)	Total cost ($M)	Cost per km ($M)
Project area						
Toolijooa Road	Austral Park Road	5.7	26.71	4.69	3.68	0.65
Austral Park Road	Woodhill Mountain Road, Berry	4.3	15.40	3.58	2.12	0.49
Woodhill Mountain Road, Berry	Schofields Lane	2.6	11.53	4.44	1.59	0.61
Traffic impact footprint						
Princes Highway: Toolijooa Road - Schofields Lane		12.6	53.64	4.26	7.40	0.59
The 'Sandtrack': Gerringong - Bomaderry		28.9	77.82	2.69	10.73	0.37

(Source: AECOM, based on RMS Southern Region Crash Data and RMS Economic Analysis Manual (Economic parameters for 2009))

Crashes on the Princes Highway in the project area between 1 July 2003 and 30 September 2010 cost an estimated total of $53.6 million, based on 2009 willingness to pay rates. The relatively short section of the Princes Highway beginning at Woodhill Mountain Road at the east of Berry, travelling through the town to Schofields Lane, incurred a total cost per kilometre of $4.4 million during this period. It is noted that the project would significantly reduce this rate by providing a bypass to re-route this section of highway to the north of the town. Around half of the total crash costs were created on the section from Toolijooa Road to Austral Park Road through the 'Foxground bends', where the proposed realignment provided by the project is anticipated to significantly improve the safety record. The total cost of crashes per kilometre on the alternative 'Sandtrack' route during this period was $2.7 million.

3.2 Travel speeds and travel times

Vehicle travel times and speeds in the traffic impact footprint have been estimated using the 2006 Gerringong to Bomaderry Sub-area TRACKS model (see Section 4.2.2) for the following two key route options within the traffic impact footprint, as shown in **Figure 3.3**:

- The Princes Highway between Toolijooa Road and Schofields Lane.
- The 'Sandtrack' between Dooley Road and Shoalhaven Heads Road.

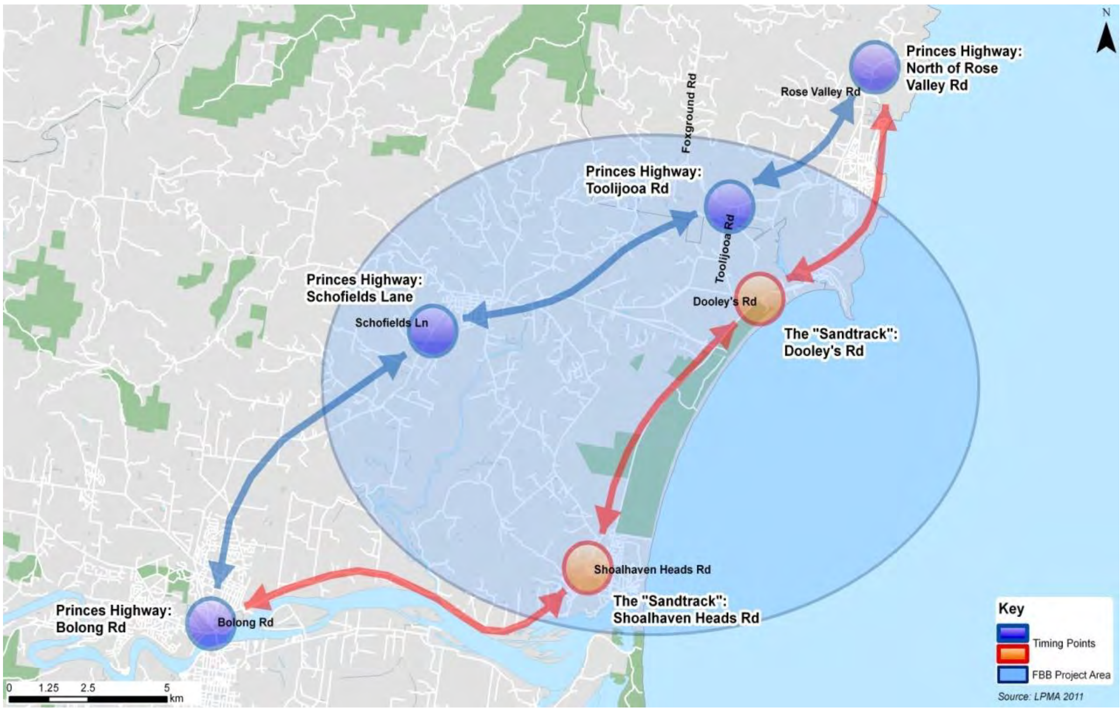


Figure 3.3: Travel time analysis routes and timing points

(Source: AECOM)

The timing points used are relevant to the boundaries of the project area and also strategic movements in the traffic impact footprint between Gerringong and Bomaderry. The results of the travel time analysis (presented in **Table 3.5**), indicates that the Princes Highway currently has an average travel time of around 14-15 minutes within the project area between Toolijooa Road and Schofields Lane. The equivalent route via the 'Sandtrack' is shorter in length and operates at a higher average speed, taking less than eight minutes on average. The longer travel time on the Princes Highway is due to a number of factors including:

- The additional distance covered when compared to the alternative 'Sandtrack' route.
- A higher proportion of slow-moving heavy vehicles than the 'Sandtrack' route.
- Steep grades and sharp bends in the project area, particularly through the 'Foxground bends'.
- Varying (lower) posted speed limits along the route.
- Delays caused by traffic conflicts when travelling through Berry.

Table 3.5: 2006 base year TRACKS modelled travel times

Route	Direction	Distance (km)	Average speed (km/h)	Average travel time (mins)
North of project area Princes Highway: North of Rose Valley Road to Toolijooa Road The 'Sandtrack': Princes Highway north of Rose Valley Road to the 'Sandtrack' at Dooley Road (via Fern Street)				
Princes Highway	Northbound	7.0	75.3	5.5
	Southbound		80.2	5.2
The 'Sandtrack'	Northbound	8.7	50.0	10.5
	Southbound		50.5	10.4
Project area Princes Highway: Toolijooa Road to Schofields Lane The 'Sandtrack': Dooley Road to Shoalhaven Heads Road				
Princes Highway	Northbound	12.6	52.6	14.4
	Southbound		51.2	14.8
'Sandtrack'	Northbound	9.9	78.4	7.5
	Southbound		77.9	7.6
South of project area Princes Highway: Schofields Lane to Bolong Road The 'Sandtrack': Shoalhaven Heads Road to the Princes Highway, Bomaderry				
Princes Highway	Northbound	13.6	63.2	12.9
	Southbound		64.8	12.6
The 'Sandtrack'	Northbound	13.8	72.4	11.5
	Southbound		70.0	11.8
Traffic impact footprint Princes Highway: North of Rose Valley Road to Bolong Road The 'Sandtrack': Princes Highway north of Rose Valley Road to the Princes Highway, Bomaderry (via Fern Street)				
Princes Highway	Northbound	33.2	60.6	32.8
	Southbound		61.1	32.6
The 'Sandtrack'	Northbound	32.4	66.0	29.5
	Southbound		65.2	29.8

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Although the 'Sandtrack' is significantly quicker in terms of travel time within the project area, the modelling shows that within the traffic impact footprint (between Gerringong and Bomaderry) the routes are comparable in both length and travel time. Between these towns the Princes Highway is around 33.2 kilometres long and takes around 32-33 minutes, while the 'Sandtrack' which is around 32.4 kilometres long takes a little under 30 minutes.

The analysis shows that the alternative routes are similar in length south of the project area; however the higher average speed of the 'Sandtrack' results in a shorter travel time. North of the project area, the 'Sandtrack' route is considerably slower, with a longer length and lower average speed than the Princes Highway. The additional travel time is created by intersection delays through Gerringong as well as lower speed limits (50 kilometres per hour and 60 kilometres per hour) through the town and along sections of the 'Sandtrack' route through Gerroa.

3.3 Definition of level of service

LoS is a measure to determine the operational conditions and efficiency of a roadway or intersection. The definition of LoS generally outlines the operating conditions in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and road safety. There are six levels of service for midblock carriageway locations, LoS A to LoS F, with LoS A representing optimum operating conditions (free flow) and LoS F the poorest (forced or breakdown in flow). Common RMS practice suggests that when a roadway falls to LoS D, investigations should be initiated to provide suitable remediation prior to the link falling to LoS E or LoS F.

A customised midblock LoS model has been developed based on the updated *Austroads, Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009*. An example of the model, which has been developed specifically for two lane undivided road conditions, is included in Appendix A.

Average delay is commonly used to assess the operational performance of intersections, with LoS used as an index. A summary of the LoS index (including specific colour coding to highlight/group the performance of each service level) is shown in **Table 3.6**.

Table 3.6: Level of service criteria for intersections

LoS	Average delay/ vehicle (secs/veh)	Traffic signals | roundabout	Give way | stop signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents would cause excessive delays	At capacity; requires other control mode
F	>70	Roundabouts require other control mode	At capacity; requires other control mode

(Source: Guide to Traffic Generating Developments, RMS 2002)

Similar to the midblock performance measures, common RMS practice suggests that when the level of service of an intersection falls to LoS D, investigations should be initiated to provide suitable remediation prior to the approach roads falling to LoS E or LoS F. It should also be noted that capacity constraint can be used as a demand management technique and that over-provision of capacity can encourage more car use.

3.4 Roadway level of service

The current midblock LoS for the Princes Highway and the ‘Sandtrack’ within the traffic impact footprint, based on 2011 AM peak, PM peak and 100th highest hour (northbound and southbound peak directional) two-way traffic volumes, are summarised in **Table 3.7**. The table indicates that the Princes Highway both north and south of Berry currently operates at LoS D in both the AM peak and PM peak, while the alternative ‘Sandtrack’ route is currently operating at LoS C. The analysis indicates that during 100th highest hour periods, the operational performance of the Princes Highway deteriorates to an unacceptable LoS E at most locations and the ‘Sandtrack’ operates at LoS D.

Table 3.7: 2011 midblock level of service summary

Location	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	730	D	875	D	1187	D	1275	E
Princes Highway: Victoria Street – South of Schofields Lane	927	D	1090	D	1248	E	1477	E
‘Sandtrack’: Dooley Road – Shoalhaven Heads Road	681	C	814	C	977	D	1144	D

(Source: AECOM, based on AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

3.5 Intersection level of service

For most of the project area, the Princes Highway intersects with minor roads and property accesses; only relatively small levels of traffic demand are generated from locations that are connected by these intersections. Where the Princes Highway passes through the town of Berry, the highway intersects with numerous roads of local and regional importance, which generate significant levels of conflicting traffic demand.

The current LoS and delay at the following six key intersections in and around Berry (shown in **Figure 3.4**) has been assessed using Paramics microsimulation modelling software (see Section 4.3 for details of traffic modelling and forecasting processes):

- Princes Highway / Victoria Street.
- Queen Street (Princes Highway) / Kangaroo Valley Road.
- Queen Street (Princes Highway) / Alexandra Street.
- Queen Street (Princes Highway) / Prince Alfred Street.
- Queen Street (Princes Highway) / Albert Street.
- Princes Highway / Tannery Road.

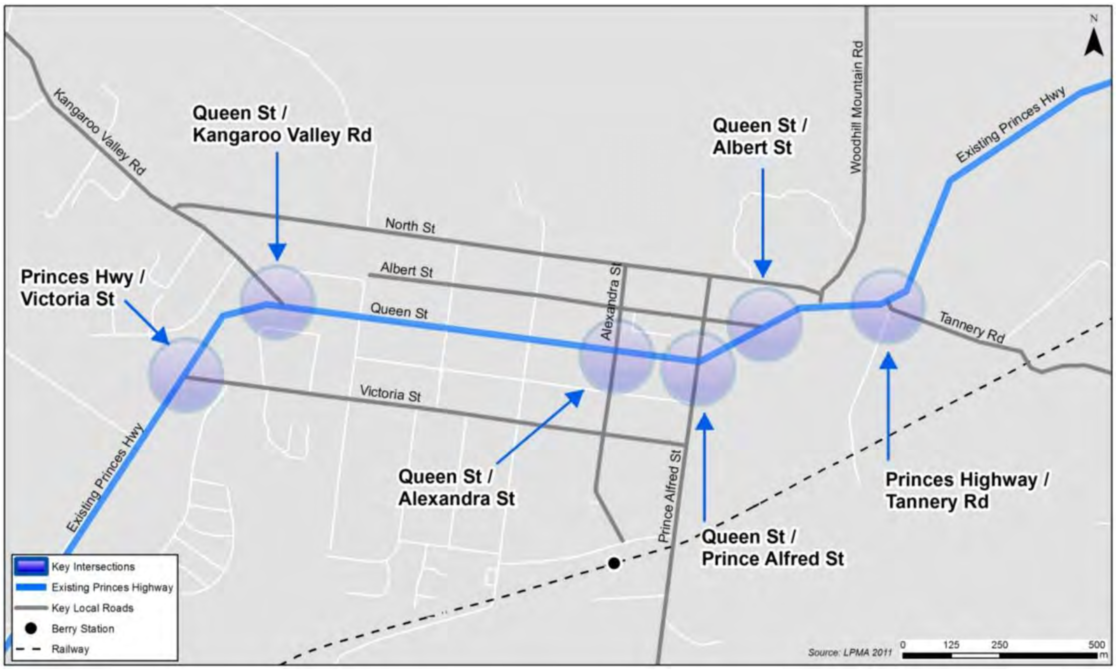


Figure 3.4: Key intersection locations in the project area

(Source: AECOM)

Table 3.8 provides a summary of intersection performance during peak hours during a 100th highest hour northbound (NB) and southbound (SB) peak period; which represents a Public Holiday weekend or equivalent traffic flow. During these periods, the intersections in Berry are subjected to the highest levels of traffic demand; it should therefore be noted that the results indicated in the table represent the poorest performance of the road network.

The LoS calculated by the Paramics modelling is based on the capacity and efficiency of the local road network and intersections within and around Berry. In comparison, the midblock LoS presented in Section 3.4 represents the operational performance of rural highway locations in the project area, based on the travel speeds and the time spent following other vehicles. For this reason, the methods produce contrasting LoS results which vary along the length of the Princes Highway within the project area. The performance of particular sections or locations should be examined and interpreted in isolation, specific to the assessment criteria.

The results of the Paramics modelling indicate that intersections in and around Berry currently have sufficient capacity to accommodate the high levels of demand associated with 100th highest hour traffic (both northbound and southbound peaks). The intersections of the Princes Highway and Victoria Street, Queen Street (Princes Highway) and Kangaroo Valley Road, Queen Street (Princes Highway) and Albert Street, and the Princes Highway and Tannery Road have three approach roads, with relatively low levels of traffic demand from their minor approaches (Kangaroo Valley Road, Albert Street and Tannery Road respectively). With little conflicting traffic demand, all of these intersections operate with minimal delay at LoS A.

In the centre of Berry, there are two significant crossroads; Queen Street (Princes Highway) and Alexandra Street, and Queen Street (Princes Highway) and Prince Alfred Street. The intersection of Queen Street and Alexandra Street provides local access to car parks, retail and recreational facilities in Berry. To the south of Berry, Prince Alfred Street leads to Coolangatta Road, a road of regional significance as it links to the ‘Sandtrack’ and Shoalhaven Heads. The analysis shows that the minor approach roads to these intersections are subjected to delays during peak holiday periods. For example, during the 100th highest hour northbound peak period, high volumes of through traffic on Queen Street limits the opportunity for vehicles to turn onto or cross the highway from minor approach roads, resulting in delays at these intersections. Right turn and through movements from the minor approach roads are the main cause of this delay, as vehicles have to wait for a gap in traffic on both the eastbound and westbound directions of Queen Street before they can proceed.

Nevertheless, during a typical 100th highest hour northbound peak, all approach roads at both of these intersections perform at LoS A, with a maximum average delay of less than 13 seconds.

Two-way traffic demand during the 100th highest hour southbound peak period on the Princes Highway is typically greater than the 100th highest hour northbound peak. The additional traffic volumes result in longer delays to traffic entering from the minor approach roads at intersections in the town. At the intersection of Queen Street and Prince Alfred Street, vehicles approaching from the minor approach road (Prince Alfred Street) experience an average delay of around 23 seconds, resulting in LoS B; however this is still within acceptable limits in terms of operational performance.

The operational performance of the Queen Street and Alexandra Street intersection also deteriorates during this period to LoS B on the minor Alexandra Street approach roads; where traffic encounters average delays of up to 22 seconds. During the 100th highest hour southbound peak scenario, it is increasingly difficult for vehicles on the minor approach roads to find gaps in the traffic flow on Queen Street, particularly for vehicles proceeding straight ahead or turning right which require a break in traffic in both directions. While the minor approach roads do experience delays, the bulk of traffic passes through the intersections on the major Queen Street approach roads and experiences very little delay regardless of the peak period scenario.

Table 3.8: 2011 intersection level of service summary

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay (s)	LoS	Approach volume (veh/h)	Average delay (s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	893	0.0	A	542	0.0	A
Victoria Street westbound	51	0.0	A	158	0.5	A
Princes Highway southbound	280	0.0	A	776	0.0	A
Total	1224	0.0	A	1476	0.1	A
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	751	0.0	A	457	0.0	A
Kangaroo Valley Road	92	3.7	A	97	3.0	A
Queen Street westbound	353	0.1	A	846	0.0	A
Total	1196	0.3	A	1400	0.2	A
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	819	0.0	A	543	0.0	A
Alexandra Street southbound	79	12.5	A	118	22.2	B
Queen Street westbound	318	0.1	A	812	0.0	A
Alexandra Street northbound	92	8.6	A	65	16.8	B
Total	1308	1.4	A	1538	2.4	A
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	816	0.0	A	517	0.1	A
Queen Street westbound	329	1.6	A	797	2.3	A
Prince Alfred Street northbound	151	9.2	A	139	22.7	B
Total	1296	1.5	A	1453	3.5	A
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	859	4.1	A	528	4.1	A
Albert Street	58	2.6	A	62	1.4	A
Queen Street westbound	367	2.7	A	865	2.4	A
Total	1284	3.6	A	1455	3.0	A
Princes Highway / Tannery Road						
Princes Highway eastbound	914	1.5	A	550	1.9	A
Princes Highway westbound	292	1.1	A	790	1.1	A
Tannery Road	66	1.2	A	79	2.4	A
Total	1272	1.4	A	1419	1.5	A

(Source: AECOM)

4 Traffic modelling and forecasting process

This chapter provides details of the integrated traffic modelling and forecasting approach that was adopted for the traffic and transport assessment; as shown in **Figure 4.1**. The objective was to make best use of strategic (TRACKS), spreadsheet (Microsoft Excel) and microsimulation (Paramics) traffic models to determine existing and future conditions on the Princes Highway and surrounding local roads; in terms of generating traffic volumes (including the predicted transfer of traffic to the project from the alternative 'Sandtrack' route) and assessing the operational performance of the project.

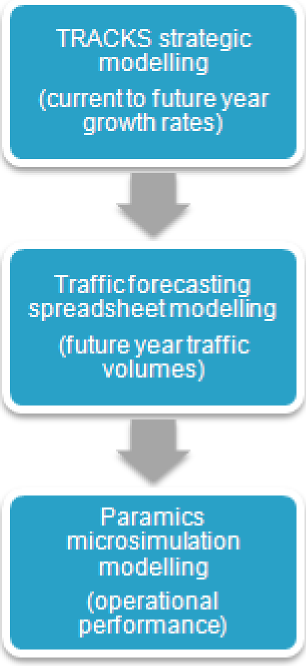


Figure 4.1: Overview of the traffic modelling approach

(Source: AECOM)

4.1 Introduction to traffic modelling

Traffic modelling is generally considered as a sequence of steps relating to the supply and demand of transport systems. The general structure of these steps is known as the classic four-stage transport model, which is illustrated within the project specific TRACKS model framework in **Figure 4.2**.

Traffic modelling is an important step in the transportation planning process because decisions and investments are often influenced by predicted travel demand. Models are used to estimate the number of trips that would be made on a transportation system at some future date as a result of change in supply (for example, the introduction of the project) or a change in travel demand (for instance, the impact of a local development such as Huntingdale Park).

However, traffic models would only provide forecasts for those factors that are explicitly accounted for in the modelling approach. For instance, traffic models generally exclude pedestrian and bicycle trips, expressing demand only as vehicular traffic, and cannot therefore be used to assess a bicycle improvement scheme. It is critical that model assumptions, simplifications and limitations are understood before a modelling exercise is begun.

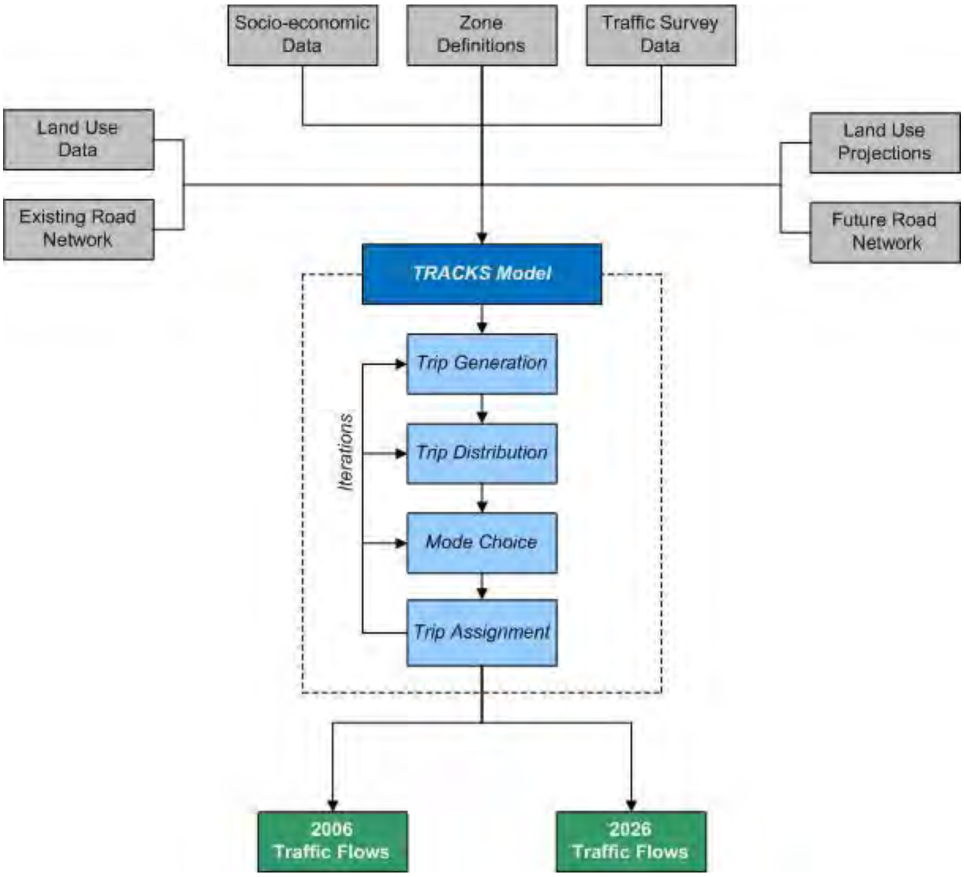


Figure 4.2: **Four-stage TRACKS modelling process**

(Source: AECOM)

4.2 Traffic forecasting methodology

There are four remaining sections of the Princes Highway to be upgraded as part of the RMS' overall upgrade of the Princes Highway between Waterfall and the Jervis Bay Road junction. The remaining sections include the recently approved Gerringong upgrade project, the project, the proposed Berry to Bomaderry upgrade project to the south which is currently in the planning phase and the South Nowra upgrade project for which construction tenders have been awarded. The modelling methodology used to forecast traffic volumes for the project, incorporated the following three key stages and sub-tasks, which are described in more detail in subsequent sections:

1) Derivation of base year traffic patterns

- Detailed analysis of average peak and daily traffic volumes using 2009 May/June and 2011 April/May survey data collected at key locations within the project area (see Section 2.4).
- Local area seasonality factor calculated using annual 2008-2010 traffic count data from the now RMS permanent site on the Princes Highway north of Rose Valley Road.
- 2009 and 2011 traffic count data updated using the calculated seasonality factor (May/June and April/May to average annual respectively).

2) **Base and future year TRACKS model development**

- Developed a Gerringong to Bomaderry sub-area model from the Illawarra regional TRACKS model.
- Internal zones disaggregated and updated to reflect local land use data.
- 2006 base year model calibrated to surveyed traffic counts.
- Updated base network with the project road network upgrades, including:
    - Re-coding the new chainage/alignment of the complete Princes Highway upgrade.
    - Addition of Berry bypass.
    - Addition of grade-separated access ramps.
    - Improvement of road classification – number of lanes, capacity, posted speed limit etc.
- Developed 2026 future year demand.
- Assigned flows at key locations extracted from the TRACKS model for the 2006 base year and 2026 future year.
- 2006 – 2026 linear traffic growth rates calculated for each location on the Princes Highway (this includes 'natural' background traffic growth as well as growth due to the switch of traffic from the ‘Sandtrack’ to Princes Highway).

3) **Application of traffic forecasting spreadsheet model**

- Developed a traffic forecasting spreadsheet model, which included the following tasks:
    - Linear growth rates (from TRACKS modelling) applied to 2009 and 2011 traffic volume survey data taken at corresponding mainline locations, producing future year forecast traffic volumes on an annual basis to 2026.
    - Linear extrapolation used to calculate forecast traffic volumes beyond 2026.
    - Existing traffic patterns used to develop classified - peak period traffic volumes for each location.
- Carriageway to ramp factors derived from the TRACKS model and origin-destination (O-D) surveys, and applied to forecast traffic volumes.
- Developed a Matrix Furness process to re-balance ramp volumes against mainline traffic volumes.
- Preliminary project traffic volumes calculated – without construction impacts.
- Updated traffic forecasts to reflect the travel time impacts and resultant redistribution of traffic to the ‘Sandtrack’ during construction of the project and the other upgrades to the Princes Highway.
- Final project traffic volumes calculated – with construction impacts.

4.2.1 Derivation of base year traffic patterns

The first stage in the modelling process was to collect up-to-date traffic count data at key strategic locations on both the Princes Highway and the 'Sandtrack':

- Site 7.800: Princes Highway, north of Rose Valley Road.
- Site 7.045: Princes Highway, west of Belinda Street.
- Site 7.816: Princes Highway, south of Victoria Street.
- Site 7.101: 'Sandtrack', south of Belinda Street.
- Site 78.200:'Sandtrack', south of Beach Road.

Section 2.4 provides details of the traffic data collected at each location, including an overview of the classified traffic volumes, daily profiles, peak and 100th highest hour factors and the seasonality factor calculated to convert temporary counts to an annual average.

4.2.2 Base and future year TRACKS model development

TRACKS model overview

Traffic volumes for the project have been forecast using base to future year linear growth rates from a project area specific version of the RMS' Illawarra Regional TRACKS Transport Model, which is developed and maintained by Gabites Porter Consultants.

The TRACKS software is a strategic modelling package designed to assist in decision making related to:

- The location and intensity of land use activity.
- The connections and capacity of the road system.
- The type of intersection which is appropriate for the network.

Gabites Porter Consultants has developed a 2006 base year and 2026 future year TRACKS model that covers the entire Illawarra Region. The 2026 model incorporates local area road network upgrades including North Kiama Bypass, Oak Flats to Dunmore, and other upgrades to the Princes Highway including the project.

Gerringong to Bomaderry sub-area TRACKS model

A Gerringong to Bomaderry sub-area TRACKS model was developed by Gabites Porter Consultants from the regional model, subsequently re-calibrating this model to a 2006 base year and further developing a 2026 future year model to provide forecast growth rates for the key road links within the traffic impact footprint.

Appendix B shows the extent of the sub-area TRACKS model in comparison to the wider area network coverage included in the regional model. The figure also shows the project alignment within the sub-area model.

During the course of this work, AECOM completed a peer review of the model development and calibration process and its subsequent performance. As well as working with Gabites Porter Consultants on refining the sub-area model to ensure that it was fit for purpose, AECOM also collaborated with Gabites Porter Consultants on other model inputs including updating internal zones to reflect local land use data.

Base year model calibration

In order to have confidence in the model as a basis for producing robust and reliable future year traffic forecasts, the base year model was calibrated to daily traffic volumes at key screenline locations in the sub-area network. Model calibration is an essential stage in the modelling process to demonstrate that the modelled network reasonably reflects existing traffic conditions across the corresponding road network, particularly on the Princes Highway and the adjacent 'Sandtrack' route.

Figure 4.3 shows the screenline locations, which were designed to ensure that the base year model was calibrated to accurately represent the north-south travel demand through the corridor and also the subsequent split of traffic between the Princes Highway and the 'Sandtrack' route options.

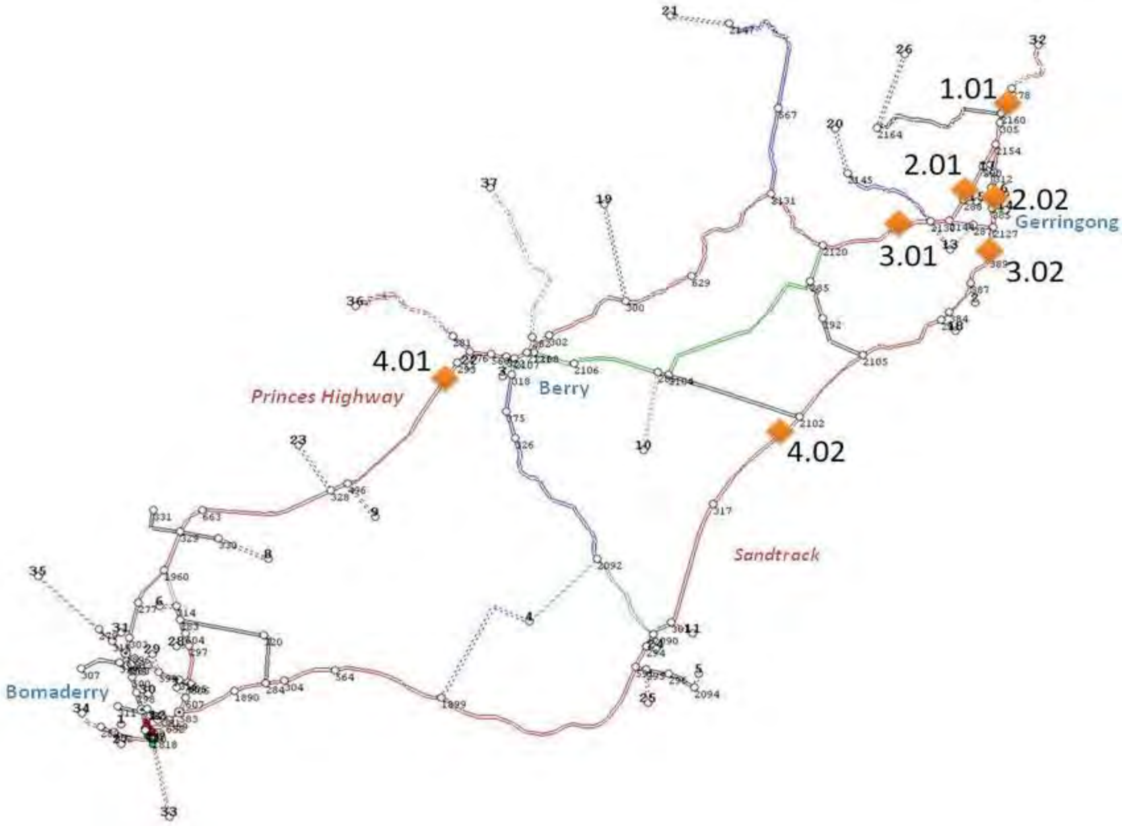
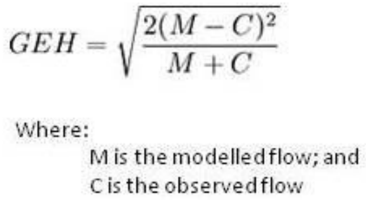


Figure 4.3: Sub-area TRACKS model screenline locations

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

For each screenline location, the model calibration process included a comparison of observed against modelled traffic flows and calculating the GEH value, which is a commonly used performance measure based on a chi-squared statistic as shown in **Figure 4.4**. An acceptable level of calibration is that all (or nearly all) screenline totals are within five per cent of observed flows and have a GEH <4.



$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where:

M is the modelled flow; and

C is the observed flow

Figure 4.4: GEH statistic

(Source: AECOM)

Table 4.1**Table 4.1** provides details of the base year model calibration results for individual and grouped screenlines by direction of travel. The table shows that the base year model is calibrated as nearly all of the screenline totals are within five per cent of observed flows and have a GEH <4, with only Screenline 4 northbound falling just short of the desired range for the two calibration measures.

Table 4.1: 24hr base year sub-area TRACKS model calibration results

Screenline			NB (to Wollongong)				SB (from Wollongong)			
No	**ID**	**Location**	**Obs**	**Mod**	**Diff**	**GEH**	**Obs**	**Mod**	**Diff**	**GEH**
1.	1.01	Princes Highway north of Rose Valley Road	9449	9350	-1%	1.0	9449	9350	-1%	1.3
Screenline 1- north of Gerringong total			9449	9350	-1%	1.0	9449	9350	-1%	1.3
2.	2.01	Princes Highway south of Fern Street	5403	5164	-4%	3.3	5036	5763	14%	9.9
	2.02	Fern Street south of Princes Highway	3979	4549	14%	8.7	4405	3950	-10%	7.0
Screenline 2 - Gerringong total			9382	9713	4%	3.4	9440	9713	3%	2.8
3.	3.01	Princes Highway west of Belinda Street	4510	4386	-3%	1.9	4767	5239	10%	6.7
	3.02	Fern Street south of Belinda Street	3923	4345	11%	6.6	3795	3401	-10%	6.6
Screenline 3 - south of Gerringong total			8433	8731	4%	3.2	8562	8640	1%	0.8
4.	4.01	Princes Highway south of Victoria Street	5690	4634	-19%	14.7	5503	5487	0%	0.2
	4.02	The 'Sandtrack' south of Beach Road	3048	3556	17%	8.8	2856	2703	-5%	2.9
Screenline 4 - south of Berry total			8737	8190	-6%	6.0	8359	8190	-2%	1.9

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Future year model development

As the future year modelled in TRACKS is 2026, the calibrated base year network was updated to include potential upgrades of the Princes Highway between Gerringong and Bomaderry, including the project.

More specifically, the future year network included the following updates as shown in **Figure 4.5**:

- Re-coding the new chainage of the complete Princes Highway upgrade, including the realignment of the highway through the Foxground and Broughton Village areas.
- Addition of grade-separated access ramps at Gerringong and Berry, including interchanges for Berry east of Tannery Road and at Kangaroo Valley Road.
- Bypass of Berry.
- Improvement of road classification – number of lanes, capacity, posted speed limit etc.

In addition to the potential road network upgrades, 2026 land use projections for the Illawarra Region underpin the travel demand included in the 2026 sub-area model. **Table 4.2** shows annual growth rates calculated from existing and projected household and employment data for key areas in the region. The local area is forecast to experience growth in households including an additional 332 dwellings in Berry (eg Huntingdale Park residential development) and 282 dwellings in Shoalhaven Heads, which equates to annual growth rates of 2.4 per cent and 2.1 per cent respectively.

Employment in the region is also expected to increase with an additional 743 jobs in Gerringong and 915 jobs in Bomaderry projected over the 20 year period. The population growth in Berry and Shoalhaven Heads and employment growth in Bomaderry and Gerringong would generate an increase in local travel demand along the Princes Highway corridor.

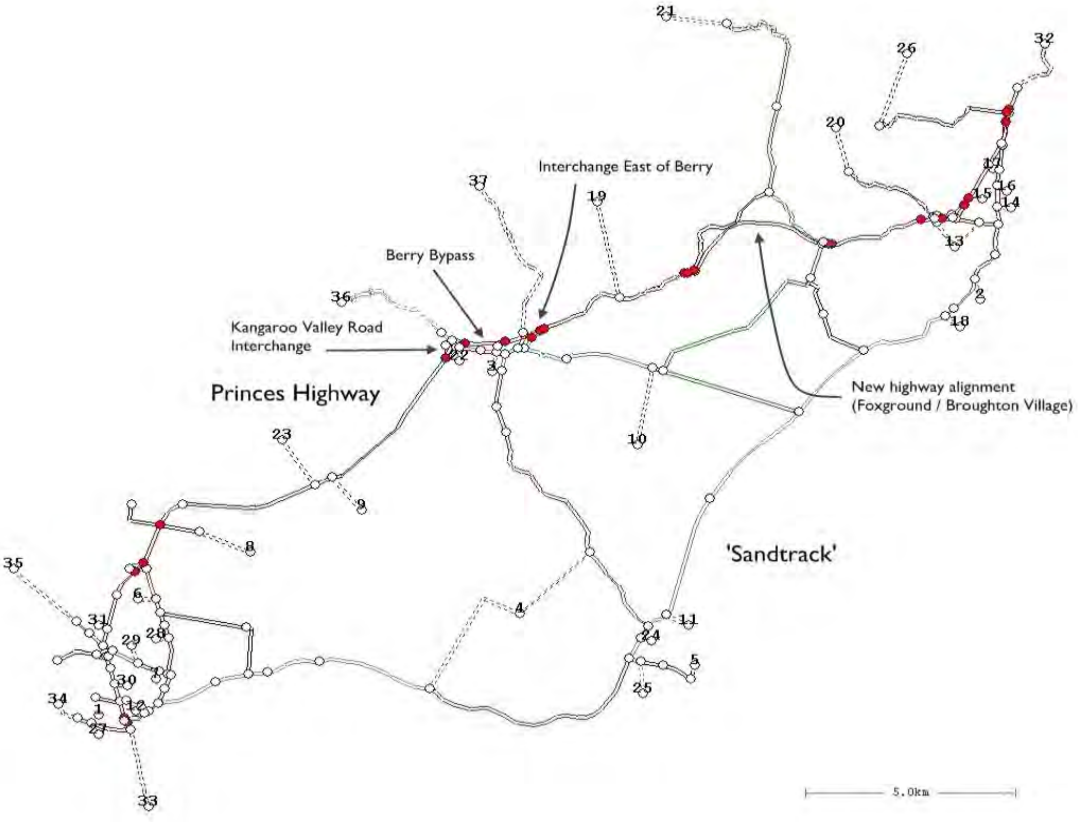


Figure 4.5: 2026 sub-area TRACKS network

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Table 4.2: Summary of household and employment data for 2006 and 2026

Area	Household			Employment		
	2006	2026	% growth (p.a)	2006	2026	% growth (p.a)
Gerringong	1454	1921	1.4 %	1023	1766	2.8 %
Berry	541	873	2.4 %	552	682	1.1 %
Shoalhaven Heads	543	825	2.1 %	265	327	1.1 %
Bomaderry	2103	2486	0.8 %	2579	3494	1.5 %

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

2026 modelled link volumes: background growth rates and traffic transfer

Table 4.3 shows the 2026 link volumes output from the subarea TRACKS models by direction for key locations in the project area and wider traffic impact footprint. The table shows corresponding base year volumes and the resultant annual growth rates between 2006 and 2026, assuming no further upgrades (Gerringong upgrade, the project and Berry to Bomaderry upgrade) of the Princes Highway within the traffic impact footprint. **Table 4.4** shows the link volumes for the 2026 subarea TRACKS models both with and without the Princes Highway upgrades, in order to illustrate the likely magnitude of additional traffic transferred from the 'Sandtrack' following their construction.

Table 4.3: 2006 and 2026 TRACKS modelled background traffic growth (without upgrade)

Location	Background growth (without upgrade)				
	Modelled traffic volumes		Modelled growth		
	2006 (veh)	2026 (veh)	Growth (veh)	Per annum (%)	Total (%)
Princes Highway, north of Rose Valley Road	18,700	30,476	11,776	3.1 %	63.0 %
Princes Highway, west of Belinda Street	9634	15,824	6190	3.2 %	64.3 %
Princes Highway, east of Tannery Road	8993	14,807	5814	3.2 %	64.7 %
Princes Highway, south of Victoria Street	10,121	16,504	6383	3.2 %	63.1 %
The 'Sandtrack', south of Belinda Street	7746	12,323	4577	3.0 %	59.1 %
The 'Sandtrack', south of Beach Road	6259	9862	3603	2.9 %	57.6 %

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Table 4.4: 2006 and 2026 TRACKS modelled traffic transfer (with/without upgrade)

Location	Background growth and traffic transfer (with upgrade)			
	Modelled traffic volumes		Modelled transfer	
	2026 – without upgrade (veh)	2026 – with upgrade (veh)	Total transfer (veh)	Total transfer (%)
Princes Highway, north of Rose Valley Road	30,476	30,476	0	0 %
Princes Highway, west of Belinda Street	15,824	24,144	8320	53 %
Princes Highway, east of Tannery Road	14,807	23,144	8337	56 %
Princes Highway, south of Victoria Street	16,504	23,253	6749	41 %
The 'Sandtrack', south of Belinda Street	12,323	4050	-8273	-67 %
The 'Sandtrack', south of Beach Road	9862	2507	-7355	-75 %

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Key observations from **Table 4.3** and **Table 4.4** include:

- The total growth rate on the Princes Highway north of Rose Valley Road is 3.1 per cent per annum for both scenarios (as this location is not impacted by traffic transferring from the 'Sandtrack').
- At the Princes Highway east of Berry (Tannery Road), the transfer of traffic from the 'Sandtrack' following the upgrade would result in over 8000 (>50 per cent) more vehicles than as a result of background growth alone. Traffic on the corresponding section of the 'Sandtrack' would decrease by a similar amount.
- Once the Princes Highway is upgraded, a significant proportion of traffic would have diverted from the 'Sandtrack' onto the highway. The split of total traffic between the two routes with the upgrade would increase to around 85 per cent /15 per cent.
- Under a do-nothing approach (without upgrade), the split of total traffic between the Princes Highway and the 'Sandtrack' would remain around 55 per cent/45 per cent respectively.

It should be noted that 2026 two-way traffic volumes included in **Table 4.3** and **Table 4.4** are direct outputs from the TRACKS model and not the final traffic forecasts for the project. The key deliverable from the modelling exercise was the annual background linear traffic growth and reduction rates highlighted in **Table 4.3** and the anticipated traffic transfer percentages following the upgrade shown in **Table 4.4**. These outputs have been used to re-forecast traffic volumes based on 2009 and 2011 traffic patterns for key locations within and surrounding the project area.

4.2.3 Application of growth rates and traffic transfer proportions /traffic forecasting spreadsheet model

Forecasting model overview

Having completed the TRACKS models, the final stage in the modelling approach was to develop a traffic forecasting spreadsheet model, which included the following key tasks:

- Calculated linear growth rates and traffic transfer proportions (from TRACKS modelling) applied to 2009 and 2011 traffic surveys collected at corresponding carriageway locations, producing future year forecast traffic volumes on an annual basis to 2026.
- Linear extrapolation used to calculate forecast traffic volumes beyond 2026.
- Existing traffic patterns used to develop classified peak period traffic volumes for the key Princes Highway and 'Sandtrack' locations within and surrounding the project area.
- Carriageway to ramp factors derived from the TRACKS model and O-D surveys, which were linked to forecast traffic volumes to develop updated ramp volumes.
- As carriageway and ramp volume forecasts for the project were developed independently, a Matrix Furness process was included in the spreadsheet model to re-balance ramp volumes against carriageway traffic volumes.
- The Matrix Furness process was the penultimate task in the overall modelling procedure, which resulted in preliminary traffic volumes – without construction impacts for intermediate years.
- The final task was to update the preliminary traffic forecasts to reflect the travel time impacts and resultant redistribution of traffic to the 'Sandtrack' during the intermediate construction periods for the project.
- Preliminary traffic volumes were updated for the construction impact years, producing the final set of traffic forecasts for the project.

An example of the traffic forecasting spreadsheet model is included in Appendix C.

Carriageway to ramp factors and re-balancing process

Importantly, the application of growth rates to individual counts raised the issue of compatibility with ramps and carriageway sections upstream and downstream. To overcome this challenge, the TRACKS model and O-D surveys were used to calculate carriageway to ramp factors for each of the ramps onto and off the Princes Highway within the project area.

Using the preliminary forecast traffic volumes and these calculated factors; traffic forecasts for each ramp movement were estimated. The collected forecasts were then input into a Matrix Furness process to refine the initial forecasts. The forecasts calculated from this process were now consistent upstream and downstream along the entire corridor.

4.2.4 Final forecast traffic volumes

Traffic modelling scenario

Table 4.5 provides details of the modelling scenarios that were developed to forecast traffic volumes for three different road network configurations. The 2009 'Do nothing' scenario was required to calibrate the base year spreadsheet model and the 2037 'Do nothing' modelling was developed to assess the impacts of forecast traffic volumes on the existing road network, to determine the consequence of no action in the study area. The 2037 modelled future year corresponds to the design year of the project, which is 20 years after the estimated completion of the upgrade (2017).

Table 4.5: Traffic modelling scenarios

Modelling scenario	EA measure	Network description	Modelled year		
			2009	2017	2037
'Do nothing'	Consequence of no action	Existing road network	√	-	√
'Do minimum'	Operational impacts	Foxground and Berry bypass and Gerringong upgrade	-	√	√
'Do something'		Full Gerringong to Bomaderry upgrade	-	-	√

(Source: AECOM)

The combined operational impacts of the project and Gerringong upgrade (north of the project) were assessed, in addition to RMS' overall upgrade of the Princes Highway to four lanes from Waterfall to the Jervis Bay Road junction; developed as 'Do minimum' and 'Do something' scenarios respectively.

The 2037 'Do minimum' scenario, which includes both the project and Gerringong upgrade road network improvements, was developed to review the traffic impacts and operational performance of this upgrade combination. In addition, the 'Do something' scenario was developed to assess the traffic impacts and operational performance of the project as a result of the completion of the Gerringong upgrade, the project and the Berry to Bomaderry upgrade.

'Do minimum' scenario – forecast traffic volumes

In summary, forecast traffic volumes for the Princes Highway and the 'Sandtrack' routes were developed by applying growth rates to 2009 and 2011 observed traffic volumes and rebalancing for consistency.

Table 4.6 provides a summary of the forecast AADT at key locations for the base year and the following modelled future years:

- 2017 'Do minimum' upgrade opening year.
- 2037 'Do minimum' upgrade opening +20 design year.

Table 4.6: Final forecast traffic volumes (key locations) – 'Do minimum' scenario

Location	Annual average daily traffic (AADT)				
	2009 (All veh)	2017 (All veh)	Diff (2009-17)	2037 (All veh)	Diff (2017-37)
Princes Highway, north of Rose Valley Road	20,902	26,167	5265	39,330	13,163
Princes Highway, west of Belinda Street	10,447	14,978	4531	31,391	16,413
Princes Highway, east of Tannery Road	10,105	14,406	4301	30,191	15,785
Princes Highway, Berry bypass	-	13,331	-	26,767	13,436
Princes Highway, south of Victoria Street	12,605	16,789	4184	30,349	13,560
The 'Sandtrack', south of Belinda Street	8692	8797	105	7363	-1434
The 'Sandtrack', south of Beach Road	8271	7616	-655	7119	-497

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Figure 4.6 provides a complete set of forecast traffic volumes at key locations in the project area including carriageway and on-ramp/off-ramp AADT for the Princes Highway upgrade 'Do minimum' scenario in 2037.

The project is planned to be completed by 2017. During the period 2009 to 2017 it is expected that:

- The Gerringong upgrade to the north of the project area would be completed, providing two lanes per direction on the Princes Highway between Mount Pleasant Lookout and Toolijooa Road.
- AADT volumes on the Princes Highway north of Rose Valley Road are expected to have increased by 5265 vehicles; equating to an average increase of about 600 vehicles per annum.
- North of Berry, AADT is expected to increase by about 4300 vehicles and 100 vehicles over the eight year period on the Princes Highway and the 'Sandtrack' respectively, including the transfer of traffic to the former from the latter following construction.
- In 2017, the bypass of Berry would accommodate around 13,000 vehicles per day, which equates to 79 per cent of the AADT on the highway south of Victoria Street.
- South of Berry, traffic on the Princes Highway is expected to increase by over 4100 vehicles and the corresponding 'Sandtrack' traffic is expected to decrease by about 650 vehicles between 2009 and 2017.
- Prior to the project, traffic is expected to follow current patterns and distributions, with a 55 per cent / 45 per cent split of total traffic between the Princes Highway and the 'Sandtrack' north of Berry, and a 60 per cent / 40 per cent split south of Berry in 2017.

Based on the predicted traffic growth from 2017 to 2037:

- AADT volumes on the Princes Highway north of Rose Valley Road are estimated to increase by about 13,000 vehicles over the 20 year post construction period (from 26,167 to 39,330 vehicles per day).
- Further south on the Princes Highway east of Tannery Road, AADT volumes are expected to grow by about 800 per annum. This increase includes a predicted transfer of traffic from the 'Sandtrack' due to improved traffic efficiency, road safety and travel time savings on the realigned and upgraded Princes Highway.
- In 2037, the bypass of Berry would accommodate around 27,000 vehicles per day, which equates to an annual growth rate of five per cent from 2017 and constitutes 88 per cent of the AADT on the highway south of Victoria Street.
- The split between the Princes Highway and the 'Sandtrack' traffic is estimated to change from 55 per cent / 45 per cent north of Berry, and 60 per cent/40 per cent south of Berry in 2009 to around 81 per cent / 19 per cent at both locations in 2037.

'Do something' scenario – forecast traffic volumes

Table 4.7 provides a summary of the forecast AADT at key locations for the modelled base year and the following two design year scenarios:

- 2017 'Do something' upgrade opening year (same road network assumptions as the 'Do minimum' scenario.
- 2037 'Do something' upgrade opening +20 design year.

Table 4.7: Final forecast traffic volumes (key locations) – 'Do something' scenario

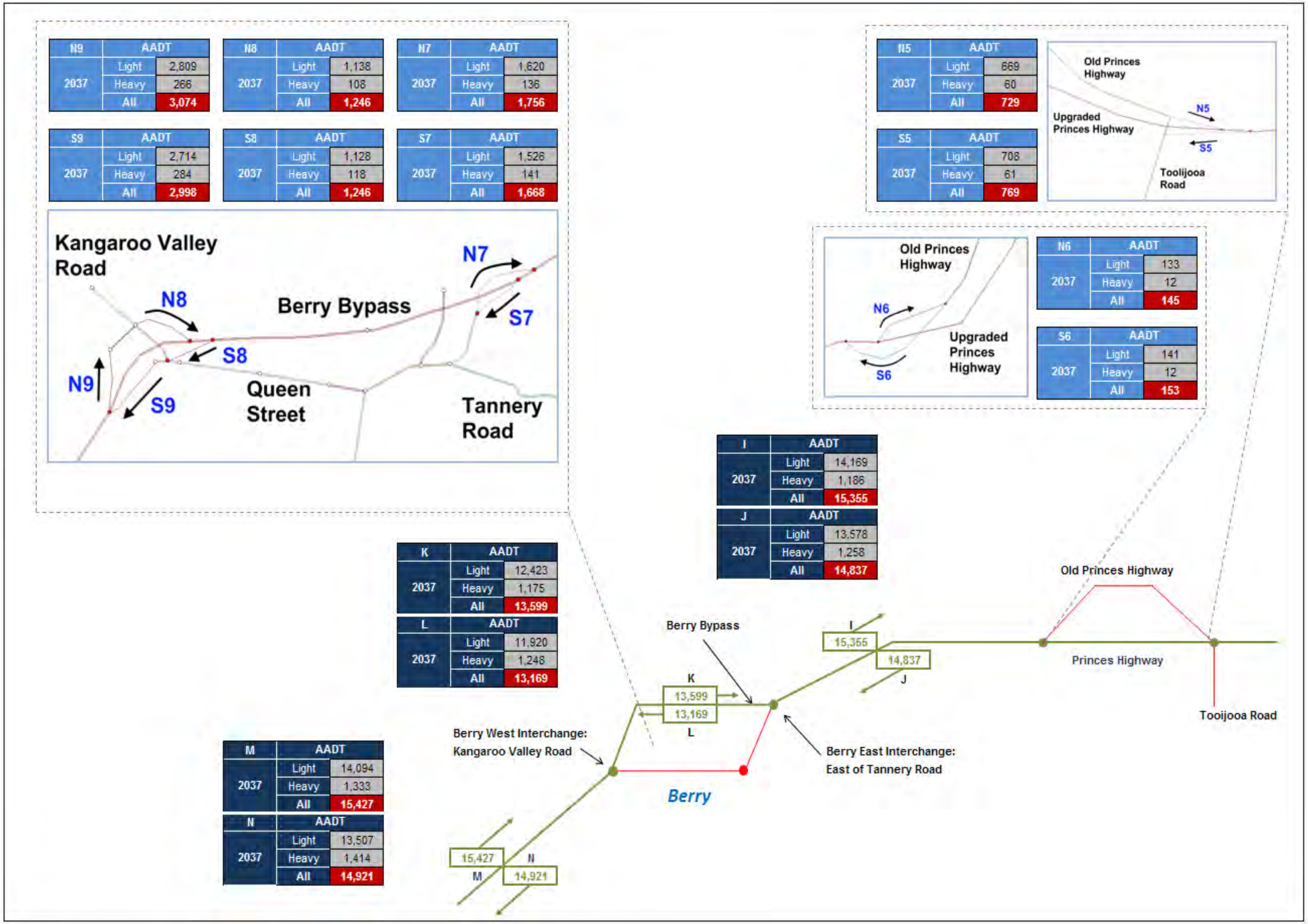
Location	Annual average daily traffic (AADT)				
	2009 (All veh)	2017 (All veh)	Diff (2009-17)	2037 (All veh)	Diff (2017-37)
Princes Highway, north of Rose Valley Road	20,902	26,167	5265	39,330	13,163
Princes Highway, west of Belinda Street	10,447	14,978	4531	32,738	17,760
Princes Highway, east of Tannery Road	10,105	14,406	4301	31,487	17,081
Princes Highway, Berry bypass	N/A	13,331	-	28,184	14,853
Princes Highway, south of Victoria Street	12,605	16,789	4184	32,746	15,957
The 'Sandtrack', south of Belinda Street	8692	8797	105	6015	-2782
The 'Sandtrack', south of Beach Road	8271	7616	-655	4722	-2894

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Figure 4.7 provides a complete set of forecast traffic volumes at all locations in the project area including carriageway, on-ramp and off-ramp AADT for the project. Based on the predicted traffic growth from 2017 to 2037:

- AADT volumes on the Princes Highway west of Belinda Street are expected to have increased by 17,760 vehicles; equating to an average increase of about 900 vehicles per annum over the 20 year period.
- On the Princes Highway south of Berry (Victoria Street), AADT is expected to grow by around 16,000 vehicles between 2017 and 2037. This increase includes a predicted transfer of traffic from the 'Sandtrack' due to improved traffic efficiency, road safety and travel time savings on the upgraded highway.
- In 2037, the bypass of Berry would accommodate around 28,000 vehicles per day, which equates to an average annual growth of around 750 vehicles from 2017 and constitutes 86 per cent of the AADT on the highway south of Victoria Street.
- The split between the Princes Highway and the 'Sandtrack' traffic is estimated to change from 55 per cent / 45 per cent to the north of Berry (60 per cent / 40 per cent to the south) in 2009 to 84 per cent / 16 per cent in 2037 (87 per cent / 13 per cent to the south), with the majority of traffic switching from the 'Sandtrack' in favour of the Princes Highway by 2037.

Table 4.8 displays the final AADT forecasts for the project carriageway, on-ramps and off-ramps throughout the project area, by vehicle classification and direction for the key modelled scenarios. The AADT forecasts for the 'Sandtrack' are also included for completeness.



N9	AADT	
2037	Light	2,809
	Heavy	266
	All	3,074

N8	AADT	
2037	Light	1,138
	Heavy	108
	All	1,246

N7	AADT	
2037	Light	1,620
	Heavy	136
	All	1,756

S9	AADT	
2037	Light	2,714
	Heavy	284
	All	2,998

S8	AADT	
2037	Light	1,128
	Heavy	118
	All	1,246

S7	AADT	
2037	Light	1,526
	Heavy	141
	All	1,668

N5	AADT	
2037	Light	669
	Heavy	60
	All	729

S5	AADT	
2037	Light	708
	Heavy	61
	All	769

N6	AADT	
2037	Light	133
	Heavy	12
	All	145

S6	AADT	
2037	Light	141
	Heavy	12
	All	153

I	AADT	
2037	Light	14,169
	Heavy	1,186
	All	15,355

J	AADT	
2037	Light	13,578
	Heavy	1,258
	All	14,837

K	AADT	
2037	Light	12,423
	Heavy	1,175
	All	13,599

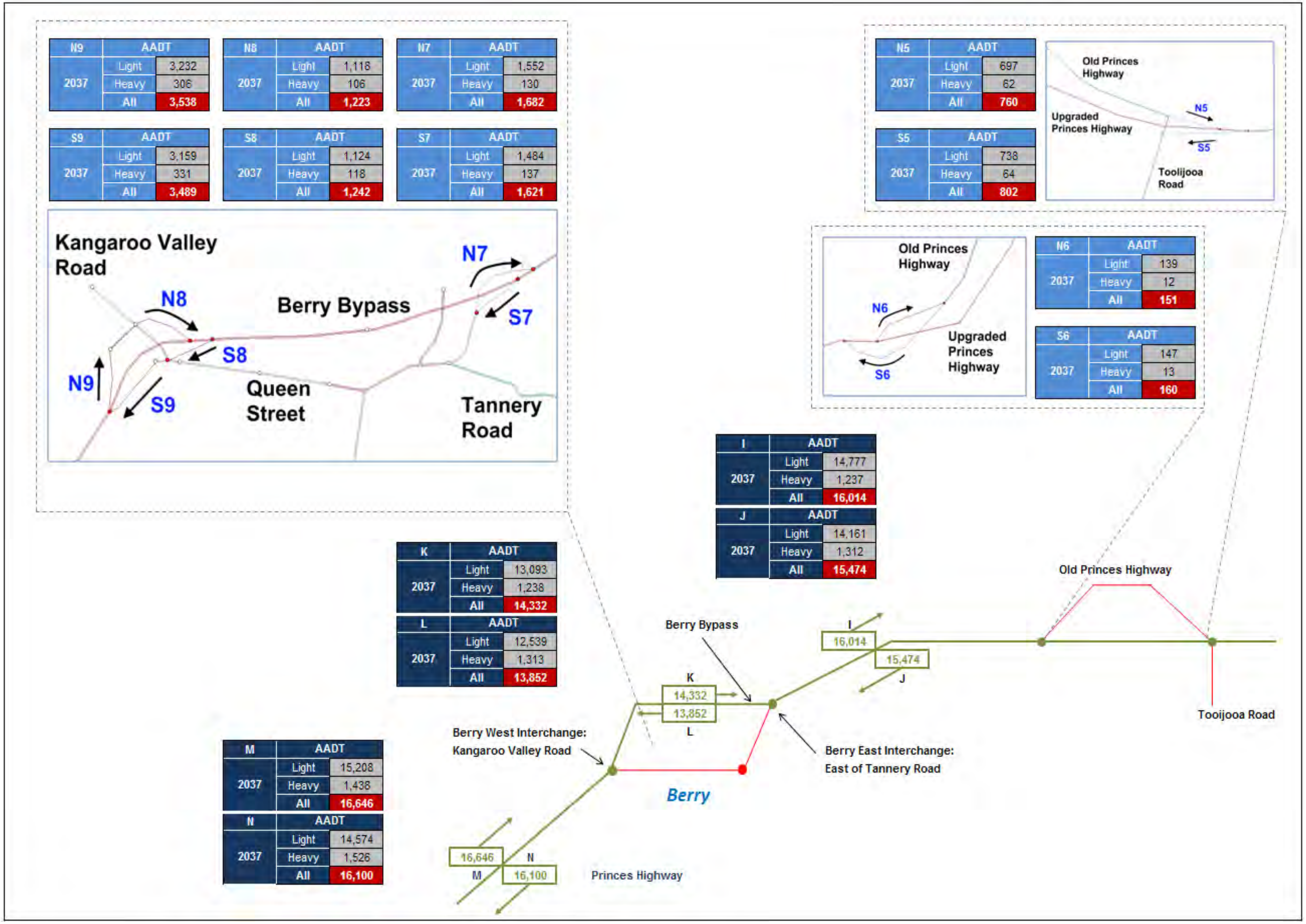
L	AADT	
2037	Light	11,920
	Heavy	1,248
	All	13,169

M	AADT	
2037	Light	14,094
	Heavy	1,333
	All	15,427

N	AADT	
2037	Light	13,507
	Heavy	1,414
	All	14,921

Figure 4.6: 2037 project carriageway and ramp AADT – 'Do minimum' scenario

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)



N9	AADT	
2037	Light	3,232
	Heavy	306
	All	3,538

N8	AADT	
2037	Light	1,118
	Heavy	106
	All	1,223

N7	AADT	
2037	Light	1,552
	Heavy	130
	All	1,682

S9	AADT	
2037	Light	3,159
	Heavy	331
	All	3,489

S8	AADT	
2037	Light	1,124
	Heavy	118
	All	1,242

S7	AADT	
2037	Light	1,484
	Heavy	137
	All	1,621

N5	AADT	
2037	Light	697
	Heavy	62
	All	760

S5	AADT	
2037	Light	738
	Heavy	64
	All	802

N6	AADT	
2037	Light	139
	Heavy	12
	All	151

S6	AADT	
2037	Light	147
	Heavy	13
	All	160

I	AADT	
2037	Light	14,777
	Heavy	1,237
	All	16,014

J	AADT	
2037	Light	14,161
	Heavy	1,312
	All	15,474

K	AADT	
2037	Light	13,093
	Heavy	1,238
	All	14,332

L	AADT	
2037	Light	12,539
	Heavy	1,313
	All	13,852

M	AADT	
2037	Light	15,208
	Heavy	1,438
	All	16,646

N	AADT	
2037	Light	14,574
	Heavy	1,526
	All	16,100

Figure 4.7: 2037 project carriageway and ramp AADT – 'Do something' scenario
(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Table 4.8: Final forecast AADT volumes (all locations)

Ref.	Route/Direction	Location	AADT																	
			2009			2010			2011			2017 (Do minimum)			2037 (Do minimum)			2037 (Do something)		
			LV	HV	All	LV	HV	All	LV	HV	All	LV	HV	All	LV	HV	All	LV	HV	All
Foxground and Berry Bypass (FBB)																				
G	Sandtrack NB	South of Belinda Street	4,276	142	4,418	4,402	146	4,549	4,529	151	4,679	4,158	176	4,334	3,399	344	3,743	2,777	281	3,058
H	Sandtrack SB	South of Belinda Street	4,136	137	4,274	4,258	142	4,400	4,381	146	4,526	4,293	170	4,463	3,288	333	3,620	2,686	272	2,958
	Two-Way		***8,412***	***280***	***8,692***	***8,661***	***288***	***8,949***	***8,909***	***296***	***9,206***	***8,451***	***346***	***8,797***	***6,687***	***676***	***7,363***	***5,463***	***553***	***6,015***
N5	Princes Hwy NB On	Toolijooa Road										315	38	352	669	60	729	697	62	760
S5	Princes Hwy SB Off	Toolijooa Road										324	39	362	708	61	769	738	64	802
N6	Princes Hwy NB Off	Austral Park Road										63	8	70	133	12	145	139	12	151
S6	Princes Hwy SB On	Austral Park Road										65	8	72	141	12	153	147	13	160
I	Princes Hwy NB	North of Berry	4,280	606	4,887	4,681	618	5,300	4,827	638	5,465	6,604	749	7,353	14,169	1,186	15,355	14,777	1,237	16,014
J	Princes Hwy SB	North of Berry	4,590	628	5,219	4,474	656	5,130	4,613	676	5,290	6,258	795	7,053	13,578	1,258	14,837	14,161	1,312	15,474
	Two-Way		***8,871***	***1,235***	***10,105***	***9,156***	***1,274***	***10,430***	***9,441***	***1,314***	***10,755***	***12,862***	***1,543***	***14,406***	***27,747***	***2,444***	***30,191***	***28,938***	***2,549***	***31,487***
N7	Princes Hwy NB On	Northern Interchange										475	54	529	1,620	136	1,756	1,552	130	1,682
S7	Princes Hwy SB Off	Northern Interchange										484	61	546	1,526	141	1,668	1,484	137	1,621
K	Princes Hwy NB	Berry Bypass										6,125	699	6,824	12,423	1,175	13,599	13,093	1,238	14,332
L	Princes Hwy SB	Berry Bypass										5,770	737	6,507	11,920	1,248	13,169	12,539	1,313	13,852
	Two-Way											***11,895***	***1,436***	***13,331***	***24,344***	***2,423***	***26,767***	***25,632***	***2,552***	***28,184***
N8	Princes Hwy NB On	Southern Interchange										387	44	431	1,138	108	1,246	1,118	106	1,223
S8	Princes Hwy SB Off	Southern Interchange										413	53	465	1,128	118	1,246	1,124	118	1,242
N9	Princes Hwy NB Off	Southern Interchange										1,953	223	2,176	2,809	266	3,074	3,232	306	3,538
S9	Princes Hwy SB On	Southern Interchange										1,932	247	2,178	2,714	284	2,998	3,159	331	3,489
M	Princes Hwy NB	South of Berry	5,707	701	6,407	5,887	723	6,609	6,067	745	6,812	7,692	877	8,569	14,094	1,333	15,427	15,208	1,438	16,646
N	Princes Hwy SB	South of Berry	5,454	743	6,197	5,626	767	6,393	5,798	790	6,588	7,289	931	8,220	13,507	1,414	14,921	14,574	1,526	16,100
	Two-Way		***11,161***	***1,444***	***12,605***	***11,513***	***1,490***	***13,002***	***11,865***	***1,535***	***13,400***	***14,981***	***1,808***	***16,789***	***27,601***	***2,748***	***30,349***	***29,781***	***2,965***	***32,746***
O	Sandtrack NB	South of Beach Road	4,093	177	4,270	4,210	182	4,393	4,328	187	4,516	3,669	218	3,887	3,155	520	3,675	2,093	345	2,437
P	Sandtrack SB	South of Beach Road	3,836	165	4,001	3,946	170	4,116	4,057	175	4,232	3,525	203	3,729	2,959	485	3,444	1,962	322	2,284
	Two-Way		***7,929***	***342***	***8,271***	***8,157***	***352***	***8,509***	***8,385***	***362***	***8,747***	***7,195***	***421***	***7,616***	***6,114***	***1,005***	***7,119***	***4,055***	***667***	***4,722***

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

4.3 Operational traffic modelling methodology

4.3.1 Introduction

The strategic TRACKS models were utilised to generate 2006 base and forecast 2026 future year traffic demand matrices for the average daily 24 hour period. As previously discussed, the key objective of the TRACKS modelling was to derive expected traffic growth rates on the Princes Highway and other key roads in the project area, based on expected land use changes as well as proposed road network improvements including the project. In turn these growth rates were used to create traffic forecasts on key regional and local roads in the project area based on these developments.

Whereas the TRACKS model provides an aggregated representation of traffic demand, Paramics microsimulation models have the ability to focus on the individual vehicles and movements at key times in a project area specific road network. By simulating driver behaviour, traffic interaction and operation, detailed engineering design such as the Berry bypass and access arrangements can be evaluated far more comprehensively, including:

- A determination of the anticipated operational performance of the project. More specifically, to assess the feasibility of the project concept design and confirm the functional capability and benefits in terms of:
    - Mobility: efficient movement of people and goods on the upgraded highway, including the operational benefits of the Berry bypass.
    - Access: the ability to enter/exit Berry via the respective off-ramps/on-ramps without delays and congestion; particularly during the periods of peak period travel demand (100th highest hour).
- To confirm that the project (carriageway and ramps) would accommodate future growth, population and freight needs or identify locations where the proposed concept design may not perform at acceptable service levels.
- Quantification and visualisation of local and regional traffic flows, including a comparison of pre and post-upgrade scenarios.

Therefore, using traffic growth rates from the TRACKS models as input, Paramics microsimulation models were developed to assess the operational performance of the road network during peak periods, with a particular focus on the two grade-separated interchanges, intersections within Berry and the surrounding local road network.

This section outlines and discusses the approach used to create Paramics microsimulation models to replicate current and future traffic conditions in Berry for a number of scenarios both with and without the construction of the project.

4.3.2 Data collection

As summarised and discussed in Section 2.4 traffic data has been collected to provide an in-depth understanding of traffic volumes and patterns in and around Berry to ensure the development of models which can accurately replicate current operating conditions. During the development of the base year model traffic data was collected on typical weekdays (Tuesday, Wednesday, and Thursday, outside of school holidays). These days are deemed to have the most stable and therefore most typical traffic volumes and patterns, as they are less likely to be influenced by weekend and holiday activities.

The following vehicle classified turning counts were collected during these times to enable the development of the models:

- Princes Highway and Victoria Street.
- Queen Street (Princes Highway) and Albany Street.
- Kangaroo Valley Road and North Street.
- Queen Street (Princes Highway) and Alexandra Street.
- Albert Street and Alexandra Street.
- Queen Street (Princes Highway) and Prince Alfred Street.
- Prince Alfred Street and Victoria Street.
- Princes Highway and Woodhill Mountain Road.
- Princes Highway and Tannery Road.

This weekday survey data was supplemented with additional traffic data (both current and historic) including tube counts and turning counts from the RMS' and local Council surveys. All data used in the development of the base year models was scrutinised to ensure it contained no errors or inconsistencies.

Historical data has shown that Berry's road network is subjected to the highest levels of demand during public holidays and other peak recreational times (100th highest hour). The distribution and volume of traffic during these times varies significantly from weekday traffic; for this reason a comprehensive suite of additional surveys were undertaken during the Easter and Anzac Day 2011 public holiday weekend (Thursday 21 April – Tuesday 26 April 2011), one of the busiest holiday peak periods of the year. The data collected was used to develop detailed O-D demand matrices for the northbound and southbound 100th highest hour models (see Section 2.4.6).

Site visits and observations were also undertaken to collect additional information regarding the layout and operation of the road network during the development of the base year model. The site visits were used to develop an understanding of the existing road network and traffic behaviour in Berry, including:

- Posted speed limits.
- Intersection configuration.
- Lane usage.
- Location of on- and off- street parking.
- Bus stop locations.
- Bottlenecks and pinch-points within and surrounding Berry.

All of the above data in conjunction with forecasting model outputs, including traffic volumes and growth rates, were used to develop the Paramics demand matrices used during the modelling process.

4.3.3 Traffic demand – base year model

Paramics traffic simulation modelling uses O-D assignment via O-D demand matrices; vehicles enter and leave the road network via model zones, with zones representing either a key location within a modelled area, or a road that leads into or out of the modelled area. O-D demand matrices list the number of trips that travel between specific zone combinations during the modelled period. Separate O-D matrices have been defined for light and heavy vehicles for all models due to the differences in trip patterns between these vehicle types.

Demand matrices detailing the movements of vehicles between zone combinations were created for the base year models using a combination of the traffic data sources listed in Section 4.3.2. Key O-D combinations were provided directly by surveyed data (see Section 2.4.6); some smaller O-D movements which were not captured directly by the surveys were calculated using an O-D matrix estimation process. This is a standard industry process which produces a representation of traffic patterns and volumes in a modelled area.

The models developed during this study represent peak-hour periods; O-D matrices have been developed with one hour demand volumes accordingly. Although the analysed model period covers only a single peak hour, a minimum 30 minute warm-up period has been used prior to the analysis period to ensure that the road network is populated at the time the analysis starts (analysed vehicles are not released into an empty model network as this would result in an inaccurate performance analysis).

In addition, the distribution of traffic over a modelled peak hour has been further refined using a peak hour profile, created from surveyed data. This allows the specific distribution of hourly traffic into 15 minute intervals, increasing the accuracy of modelling and allowing a finer level of detail during the assessment.

4.3.4 Base year model development

It is standard microsimulation practice to create a base model to replicate existing traffic conditions before developing any future options scenarios. This process, known as model calibration, is undertaken to ensure that vehicles in the modelled road network behave as expected; this includes ensuring typical routes are used, movements at intersections are representative and accurate, and modelled traffic volumes match surveyed data.

The Berry Paramics model was calibrated against the criteria outlined in the *Highways Agency's (UK) Volume 12 of the Design Manual for Roads and Bridges (DMRB)* and audited following the *RTA's Audit Schedule* defined by the *RTA NSW Manual for Modellers, Stage 4 Auditing*, as part of the *Gerringong to Bomaderry Princes Highway Upgrade Preliminary Traffic Assessment*, creating a calibrated base year model for 2008 weekday AM peak and PM peak hours. **Figure 4.8** shows the modelled area and the correlation between key locations in and around Berry and zones within the Paramics models. **Figure 4.9** shows the base year road network and zones in the Paramics model.

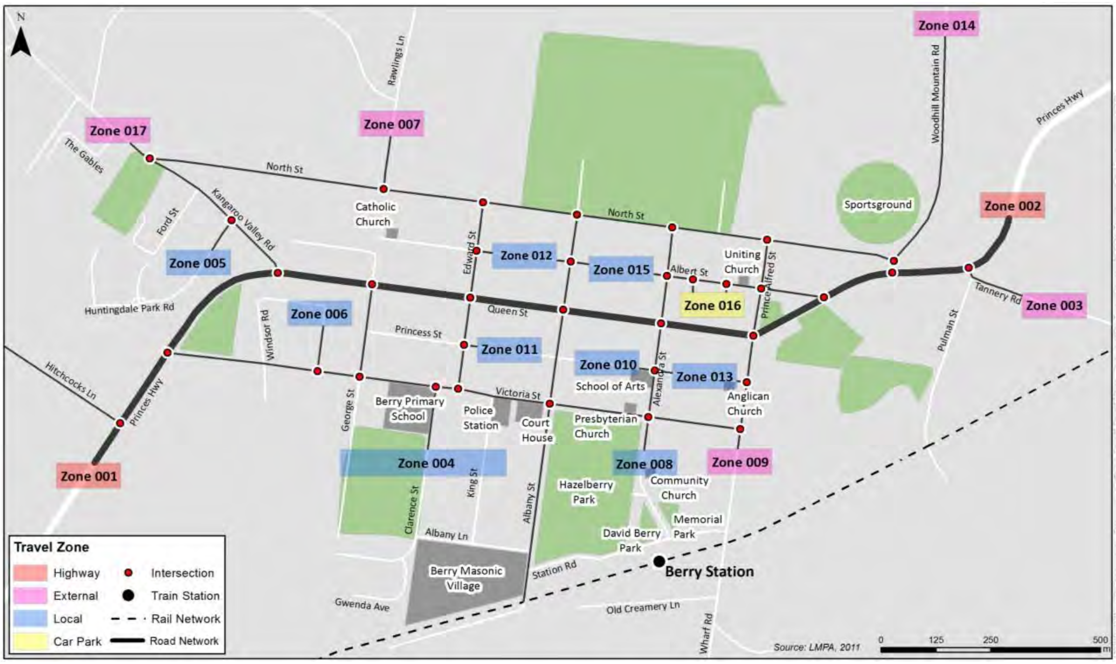


Figure 4.8: **Paramics model area and zone coverage**

(Source: AECOM)

Figure 4.9: **Paramics base year road network and zone system**

(Source: AECOM)

4.3.5 Future year model development

Following the calibration of the base model, forecast traffic growth has been applied to model a 'Do nothing' scenario, including the anticipated future performance in 2037 – the design year of the project – should the project not be constructed. Modelling of the 'Do nothing' scenario therefore used the existing road network, shown in **Figure 4.9**.

The 'Do nothing' scenario incorporates forecast traffic demand using the corresponding future year TRACKS model growth rates; in broad terms this assumes that traffic distribution patterns in and around Berry remain roughly unchanged, and that traffic would continue to grow at the current rate of over three per cent per annum.

Following the development of a ‘Do nothing’ model, ‘Do minimum’ and ‘Do something’ models were created to assess the performance of Berry’s road network including the Berry bypass and access arrangements proposed by the project. **Figure 4.10** indicates the modifications made to the base year road network in these models.

Figure 4.10: Paramics ‘Do minimum’ and ‘Do something’ road network and zone system

(Source: AECOM)

As well as changes to the road network the ‘Do minimum’ and ‘Do something’ scenarios also assume variations to the ‘Do nothing’ models in terms of traffic patterns and volumes in and around Berry, largely caused by the anticipated transfer of traffic from the ‘Sandtrack’ to the Princes Highway following the upgrade. Corresponding TRACKS models for these scenarios were used to predict growth rates to be applied to the base year Paramics model demand, including this transfer of traffic. In this scenario, traffic on the Princes Highway would be expected to grow at a higher rate than the three per cent per annum used in the ‘Do nothing’ models. Traffic demand on local roads and other regional routes including Kangaroo Valley Road, Tannery Road and Prince Alfred Street also used route-specific growth rates based on the expected re-routing of traffic following construction.

A further scenario was developed to determine the performance of the road network during construction for a worst-case situation. This model was used to analyse the effects of traffic transferring from the ‘Sandtrack’ in advance of construction being completed. In this case an increase in traffic demand and change in traffic distribution based on the ‘Do something’ scenario, including high growth on the Princes Highway due to the transfer of traffic from the ‘Sandtrack’, was paired with the ‘Do nothing’ road network.

As discussed in Section 2.4 and Section 4.3.2, traffic in and around Berry is highest during public holiday and other recreational peak times (100th highest hour); it is at these times when the road network would be subjected to the highest demand, and therefore at its lowest levels of performance. Paramics modelling has therefore been used to analyse the performance of Berry’s road network for the ‘Do nothing’, ‘Do minimum’, ‘Do something’, and construction scenarios, when subjected to 100th highest hour levels of demand.

The 2011 northbound and southbound 100th highest hour demand O-D matrices were developed (as discussed in Section 4.3.3) using a comprehensive suite of traffic data collected during the Easter 2011 period. The 2011 matrices were then developed using scenario-specific growth factors from the TRACKS model and anticipated changes to trip patterns to create 2037 100th highest hour northbound (NB) and 2037 100th highest hour southbound (SB) peak period O-D demand matrices.

The 100th highest hour demand matrices have been used to analyse the ‘Do nothing’ models, assessing the performance of the current road network both now and in the future during traffic peaks of this magnitude. In addition, corresponding 100th highest hour models for all scenarios including the construction of the project have also been created, analysing the performance of the proposed upgrade including an assessment of highway, ramp and interchange performance, as well as the elements and intersections within Berry that would remain unchanged.

The results of the future year Paramics microsimulation modelling are included in Chapter 5 and Chapter 7.

5 Future conditions without the project

This chapter focuses on the anticipated performance of the road network in the project area should the highway not be upgraded, which is referred to as the ‘Do nothing’ scenario. The forecast roadway LoS, based on the operational speed and time spent following vehicles on extra-urban sections of the highway has been assessed using forecast AM peak, PM peak and 100th highest hour (northbound and southbound peak directional) traffic volumes for the project design year of 2037. Intersection LoS, based on the capacity and efficiency of the local road network and intersections in the urban area of Berry, has also been assessed using Paramics models that have been specifically developed for this scenario.

5.1 Roadway level of service

Table 5.1 indicates that midblock locations on the Princes Highway in the project area would operate at an unacceptable LoS E or LoS F for all peak periods in the absence of the project, should traffic continue to grow at current rates. This compares to LoS D during AM and PM peak hours and LoS E during 100th peak hours at present, as discussed in Section 3.4.

During the 100th highest hour northbound (NB) and southbound (SB) peak hours, the Princes Highway is anticipated to operate at LoS F, indicating that the traffic volumes forecast would exceed the existing capacity of the highway, resulting in traffic flow breakdown and major delays. The alternative ‘Sandtrack’ route would also be expected to deteriorate to LoS D during typical AM peak and PM peak hours and LoS E during the 100th highest hour (southbound) peak period. Overall, the results show that the provision of additional road capacity throughout the project area is necessary to ensure acceptable highway performance.

Table 5.1: 2037 midblock level of service summary (‘Do nothing’ scenario)

Location	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	1381	E	1658	E	2172	F	2372	F
Princes Highway: Victoria Street – South of Schofields Lane	1749	E	2062	E	2286	F	2714	F
‘Sandtrack’: Dooley Road – Shoalhaven Heads Road	1108	D	1324	D	1539	D	1789	E

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

5.2 Intersection level of service

Paramics microsimulation modelling software has been used to assess the road network within and around Berry for the project design year of 2037, assuming that the road network is not upgraded. The results, which are included in **Table 5.2**, illustrate that the existing performance of key intersections in the town would deteriorate when subjected to the expected traffic demand from both local traffic and through movements, particularly during the 100th highest hour southbound peak period.

Table 5.2: **2037 intersection level of service summary ('Do nothing' scenario)**

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay(s)	LoS	Approach volume (veh/h)	Average delay(s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	1681	0.0	A	870	94.7	A
Victoria Street westbound	83	0.2	A	173	3.9	A
Princes Highway southbound	486	0.0	A	918	0.0	A
Total	2250	0.0	A	1961	42.4	D
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	1469	0.2	A	733	104.4	F
Kangaroo Valley Road	270	276	F	106	773.9	F
Queen Street westbound	663	19.5	B	1056	15.4	B
Total	2402	36.5	C	1895	92.3	F
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	1637	0.6	A	789	86.2	F
Alexandra Street southbound	130	276	F	106	426.6	F
Queen Street westbound	634	1.0	A	1011	3.3	A
Alexandra Street northbound	136	329	F	98	438.9	F
Total	2537	32.4	C	2004	79.6	F
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	1589	2.0	A	766	90.2	F
Queen Street westbound	659	3.9	A	1002	5.3	A
Prince Alfred Street northbound	222	197	F	156	296.9	F
Total	2470	20.0	B	1924	62.7	E
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	1595	4.6	A	766	72.6	F
Albert Street	83	20.5	B	42	137.7	F
Queen Street westbound	855	16.8	B	1100	41.6	C
Princes Highway / Tannery Road	2533	8.9	A	1908	56.2	E
Princes Highway / Tannery Road						
Princes Highway northbound	1656	4.0	A	776	72.7	F
Princes Highway southbound	583	1.2	A	996	25.6	B
Tannery Road	166	5.4	A	81	696.7	F
Total	2405	3.4	A	1853	74.7	F

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

It should be noted that the LoS calculated by the Paramics modelling is based on the capacity and efficiency of the local road network and intersections within and around Berry. In comparison, the midblock LoS presented in Section 5.1 represents the operational performance of rural highway locations in the traffic impact footprint, based on the travel speeds and the time spent following other vehicles. For this reason, the methods produce contrasting LoS results which vary along the length of the Princes Highway within the project area. The performance of particular sections or locations should be examined and interpreted in isolation; specific to the assessment criteria.

Large volumes of traffic demand on Queen Street (Princes Highway) would leave few gaps in the traffic flow and would therefore create significant delays to vehicles proceeding via the minor approach roads of intersections. In addition to this, some major intersection approach roads on Queen Street would also begin to incur delays (for example at Kangaroo Valley Road, Prince Alfred Street, Albert Street and Tannery Road), resulting in widespread congestion across the town.

Paramics modelling shows that as well as significant traffic delays at intersections, traffic queuing back to adjacent intersections could also become an issue, further diminishing the performance of the local road network in Berry. The results of the modelling undertaken illustrate that some local roads and intersections in Berry would operate at unacceptable performance levels based on the predicted increase in traffic if the current road network remains unchanged.

5.3 Travel speeds and travel times

Travel times throughout the project area would increase as the level of traffic and congestion grows on the existing road network. In the west of the project area, intersection delays in Berry would significantly increase especially during the peak periods, as shown in Section 5.2. This would be caused by local traffic conflicting with major through movements in the town at key intersections. The analysis shows that during peak holiday periods the average delay to vehicles approaching intersections from key local roads such as Tannery Road and Alexandra Street would be in the order of four to five minutes; Prince Alfred Street three minutes; and Kangaroo Valley Road two minutes. Through movements on the Princes Highway would also experience delays of up to one minute per intersection during the busiest holiday peak periods.

To the north of Berry where the Princes Highway passes through rural areas, an increase in traffic on the existing highway would result in lower operating speeds and therefore longer travel times. Midblock LoS analysis (documented in Section 5.1) indicates that in 2037 average travel speeds in the AM peak hour would fall to around 55 kilometres per hour at locations with an 80 kilometres per hour or 90 kilometres per hour posted speed; this is significantly lower than the existing average operating speed. Average travel speeds in the PM peak hour would fall further still, with higher traffic volumes than the AM peak. During the busiest holiday peaks traffic would not be expected to exceed an average speed of 45 kilometres per hour.

In addition, an increase in traffic on the existing highway would increase the likelihood of crashes and other incidents that lead to travel delays and congestion (see Section 5.4). As an example, following construction of the recently approved Gerringong upgrade, the highway immediately to the north of the project area would be upgraded to four lanes with a central median and safety barrier separating opposing traffic. This would require southbound highway traffic to merge into a single lane immediately east of Toolijooa Road should the Foxground and Berry bypass project not be constructed, creating potential performance and safety issues at this location.

Increased travel times due to these factors would result in negative economic impacts to freight, commuter and tourist traffic travelling both within the project area and longer distance regional destinations. Increases in travel times on the highway would reduce the attractiveness of the local area to commercial business and industry; new businesses may choose to locate outside the area to gain adequate freight access, while increased commuting times in the project area would hinder employment growth in the region. The significant tourism industry in the region would also suffer with recreational travellers becoming less willing to accept the time and cost associated with travelling through the area.

5.4 Traffic crashes

The frequency of crashes on both the Princes Highway and the ‘Sandtrack’ would be expected to increase should traffic continue to grow while the road network within the traffic impact footprint remains unchanged. The same potential for crashes, indicated by the crash rates per vehicle kilometre travelled in Section 3.1, would remain. On the Princes Highway, crashes due to the substandard horizontal and vertical alignment in the northern section of the project area would continue to be a particular concern. Continued traffic growth on the ‘Sandtrack’ would also be expected to increase the frequency of crashes on this alternative route, where a number of fatalities have occurred in recent years.

Traffic on the road network within the traffic impact footprint is expected to continue to grow at current rates of around three per cent per annum in the ‘Do nothing’ scenario; this would result in total linear growth of 78 per cent by the design year of 2037. Assuming current crash trends remain constant in the future; this increase in traffic would create a directly proportional increase in crash frequency and costs. Annual crashes on the Princes Highway would be expected to increase from an average of over 16 to around 29. The total annual cost of crashes would rise from $7.4 million to $13.2 million. The total annual cost of crashes on the ‘Sandtrack’ would be expected to increase from $10.7 million to over $19.1 million.

These estimates assume that the likelihood and severity of crashes would remain constant despite a significant increase in traffic. It is likely however that continued traffic growth would increase the probability of crashes per kilometre travelled.

As an example, growth in intersection throughput in the project area would increase the frequency of conflicting at-grade turning movements and consequently the potential for crashes, particularly in and around Berry. In addition, an increase in demand on rural sections of the highway would result in lower operating speeds and more time spent following other vehicles. This often results in vehicles travelling closer together, increasing the likelihood of rear-end crashes. In these conditions drivers can also become frustrated as their ability to travel their desired speed is impaired; often more risks are taken and crashes occur as a result. Similarly a reduction in the gap between vehicles would also increase the difficulty for vehicles joining and leaving the highway via local roads and property accesses; motorists may take greater risks when entering and leaving the highway as the opportunities to do so become less frequent.

Although the frequency of crashes typically increases in proportion to traffic growth, it is also known that increases in traffic can lead to a decrease in the severity of crashes that occur. For example this could be as a result of lower operating speeds, or changes in commonly occurring crash types. In the ‘Do nothing’ scenario it has been assumed that crash costs per kilometre travelled would remain constant in the future, and that the additional costs associated with increased crash frequency would be balanced by a reduction in the average crash cost based due to a decrease in the typical severity of crashes that occur.

In summary, the forecast growth in traffic on the existing road network within the traffic impact footprint would result in a considerable increase in the total number and cost of crashes occurring. Assuming current crash rates and costs remain constant the total number and cost of crashes would increase by 78 per cent by the design year of 2037.

5.5 Public transport

Current public transport options in the project area comprise buses, trains, walking and cycling, described in Section 2.3.

An increase in vehicles on the existing road network within the project area would result in lower travel speeds on the Princes Highway in rural areas, and increased delays at intersections within Berry. Higher traffic volumes in Berry would also reduce the amenity of the town for pedestrians and increase walking and cycling travel times in the town. If the project was not constructed, the following impacts to public transport services in the project area would potentially be experienced:

- Buses:
  - An increase in bus service travel times due to slower travel speeds and increased intersection delays.
  - More frequent delays to services caused by traffic incidents and congestion in the project area.
  - The potential for crashes caused by buses stopping on the Princes Highway and local roads to pick-up and drop-off passengers would increase in proportion to the expected growth in traffic.
  - Longer travel times to and from bus stops by supplementary travel modes (e.g. car passenger, walking to/from bus stop, etc) due to an increase in traffic volumes, slower travel speeds and increased intersection delays.
  - Reduced amenity for bus users waiting at stops; an increase in traffic would result in impacts including a reduction in air quality, increase in noise, and reduction in pedestrian roadside safety.
- Rail services:
  - Longer travel times for rail passengers travelling to and from Berry train station by car, bus, walking and cycling, due to an increase in traffic volumes, slower travel speeds and increased intersection delays.
- Walking:
  - Increased delays when crossing roads at uncontrolled points without pedestrian facilities in the project area (particularly Berry), caused by heavier traffic flows.
  - Reduced overall amenity throughout the project area including a reduction in air quality, increase in noise, and reduction in pedestrian safety.
- Cycling:
  - Increased delays at intersections in Berry due to an increase in conflicting traffic volumes travelling through the town.
  - Reduced cyclist road safety; increased potential for accidents with other road users throughout the project area caused by an increase in traffic on the existing road network.
  - Reduced overall amenity throughout the project area including a reduction in air quality and increase in noise.

6 The Foxground and Berry bypass project

6.1 Description of the project

The project would involve widening and realigning of 11.6 kilometres of the Princes Highway, located within the Kiama and Shoalhaven LGAs. The project would achieve a four lane divided highway (two lanes in each direction) with median separation between Toolijooa Road north of Foxground and Schofields Lane, south of Berry (the project). The project would include bypasses of Foxground and Berry.

The project would comprise the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.
- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around 190 metres long and 13 metres in height.
  - A bridge at Berry, an 18 span concrete structure around 600 metres long and up to 12 metres in height.

- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.
- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
  - Property access and fauna underpass in the vicinity of Toolijooa Ridge at chainage 8400.
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12770.
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13700.
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100.
- Modifications to local roads, including Toolijooa Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane.
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.
- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent stockpiling site for general road maintenance.

Construction activities as part of the project would include the following:

- Site preparation and establishment works.
- Temporary construction facilities, including construction compounds, stockpile sites, creek crossings, sediment control basins and haulage roads.
- Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks.
- Earthworks and bridge construction.
- Pavement construction.
- Drainage construction.
- Road furniture installation.
- Site restoration.

The project and the key features of the project are shown in **Figure 6.1** and **Figure 6.2**.

During detailed design, refinements could be made to the design features and construction methods (refer to Chapter 4 of the environmental assessment).

6.2 Project objectives

The project objectives are to:

- Improve road safety.
- Improve efficiency of the Princes Highway between Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry).
- Support regional and local economic development.
- Provide value for money.
- Provide significant beneficial environmental effects for Berry town centre and manage potential adverse environmental impacts elsewhere.
- Optimise the benefits and minimise adverse impacts on the local social environment.

Supporting the project objectives are the following six sub-objectives and design principles that make up the urban and regional design framework:

- Provide a flowing highway alignment that is responsive and integrated with the natural landscape.
- Protect the natural systems and ecology of the corridor.
- Protect and enhance the heritage and cultural values of the corridor.
- Respect the communities and towns along the highway.
- Provide an enjoyable, interesting highway with strong visual connections to the immediate hinterland and the mountains to the west.
- Develop a simple and unified palette of elements and details that are easily maintained.

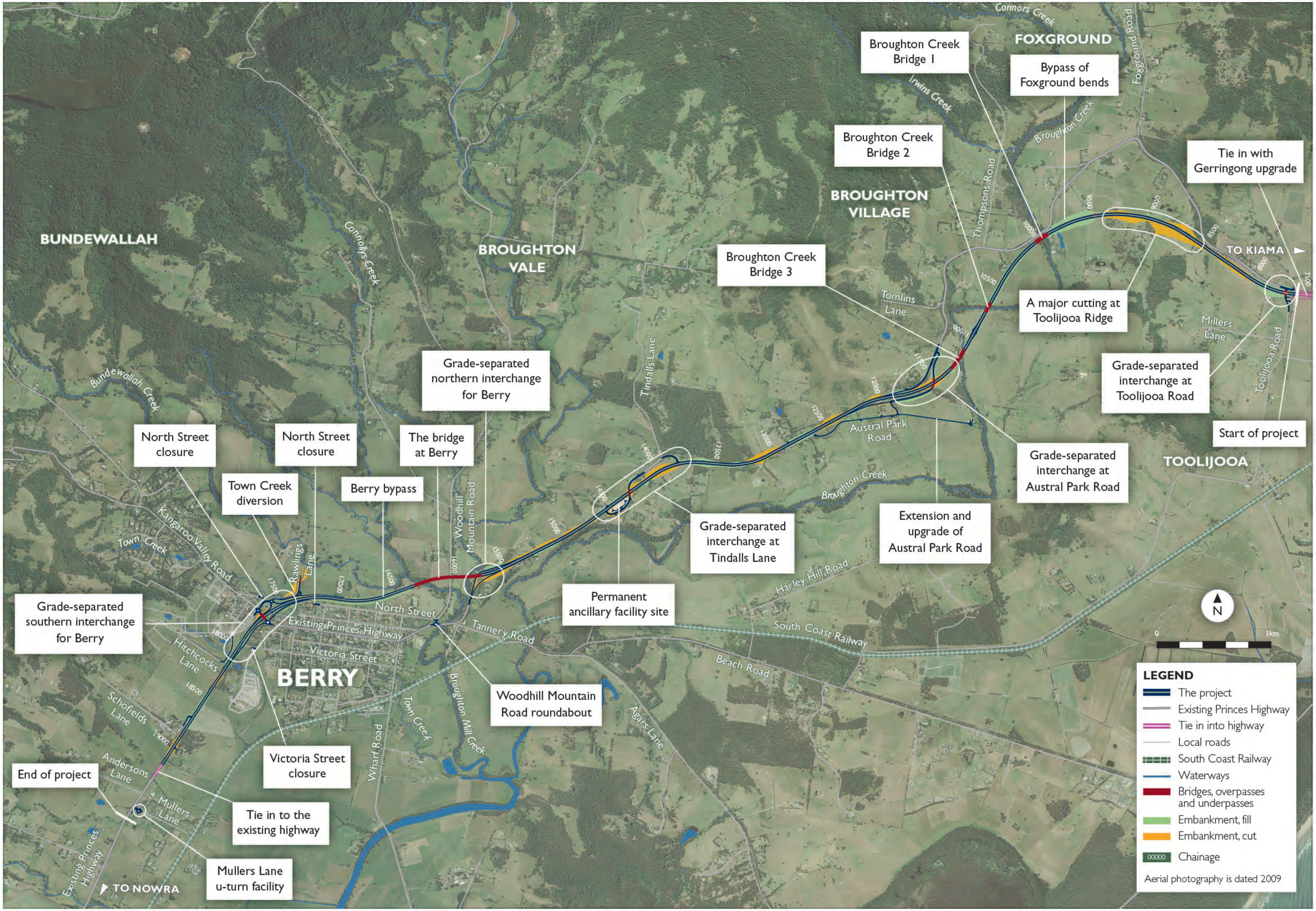


Figure 6-1: Project concept design (Source: AECOM)

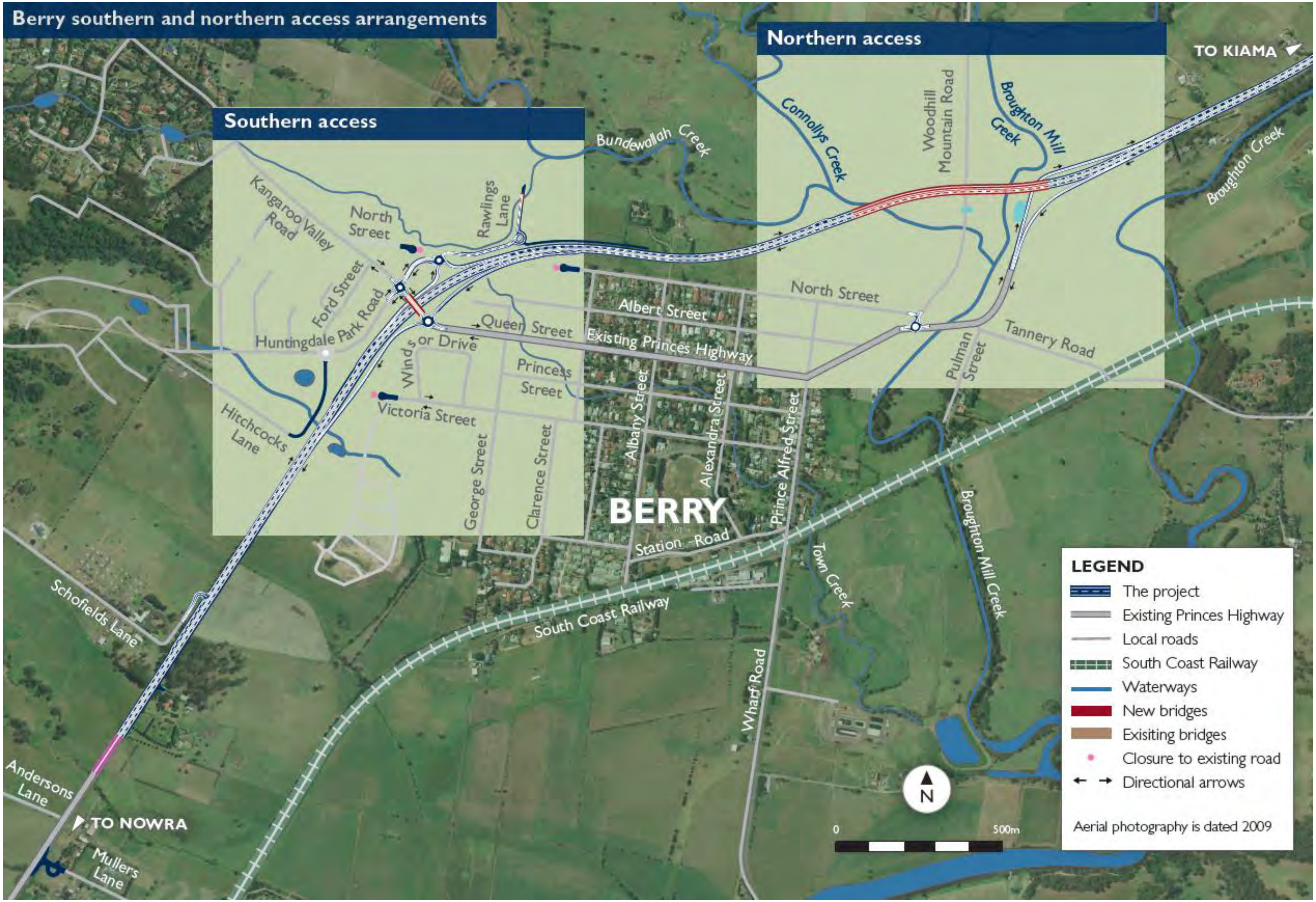


Figure 6.2: Berry southern and northern access arrangements

7 Traffic impact assessment

This chapter provides details of the traffic impact assessment that was completed for different stages and scenarios, including the construction and operational impacts of the project for both ‘Do minimum’ and ‘Do something’ traffic modelling scenarios (see Section 4.2.4).

7.1 Construction impacts

7.1.1 Constructability and staging

The construction activities required for the project would pose a number of staging challenges. Sections involving the widening or duplication of the existing highway pose greater construction and road user management challenges. They would require the widening of road shoulders, temporary ramps and traffic switches to enable the highway to remain open during construction.

Other than the partial use of completed sections of the highway during construction, it is not intended that completed sections of the project would be opened prior to the completion of the full project.

As a result of these challenges, a number of staging options have been developed. There are currently three potential staging options for the construction of the project which differ in the sequence of construction events but would ultimately deliver the project in the same manner.

The first option would be to deliver the project in four stages based on whether construction would occur on line or off line. The four stages would be based around the following geographical areas:

- Toolijooa Road to Austral Park Road (off line).
- Austral Park Road to the bridge at Berry (on line).
- The bridge at Berry to Kangaroo Valley Road (off line).
- Kangaroo Valley Road to Schofields Lane (on line).

The second option would be to deliver the project in two stages with discrete construction zones within each stage. The zones would be developed with the aim to achieve an earthworks balance based on balancing the earthworks (cut equal to and fill) required across each stage. The two stages would be:

- Toolijooa Road to the northern end of the bridge at Berry.
- The bridge at Berry to Schofields Lane.

The third option would be to deliver the project through a series of early works packages as an early works stage followed by a remaining road works stage package. The road works package would be delivered in a similar way to option two, with stages and construction zones developed to achieve balanced earthworks: areas and the sequence would be based on the balanced earthworks zones described in option two. The stages would include:

- Construction of the Toolijooa Road interchange.
- Construction of all bridges.
- Remaining road works:
  - Toolijooa Road interchange to the northern end of the bridge at Berry.
  - The bridge at Berry to Schofields Lane.

Further details of each staging option are provided in the concept design report which is available on the project website (www.rms.nsw.gov.au/fbb). The final staging strategy would be determined during detailed design and would be dependent on the construction contractor.

7.1.2 Construction traffic

The construction of the project would inevitably generate construction vehicles travelling to, from, and within the project area on the existing Princes Highway and local roads which provide site access. Traffic generation and control details are currently limited as these would depend on the final detailed design and the contractor's work methods. Additional traffic demand would be expected to be generated by sources including:

- Construction workers travelling to and from worksites.
- The delivery of heavy vehicles and machinery, and other equipment required for highway construction.
- The delivery of construction materials including dry bulk such as cement and aggregates, significant quantities of steel, as well as pre-fabricated structures.
- The movement of spoil generated by earthworks, including the movement of materials within the site, transferral to stockpile sites and/or removal from the project area.

It is anticipated that most construction-related heavy traffic would travel to and from the project area from the north, particularly the Wollongong area. Here, the Princes Highway would be a four-lane highway, mostly with a central median and safety barrier separating opposing traffic. The Gerringong upgrade between Mount Pleasant and Toolijooa Road is expected to be largely complete prior to construction of this project. The Princes Highway would therefore provide a suitable route for construction-related vehicles to travel safely and efficiently to and from work sites in the project area.

Of the total 11.6 kilometre project length, 6.6 kilometres would be completed offline from the existing alignment. In addition, a significant proportion of the online upgrade would involve construction on either side of the existing Princes Highway, maximising efficiency and safety of construction, while minimising delays to highway traffic. Wherever practicable, offline construction would be completed first, with the aim of removing construction-related vehicles from the existing highway. Construction traffic would use the cleared project footprint where possible, to transport materials either adjacent to the highway or via a haul route as appropriate. Construction traffic entry and exit points would be minimised and controlled and the use of the existing highway would be restricted at peak hours, especially during holiday periods. Once offline sections are completed, traffic can be rerouted onto new highway sections, enabling the safe and efficient renewal of the existing roadway.

During construction of the bypass at Berry, heavy construction vehicles would be present in the northern end of the town to source and transport material to/from the project footprint to the proposed stockpile site and compound/office adjacent to Woodhill Mountain Road and also to the compound/office south of North Street; accessed via Kangaroo Valley Road. All other compound stockpile sites and construction compound/offices would be accessed directly from the existing highway or vehicles would be required to travel a short distance on a local road after turning off the highway (eg Toolijooa Road).

Heavy traffic volumes generated by construction would be significantly influenced by the volume of material requiring transportation to, from, and within the project area. Estimates of construction resources including bulk earthworks volumes, a discussion of pavement materials, and material sources are included in the project Concept Design Report (Chapter 15). Preliminary estimates forecast total earthworks of about 1,000,000 cubic metres and in the region of 160,000 cubic metres excess material. Total pavement area of the current design is about 240,000 square metres.

Detailed quantities of earthworks, construction material quantities, and person hours required to construct the project would be confirmed during detailed design; for this reason earthworks, material quantities and person hours, and traffic generated by the haulage of materials and personnel, has been estimated for the concept design of the project.

Table 7.1 indicates forecast traffic generated by the construction of the project. Assumptions including typical vehicle capacities and operating hours have been used to estimate total and average daily vehicle generation.

It is estimated that around 45,000 heavy vehicles would be required to travel to and from the project area during construction, generating a total of about 90,000 vehicle movements. Earthworks haulage and the delivery of dry bulk materials is expected to generate the vast majority of heavy vehicle movements, with small volumes of heavy traffic required to deliver steel and pre-fabricated units. Assuming a three year construction period and an even spread of total vehicles over this period, the project would generate around 50 heavy vehicles, or 100 vehicle movements per day.

Assuming construction workforce hours of around 105,000 per kilometre, a total of over 1.2 million workforce hours would be required to construct the 11.6 kilometre project. Construction is estimated to be completed in three years (9440 hours based on the construction period assumptions in **Table 7.1**). Completion of the project within this timeframe would require 130 person hours (130 personnel on site) on average during every construction hour. Assuming an average of two construction personnel per vehicle travelling to and from the project area, 65 light vehicles per day would be generated by construction personnel.

Previous upgrades to sections of the Princes Highway north and south of the project area have been used to validate the construction traffic forecasts in this section. The upgrade of the Princes Highway between Kinghorne Street and Warra Warra Road, south of Nowra, anticipated that construction activities were expected to generate on average 60 truck movements per day (*Princes Highway Upgrade Kinghorne Street to Warra Warra Road, south of Nowra – Review of Environmental Factors, Nov 2009*); the construction of additional access ramps for Kiama bypass anticipated 50 trucks per day would be generated by construction activities (*Kiama Bypass Additional access ramps – Review of Environmental Factors, July 2006*). Anticipated heavy traffic generated by both of these projects is therefore in line with the forecast of around 50 heavy vehicles per day created by the project.

As with any increase in traffic, construction traffic on the Princes Highway would be expected to decrease road network performance. It would also be expected that traffic generated by construction, and in particular heavy vehicles, would increase noise, reduce air quality, and decrease general amenity, especially if required to travel through Berry. It is not however expected that this increase in traffic would reduce road safety, provided adequate traffic management measures are employed.

Although the numbers included in **Table 7.1** are indicative of the likely magnitude of construction traffic generated by the project, key features including the location and size of stockpile sites, the need for and location of mobile batching plants, and material suppliers selected would all influence construction traffic volumes and movement patterns at both a local and regional level. These key features, and consequently detailed forecasts of traffic volumes and trip patterns, would need to be developed from the final detailed design.

Following the finalisation of the detailed design and construction staging planning, periods of key activity relating to construction traffic generation and movements would be identified. During these periods information and advice would be issued to affected residents, businesses and road users through channels including community updates and other material distributed via project mailing lists, announcements through local and regional media channels, and updates on the project website. The communication process would be managed to ensure relevant and concise information is provided to affected parties as appropriate.

Table 7.1: Estimated construction traffic generation, based on example project construction material and workforce requirements

Project details:	
Project name:	Foxground and Berry bypass
Project length:	11.6 km
Construction period:	Three years (52 weeks per year; 5.5 days per week; 11 hours per day)
Road type:	Four lane divided carriageway
Project features:	− Bypass of Berry and 'Foxground bends'. − Grade separated interchanges to north and south of Berry and 'Foxground bends'. − At-grade intersections with 'left-in left-out' only arrangements providing direct access between the upgraded highway and local roads and properties. − Design capable of widening to 6 lanes. − 600-metre-long Berry divided four lane bridge spanning Broughton Mill Creek, Woodhill Mountain Road and Bundewallah Creek. − Additional single lane bridges at interchanges and local roads. − Two 3.5 metre traffic lanes and 2.5 metre (minimum) paved outer shoulder per direction.

Estimated construction traffic generation – heavy vehicles:

Source	**Estimate (average, per km)**	**Estimate (total)**	**Vehicle capacity (average)**	**Estimated vehicle generation**	
				Total	**Daily (average)**
Earthworks	-	1,000,000 m^3	30 m^3	33,333	39
Dry bulk materials	28,450 m^3	330,000 m^3	30 m^3	11,000	13
Reinforcing steel	460 tonnes	5320 tonnes	10 tonnes	532	1
Pre-fabricated units	18 units	205 units	1 unit	205	<1
Total – heavy vehicles	-	-	-	45,000	53

Estimated construction traffic generation – light vehicles:

Source	**Estimated person hours (average, per km)**	**Estimated person hours (total)**	**Construction hours (total)**	**Person hours per construction hour (average)**	**Estimated vehicle generation (daily, average)**
Construction personnel	105,880	1,230,000	9440	130	65

(Source: AECOM)

7.1.3 Traffic delays and disruptions

Large sections of the project (6.6 kilometres of the total 11.6 kilometre project length) would be completed offline from the existing alignment, including significant construction operations during the realignment through Foxground such as the cutting at Toolijooa Ridge and the three bridges over Broughton Creek, and the Berry bypass which includes a bridge 600 metres in length. The offline location of these major works, as well as a large proportion of construction occurring on either side of the existing alignment, should ensure that construction can be carried out at these sites with minimal impacts to traffic efficiency on the current road network.

During construction, traffic management measures are employed to maintain road safety for all users. Although it is RMS' goal to maintain an 80 kilometres per hour construction speed zone (where normal posted speeds are higher than 80 kilometres per hour), additional delays for traffic using the Princes Highway would be expected during the construction phase in those periods when the project requires online works and/or ties in with the existing highway. Some temporary disruptions and delays to local and highway traffic would be experienced during construction of the project due to the narrowing of lanes and temporary speed reductions. There would also be delays to local traffic during periods when other local or private roads are being bridged or tied in with the project.

Local roads that would potentially experience some delays during construction include Toolijooa Road, Austral Park Road, and Tindalls Lane. The north and south interchanges accessing Berry may also incur specific delays during the tie-in with the Berry bypass. It is also likely that roads directly linked to, or serviced by, the new grade-separated interchanges would experience detours at some stages during construction. This includes residents in the Foxground and Broughton Village areas who would use the new interchanges at Toolijooa Road and Austral Park Road. Moreover, construction of the new Kangaroo Valley Road overpass at the southern interchange to Berry would require a temporary road closure. It is anticipated that traffic would be diverted along North Street and as a result, the overpass would need to be operational before construction of the bypass section that severs North Street begins.

It is expected that approximately three per cent of through traffic in the traffic impact footprint (ie combined traffic on both the Princes Highway and the 'Sandtrack') would divert to the 'Sandtrack' during construction. Although heavy vehicles (over five tonnes) are restricted from using the 'Sandtrack', vehicles within this limit are free to use this route. It is anticipated that some vehicles may opt to use the 'Sandtrack' to travel between Gerringong, Berry and Bomaderry to avoid actual or perceived delays through construction zones associated with the project. The proportion of vehicles has been estimated based on 80 kilometres per hour construction zone speed limits and passing constraints, with the effects included in traffic forecasting figures and performance analyses. The roadway level of service impacts of vehicles using the 'Sandtrack' in favour of the Princes Highway during construction are discussed in Section 7.1.4.

Toolijooa Road is a local road that currently carries very low traffic volumes (less than 500 vehicles per day), with the majority of vehicles using it to access properties along its length between the Princes Highway and Beach Road. It could potentially offer an alternative route to the Princes Highway during construction, as the intersection between Toolijooa Road and the Princes Highway is located at the extent of the project area to the east. However, it is anticipated that Toolijooa Road would continue to be primarily used by local residents during construction, based on the following factors:

- It is signposted as a local road and most motorists are unaware that it ultimately connects to Beach Road (and on to Berry).
- The road is of a much lower standard than both the Princes Highway and the ‘Sandtrack’; it offers a lower quality road surface, narrow lanes and poor road alignment at a number of locations.
- The posted speed limit is 60 kilometres per hour.
- There is an unsealed section at the western end of Toolijooa Road, which is particularly narrow and undesirable for through traffic.

The use of local roads by heavy vehicles associated with construction would be limited to where these roads provide access to construction ancillary sites, or where local road modifications are proposed. Two construction ancillary sites are located off the Princes Highway which would require travel along local roads, being the site located off Woodhill Mountain Road and the site located adjacent to North Street (and accessed via Kangaroo Valley Road).

The existing AADT on Woodhill Mountain Road and Kangaroo Valley Road is 970 and 1485 vehicles respectively. Assuming a maximum of 53 heavy vehicles per day, the impacts on both local roads is likely to be between a three per cent and five per cent increase on existing traffic volumes. Although the presence of heavy vehicles close to the town would be a temporary inconvenience to the community during construction of the bypass, the additional trucks would have a negligible impact on the operational performance of both roads with minimal delay and congestion. This is due to the low volume of daily and peak period local traffic flows that currently travel on Woodhill Mountain Road and Kangaroo Valley Road, the close proximity of the stockpile/ compound sites and direct access to the Princes Highway to transport residual material to other sites/locations external to the town.

7.1.4 Roadway level of service

Both most-likely and worst-case scenarios have been developed to assess roadway and intersection LoS during construction. The most-likely scenario represents a typical day during construction of the project. Forecast construction traffic would increase overall daily traffic on the Princes Highway, while a proportion of traffic currently using the highway would transfer to the ‘Sandtrack’ to avoid delays through construction zones.

The worst-case construction scenario assesses the local and regional road network performance when traffic is at 100th highest hour levels during holiday peaks. The project would be planned and managed to avoid construction work (and the additional impacts created by construction traffic) during these times. Despite this, overall traffic volumes would be much higher than during the most-likely scenario due to the large proportions of recreational traffic at these times. These traffic volumes, combined with traffic management measures through construction zones including speed restrictions and passing constraints, would result in the poorest performance of the road network during construction.

Most-likely construction scenario

The most-likely construction scenario has been developed to assess roadway and intersection LoS on a typical day during construction. Traffic forecasts for this scenario have been developed based on assumptions including:

- 2017 AM peak and PM peak 'Do something' traffic volumes prior to project completion. This assumes no transfer of traffic from the 'Sandtrack' to the Princes Highway (expected following completion of the project).
- Temporary transfer of light vehicles from the Princes Highway to the 'Sandtrack', based on vehicles avoiding estimated delays associated with construction on the Princes Highway.
- Construction traffic generated by material and equipment deliveries, earthworks haulage and construction personnel travelling on the Princes Highway (see Section 7.1.12).
- An 80 kilometres per hour construction zone speed limit throughout the project area (at locations where current posted speed is currently >80 kilometres per hour).
- Existing highway layout (two-lane, two-way; no upgraded sections open to highway traffic).
- Passing constrained throughout the project area due to construction zones.

As referenced in previous sections, customised midblock LoS models have been developed based on the updated *AUSTROADS, Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009*. An example of the model, which is designed to assess the operational performance of the project, is included in Appendix D.

Table 7.2 provides a summary of the anticipated midblock LoS on both the Princes Highway and the 'Sandtrack' for the most likely construction scenario. The analysis examines the AM and PM peak hours of a typical day during construction.

The results show that the Princes Highway is expected to operate at LoS E both north and south of Berry in 2017, the final year of construction; this indicates a deterioration from 2011 levels (LoS D). The analysis undertaken indicates that average travel speeds on the Princes Highway would be around 50-60 kilometres per hour, with passing constrained by traffic management measures through construction zones.

Table 7.2: 2017 midblock level of service summary (most-likely construction scenario)

Location	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	972	E	1150	E
Princes Highway: Victoria Street – South of Schofields Lane	1160	E	1348	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	728	C	870	C

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The volume of construction traffic when compared to total traffic on the Princes Highway is expected to be relatively small. Construction personnel travelling in light vehicles would be expected to mainly travel at the beginning and end of the day; it has been assumed that a maximum of 65 light vehicles used by construction personnel would travel in the AM and PM peaks of a typical day. Heavy vehicles associated with construction have been assumed to follow a more even distribution throughout a typical day; a maximum of 10 (of around 50 daily) heavy vehicles have been assumed to travel during AM and PM peak hours.

Construction traffic would comprise no more than eight per cent of total traffic on the Princes Highway during peak hours based on these estimates; further analysis of the most-likely construction scenario indicates that the Princes Highway would operate at LoS E without the introduction of estimated construction traffic (although travel speeds would be expected to decrease marginally when it is included). Provided that access to and from construction sites is planned and managed correctly, the introduction of construction traffic on the Princes Highway would not decrease current levels of road safety.

Traffic on the ‘Sandtrack’ is expected to increase from current levels, including annual growth as well as the effects of light vehicles using this alternative route to avoid construction zones on the Princes Highway. Despite this the ‘Sandtrack’ is expected to continue to operate at LoS C up to and including the final year of construction during typical AM and PM peak hours. The relatively small increase in traffic is not expected to decrease the safety of this route.

Worst-case construction scenario

In order to estimate the potential LoS of a worst-case construction scenario, the following assumptions have been used to model the operational impacts:

- 2017 100th highest hour ‘Do something’ traffic volumes.
- The completion and opening of some sections of the project, resulting in a transfer of traffic from the ‘Sandtrack’ to the Princes Highway.
- No construction traffic travelling on the Princes Highway (construction would not occur during 100th highest hour traffic peaks).
- An 80 kilometres per hour construction zone speed limit through construction zones project area (at locations where current posted speed is currently >80 kilometres per hour).
- Existing highway layout (two-lane, two-way) on some sections of the Princes Highway north and south of Berry; combination of upgraded and non-upgraded highway conditions throughout the project area.
- At least one construction zone on the Princes Highway both north and south of Berry.
- Passing constrained in construction zones.

The worst-case construction scenario includes a three per cent transfer of traffic from the ‘Sandtrack’ to the Princes Highway prior to the completion of the project. This assumption is based on the scenario that the Gerringong upgrade has been completed and a section of the highway, such as the realignment through Toolijooa Ridge, is completed and opened to traffic prior to the completion of other sections within the project area. In this scenario ‘Sandtrack’ traffic would potentially transfer to the Princes Highway to benefit from travel time savings and improved road safety on upgraded sections of the project area, while construction would still be continuing on others. In the 100th highest hour peak period this is more likely than during a typical day as large proportions of recreational, non-local traffic would be travelling through the area, with less knowledge of potential delays caused by traffic management in the project area.

The performance analysis using the above conditions and summarised in **Table 7.3**, indicates that the two midblock locations on the Princes Highway would operate at LoS E during both the 100th highest hour northbound and southbound scenarios. This analysis assumes the presence of at least one construction zone on the Princes Highway both north and south of Berry. Average travel speeds on the Princes Highway would be expected to drop to around 50 kilometres per hour or less; key factors contributing to this deterioration include the expected increase in traffic, and speed restrictions and the prevention of overtaking through construction zones in the project area. The analysis indicates that despite a poor LoS and low travel speeds during peak hours, the Princes Highway does have the capacity to accommodate worst-case traffic volumes during construction.

Table 7.3: 2017 midblock level of service summary (worst-case construction scenario)

Location	100NB (veh/hr)		100SB (veh/hr)	
	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	1666	E	1793	E
Princes Highway: Victoria Street – South of Schofields Lane	1674	E	1967	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	792	C	924	D

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The results show the roadway LoS on the 'Sandtrack' would remain relatively unchanged despite a reduction in traffic (with traffic expected to transfer to the Princes Highway), operating at LoS C during the 100th highest hour northbound period, and deteriorating to LoS D during the busier 100th highest hour southbound period.

7.1.5 Intersection level of service

Construction of the project does not include any major works within the centre of Berry. The most significant modification to the town's local road network would occur at the new Kangaroo Valley Road interchange, which would require a temporary road closure with an alternative route available via North Street. The online construction of a new roundabout at the intersection of the Princes Highway and Woodhill Mountain Road would also create minor traffic delays at this location. The majority of works in the vicinity of Berry would be constructed offline and although it is likely there would be some adverse effects during the tie-in of offline to online sections, these occurrences would only last for short periods of time.

Intersection LoS for both the most-likely and worst-case construction scenarios has been estimated using the assumption that the road network throughout Berry has not been upgraded, and that all traffic travelling on the Princes Highway travels through the town (the Berry bypass and grade-separated interchanges are not operational). Traffic volumes used for this analysis have been developed based on the assumptions listed in Section 7.1.4.

The posted speed limit on Queen Street (Princes Highway) through Berry is currently 50 kilometres per hour; it is assumed this would remain unchanged during construction. The major factors influencing the performance of the road network and intersections in Berry include traffic management during road closures and natural traffic growth.

Most-likely construction scenario

Table 7.4 provides a summary of the expected intersection LoS in Berry during the most-likely construction period, described in Section 7.1.4.

The results of the modelling included in **Table 7.4** indicates that the local road network would be expected to accommodate forecast traffic, including light and heavy construction vehicles, with minimal delay. Only the intersection approaches from Alexandra Street and Prince Alfred Street would be expected to drop to LoS B during typical 2017 AM and PM peak hours, with a maximum average delay of around 24 seconds.

Table 7.4: 2017 intersection level of service summary (most-likely construction scenario)

Intersection / approach road	AM peak hour			PM peak hour		
	Approach volume (veh/hr)	Average delay (s)	LoS	Approach volume (veh/hr)	Average delay (s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	609	0.0	A	695	0.0	A
Victoria Street westbound	33	0.4	A	37	0.3	A
Princes Highway southbound	565	0.0	A	597	0.0	A
Total	1207	0.0	A	1329	0.0	A
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	569	0.0	A	685	0.0	A
Kangaroo Valley Road	282	4.4	A	191	5.7	A
Queen Street westbound	614	0.0	A	796	0.7	A
Total	1465	0.8	A	1672	1.0	A
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	714	0.2	A	750	0.0	A
Alexandra Street southbound	48	19.1	B	98	23.6	B
Queen Street westbound	620	0.2	A	684	0.1	A
Alexandra Street northbound	33	10.6	A	52	13.9	A
Total	1415	1.1	A	1584	2.0	A
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	612	0.2	A	682	0.2	A
Queen Street westbound	650	2.4	A	622	2.1	A
Prince Alfred Street northbound	137	13.4	A	210	17.6	B
Total	1399	2.5	A	1514	3.4	A
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	609	4.2	A	660	4.2	A
Albert Street	18	2.4	A	18	1.9	A
Queen Street westbound	667	2.7	A	637	2.3	A
Total	1294	3.4	A	1315	3.2	A
Princes Highway / Tannery Road						
Princes Highway northbound	601	2.8	A	683	2.1	A
Princes Highway southbound	503	1.2	A	530	1.2	A
Tannery Road	130	1.4	A	112	0.7	A
Total	1234	2.0	A	1325	1.6	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

Worst-case construction scenario

Table 7.5 shows the performance of key intersections in Berry for the 2017 worst-case construction scenario, described in Section 7.1.4.

Table 7.5 2017 intersection level of service summary (worst-case construction scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/hr)	Average delay (s)	LoS	Approach volume (veh/hr)	Average delay (s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	1182	0.0	A	743	0.0	A
Victoria Street westbound	73	0.0	A	159	3.7	A
Princes Highway southbound	371	0.0	A	996	0.0	A
Total	1626	0.0	A	1898	0.3	A
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	1037	0.0	A	650	0.0	A
Kangaroo Valley Road	286	32.7	C	281	8.2	A
Queen Street westbound	483	2.9	A	1084	0.3	A
Total	1806	6.0	A	2015	1.3	A
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	1178	0.0	A	796	0.3	A
Alexandra Street southbound	76	40.2	C	142	90.3	F
Queen Street westbound	445	0.0	A	1040	0.3	A
Alexandra Street northbound	119	21.7	B	93	41.5	C
Total	1818	3.1	A	2071	8.3	A
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	1163	0.3	A	772	3.6	A
Queen Street westbound	447	2.2	A	1054	3.0	A
Prince Alfred Street northbound	198	23.2	B	214	65.2	E
Total	1808	3.3	A	2040	9.8	A
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	1173	4.1	A	764	4.3	A
Albert Street	57	8.4	A	56	2.5	A
Queen Street westbound	495	4.0	A	1124	3.5	A
Total	1725	4.2	A	1944	3.8	A
Princes Highway / Tannery Road						
Princes Highway northbound	1221	1.8	A	798	3.2	A
Princes Highway southbound	401	0.9	A	1034	1.3	A
Tannery Road	74	2.0	A	101	3.5	A
Total	1696	1.6	A	1933	2.2	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The results in **Table 7.5** show that the road network in Berry would continue to operate at acceptable performance levels during peak periods; as the majority of intersection approach roads would continue to operate at LoS A. However, the increase in traffic demand on the Princes Highway (Queen Street) would result in additional delays for some of the minor intersection approach roads, notably at Kangaroo Valley Road, Alexandra Street and Prince Alfred Street.

With the majority of traffic demand on the Queen Street approach roads (priority through movements), vehicles using the minor approach roads would find gaps in traffic less frequent and subsequently incur additional delays. The 100th highest hour southbound period modelling scenario indicates that vehicles travelling southbound on Alexandra Street would experience an average delay of about 90 seconds, resulting in LoS F. In addition, vehicles travelling on the Prince Alfred Street northbound approach would experience an average delay of 65 seconds. All other intersection approach roads in Berry would operate at LoS C or better.

In summary, it can be concluded that due largely to the offline construction of the Berry bypass, the local road network and intersections in Berry would still perform adequately during both the most-likely and worst-case construction scenarios; without the provision of additional temporary traffic management measures.

7.2 Operational impacts

7.2.1 Roadway level of service

The midblock LoS of the Princes Highway and the 'Sandtrack' at key locations on the regional road network have been assessed for the 2037 design year, 20 years after the 2017 year of opening. Both the 'Do minimum' and 'Do something' scenarios, described in Section 4.2.4, include the construction of the project and the operational performance of the highway for both scenarios is summarised in **Table 7.6** and **Table 7.7** respectively.

Table 7.6: 2037 midblock level of service summary ('Do minimum' scenario)

Location	Dir	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
		Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway: Toolijooa Road – Berry east interchange	NB	1050	A	1420	B	2295	C	1298	B
	SB	1114	B	1228	B	795	A	2036	C
Princes Highway: Berry bypass	NB	990	A	1233	B	1894	C	1031	B
	SB	989	A	1086	A	575	A	1691	C
Princes Highway: Kangaroo Valley Road interchange – South of Schofields Lane	NB	1123	B	1399	B	2179	C	1299	B
	SB	1110	B	1260	B	742	A	2103	C
'Sandtrack': Dooley Road – Shoalhaven Heads Road	Two-way	532	C	627	C	660	C	774	C

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The results indicate that the upgraded highway would operate at LoS A or LoS B throughout the project area during typical AM peak or PM peak periods, for both the ‘Do minimum’ and ‘Do something’ scenarios. During the 100th highest hour northbound (NB) and southbound (SB) periods, the highway would be expected to operate at LoS C or better based on forecast traffic volumes. In addition, the alternative ‘Sandtrack’ route is expected to operate at LoS C during all peak periods, as traffic is anticipated to reduce from current levels due to the significant proportion of vehicles expected to transfer to the Princes Highway following its upgrade. The reduction in traffic on the ‘Sandtrack’ would improve its safety and efficiency, which would enhance the characteristic of this scenic coastal route.

Table 7.7: 2037 midblock level of service summary (‘Do something’ scenario)

Location	Dir	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
		Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway: Toolijooa Road – Berry east interchange	NB	1096	B	1481	B	2419	C	1366	B
	SB	1162	B	1280	B	838	A	2146	C
Princes Highway: Berry bypass	NB	1043	A	1299	B	2007	C	1092	B
	SB	1041	B	1142	B	611	A	1791	C
Princes Highway: Kangaroo Valley Road interchange – South of Schofields Lane	NB	1211	B	1509	B	2297	C	1369	B
	SB	1198	B	1359	B	782	A	2215	C
‘Sandtrack’: Dooley Road – Shoalhaven Heads Road	Two-way	353	C	416	C	428	C	501	C

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The project would provide two lanes in each direction, which when coupled with the improved alignment would increase the safe operating speed of the Princes Highway in the project area. These features contribute to the modelled improvement in performance from the current LoS. In addition, the provision of a central median and safety barrier enables the directional flows on the highway to operate independently; a heavy flow of traffic resulting in a decrease in the LoS in one direction does not reduce the LoS in the other. This is particularly relevant during 100th highest hour northbound (NB) and southbound (SB) periods, when highway traffic volume splits increase by up to 80:20 in favour of the peak direction. The following example illustrates this: during the 100th highest hour NB peak period for the ‘Do something’ scenario, the northbound carriageway north of Berry is expected to operate at LoS C, carrying over 2400 vehicles per hour as recreational travellers travel towards Wollongong and Sydney; however the southbound carriageway at this time is forecast to carry only around 840 vehicles and operate at LoS A.

The results indicate that the Princes Highway in the project area would perform at an acceptable LoS during peak hours for the 2037 design year in both scenarios. In addition, further sensitivity testing for post 2037 scenarios has been conducted, and the results show that the highway would have sufficient capacity to accommodate a significant amount of additional traffic demand before deteriorating to an unacceptable LoS.

In summary, the predicted midblock LoS for all highway locations and scenarios falls within the Concept Design Criteria set out for the project, which states that the project must perform at LoS C (represents optimum free flow conditions) or better for the 100th highest hour (holiday peak hour) in its design year of 2037.

Although roadway LoS is expected to improve within the project area, the increase in traffic on the Princes Highway following construction of the project could put pressure on unimproved sections of the highway to the south. For example, the Princes Highway between Schofields Lane and Cambewarra Road would still be awaiting upgrade and likely to experience additional traffic growth as a result of motorists switching from the ‘Sandtrack’ to the Princes Highway.

7.2.2 Intersection level of service

As discussed in Section 4.3. Paramics microsimulation models have been developed to assess the performance of the local road network and intersections in and around Berry following the construction of the project. Models have been constructed for the design year of 2037 for both the ‘Do minimum’ and ‘Do something’ scenarios using traffic demand matrices for both the 100th highest hour northbound (100NB) and southbound (100SB) holiday peak periods.

The project proposes grade separated interchanges at the northern and southern ends of Berry as shown in **Figure 6.2**. At the northern end, an interchange would be provided for vehicles to join the highway in the northbound direction and exit the highway in the southbound direction. These ramps would connect to the existing Princes Highway. Intersections with the existing Princes Highway in the east and centre of the town would remain unchanged in their layout and operation, with the exception of the Queen Street and Woodhill Mountain Road intersection which would be reconfigured as a roundabout.

At the southern end of town, a full grade separated interchange would be provided at Kangaroo Valley Road, providing on-ramps and off-ramps to and from the highway both northbound and southbound. The construction of this interchange would include two new roundabouts on Kangaroo Valley Road to the southeast and northwest of the bypass, at the approximate locations of the existing priority intersections of Kangaroo Valley Road and Huntingdale Park Road, and Queen Street (Princes Highway) and Kangaroo Valley Road respectively. In addition, a new road connection and roundabout would be constructed to the northeast of Kangaroo Valley Road, linking the northbound off ramps and on-ramps and Rawlings Lane to Kangaroo Valley Road.

Key intersections in Berry following the construction of the project and therefore included in the Paramics models and subsequent analysis are shown in **Figure 7.1**.

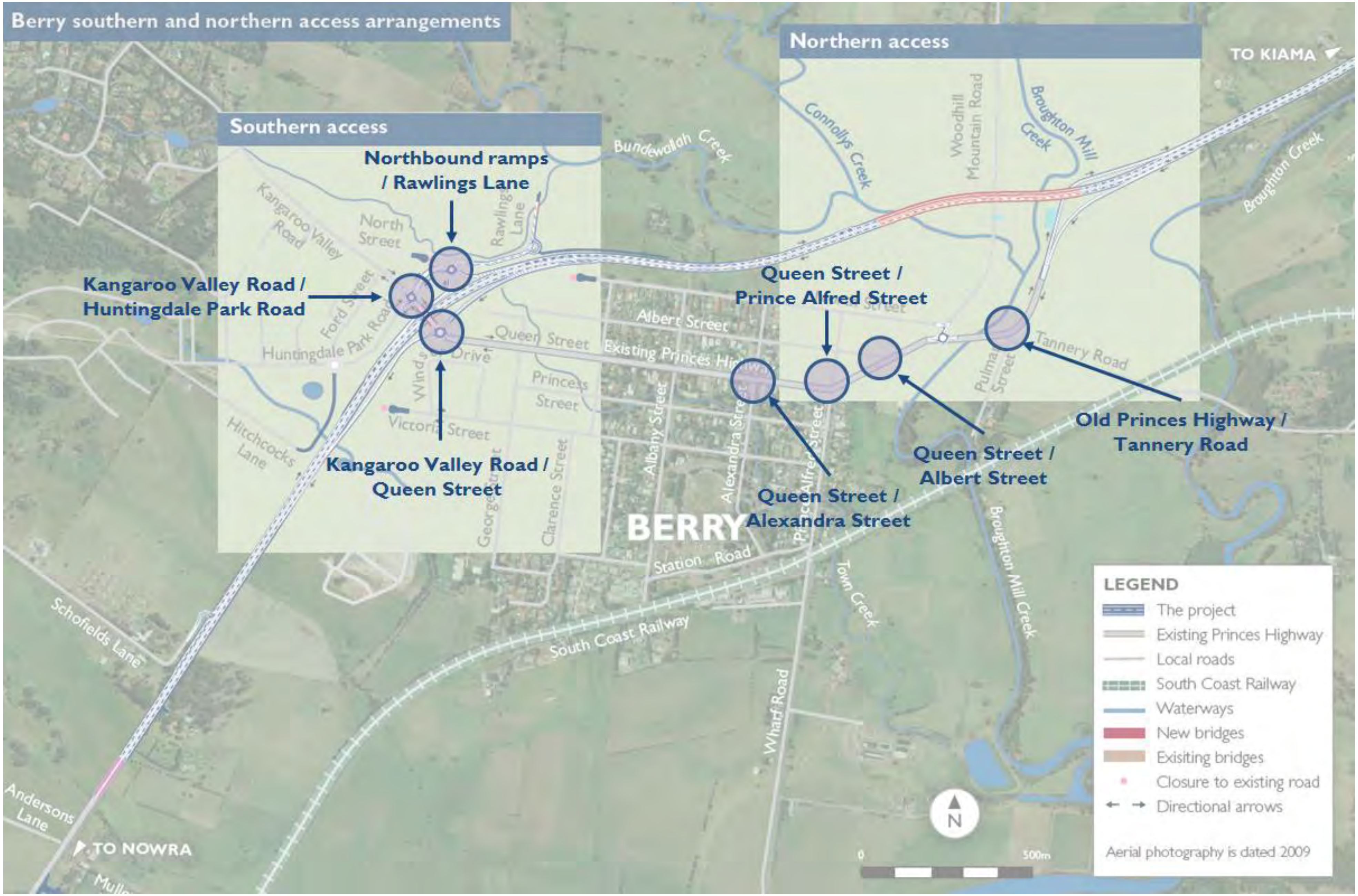


Figure 7.1: Key intersection locations in project area (post-construction) (Source: AECOM)

Table 7.8 and **Table 7.9** provide details of the operational performance of key intersections in Berry (for the southern and central/eastern intersections respectively) for the 2037 design year ‘Do something’ scenario. Paramics models have been developed using both 100th highest hour NB and SB holiday peak period forecast travel demand; at these times the local and regional road network would be subjected to the highest traffic volumes.

As discussed in previous chapters, the LoS calculated by the Paramics modelling is based on the capacity and efficiency of the local road network and intersections within and around Berry. In comparison, the midblock LoS presented in Section 7.2.1 represents the operational performance of rural highway locations in the project area, based on the travel speeds and the time spent following other vehicles. For this reason, the methods produce contrasting LoS results which vary along the length of the Princes Highway within the project area. The performance of particular sections or locations should be examined and interpreted in isolation, specific to the assessment criteria.

For both 100th highest hour scenarios, Paramics modelling of the proposed intersection arrangements at Kangaroo Valley Road at the southern end of Berry, indicates that all approach roads to the three intersections are expected to operate at LoS A, with minimal delays incurred as shown in **Table 7.8**.

Table 7.8: 2037 southern intersections level of service summary (‘Do something’ scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay (s)	LoS	Approach volume (veh/h)	Average delay(s)	LoS
Kangaroo Valley Road / Huntingdale Park Road						
Huntingdale Park Rd	252	0.5	A	244	0.5	A
Kangaroo Valley Rd southbound	141	0.9	A	164	0.9	A
New road connection westbound	603	0.9	A	547	1.1	A
Kangaroo Valley Road northbound	379	0.7	A	259	0.7	A
Total	1375	0.8	A	1214	0.9	A
Northbound highway ramps / Rawlings Lane						
Rawlings Lane	33	0.2	A	18	0.4	A
Northbound off-ramp	585	1.3	A	541	1.8	A
New road connection eastbound	172	0.3	A	141	0.3	A
Total	790	1.0	A	700	1.5	A
Kangaroo Valley Road / Queen Street						
Kangaroo Valley Road	790	0.9	A	664	0.7	A
Southbound off-ramp	166	6.1	A	135	2.4	A
Queen Street	501	0.9	A	701	1.0	A
Total	1457	1.5	A	1500	1.0	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The Kangaroo Valley Road and Queen Street intersection would be subjected to the highest volumes of traffic levels during the 100SB peak period, with an hourly throughput of around 1500 vehicles per hour. During the 100NB peak period, maximum hourly throughput would be expected to reach around 1450 vehicles per hour. Traffic modelling indicates that the intersection would operate well within its limits and traffic would experience little congestion or delay.

The proposed access arrangements would create a new roundabout to the northeast of Kangaroo Valley Road, linking the northbound off-ramps and on-ramps and Rawlings Lane to Kangaroo Valley Road via a new road connection, as shown in **Figure 7.1**. It is estimated that during the 100th highest hour southbound (100SB) peak period, traffic exiting the highway via this off-ramp would reach 585 vehicles per hour. Traffic modelling indicates that the roundabout provided at this intersection would operate efficiently, with very little delay to traffic on all approaches during both modelled peak periods.

The proposed roundabout between Kangaroo Valley Road and Huntingdale Park Road would replace the existing priority t-intersection, including a new road connection to the northbound highway off-ramps and on-ramps and Rawlings Lane. Traffic modelling indicates that during peak holiday periods hourly throughput is expected to reach around 1375 vehicles; incorporating this volume of traffic, this arrangement would operate effectively with minimal delay.

Table 7.9: 2037 central/eastern intersections level of service summary ('Do something' scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay (s)	LoS	Approach volume (veh/h)	Average delay(s)	LoS
Queen Street / Alexandra Street						
Queen Street eastbound	799	0.2	A	543	0.1	A
Alexandra Street southbound	124	8.9	A	216	15.9	B
Queen Street westbound	231	0.0	A	330	0.0	A
Alexandra Street northbound	248	7.3	A	220	11.7	A
Total	1402	2.2	A	1309	4.6	A
Queen Street / Prince Alfred Street						
Queen Street eastbound	448	0.0	A	403	0.0	A
Queen Street westbound	322	0.0	A	411	0.0	A
Prince Alfred Street northbound	356	4.5	A	344	3.8	A
Total	1126	1.4	A	1158	1.1	A
Queen Street / Albert Street						
Queen Street eastbound	492	0.0	A	429	0.0	A
Albert Street	123	2.4	A	103	0.2	A
Queen Street westbound	377	0.0	A	526	0.1	A
Total	992	0.3	A	1058	0.1	A
Old Princes Highway / Tannery Road						
Old Princes Highway northbound	580	0.0	A	487	0.2	A
Old Princes Highway southbound	245	0.4	A	402	0.6	A
Tannery Road	99	1.0	A	125	1.0	A
Total	924	0.2	A	1014	0.5	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

Table 7.9 shows the performance of intersections located in the centre and to the east of Berry. Modelling results indicate that delays would be expected to decrease from existing levels at these locations. The project would result in a change in traffic distribution and patterns at key intersections in the future. While major through movements would be reduced, demand generated by the town and its local surroundings is expected to continue to grow. This would result in a significant increase in the proportion of demand generated by the minor approach roads at these intersections.

Peak period traffic demand at Prince Alfred Street is forecast to grow from currently around 150 vehicles per hour to around 360 vehicles per hour by 2037; with traffic at Alexandra Street northbound expected to increase from about 100 vehicles per hour to over 250 vehicles. Conversely, traffic on the major Queen Street (Princes Highway) intersection approaches is expected to reduce following the provision of the Berry bypass, removing through traffic from the town centre. In 2011, eastbound traffic on Queen Street at the intersection with Alexandra Street peaked at over 900 vehicles per hour; westbound traffic peaked at over 860 vehicles per hour. However, 2037 future year traffic modelling indicates that on completion of the upgrade, eastbound traffic would reduce during peak periods to around 550 vehicles per hour, and westbound traffic to around 330 vehicles per hour. The modelled westbound flow is considerably lower than the eastbound flow. This is partially due to the provision of a second southbound off-ramp at Kangaroo Valley Road; this allows traffic travelling southbound on the Princes Highway to access areas in the west of Berry and Kangaroo Valley Road without travelling through the town centre.

Despite the growth in locally generated traffic increasing demand from minor approaches, the reduction in traffic on Queen Street would see an overall improvement in LoS and reduced average delay. During the busiest peak periods all intersection approach roads would operate at LoS A and experience minimal congestion or delay (with the exception of Alexandra Street southbound, which would operate at LoS B, with an average delay of around 16 seconds), as the bypass of Berry would remove large volumes of through-traffic from the centre of town.

Further analysis of the Princes Highway/Kangaroo Valley Road NB off-ramp

The Paramics modelling for the 2037 ‘Do something’ 100th highest hour holiday peak period scenarios showed that proposed access arrangements including a single northbound off-ramp would accommodate projected traffic demand to Berry from the south with minimal delay and LoS A. In addition, further sensitivity analysis was completed to determine the volume of traffic that would be required to reduce the performance of this arrangement to an unacceptable LoS and the year that traffic is expected to reach this level.

Table 7.10: Northbound off-ramp intersection performance - sensitivity analysis

Intersection / approach road	2037 100NB		2037 100NB x 2		2037 100NB x 3		2037 100NB x 4	
	Approach volume (veh/h)	LoS	Approach volume (veh/h)	LoS	Approach volume (veh/h)	LoS	Approach volume (veh/h)	LoS
Kangaroo Valley Road / Huntingdale Park Road: New road connection westbound	603	A	951	A	1135	C	1172	F

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The total demand matrix used in the 2037 'Do something' 100th highest hour NB Paramics model was factored by multiples of two, three and four, and the resulting matrices were assigned to the modelled network to assess the performance of the northbound off-ramp arrangement at Berry when subjected to large increases in future year traffic volumes. **Table 7.10** provides details of the traffic volumes and corresponding LoS for the intersection sensitivity modelling.

Modelling indicates the new road connection approach to the Kangaroo Valley Road and Huntingdale Park Road intersection, which links the northbound off-ramp to Kangaroo Valley Road[2], would still operate at LoS A when northbound off-ramp traffic is increased to double the expected volume during the busiest peak periods in 2037. Intersection performance would deteriorate to LoS C when subjected to three times the volume of off-ramp traffic expected in 2037. More critically at this point however, qualitative analysis of this scenario indicated that the capacity of the approach roads (ie the capacity of the single lane new road connection and off-ramp) to this intersection would be exceeded by an increase in demand of this magnitude. This would lead to a significant deterioration in overall network performance. Extrapolation of future year forecast traffic volumes for the off-ramp shows that this level of traffic demand would not be expected to be reached until around 2070, or around 35 years after the project design year.

Assuming the capacity constraints of the approach roads were mitigated, the modelling indicates that intersection performance would fall to an unacceptable LoS F with four times the peak period demand forecast in 2037.

Performance analysis of the other intersections at the Kangaroo Valley Road interchange and local roads within Berry has shown that the access arrangements proposed as part of the project are suitable for the forecast traffic flows. Despite this, concept design work has included an investigation of suitable locations where an additional northbound off-ramp could be located to access Berry from the south. This analysis identified the only feasible connection for a second northbound off-ramp would be at Woodhill Mountain Road, although unfavourable geographical and geological conditions would result in significant impacts to the current environment both during construction and operation.

In summary, Paramics modelling shows that the proposed northbound off-ramp arrangement at the southern interchange would have sufficient operating capacity to adequately accommodate traffic volumes much higher than those predicted at the time of the design year in 2037. Further to this, it is anticipated that other environmental impacts (for example noise and air quality impacts created by traffic) would be within relevant thresholds based on the proposed design, without the provision of a second northbound off-ramp.

Due to this, the social and environmental impacts that would be created by the construction of a second northbound off-ramp would not be justifiable when considering the project objectives; this is especially true when considering the proposed site for an additional off-ramp to Woodhill Mountain Road. Hence, a second northbound off-ramp in Berry is not required to accommodate projected traffic volumes or mitigate other environmental impacts and is not being provided as part of this project.

Despite this, the concept design does not preclude the future addition of a second northbound off-ramp for Berry at Woodhill Mountain Road should it become warranted in the future. The construction of this facility would be subject to a separate environmental assessment.

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[2] The performance of the Kangaroo Valley Road / Huntingdale Park Road intersection was assessed as it is at this location that conflicting traffic demand generated by the northbound off-ramp, Kangaroo Valley and Huntingdale Park would be greatest, and intersection performance poorest.

7.2.3 Travel speeds and travel times

The 2006 Gerringong to Bomaderry sub-area TRACKS traffic model, produced by Gabites Porter Consultants, has been developed with inputs including surveyed traffic volumes and travel times, plus land use and demographic data. Using these inputs, the model has been calibrated to ensure an accurate representation of current highway conditions in the project area. The results of current travel time modelling and analysis are discussed in Section 3.2.

Following the development of this model to represent current traffic conditions, a future year (2026) model has been developed by Gabites Porter Consultants to estimate the effects the project would have on future travel times and speeds. The results of this modelling are included in **Table 7.11**, with the routes and timing points used shown in **Figure 7.2**.

Table 7.11: 2006 pre-upgrade and 2026 post-upgrade TRACKS modelled travel times

Route	Direction	Pre-upgrade (2006)			Post-upgrade (2026)		
		Distance (km)	Average speed (km/h)	Average travel time (mins)	Distance (km)	Average speed (km/h)	Average travel time (mins)
North of project area Princes Highway: North of Rose Valley Road to Toolijooa Road The 'Sandtrack': Princes Highway north of Rose Valley Road to 'Sandtrack' at Dooley Road (via Fern St)							
Princes Highway	Northbound	7.0	75.3	5.5	6.8	97.5	4.2
	Southbound		80.2	5.2		97.5	4.2
The 'Sandtrack'	Northbound	8.7	50.0	10.5	8.7	49.9	10.5
	Southbound		50.5	10.4		51.1	10.3
Project area Princes Highway: Toolijooa Road to Schofields Lane The 'Sandtrack': Dooley Road to Shoalhaven Heads Road							
Princes Highway	Northbound	12.6	52.6	14.4	11.2	98.5	6.8
	Southbound		51.2	14.8		98.5	6.8
'Sandtrack'	Northbound	9.9	78.4	7.5	9.9	78.9	7.5
	Southbound		77.9	7.6		79.0	7.5
South of project area Princes Highway: Schofields Lane to Bolong Road The 'Sandtrack': Shoalhaven Heads Road to the Princes Highway, Bomaderry							
Princes Highway	Northbound	13.6	63.2	12.9	13.6	69.0	11.8
	Southbound		64.8	12.6		68.8	11.9
The 'Sandtrack'	Northbound	13.8	72.4	11.5	13.8	72.3	11.5
	Southbound		70.0	11.8		72.5	11.4
Traffic impact footprint Princes Highway: North of Rose Valley Road to Bolong Road The 'Sandtrack': Princes Highway north of Rose Valley Road to the Princes Highway, Bomaderry (via Fern Street)							
Princes Highway	Northbound	33.2	60.6	32.8	31.6	83.0	22.8
	Southbound		61.1	32.6		82.9	22.9
The 'Sandtrack'	Northbound	32.4	66.0	29.5	32.4	66.0	29.5
	Southbound		65.2	29.8		66.6	29.2

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

The project shortens the length of the Princes Highway through the major realignment of the existing carriageway. Bypassing the 'Foxground bends' in the east of the project area, the upgraded highway would provide a shortened route and also benefit from significantly improved horizontal and vertical alignment, resulting in increased safe travel speeds in the area. In the project area the existing Princes Highway is longer, and has an average travel time close to double that of the equivalent 'Sandtrack' route to the south.

The project would create a shorter travel time on the Princes Highway than the 'Sandtrack' in the project area in the future, with estimated travel time savings of over seven minutes on the Princes Highway between Toolijooa Road and Schofields Lane. It is estimated that average travel times along the 'Sandtrack' would remain roughly constant at around 7.5 minutes.

Without the project, the 'Sandtrack' has a substantially shorter average travel time in the project area than the Princes Highway (although travel times between within the traffic impact footprint between Gerringong and Bomaderry are similar overall). The significant travel time savings that would be created by the project are anticipated to result in a large amount of traffic transferring from the 'Sandtrack' in favour of the upgraded highway following construction. Similar upgrades to the north and south of the project area are likely to improve travel times further on the Princes Highway within the traffic impact footprint, adding to the proportion of overall traffic using the highway rather than the alternative 'Sandtrack' route.

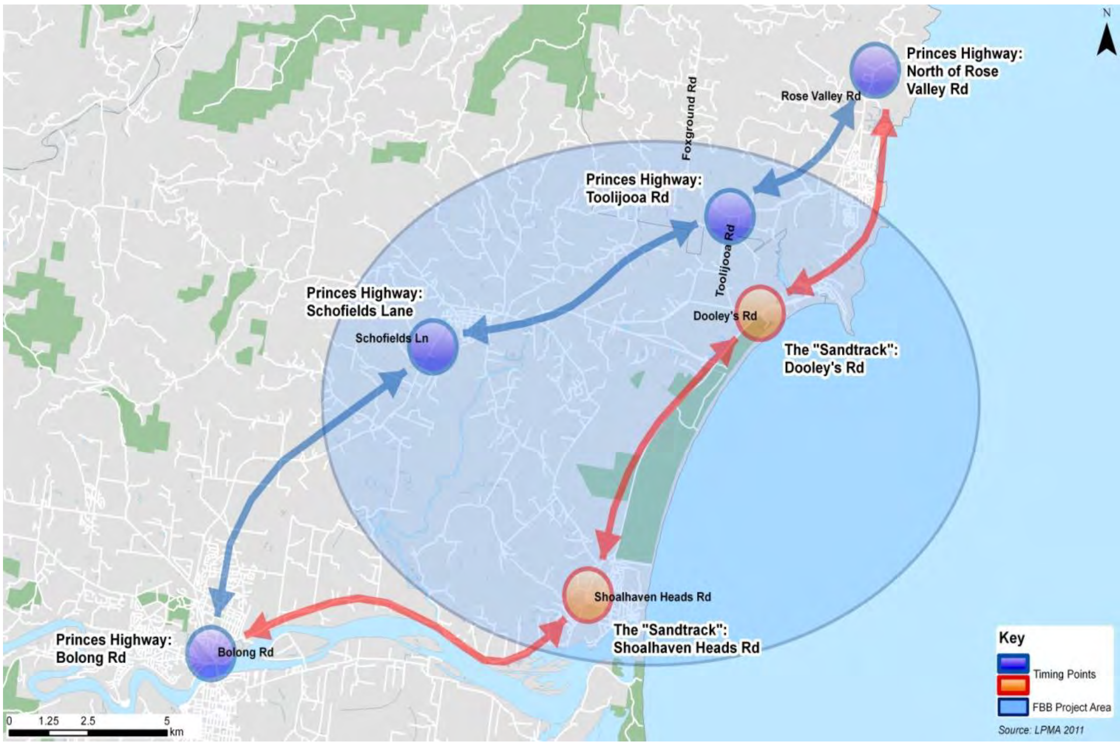

Figure 7.2: **Travel time analysis routes and timing points**

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

7.2.4 Climbing lane assessment

Significant and/or sustained uphill gradients can reduce heavy vehicle travel speeds to a point where the efficiency of the four lane divided carriageway would be considerably reduced, impacting the ability of the proposed upgrade to meet the project objectives. Consequently, the need for climbing lanes has been assessed due to the variations in vertical alignment (as a result of the natural geography) of the project in the project area.

For divided, multi-lane highways climbing lanes are warranted if the following criteria are both met (*Austroads Guide to Road Design Part 3 – Geometric Design; Chapter 9 – Auxiliary Lanes*):

- Heavy vehicle speed drops below 40 kilometres per hour.
- Traffic volumes equal or exceed those in **Table 7.12**.

In addition, climbing lanes should also be considered in the following cases:

- Long grades over eight per cent occur.
- Accidents attributable to the effects of slow moving trucks are significant.
- The highway operates at LoS E or worse, (or the LoS falls two levels from the LoS on approach to the incline).

Heavy vehicle speed calculations are available both in the RMS *Road Design Guide (Section 9)* as well as various Austroads publications. The following sources have been used for calculations in this analysis:

- Heavy Vehicle Speed Calculations: *Austroads Guide to Road Design Part 3 - Geometric Design (Chapter 9 – Auxiliary Lanes, Table 9.5 and Figure 9.4*).
- LoS Calculations: *Austroads Guide to Traffic Management Part 3 – Traffic Studies and Analysis (Chapter 4)*.

Table 7.12: Volume guidelines for partial climbing lanes

Overtaking opportunities over the preceding 5 km[3]		Current year design volume (AADT)		
		Percentage of slow vehicles[4]		
Description	Per cent length providing overtaking	5 %	10 %	20 %
Excellent	70 – 100	4500	4000	3500
Good	30 – 70	3500	3000	2600
Moderate	10 – 30	2500	2200	2000
Occasional	5 – 10	1800	1600	1400
Restricted	0 – 5	1200	1000	900
Very restricted[5]	0	700	600	500

(Source: Austroads Guide to Road Design Part 3 - Geometric Design, 2010)

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[3] Depending on road length being considered, this distance can range from 3 to 10 kilometres.
[4] Including light trucks and cars towing trailers, caravans and boats.
[5] No overtaking for 3 kilometres in either direction.

A total of six locations in the project area have been identified with the potential to warrant a climbing lane based on the grade, and the length of grade associated with the proposed highway upgrade. These locations are listed below (drawings of these sections are provided in Appendix E):

- A: CH6920-8800 (beginning 800 metres east of Toolijooa Road), southbound.
- B: CH11040-8800 (beginning 1 kilometre east of Austral Park Road), northbound.
- C: CH11040-11700 (beginning 1 kilometre east of Austral Park Road), southbound.
- D: CH12780-11700 (beginning 500 metres west of Austral Park Road), northbound.
- E: CH13540-14160 (beginning 400 metres east of Tindalls Lane), southbound.
- F: CH16400-14160 (beginning 400 metres west of Woodhill Mountain Road), northbound.

The locations include significant inclines for sustained periods, which could result in heavy vehicle speeds dropping below the 40 kilometres per hour threshold and/or significant decreases in LoS. The current project concept design includes climbing lanes in the vicinity of Toolijooa Ridge in the southbound direction at location A and in the northbound direction at location B.

Table 7.13 indicates the lengths on constant individual grades that are required to reduce heavy vehicle speeds to 40 kilometres per hour. The table shows the relationship between the approach design speed, grade and length of the incline. For example, **Table 7.13** shows that a climbing lane would likely be required on a road link with an approach speed of 100 kilometres per hour and a constant seven per cent grade over a distance greater than 800 metres as this would cause truck speeds to drop below 40 kilometres per hour.

Table 7.13: Grade/distance relationship (lengths to reduce truck vehicle speed to 40 km/h)

Approach speed (km/h)	Uphill gradient (%) / length (m)						
	4 %	5 %	6 %	7 %	8 %	9 %	10 %
100	-	-	1050	800	650	550	450
80	630	460	360	300	270	230	200
60	320	210	160	120	110	90	80

(Source: Austroads Guide to Road Design Part 3 - Geometric Design, 2010)

For each location, the total length and elevation has been extracted from the concept design; these values in turn can be used to calculate the average grade. However, because relatively small differences in highway grade have a significant effect on truck speed (as shown in **Figure 7.3**), it is necessary to divide each location into smaller subsections for the assessment. This allows for analysis that takes into account the grades of individual subsections at each location, with the speed at the end of one subsection carried through as the speed at the start of the next, based on the speed curves shown in **Figure 7.3**.

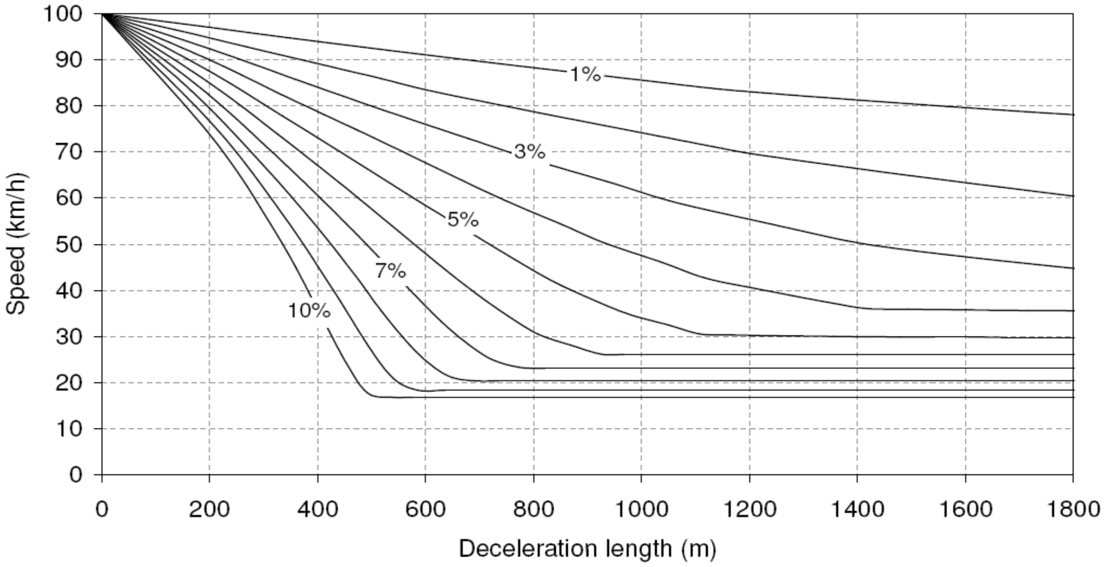


Figure 7.3: **Determination of truck speeds on grade, B-double (62.4t) carrying a maximum load**

(Source: Austroads Guide to Road Design Part 3 - Geometric Design, 2010)

The climbing lane assessment, which is summarised in **Table 7.14** (full analysis is included in **Appendix E**), indicates that truck speeds would drop below 40 kilometres per hour at location A southbound, and location B northbound as heavy vehicles traverse Toolijooa Ridge. In this area traffic volumes on the Princes Highway are forecast to exceed 30,000 vehicles per day by the design year of 2037; this is in excess of the volume guidelines shown in **Table 7.12**, and confirms that locations A and B both satisfy the criteria that warrant climbing lanes.

For the remaining four locations, truck speeds are expected to drop to no lower than approximately 70 kilometres per hour, indicating there is no requirement for climbing lanes to maintain an adequate LoS.

Table 7.14: **Truck speed analysis summary**

Location	Direction	Posted speed (km/h)	Length (m)	Elevation (m)	Maximum grade (%)	Minimum truck speed (km/h)
A	Southbound	100	1880	72	6.0 %	**26.0**
B	Northbound	100	2240	54	4.9 %	**36.0**
C	Southbound	100	660	17	4.8 %	75.0
D	Northbound	100	1080	23	2.5 %	70.0
E	Southbound	100	620	16	4.0 %	75.0
F	Northbound	100	2240	26	2.9 %	68.0

(Source: AECOM, based on AUSTROADS Guide to Road Design Part 3 – Geometric Design, 2010)

7.2.5 Highway access constraints

The introduction of a central median and safety barrier would provide significant improvements in road safety, including the separation of opposing traffic flows, and elimination of right turn movements between the Princes Highway and minor roads and property accesses across fast-moving two-way traffic (at locations where right turns can currently be made prior to the introduction of a central median and safety barrier). The crash data analysis shown in Section 7.2.7 shows that around 20 per cent of crashes in the project area occurred either at intersections or between vehicles travelling in opposite directions. Minor roads which join the Princes Highway currently have the ability to turn either left or right to or from the highway. Once a central median and safety barriers are installed local roads and accesses in rural areas would be provided with left in and left out only turning facilities. Low daily volumes of traffic, which would previously have turned right from, or into a minor road, would be required to travel to the nearest u-turn facility to make a safe right hand turn to proceed in the desired direction. Although this would inconvenience a small proportion of local traffic as it would require additional travel when compared to existing arrangements.

Current access arrangements would be restricted for the following key sections of the Princes Highway in the project area:

- Schofields Lane to Berry (south) interchange.
- Berry (north) interchange to Tindalls Lane.
- Tindalls Lane to Austral Park Road.

Figure 7.4 shows the access constraints between Schofields Lane and the southern half of the interchange at Kangaroo Valley Road following the construction of the project. Due to left-in-left-out only arrangements for access points along this length including Schofields Lane, traffic desiring to turn right across opposing traffic flows into or out of these accesses, would have to travel to either the highway interchange at Kangaroo Valley Road, or Mullers Lane to turn around before proceeding in the desired direction.

From	Properties in and north of Schofields Lane to the southern interchange for Berry accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at the southern interchange for Berry.
Maximum additional travel (typical conditions)	2.8 km (2.3 minutes).

From	Properties south of Victoria Street accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Mullers Lane.
Maximum additional travel (typical conditions)	2.8 km (2.4 minutes).

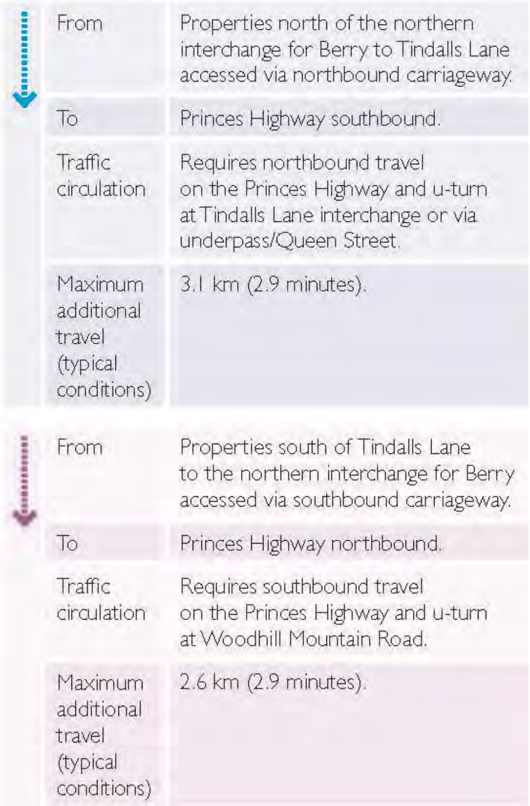
Figure 7.4: Access constraints - Schofields Lane to southern interchange for Berry

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Similarly:

- **Figure 7.5** shows the access constraints between the Berry (north) interchange and Tindalls Lane interchange following construction of the project; and
- **Figure 7.6** shows the access constraints between the Tindalls Lane and the Austral Park Road interchanges following construction of the project.

Again due to access restrictions at these locations on the upgraded Princes Highway, traffic desiring to turn right across opposing traffic flows into or out of these accesses, would have to travel in the opposite direction to the adjacent interchange to turn around before proceeding in the desired direction.



From	Properties north of the northern interchange for Berry to Tindalls Lane accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at Tindalls Lane interchange or via underpass/Queen Street.
Maximum additional travel (typical conditions)	3.1 km (2.9 minutes).

From	Properties south of Tindalls Lane to the northern interchange for Berry accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Woodhill Mountain Road.
Maximum additional travel (typical conditions)	2.6 km (2.9 minutes).

Figure 7.5: Access constraints – northern interchange for Berry to Tindalls Lane

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

From	Properties north of Tindalls Lane to Austral Park Road interchange accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at Austral Park Road interchange.
Maximum additional travel (typical conditions)	3.2 km (2.9 minutes).

From	Properties south of Austral Park Road to Tindalls Lane accessed via southbound carriageway.
To	Princes Highway northbound
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Tindalls Lane interchange or via Austral Park Road interchange.
Maximum additional travel (typical conditions)	2.9 km (2.8 minutes).

Figure 7.6: Access constraints - Tindalls Lane to Austral Park Road

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

7.2.6 Local access constraints

In addition to the constraint of right turns imposed by the provision of a central median and safety barrier, the proposed concept design would sever the current road link provided by North Street between Rawlings Lane and Edward Street. North Street currently provides an alternative route to the Princes Highway between Kangaroo Valley Road and Woodhill Mountain Road to the north of Berry. Although only a small proportion of through traffic currently uses this route, the construction of the Berry bypass would require vehicles to use either the Berry bypass (vehicles travelling between Kangaroo Valley Road and areas east of Berry) or Queen Street as an alternative to North Street in the future.

Local properties whose connection to the local road network is affected would be provided with an alternative means of access. Properties to the north of North Street, which currently gain access to the local road network via Rawlings Lane, would be provided with a link via a new road connection to Kangaroo Valley Road. All local properties to the south of the bypass travelling to and from Kangaroo Valley Road would do so via Queen Street.

The severance of North Street would also impact local services. Garbage trucks servicing properties on North Street would encounter cul-de-sacs on both sides of the bypass. Turning provision would be provided on the residual sections of North Street to allow trucks to turn, while travel between these sections would be via Kangaroo Valley Road, Queen Street and Edward Street.

7.2.7 Victoria Street design options

Introduction

Victoria Street currently intersects with the Princes Highway at the southern extent of Berry adjacent to Mark Radium Park; allowing for all turning movements between the two roads. Under the project, various treatments could occur at this intersection, which would change the volume and distribution of traffic on local roads; particularly along and between Victoria Street and Queen Street.

The project team identified three design options that could 'work' with the overall project from the point of view of road safety, traffic efficiency and general operational performance. The details of each option are listed below and shown in **Figure 7.7**.to **Figure 7.9**.

Option 1 - Victoria Street closed and one-way southbound on-ramp

- Direct access to the upgraded highway from Queen Street via a southbound on-ramp and the closure of Victoria Street (via creation of a cul-de-sac or turnaround area) west of the current BUPA/Arbour developments' access point.
- This would have very limited (although not zero) impact on Mark Radium Park, as shown in **Figure 7.7**.

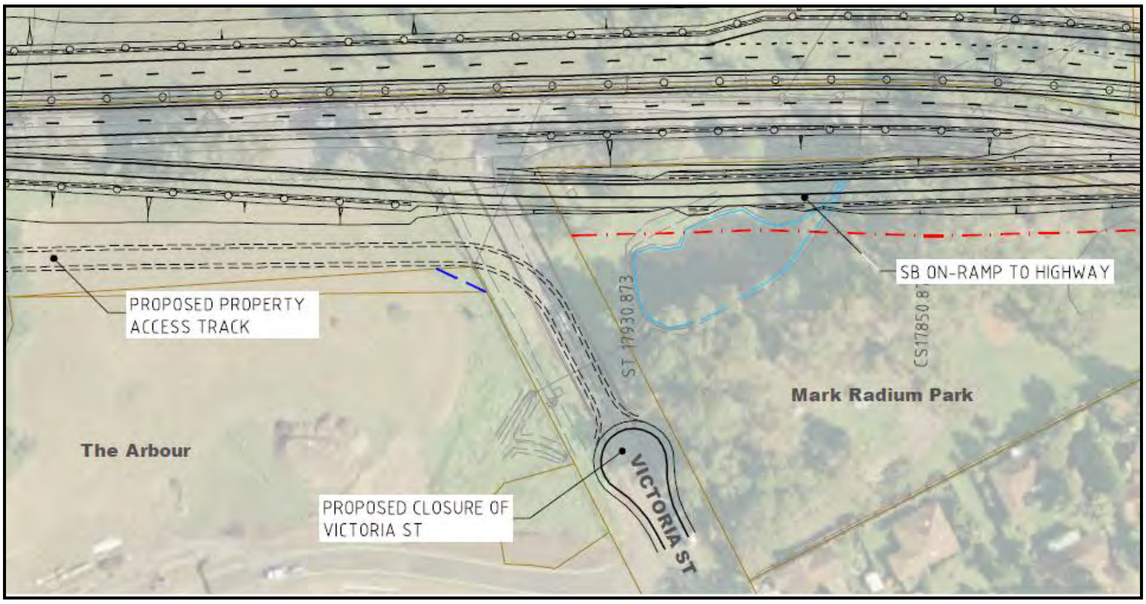


Figure 7.7: **Victoria Street design option 1**

(Source: AECOM)

Option 2 - Victoria Street open and one-way southbound on-ramp

- Maintaining a one-way link between Queen Street and Victoria Street for southbound traffic only.
- Traffic heading southbound from Berry onto the upgraded highway would also be able to access the on-ramp from Victoria Street.
- This option would require utilisation of a portion of Mark Radium Park, however to a lesser extent than the two-way option 3, as shown in **Figure 7.8**.

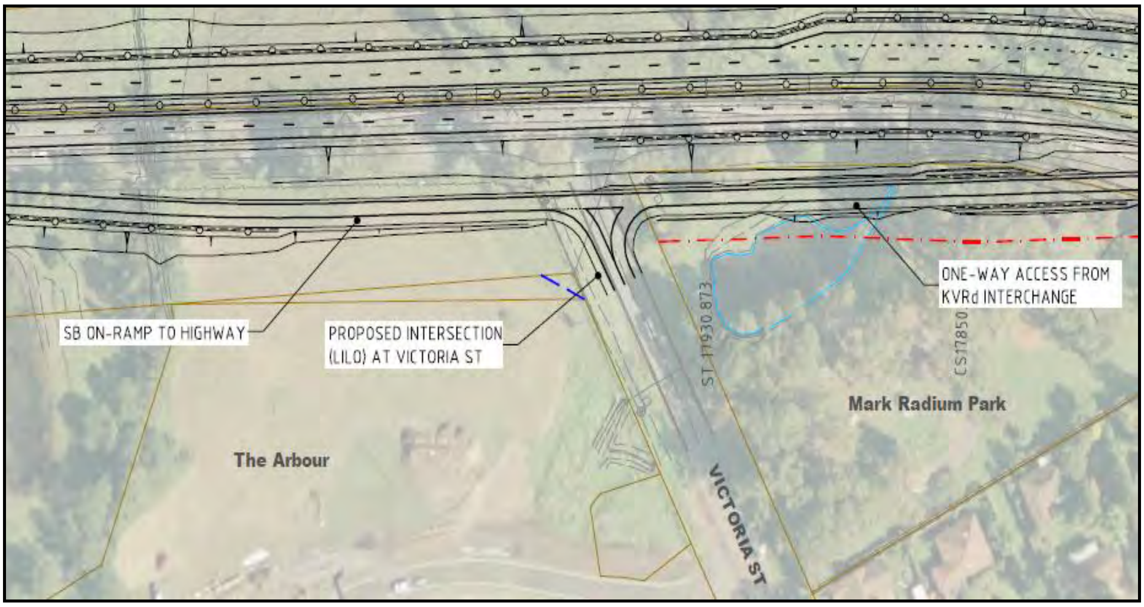


Figure 7.8: Victoria Street design option 2
(Source: AECOM)

Option 3 - Victoria Street open and two-way southbound on-ramp

- Maintaining a two-way link between Queen Street and Victoria Street through the construction of a local road between the upgraded highway and Mark Radium Park.
- Traffic heading southbound from Berry onto the upgraded highway would also be able to access the on-ramp from Victoria Street.
- This option would require utilising a portion of Mark Radium Park, extending to and including part of the 'duck pond' water feature, as shown in **Figure 7.9**.

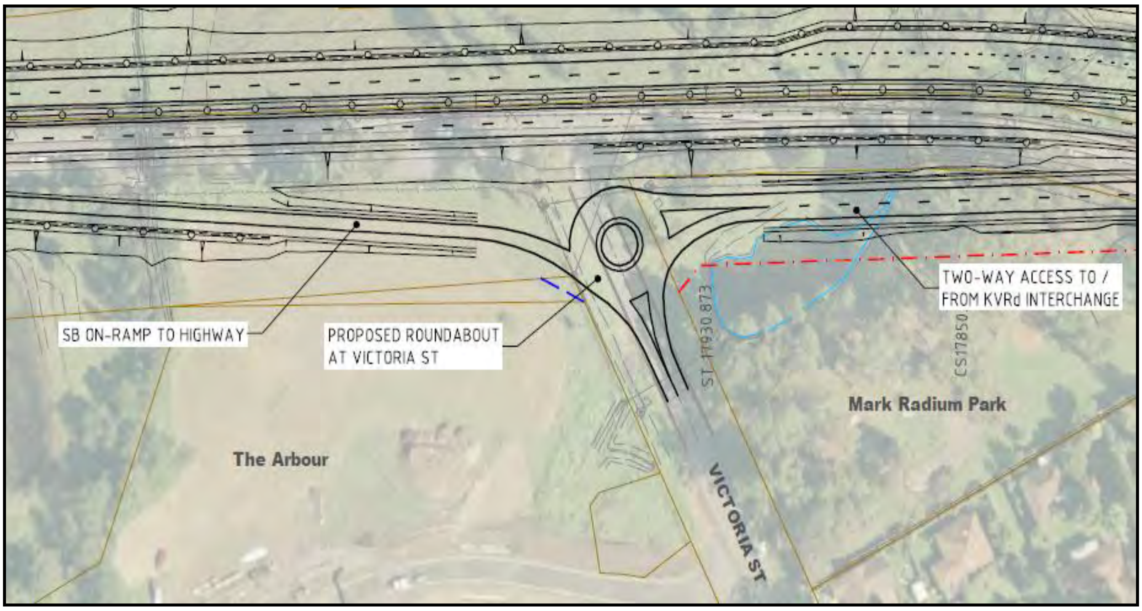


Figure 7.9: Victoria Street design option 3
(Source: AECOM)

Existing year (2012) traffic volumes and patterns

In order to assess the local road traffic impacts of the three options identified, RMS and Shoalhaven City Council commissioned the following traffic surveys; which were undertaken during April / May 2012 to measure traffic volumes and patterns on Victoria Street and other key adjacent local roads:

- Automatic Traffic Counts - ATC 'tubes' were put down on 13 local roads in Berry for several weeks to record daily traffic volumes.
- Intersection Turning Counts - surveyors manually recorded the number of vehicles turning at the Victoria Street intersections with the Princes Highway and Prince Alfred Street during the AM peak and PM peak periods on an average weekday.
- Origin-destination (O-D) Surveys - surveyors manually recorded number plates of vehicles entering and exiting Victoria Street to/from the highway and Prince Alfred Street; to determine the proportion of 'through' traffic on average weekdays and during the May 2012 Berry Country Fair. Further details of these surveys are provided in Section 2.4.6.

Figure 7.10 summarises 2012 AADT volumes on Victoria Street, Queen Street and the five local north-south roads. AADT on Victoria Street is currently highest at the western end, near the Princes Highway intersection with around 2200 vehicles per day in comparison to around 1200 vehicles per day at the eastern end between Prince Alfred Street and Alexandra Street. The figure also shows the AADT on the four key north-south roads between these two locations on Victoria Street, which peaks at 750 vehicles per day on Albany Street, with an average AADT of around 350-450 vehicles on the other roads. In addition, the figure highlights the existing spread of combined AADT across the four north-south roads, ranging from 18 per cent of combined north-south daily traffic travelling on Edward Street to 39 per cent on Albany Street.

Existing turning volumes at the Princes Highway and Victoria Street intersection were recorded to gain an understanding of the amount of traffic that would be re-distributed to other local roads, which would vary depending on the option selected.

Figure 7.10: 2012 AADT and traffic patterns

(Source: AECOM)

Figure 7.11 displays the 2012 AADT turning volumes at the intersection, and shows the movement from Victoria Street to the Princes Highway southbound as the most heavily trafficked at around 1100 vehicles per day. The opposite movement from the Princes Highway northbound into Victoria Street has a similar level of daily traffic with an AADT of 925 vehicles.

The other two turning movements accommodate a small amount of daily traffic ranging from 30 to 110 vehicles. This suggests that a one-way or two-way link between Queen Street and Victoria Street (Option 2 and Option 3) may not be warranted based on the potential levels of traffic that would utilise the road.

The project would provide an access to the southbound Princes Highway on-ramp via Victoria Street or Queen Street and in terms of accessibility this would not be a significant change from existing conditions. However, the existing access from the Princes Highway northbound into Victoria Street would be removed for all options and traffic currently travelling along this route would need to utilise the Kangaroo Valley Road interchange to access Berry.

As previously discussed, the existing AADT for this movement is 925 vehicles per day, and the AADT on Victoria Street east of the highway intersection is 2200 vehicles per day. Therefore, there would be around a 43 per cent reduction (925/2170) in traffic on Victoria Street regardless of the design option selected.

O-D Surveys were conducted during typical weekday and weekend peak periods in May 2012 established the proportion of through traffic that currently travels (without stopping) along the entire length of Victoria Street, between the Princes Highway and Prince Alfred Street intersections.

Findings from the O-D surveys (see Section 2.4.6) showed that around 20 per cent of vehicles travel through the entire length of Victoria Street during typical weekday AM peak and PM peak periods, with the remaining 80 per cent of vehicles either stopping or turning off to a side street before the other end of Victoria Street. The proportion of through traffic reduced to around nine per cent during the busy four hour peak period of the Berry Country Fair, due to increased levels of traffic travelling along Victoria Street to access the Berry Showground and surrounding areas.

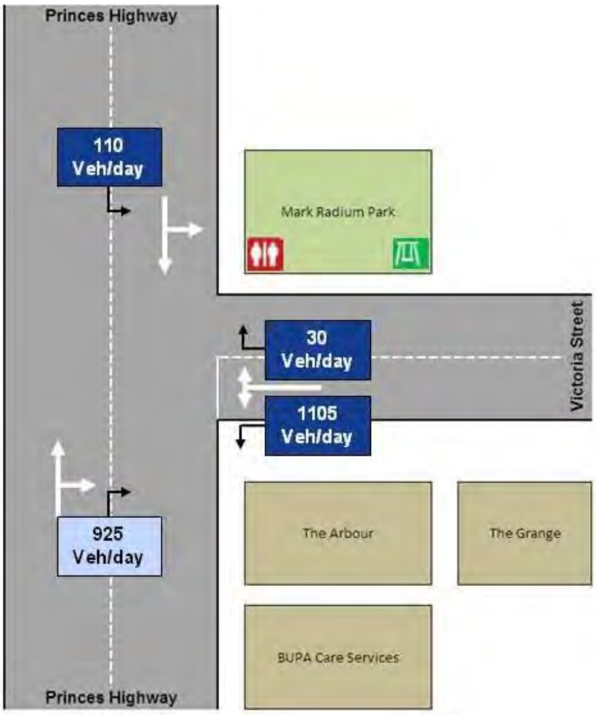


Figure 7.11: 2012 AADT at the Princes Highway and Victoria Street intersection
(Source: AECOM)

Traffic distribution model development

ATC, intersection and O-D survey data was used as inputs to a Berry local road distribution model (see **Appendix F**), which was developed to assess the traffic impacts in the town as a result of each Victoria Street design option. The modelling methodology was aligned with and included traffic projections from, the main traffic modelling and forecasting process and involved a series of steps and assumptions, as summarised below:

- A future design year of 2037, which is 20 years after the 2017 year of opening, was selected as required for the traffic assessment of the project.
- Daily traffic volumes on local roads are predicted to increase by two per cent per annum due to population and employment growth projections; as advised by Shoalhaven City Council.
- The projected increase in traffic volumes generated from Huntingdale Park were derived from separate assumptions, as this is the main development area in the town and growth rates will be higher compared to other areas of Berry.
- The predicted transfer or re-distribution of traffic for the closure, or part closure, of Victoria Street options was based on:
  - Projected Princes Highway mainline and ramp traffic volumes as discussed in Section 4.2.4.
  - Existing volumes and proportions of total AADT across George Street, Edward Street, Albany Street and Alexandra Street.
  - 80 per cent local and 20 per cent through traffic split on Victoria Street to / from the Princes Highway and Prince Alfred Street.

Forecast year (2037) traffic volumes and patterns for each option

Detailed illustrations of the four distribution models, showing traffic volumes and patterns, are included in **Appendix F.** In addition, **Table 7.15** (and **Figure 7.12**) provides a summary of the forecast traffic volumes and calculated level of service (LoS) at key local road locations for the 2012 modelled base year and 2037 design year for the three Victoria Street design options. In addition, the percentage difference in AADT is also included; showing the predicted change on each road compared to existing traffic volumes.

Option 1, which would provide access to the main alignment from Queen Street via a southbound on-ramp and the closure of Victoria Street via creation of a cul-de-sac or turnaround area, would result in the following key local road impacts, based on predicted traffic growth from 2012 to 2037, and traffic rerouting following construction of the project:

- In 2037, daily traffic volumes on Queen Street would be potentially 47 per cent less than existing levels due to construction of the bypass; and would be expected to operate at LoS C during the 100th highest hour southbound (100SB) peak period.
- Victoria Street would have a six per cent reduction in AADT at the eastern end near Prince Alfred Street.
- Traffic volumes on George Street, Edward Street and Alexandra Street would grow by around 185 per cent over the next 25 years, resulting in similar daily traffic volumes to existing levels on Victoria Street (east).
- Albany Street traffic volumes are also expected to grow by around 185 per cent to an AADT of 2140 vehicles per day in 2037, resulting in similar daily traffic volumes to existing levels on Victoria Street (west).
- AADT on Prince Alfred Street is expected to grow by 53 per cent over the next 25 years.
- Peak hourly traffic volumes for the 100SB scenario would be less than 200 vehicles per direction for all local roads (excluding Queen Street), resulting in LoS B or better.

Option 2, which would maintain a one-way link between Queen Street and Victoria Street, is predicted to result in the following key local road impacts, based on predicted traffic growth from 2012 to 2037, and traffic rerouting following construction of the project:

- In 2037, daily traffic volumes on Queen Street are expected to be 62 per cent lower than existing levels with the bypass constructed and Victoria Street open with a left-turn to the southbound on-ramp. It is predicted that Queen Street would operate at LoS B during the 100SB peak period for this scenario.
- Victoria Street is expected to have a 16 per cent reduction and 26 per cent increase in AADT at its western and eastern ends respectively.
- Traffic volumes on George Street, Edward Street and Alexandra Street would grow by 110 per cent over the next 25 years, resulting in similar daily traffic volumes to existing levels on Albany Street.
- Albany Street traffic volumes are also expected to grow by 110 per cent to an AADT of 1575 vehicles per day in 2037.
- AADT on Prince Alfred Street is predicted to grow by 52 per cent over the next 25 years, which is consistent across all options.
- Peak hourly traffic volumes for the 100SB scenario would be less than 200 vehicles per direction for all local roads (excluding Queen Street), resulting in LoS B or better.

Option 3, which would maintain a two-way link between Queen Street and Victoria Street, is predicted to result in the following key local road impacts, based on predicted traffic growth from 2012 to 2037, and traffic rerouting following construction of the project:

- In 2037, daily traffic volumes on Queen Street are expected to be 62 per cent lower than existing levels with the bypass constructed and Victoria Street open with a left and right turn to the southbound on-ramp. It is predicted that Queen Street would operate at LoS B during the 100SB peak period for this scenario.
- Victoria Street is expected to have a 14 per cent reduction and 26 per cent increase in AADT at its western and eastern ends respectively.
- Traffic volumes on George Street, Edward Street and Alexandra Street are expected to grow by 107 per cent over the next 25 years, resulting in similar daily traffic volumes to existing levels on Albany Street.
- Albany Street traffic volumes would also grow by 107 per cent to an AADT of 1560 vehicles per day in 2037.
- AADT on Prince Alfred Street is predicted to grow by 52 per cent over the next 25 years, which is consistent across all options.
- Peak hourly traffic volumes for the 100SB scenario would be less than 200 vehicles per direction for all local roads (excluding Queen Street), resulting in LoS B or better.

In summary, for all three Victoria Street design options, the four local north-south roads between George Street and Alexandra Street are expected to experience the largest increase in daily traffic volumes, ranging between 107 per cent and 185 per cent over the next 25 years. These figures appear relatively high, however AADT would be around or less than 2000 vehicles per day in 2037, which equates to:

- Approximately 100 vehicles per hour in each direction during the busiest 100SB peak period, or less than 2 vehicles per minute.
- The existing daily traffic volumes on Victoria Street near Mark Radium Park.

Table 7.15: Final forecast traffic volumes and LoS – local roads

Location	Measurement	Existing 2012 Road Network	Option 1 - 2037 Victoria St closed | one-way ramp	Option 2 - 2037 Victoria St open | one-way ramp	Option 2 - 2037 Victoria St open | two-way ramp
Queen St	AADT	12,285	6510	4690	4645
	% Difference (vs. 2012)	-	-47%	-62%	-62%
	100SB 1hr Flow (2-way)	1548	820	591	585
	100SB 1hr Flow (1-way)	774	410	295	293
	LoS	D	C	B	B
Victoria St (west)	AADT	2,170	-	1820	1865
	% Difference (vs. 2012)	-	-	-16%	-14%
	100SB 1hr Flow (2-way)	273	-	229	235
	100SB 1hr Flow (1-way)	137	-	115	117
	LoS	A	-	A	A
Victoria St (east)	AADT	1,140	1070	1430	1430
	% Difference (vs. 2012)	-	-6%	26%	26%
	100SB 1hr Flow (2-way)	144	135	180	180
	100SB 1hr Flow (1-way)	72	67	90	90
	LoS	A	A	A	A
George St	AADT	410	1165	860	850
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	52	147	108	107
	100SB 1hr Flow (1-way)	26	73	54	54
	LoS	A	A	A	A
Edward St	AADT	350	990	725	720
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	44	125	91	91
	100SB 1hr Flow (1-way)	22	62	46	45
	LoS	A	A	A	A
Albany St	AADT	750	2140	1575	1560
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	95	270	198	197
	100SB 1hr Flow (1-way)	47	135	99	98
	LoS	A	A	A	A
Alexandra St	AADT	435	1235	910	900
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	55	156	115	113
	100SB 1hr Flow (1-way)	27	78	57	57
	LoS	A	A	A	A
Prince Alfred St	AADT	1,925	2940	2925	2925
	% Difference (vs. 2012)	-	53%	52%	52%
	100SB 1hr Flow (2-way)	243	370	369	369
	100SB 1hr Flow (1-way)	121	185	184	184
	LoS	A	B	B	B

(Source: AECOM)

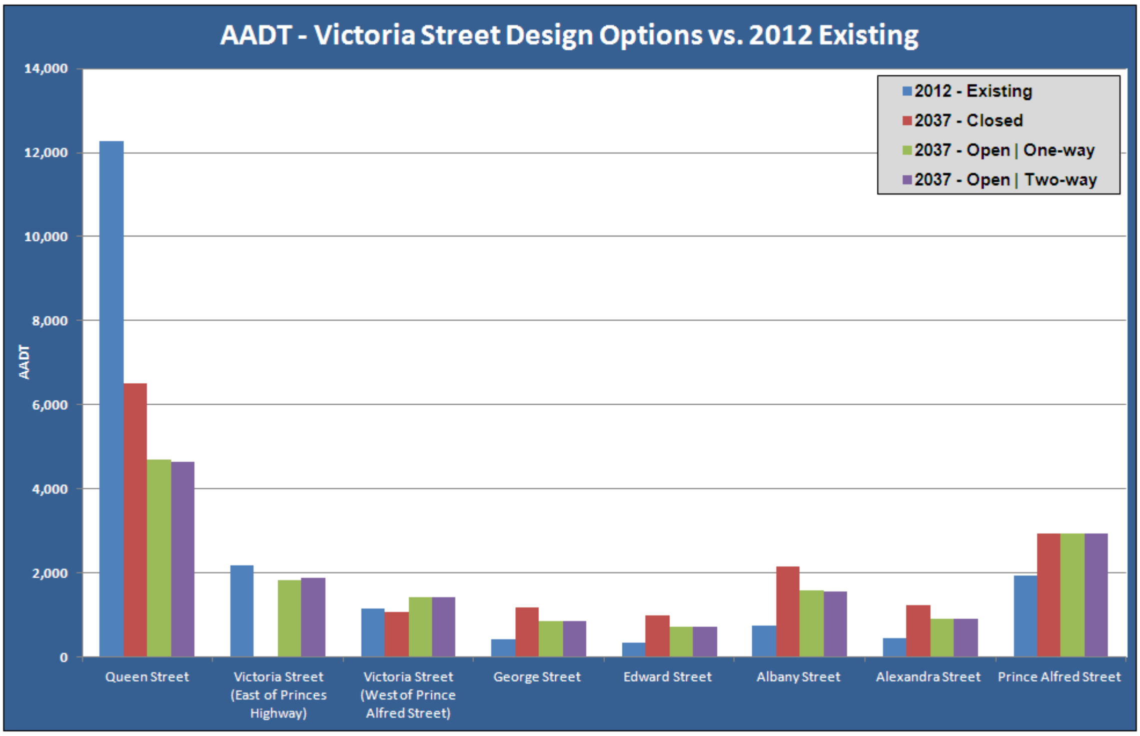


Figure 7.12: **2037 Victoria Street design options vs. 2012 existing AADT**

(Source: AECOM)

Key findings and summary

Table 7.16 provides a summary of both the positive and negative traffic related impacts for the three Victoria Street design options. The table shows that each Victoria Street option would either result in less or more daily traffic in comparison to existing levels depending on location, with the magnitude varying for each option. For example, option 1 would re-distribute the largest amount of traffic from Victoria Street to other local roads, resulting in a 35 per cent increase on George Street, Edward Street, Albany Street and Alexandra Street when compared to the other two options. Inversely, option 1 would also remove 2000 vehicles per day from the western end of Victoria Street and a 45 per cent reduction at the eastern end.

Although traffic growth is predicted to be large when compared to existing levels, the resulting daily volumes, which include a two per cent per annum increase due to population and employment growth projections, are relatively low; with local roads accommodating between 700 and 2000 vehicles per day in 2037.Moreover, the resulting level of service (LoS) for all local roads is predicted to be LoS A or LoS B in 2037, which represents optimum operating conditions (free flow).

Therefore, for all options, predicted traffic volumes 25 years from now would not significantly change the residential nature of the local road network in Berry, particularly as AADT on Queen Street in 2037 is expected to be at least 50 per cent less than existing daily traffic volumes.

RMS is required to present one option for the purpose of the environmental assessment and has moved forward with Option 1, with Victoria Street closed in the concept design. Nonetheless, RMS is able to deliver any of the Victoria Street design options through the project.

RMS will continue discussions and encourage feedback and submissions through the environmental assessment display period and traffic impacts along with other environmental impacts will contribute to the selection of a final solution for Victoria Street.

Table 7.16: Victoria Street design options – summary of traffic and transport impacts

Traffic related impacts	Option 1 - Victoria St closed | one-way ramp	Option 2 - Victoria St open | one-way ramp	Option 3 - Victoria St open | two-way ramp
Positive	• In 2037, daily traffic volumes on Queen Street would be around 50 per cent less than today. • Around 2000 vehicles removed from the western end of Victoria Street. • Reduces traffic volumes on the eastern end of Victoria Street by around 45 per cent in 2037 when compared to the other options. • All local roads would perform at LoS A or LoS B in 2037, with only Queen Street operating at LoS C. • Least impact and land-take of Mark Radium Park and the closure of Victoria Street would allow for safer pedestrian connectivity to the park. • Provides a turning circle at the eastern end of Victoria Street (adjacent to Mark Radium Park) that could be used as a u-turn for larger vehicles (buses, garbage trucks etc.)	• In 2037, daily traffic volumes on Queen Street would be around 60 per cent less than today. • Reduces traffic volumes on the local north-south roads between Victoria Street and Queen Street by around 35 per cent in 2037 when compared to option 1. • Maintains most of the existing traffic movements and patterns on the local road network, including direct access from Victoria Street to the Princes Highway southbound. • All local roads would perform at LoS A or LoS B in 2037.	• In 2037, daily traffic volumes on Queen Street would be around 60 per cent less than today. • Reduces traffic volumes on the local north-south roads between Victoria Street and Queen Street by around 35 per cent in 2037 when compared to option 1. • Maintains the majority of existing traffic movements and patterns on the local road network, including direct access from Victoria Street to the Princes Highway southbound. • All local roads would perform at LoS A or LoS B in 2037. • Provides a roundabout at the Victoria Street and southbound on ramp intersection that could be used as a u-turn for larger vehicles (buses, garbage trucks etc.).
Negative	• In 2037, daily traffic volumes on local north-south are predicted to be three times greater when compared to existing levels. • Largest impacts on the local road network due to additional traffic volumes (around 35 per cent more than the other two options) on the north-south roads between Victoria Street and Queen Street. • Additional travel time to/from residential areas along and adjacent to Victoria Street to/from the south.	• In 2037, daily traffic volumes on local north-south are predicted to double when compared to existing levels. • Additional travel time to residential areas along and adjacent to Victoria Street from the south. • Potential safety issues due to slow moving traffic turning left from Victoria Street merging with vehicles accelerating on the southbound on ramp.	• In 2037, daily traffic volumes on local north-south are predicted to double when compared to existing levels. • Only 45 vehicles per day would travel northbound on Queen St (the southbound on ramp) between the Victoria Street and Kangaroo Valley Road intersections. This low volume of traffic shows that the two-way ramp option would provide a negligible benefit when compared to the other two options – particularly option 2. • Additional travel time to residential areas along and adjacent to Victoria Street from the south.

(Source: AECOM)

7.2.8 Traffic crashes

As listed in Section 6.2, one of the key objectives of the project is to improve road safety in the project area. An analysis of crashes that have recently occurred on the Princes Highway in the project area is shown in Section 3.1. The crash severity index in the project area is 1.31, significantly higher than the NSW average of 1.23 for all public roads, indicating a higher than average proportion of injury and fatal crashes on this section of the Princes Highway. Significantly, **Table 3.7** shows that the Princes Highway in the project area currently has a fatality rate of 0.8 per 100MVKM; this indicates that fatal crashes are 50 per cent more likely per kilometre travelled than the NSW average for all roads open to the public. Historical data also shows five fatal crashes on the 'Sandtrack' between 1 July 2003 and 30 September 2010, at a rate of 0.7 per 100MVKM.

The proposed highway upgrades are expected to significantly improve road safety, along and adjacent to the project. Crash analysis has been undertaken by comparing existing and proposed conditions to determine estimated crash reduction statistics based on historical data between 1 July 2003 and 30 September 2010, using the RMS' *Crash Reduction Guide*. Average crash costs based on a 'Willingness to pay' approach, have been provided by the RMS *Economic Analysis Manual (Economic Parameters for 2009)*, as discussed in Section 3.1.

The analysis assumed the following road safety improvements are implemented on the Princes Highway:

- Central median and safety barrier separating opposing traffic flows along the length of the project.
- Improved road alignment.
- Provision of additional and wider lanes and shoulders.
- Grade separated interchanges.
- Improved alignment and/or sight distances, and acceleration and deceleration provision at retained at-grade intersections on the Princes Highway.
- New alignment of the Princes Highway via the cutting at Toolijooa Ridge, bypassing the Foxground bends.
- Bypass of Berry.
- Central safety barrier resulting in median closure at all intersections (left in and left out turns only at local accesses)[6].

An estimate of the improvement in road safety created by these measures has been calculated using RMS' *Crash Reduction Guide;* this guide includes typical percentage reductions in crashes by definitions for coding accidents (DCA) codes based on highway and intersection treatments, which have been applied in this analysis. In addition, existing crash data in the area has been further analysed to determine if any crashes could have been prevented, or consequences minimised as a result of the construction of the project.

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[6] The median safety barrier would be discontinued at the intersection of the Princes Highway and Mullers Lane at the southern extent of the project. Vehicles travelling southbound on the Princes Highway would be provided with a facility to turn into Mullers Lane, perform a safe u-turn and re-join the Princes Highway in the northbound direction.

The results shown in **Table 7.17** indicate crashes between vehicles travelling in opposing directions would see the greatest reduction (100 per cent) based on the proposed conditions, following the introduction of a central median and safety barrier. Crashes at intersections are estimated to reduce by 83 per cent as current at-grade intersections would be upgraded to grade separated interchanges or constrained to left in left out only access with acceleration and deceleration provision. It is also expected that highway improvements would reduce the frequency of crashes between vehicles travelling in the same direction (50 per cent reduction). Off path, on curve crashes, currently the most frequently occurring crash type in the project area, are estimated to be reduced by 74 per cent due to improvements in the horizontal and vertical alignment of the highway. It is estimated that total crashes on the Princes Highway in the project area would be reduced by 64 per cent under the upgraded conditions.

Upgrades of existing heavy vehicle rest areas north and south of the project area are currently being planned and are proposed by RMS within the scope of other projects. The Princes Highway in the project area is part of a key regional route for heavy vehicles travelling long distances between Sydney and Wollongong to the NSW south coast to Victoria. Fatigue is often a factor involved in traffic crashes, particularly for heavy vehicles making long distance journeys. The upgrading of existing rest areas for drivers would be expected to help reduce the risk of crashes of this type occurring in and around the project area.

In the section between Toolijooa Road and Austral Park Road, off path, on curve crashes currently account for over half of all crashes. In this area crashes of this type would reduce by around 75 per cent, primarily as a result of the realignment of the highway through Toolijooa Ridge, bypassing the ‘Foxground bends’. The next most frequent crash type involves vehicles from opposing directions. The provision of a central median and safety barrier would eliminate the possibility of crashes of this type.

Between Austral Park Road and Woodhill Mountain Road, off path, on curve crashes are also the most commonly occurring crash type at present, accounting for over half of all crashes. Half of the crashes of this type that occurred in the analysis period also listed a steep grade or crest as a contributing factor to the crash. The combinations of curves at locations with poor vertical alignment is a significant road safety issue at present. The project would include significant improvements to the horizontal and vertical alignment of the highway which is expected to reduce the occurrence of crashes of this type by over 70 per cent in this section.

Between Woodhill Mountain Road and Schofields Lane the highway currently bisects Berry. Through this section the road environment changes significantly; the posted speed is reduced to 50 kilometres per hour through Berry and numerous urban roads intersect with the Princes Highway. Crashes involving vehicles travelling in the same direction were most common; seven of the ten of this type that occurred were rear end crashes. Crashes occurring at intersections were the next most frequent crash type; traffic travelling straight across or turning right at intersections caused all crashes of this type. The project would not remove the possibility of these crashes occurring; however the construction of the Berry bypass would remove a significant proportion of traffic currently travelling through Berry on the existing Princes Highway (Queen Street). This would in turn reduce the amount of conflicting movements occurring in the town and therefore decrease the potential for crashes to occur.

Table 7.18 shows that following construction of the project, total crashes occurring between Toolijooa Road and Austral Park Road would be expected to reduce by between 4 and 5 per year, with the potential to substantially reduce the occurrence of fatal and injury crashes. The frequency of crashes (indicated by the crash rate per 100 MVKM) would be expected to fall from 30.8 to 12.4, indicating less than half as many crashes would occur per vehicle kilometre travelled. Although the crash severity index shows a similar rating for the proposed conditions, the reduced frequency of crashes means that crash costs per kilometre following the upgrade would drop from $0.65 million to $0.29 million, a saving of around 55 per cent.

Between Austral Park Road and Woodhill Mountain Road, total crashes would be reduced by nearly 70 per cent based on the proposed conditions of the project. The analysis shows that the fatal crash that occurred over this period could potentially have been avoided, as could around two-thirds of all injury crashes. The crash rate per 100 MVKM travelled would potentially reduce by over 60 per cent from 27.8 to 10.0. With a reduced crash severity index and crash frequency following construction, crash costs per kilometre would drop to $0.1 million, a reduction of nearly 80 per cent.

Between Woodhill Mountain Road and Schofields Lane, construction of the Berry bypass would potentially see total crashes reduce by around 55 per cent and injury crashes by 65 per cent. A reduction in the frequency of crashes from 40.9 to 16.5 per 100 MVKM travelled, and reduction in crash severity index from 1.29 to 1.23, would see crash costs drop from $0.61 million per kilometre at present to $0.2 million in the future, a reduction of close to 70 per cent.

In addition to the road safety improvements on the Princes Highway, by drawing traffic from the alternative ‘Sandtrack’ route the project would be expected to further reduce the overall cost and frequency of crashes within the traffic impact footprint. Historical crash statistics for the ‘Sandtrack’ are provided in Section 3.1; this data shows that between Gerringong and Bomaderry crashes occurred at an average rate of 29.9 per 100 MVKM, with 0.7 fatal crashes per 100 MVKM. The average annual cost of crashes on the ‘Sandtrack’ is currently about $10.7 million.

Vehicles currently using the ‘Sandtrack’ would be expected to switch to the Princes Highway following the completion of the project to benefit from improved road safety, as well as travel time savings. It is estimated that without the project (the ‘Do nothing’ scenario) annual vehicle kilometres travelled on the ‘Sandtrack’ between Gerringong and Bomaderry would increase from around 90 MVKM at present to 160 MVKM by the design year of 2037. This would be expected to increase crash occurrences by a similar proportion, and in turn increase the total annual cost of crashes on this route from $10.7 million to $18.4 million, assuming current crash rates remain unchanged.

Conversely the ‘Do something’ scenario, which assumes the project is constructed, estimates that in 2037 significantly less traffic would use the ‘Sandtrack’ on a daily basis than at present. Forecasts indicate that in 2037 vehicle kilometres travelled on the ‘Sandtrack’ between Gerringong and Bomaderry would have decreased to 53 MVKM, a 57 per cent reduction from existing levels. Assuming current crash rates remain constant, the reduction in vehicle kilometres travelled on this route would result in a directly proportional drop in crash occurrences and costs. The vehicles switching to the upgraded Princes Highway from the ‘Sandtrack’ would benefit from a much higher level of safety, and hence lower potential for crashes.

In summary, the project could be expected to significantly reduce the frequency and severity of crashes occurring on the Princes Highway in the project area for existing users, as well as provide an alternative with a much higher level of safety than experienced by current users of the ‘Sandtrack’. This would both increase the level of road safety to highway users, and reduce the cost attributable to crashes that occur across the traffic impact footprint.

Table 7.17: Existing and proposed crash statistics based on proposed safety improvements (1 July 2003 – 30 September 2010)

Section	Scenario	Length (km)	Accident type (From DCA code)						
			Intersection (adjacent approaches)	Vehicles from opposing directions	Vehicles from same direction	Off path, on straight	Off path, on curve	Other	Total
Toolijooa Road to Austral Park Road	Existing conditions	5.7	0	10	8	4	28	0	50
	Proposed conditions	4.6	0	0	5	4	7	0	16
Austral Park Road to Woodhill Mountain Road	Existing conditions	4.3	0	6	6	3	18	1	34
	Proposed conditions	3.9	0	0	3	3	5	0	11
Woodhill Mountain Road to Schofields Lane	Existing conditions	2.6	6	3	10	6	0	9	34
	Proposed conditions	2.9	1	0	4	5	0	5	15
Project area	Existing conditions	12.6	6	14	24	13	46	10	118
	Proposed conditions	11.3	1	0	12	12	12	5	42
	Crash reduction (%)	-	83%	100%	50%	8%	74%	50%	64%

(Source: AECOM, based on RMS' 'Southern Region Crash Data and RMS Crash Reduction Guide')

Table 7.18: Existing and proposed crash statistics based on proposed safety improvements (Annual average, 1 July 2003 – 30 September 2010)

Section	Scenario	Length (km)	Total crashes	Fatal crashes	Injury crashes	Tow-away crashes	Crash rate per 100MVKM (Total)	Crash severity index	Cost per km ($M)	Total cost ($M)
Toolijooa Road to Austral Park Road	Existing conditions	5.7	6.9	0.3	3.4	3.2	30.8	1.33	0.65	3.68
	Proposed conditions	4.6	2.2	0.1	0.8	1.2	12.4	1.31	0.29	1.33
	Change in conditions	-1.1	-4.7	-0.2	-2.6	-2.0	-18.4	-0.02	-0.35	-2.36
Austral Park Road to Woodhill Mountain Road	Existing conditions	4.3	4.7	0.1	2.2	2.3	27.8	1.29	0.49	2.12
	Proposed conditions	3.9	1.5	0.0	0.7	0.8	10.0	1.23	0.10	0.40
	Change in conditions	-0.4	-3.2	-0.1	-1.5	-1.5	-17.8	-0.07	-0.39	-1.72
Woodhill Mountain Road to Schofields Lane	Existing conditions	2.6	4.7	0.0	2.8	1.9	40.9	1.29	0.61	1.59
	Proposed conditions	2.9	2.1	0.0	1.0	1.1	16.5	1.23	0.20	0.56
	Change in conditions	0.3	-2.6	0.0	-1.8	-0.8	-24.4	-0.06	-0.42	-1.03
Project area	Existing conditions	12.6	16.3	0.4	8.4	7.4	32.1	1.31	0.59	7.40
	Proposed conditions	11.3	5.8	0.1	2.5	3.2	12.7	1.26	0.20	2.29
	Change in conditions	-1.3	-10.5	-0.3	-5.9	-4.3	-19.4	-0.05	-0.38	-5.11

(Source: AECOM, based on RMSs ‘Southern Region Crash Data, RMS Crash Reduction Guide’ and RMS’ ‘Economic Analysis Manual’ (Economic parameters for 2009)

7.2.9 Emergency u-turns, cross over facilities and public u-turn facilities

The project would include emergency u-turn facilities which provide an opportunity for emergency service vehicles to execute a u-turn manoeuvre on the highway rather than travelling to the next grade-separated interchange, which are provided at Austral Park Road, Tindalls Lane, and the southern and northern ends of Berry to access the town. The median safety barrier would be discontinued and a permanent gap provided. In addition, signposting would denote that the facility is for use by emergency vehicles only, and a lay-by with an emergency telephone would be incorporated with this facility. One such facility is provided in the concept design.

Unlike emergency u-turn facilities, emergency cross over facilities are intended to enable contra-flow arrangements to be put in place by emergency services in the case of a significant traffic incident blocking one direction of flow. These facilities operate in tandem, with one facility directing traffic into the contra-flow arrangement, and another directing traffic back to the normal arrangement. The emergency u-turn facilities provided by the project could also be used to facilitate contra-flow arrangements in the event of an emergency. There is also the potential for the proposed bypass sections of the highway at both Berry and Foxground, and the alternative ‘Sandtrack’ route to be utilised as part of the current incident management plan for the area.

Emergency u-turn and cross over facilities are not intended to be used to facilitate routine maintenance activities or vehicle movements. It is likely that the median safety barrier would be continuous with provision for the barrier to be ‘dropped’ at key locations when the facility was needed.

The regular spacing of grade-separated interchanges minimises the need for dedicated at-grade public u-turn facilities. Two are to be provided; one on a section of the residual highway just north of the Austral Park Road interchange, and the other at Mullers Lane south of Berry.

7.2.10 Public transport

In addition to the impacts associated with specific vehicular traffic discussed in previous sections, the following operational impacts to public transport created by the construction of the project have been identified:

- Buses:
  - Bus travel times would be improved; the project would enable higher safe travel speeds on the Princes Highway, while intersection delays in Berry would reduce as a result of fewer vehicles travelling through the town. A reduction of traffic on the ‘Sandtrack’ would also benefit travel times for buses using this alternative route.
  - Delays to services caused by traffic incidents and congestion would reduce: the construction of the project is expected to lessen the frequency of traffic crashes (see Section 7.2.6), reducing the occurrence of incidents that would cause delays. The provision of two lanes per direction on the Princes Highway would significantly ease congestion and improve the LoS during peak times, as discussed in Section 7.2.1.
  - Reduced potential for crashes caused by buses stopping on the Princes Highway. Following construction the practice of buses stopping at intersections with local roads and property accesses would be discouraged. This would remove the risk of crashes caused by buses speeding up from or slowing down to a stop in high-speed traffic.
  - Travel times to and from bus stops in Berry by supplementary travel modes would be shortened. Travel to and from bus stops by car, walking and cycling would be quicker in Berry, due to a reduction in traffic throughout the town, as shown in the intersection analysis in Section 7.2.2.

  - Improved amenity for bus users waiting at stops within Berry and on the ‘Sandtrack’; a reduction in traffic within Berry and on the ‘Sandtrack’ would result in improved air quality, decreased noise levels and enhanced pedestrian safety.
- Rail services:
  - Shorter travel times for rail passengers travelling to and from Berry train station as a result of a decrease in traffic volumes (and associated travel delays) in Berry as well as improved travel speeds throughout the project area, as discussed in Section 7.2.2 and Section 7.2.3.
- Walking:
  - Improved travel times in Berry; less traffic in the town would reduce the delays incurred when crossing roads within the town.
  - Improved amenity in the project area; lower volumes of traffic within Berry and on the alternative ‘Sandtrack’ route would improve air quality, reduce noise and enhance pedestrian safety.
- Cycling:
  - Reduced delays for cyclists at intersections in Berry; this would follow a reduction of traffic in the town as a result of the bypass.
  - Improved cyclist safety; within Berry lower traffic volumes would reduce the potential for crashes with other road users. In rural areas, cyclists would utilise the 2.5 metre shoulder provided on the upgraded highway, allowing greater separation between bicycles and high speed traffic than existing conditions. A reduction in traffic on the ‘Sandtrack’ would also improve safety on this alternative route.
  - Improved amenity in Berry and the ‘Sandtrack’; cyclists would benefit from a reduction of traffic in Berry and on the ‘Sandtrack’, resulting in an improvement in air quality levels and reduced noise.
  - Provision for a shared cycleway/pedestrian footpath facility connecting the northern side of Berry to Kangaroo Valley Road, North Street and Queen Street is part of the project concept design and would be determined in consultation with the community.
  - The project would generally support and complement the Berry Pedestrian Access and Mobility Plan (PAMP) developed by Shoalhaven City Council.

In addition to the positive impacts generated by the project, there are also some potential negative impacts to bus services, pedestrians and cyclists.

School bus services currently stop at numerous intersections in rural areas between the Princes Highway and local roads and accesses in the project area, as described in Section 2.3.1. It is proposed that to improve road safety following the construction of the project this practice would be discouraged; public and school buses would only stop at dedicated facilities built for this purpose at the grade separated interchanges at Tindalls Lane and Toolijooa Road. This would effectively result in a reduction in the number of bus stops on the Princes Highway in the project area, inconveniencing users of the removed stop locations who would be required to travel to and from other stop locations, but improving overall safety.

Within Berry, the addition of two roundabouts on Kangaroo Valley Road to the west of the town was identified as a concern by the community, potentially reducing amenity for pedestrians and cyclists. This would include pedestrians and cyclists re-routed from North Street following its severance by the Berry bypass.

Contemporary guidelines relating to road design, specifically *Austroads Guide to Road Design Part 4B: Roundabouts (2009),* states that there is no evidence to suggest that roundabouts are less safe for pedestrians than other forms of intersection control. With most roundabouts, the installation of well-designed splitter islands of sufficient size to hold and protect pedestrians allows them to cross only one direction of traffic at a time. This should result in pedestrians being able to move more safely and freely around the intersection than was the case before installation of the roundabout.

Suitable pedestrian and cyclist arrangements would be provided according to relevant guidelines to ensure that safe pedestrian access is maintained following construction of the project.

8 Management of impacts

8.1 Construction

A traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements and procedures to be used when construction activities would have a potential impact on existing traffic arrangements. It would ensure that delays and disruptions are kept to a minimum, and identify and respond to any changes in road safety (including the 'Sandtrack') as a result of highway construction works.

The TMP would be submitted in stages to reflect the progress of work and would include:

- Signage requirements (eg temporary speed restrictions, changes to the road environment, traffic management controls deployed).
- Lane possession and approval process during periods of online construction (eg linemarking and temporary barriers).
- Traffic control devices such as temporary traffic signals.
- A local and regional communications strategy. This would include methods to provide advanced notice of any major or prolonged impacts (eg leaflets and local media), and real-time information regarding current impacts (e.g. variable message signs, radio traffic news).

To minimise the impacts of construction on road network performance and safety, offline construction would be undertaken wherever possible. In addition, to further minimise the potential effects of any major sources of delay, any works which would significantly reduce the performance of the road network in the project area would be scheduled for periods of typically lower traffic volumes where possible.

Traffic would be routed from old sections to new sections through a combination of linemarking and barriers with appropriate signage as necessary.

Where offline construction is not practical, and for tie-ins between online and offline sections of the project, construction sequencing and any temporary works identified would aim to minimise user delay while providing sufficient flexibility for the selected contractor to safely and efficiently construct the project.

Signage would be used to clearly indicate the traffic controls in use; this could also include temporary speed restrictions and passing constraints if required to maintain road safety levels. In some instances road closures and clearly signed detours would be implemented to remove road traffic from construction zones altogether.

The TMP would provide details of both the general approach to be used to ensure suitable locations are chosen for access and egress points to worksites (eg minimum sight distances, maximum grade allowances, etc), and the specific controls required at selected locations (signage, barriers, signalling requirements).

The Princes Highway is currently used by emergency service vehicles for travel to and from call outs. The TMP would be developed in consultation with the local emergency services to ensure that procedures are in place to maintain an unrestricted and safe environment for vehicles to swiftly pass through the construction zones.

Local emergency services would be frequently updated on the staging and progress of construction works and communication systems would be in place with traffic controllers to provide appropriate access and routes (eg gaps in concrete barriers, side-tracks, wide verges etc) for emergency vehicles to bypass any queued traffic.

Overall, the TMP would ensure:

- Construction methods and staging would be designed to minimise road closures, subject to other project constraints, and ensure that disruptions to existing traffic are within acceptable levels.
- Where feasible, the provision of an 80 kilometres per hour construction speed zone for highway traffic.
- Continuous access to local roads and properties.
- Road occupancy licences would be obtained for all work that impacts traffic on the existing highway.
- The continuing performance of the local road network in Berry during the proposed closure of Kangaroo Valley Road.
- Suitable road network safety and performance is maintained during construction of the project.

8.2 Operation

Although the project would significantly improve the performance of the Princes Highway in the project area for the majority of road users, it is recognised that some negative impacts would be created, as noted in Section 7.2. In some cases these effects can be negated; where this is not the case any impacts would be minimised and balanced by the overall benefits provided by the upgrade.

The project is expected to significantly improve road safety in the project area. The project is being designed to current safety standards and a road safety audit has been undertaken by qualified auditors as part of the concept design to examine the design from a road safety perspective and identify potential safety issues created by the design. This process was undertaken in accordance with the RMS *Accident Reduction Guide Part 2: Road Safety Audits (2005)*. As part of this process, stage 3 (detailed design stage) and stage 4 (immediately prior to opening to traffic) road safety audits would be carried out.

Traffic levels and operational performance would be monitored six months and 12 months following construction, particularly during peak periods, to ensure that the road network performs as expected. Traffic monitoring would be undertaken on the Princes Highway and key local roads in Berry including the bypass, on- and off- ramps, Kangaroo Valley Road and Queen Street, and traffic volumes would be assessed against those predicted. The performance of climbing lanes provided by the project would be similarly monitored. A comparison of actual versus modelled performance of the road network in this way would identify any significant differences at an early stage. As a result, revised traffic forecasting would be undertaken and the adjusted traffic predictions would be input to the Paramics modelling to re-assess the future operational performance of the project and plan in advance of any major impacts occurring.

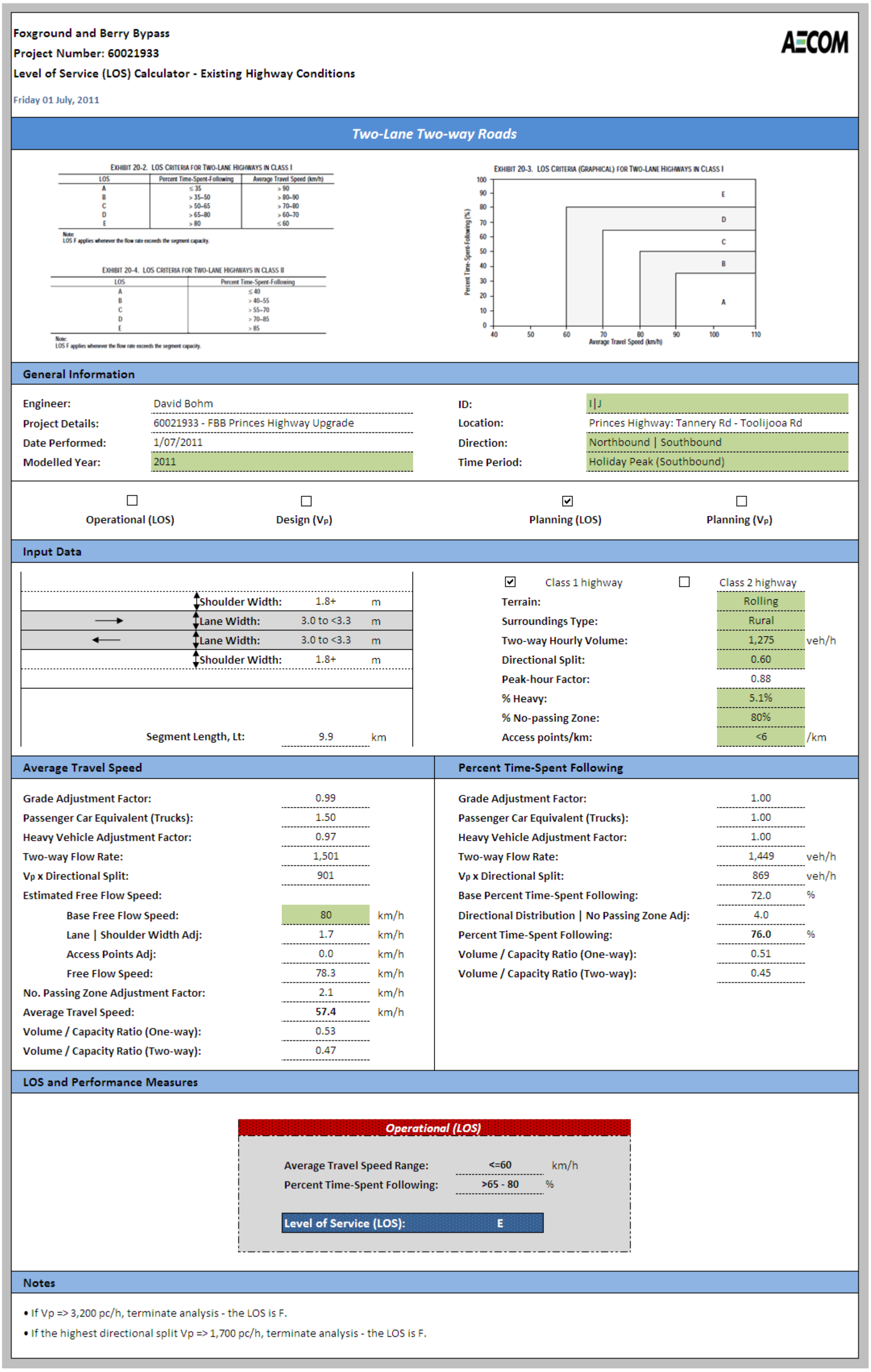
The current concept design proposes to retain the current bus interchange at Tindalls Lane, and incorporate a new interchange at Toolijooa Road to minimise the negative impacts imposed by a reduction of stops in rural sections of the project area. The project would provide turning facilities in newly created cul-de-sacs, and buses would be required to use the alternative Queen Street route. The negative impacts would be reduced to a small amount of additional travel in this area. Turning facilities for garbage trucks and buses would be provided to ensure current routes/services are maintained.

Pedestrian and cyclist arrangements would be provided according to relevant guidelines to ensure that adequate access is maintained. The project includes the following provisions for cyclists and pedestrians:

- A 2.5 metre wide shoulder that would provide adequate space for cyclist access along the main alignment of the project.
- Provision of shared pedestrian and cyclist facilities on both sides of the Kangaroo Valley Road overbridge. The shared facilities would be separated from traffic and provide a link between Berry town centre and residential development to the north-west along Kangaroo Valley Road and beyond. This is discussed in more detail in Section 7.6 and Appendix I.
- Shared pedestrian and cyclist facilities along the northern side of North Street. This facility would provide connectivity between Kangaroo Valley Road and the sports grounds and mitigate the loss of connectivity associated with the bypass and the cul-de-sac of North Street by maintaining the existing level of recreational connectivity. This is discussed in more detail in Section 7.6 and Appendix I.
- All provisions for cyclists would comply with the RMS *NSW Bicycle Guidelines and Austroads Traffic Engineering Practice - Part 14*; this includes provision for cyclists at all interchanges and intersections constructed as part of the project
- Provision for pedestrians and cyclists in and around Berry would support and complement any Berry Pedestrian Access and Mobility Plans (PAMP) and would be developed further during detailed design in consultation with Shoalhaven City Council.

Appendix A

Midblock level of service (LoS) model - two lane roads (example location)



Foxground and Berry Bypass
Project Number: 60021933
Level of Service (LOS) Calculator - Existing Highway Conditions

Friday 01 July, 2011

AECOM

Two-Lane Two-way Roads

EXHIBIT 20-2. LOS CRITERIA FOR TWO-LANE HIGHWAYS IN CLASS I

LOS	Percent Time-Spent-Following	Average Travel Speed (km/h)
A	≤ 35	> 90
B	> 35–50	> 80–90
C	> 50–65	> 70–80
D	> 65–80	> 60–70
E	> 80	≤ 60

Note:
LOS F applies whenever the flow rate exceeds the segment capacity.

EXHIBIT 20-4. LOS CRITERIA FOR TWO-LANE HIGHWAYS IN CLASS II

LOS	Percent Time-Spent-Following
A	≤ 40
B	> 40–55
C	> 55–70
D	> 70–85
E	> 85

Note:
LOS F applies whenever the flow rate exceeds the segment capacity.

EXHIBIT 20-3. LOS CRITERIA (GRAPHICAL) FOR TWO-LANE HIGHWAYS IN CLASS I

General Information

Engineer:	David Bohm	**ID:**	I|J
Project Details:	60021933 - FBB Princes Highway Upgrade	**Location:**	Princes Highway: Tannery Rd - Toolijooa Rd
Date Performed:	1/07/2011	**Direction:**	Northbound | Southbound
Modelled Year:	2011	**Time Period:**	Holiday Peak (Southbound)

☐ **Operational (LOS)** ☐ **Design (V_P)** ☑ **Planning (LOS)** ☐ **Planning (V_P)**

Input Data

Shoulder Width:	1.8+	m
Lane Width:	3.0 to <3.3	m
Lane Width:	3.0 to <3.3	m
Shoulder Width:	1.8+	m
Segment Length, Lt:	9.9	km

☑ Class 1 highway ☐ Class 2 highway

Terrain:	Rolling	
Surroundings Type:	Rural	
Two-way Hourly Volume:	1,275	veh/h
Directional Split:	0.60	
Peak-hour Factor:	0.88	
% Heavy:	5.1%	
% No-passing Zone:	80%	
Access points/km:	<6	/km

Average Travel Speed

Grade Adjustment Factor:	0.99	
Passenger Car Equivalent (Trucks):	1.50	
Heavy Vehicle Adjustment Factor:	0.97	
Two-way Flow Rate:	1,501	
V_P x Directional Split:	901	
Estimated Free Flow Speed:		
Base Free Flow Speed:	80	km/h
Lane | Shoulder Width Adj:	1.7	km/h
Access Points Adj:	0.0	km/h
Free Flow Speed:	78.3	km/h
No. Passing Zone Adjustment Factor:	2.1	km/h
Average Travel Speed:	**57.4**	km/h
Volume / Capacity Ratio (One-way):	0.53	
Volume / Capacity Ratio (Two-way):	0.47	

Percent Time-Spent Following

Grade Adjustment Factor:	1.00	
Passenger Car Equivalent (Trucks):	1.00	
Heavy Vehicle Adjustment Factor:	1.00	
Two-way Flow Rate:	1,449	veh/h
V_P x Directional Split:	869	veh/h
Base Percent Time-Spent Following:	72.0	%
Directional Distribution | No Passing Zone Adj:	4.0	
Percent Time-Spent Following:	**76.0**	%
Volume / Capacity Ratio (One-way):	0.51	
Volume / Capacity Ratio (Two-way):	0.45	

LOS and Performance Measures

Operational (LOS)

Average Travel Speed Range:	**<=60**	km/h
Percent Time-Spent Following:	**>65 - 80**	%
Level of Service (LOS):	**E**	

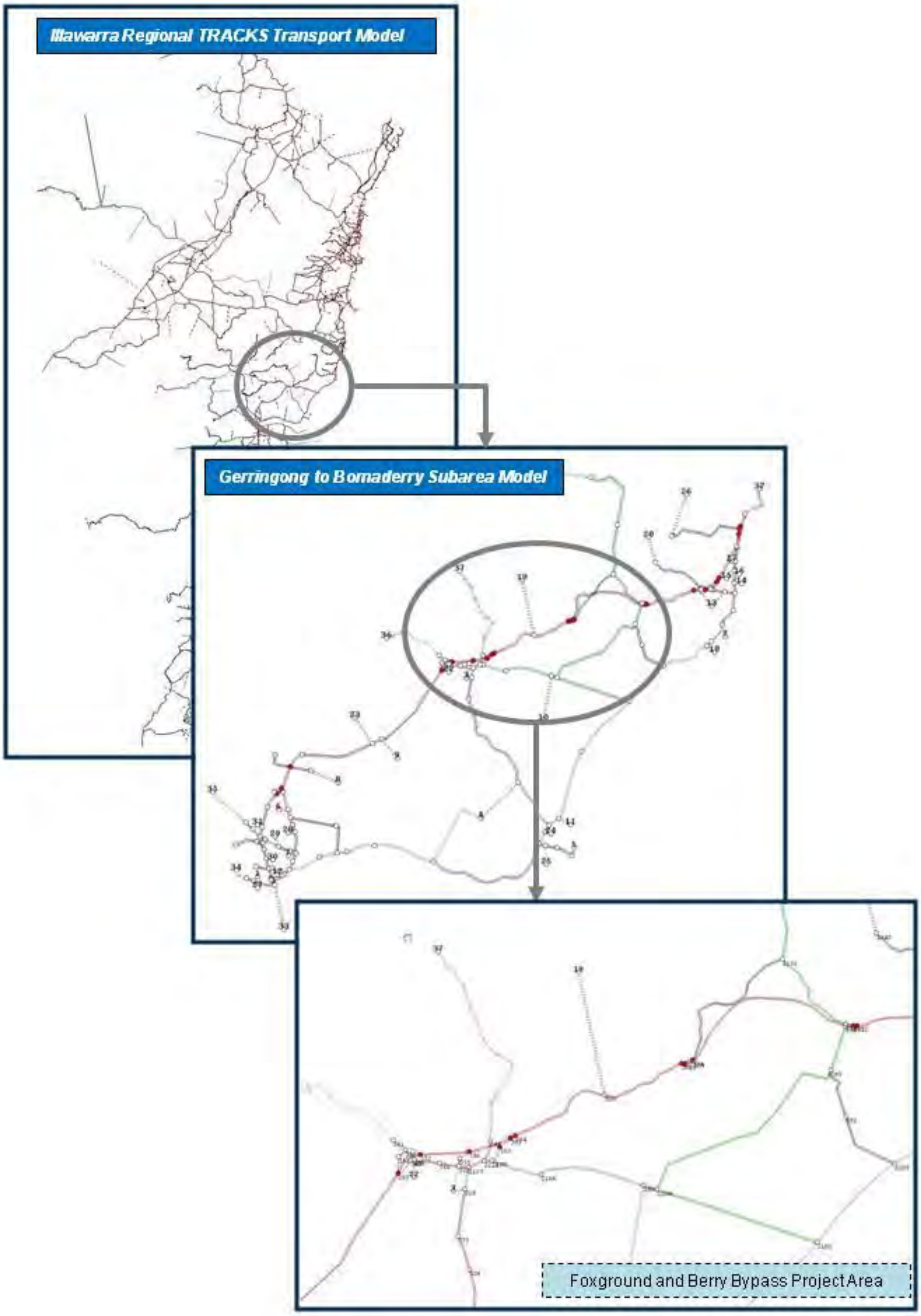
Notes

- If Vp => 3,200 pc/h, terminate analysis - the LOS is F.
- If the highest directional split Vp => 1,700 pc/h, terminate analysis - the LOS is F.

Appendix B

Regional and sub-area TRACKS model network coverage

Regional and sub-area TRACKS model network coverage



Appendix C

Traffic forecasting spreadsheet model (example location)

Traffic forecasting spreadsheet model (example location)

Location:	Princes Hwy: Berry Bypass Between Between Berry East and West Ramps		
Site ID:	K | 1		
TRACKS Modelled Data 2026	Princes Hwy South of Berry	Berry Bypass	Bypass Use (%)
Northbound	11635	10245	88.1%
Southbound	11618	10289	88.6%
Two-Way	23253	20534	88.3%
100th:	11.62%	(of AADT)	

Proposed Construction Dates	
2011	Project 1 Begins
2014	Project 1 Completed
2017	Project 2 Completed
2019	Project 3 Completed

Annual Average Daily Traffic (AADT) - Annual Forecast Summary

Year	Southbound				Northbound				Two-way			
	Light	Heavy	% Heavy	All Veh	Light	Heavy	% Heavy	All Veh	Light	Heavy	% Heavy	All Veh
2009	-	-	-	-	-	-	-	-	-	-	-	-
2010	-	-	-	-	-	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-	-	-	-
2017	6,455	824	11.3%	7,280	6,773	773	10.2%	7,545	13,228	1,597	10.8%	14,825
2018	6,568	845	11.4%	7,413	6,888	792	10.3%	7,680	13,456	1,637	10.8%	15,093
2019	7,579	866	10.3%	8,445	7,870	812	9.3%	8,682	15,449	1,677	9.8%	17,127
2020	7,821	877	10.1%	8,697	8,119	822	9.2%	8,941	15,939	1,698	9.6%	17,638
2021	8,062	888	9.9%	8,949	8,368	832	9.0%	9,200	16,430	1,719	9.5%	18,149
2022	8,303	898	9.8%	9,201	8,617	842	8.9%	9,459	16,920	1,740	9.3%	18,660
2023	8,544	909	9.6%	9,453	8,866	852	8.8%	9,718	17,410	1,761	9.2%	19,171
2024	8,785	920	9.5%	9,705	9,115	862	8.6%	9,977	17,900	1,782	9.1%	19,682
2025	9,103	953	9.5%	10,056	9,444	893	8.6%	10,337	18,546	1,846	9.1%	20,393
2026	9,420	986	9.5%	10,406	9,773	924	8.6%	10,697	19,192	1,911	9.1%	21,103
2027	9,737	1,020	9.5%	10,756	10,102	955	8.6%	11,057	19,838	1,975	9.1%	21,813
2028	10,054	1,053	9.5%	11,106	10,431	987	8.6%	11,417	20,484	2,039	9.1%	22,523
2029	10,371	1,086	9.5%	11,457	10,759	1,018	8.6%	11,777	21,130	2,104	9.1%	23,234
2030	10,688	1,119	9.5%	11,807	11,088	1,049	8.6%	12,137	21,776	2,168	9.1%	23,944
2031	11,005	1,152	9.5%	12,157	11,417	1,080	8.6%	12,497	22,422	2,232	9.1%	24,654
2032	11,322	1,186	9.5%	12,507	11,746	1,111	8.6%	12,857	23,068	2,297	9.1%	25,364
2033	11,639	1,219	9.5%	12,857	12,075	1,142	8.6%	13,217	23,714	2,361	9.1%	26,075
2034	11,956	1,252	9.5%	13,208	12,404	1,173	8.6%	13,577	24,360	2,425	9.1%	26,785
2035	12,273	1,285	9.5%	13,558	12,733	1,204	8.6%	13,937	25,006	2,490	9.1%	27,495
2036	12,590	1,318	9.5%	13,908	13,062	1,235	8.6%	14,297	25,652	2,554	9.1%	28,205
2037	12,907	1,352	9.5%	14,258	13,391	1,267	8.6%	14,657	26,297	2,618	9.1%	28,916
2038	13,224	1,385	9.5%	14,609	13,720	1,298	8.6%	15,017	26,943	2,682	9.1%	29,626
2039	13,541	1,418	9.5%	14,959	14,049	1,329	8.6%	15,377	27,589	2,747	9.1%	30,336
2040	13,858	1,451	9.5%	15,309	14,377	1,360	8.6%	15,737	28,235	2,811	9.1%	31,046

Bypass growth rate post Sandtrack transfer: 3.76%

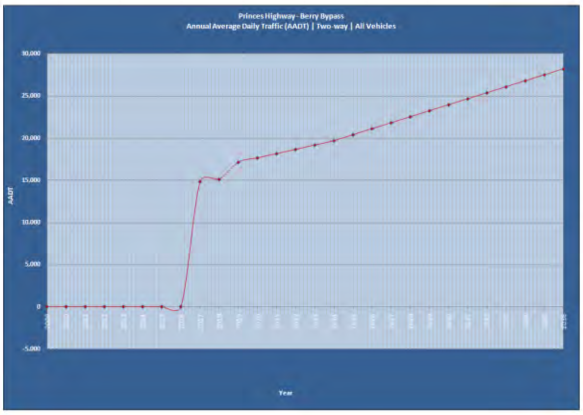
Annual Average Daily Traffic (AADT) - Daily Forecast Analysis

Direction	Year	AADT	9 Hour AADT (22:00 - 07:00)		15 Hour AADT (07:00 - 22:00)		AM Peak	PM Peak	100th Hour	PM Peak - 100th Hour Factor Hour	% Heavy	Expansion Factor
			Total	Peak	Total	Peak						
Light Vehicles												
Southbound	2037	12,907	928	343	11,978	1,098	964	1,098	1,500	1.37	-	13.4
Heavy Vehicles												
Southbound	2037	1,352	269	87	1,082	107	107	78	157	2.02	-	12.6
All Vehicles												
Southbound	2037	14,258	1,258	448	13,000	1,163	1,073	1,163	1,657	1.42	#N/A	13.3

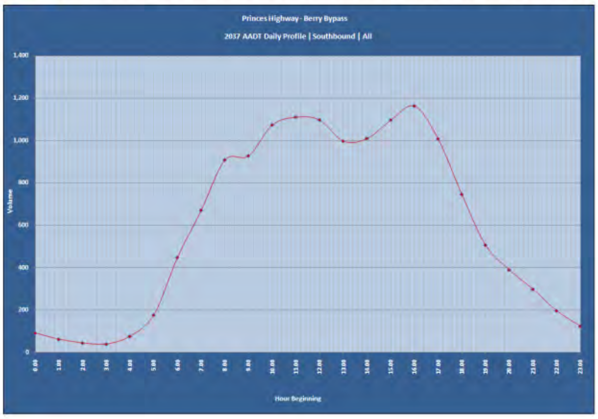
Periods: 9 Hour AADT (hours 0–6); AM Peak (hours 7–10); 15 Hour AADT (hours 7–21); PM Peak (hours 16–19)

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Light Vehicles																								
Profile %	0.5%	0.3%	0.2%	0.2%	0.3%	0.9%	2.7%	4.3%	6.4%	6.4%	7.5%	7.8%	7.9%	7.1%	7.2%	7.9%	8.5%	7.6%	5.5%	3.7%	2.8%	2.2%	1.4%	0.8%
Volume	67	39	20	20	34	117	343	556	821	829	964	1,007	1,017	920	929	1,023	1,098	975	712	482	366	280	180	108
Heavy Vehicles																								
Profile %	1.5%	1.3%	1.4%	1.1%	2.4%	3.5%	6.5%	7.4%	6.4%	7.0%	7.9%	7.7%	6.4%	6.1%	6.3%	6.1%	5.7%	3.8%	3.3%	2.3%	2.1%	1.6%	1.3%	1.0%
Volume	20	18	18	15	32	48	87	100	87	95	107	104	87	82	85	82	78	51	45	31	28	21	17	14
All Vehicles																								
Profile %	0.6%	0.4%	0.3%	0.3%	0.5%	1.2%	3.1%	4.7%	6.4%	6.5%	7.5%	7.8%	7.7%	7.0%	7.1%	7.7%	8.2%	7.1%	5.2%	3.6%	2.7%	2.1%	1.4%	0.9%
Volume	91	62	44	39	76	177	448	670	908	928	1,073	1,110	1,097	997	1,009	1,096	1,163	1,008	746	506	390	299	197	124

Hour Profile %	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Light Vehicles																								
Northbound	0.3%	0.2%	0.1%	0.2%	0.6%	1.2%	2.8%	4.4%	5.5%	6.8%	7.3%	8.0%	8.2%	7.9%	8.4%	9.3%	9.4%	8.4%	4.6%	2.5%	1.5%	1.2%	0.8%	0.4%
Southbound	0.5%	0.3%	0.2%	0.2%	0.3%	0.9%	2.7%	4.3%	6.4%	6.4%	7.5%	7.8%	7.9%	7.1%	7.2%	7.9%	8.5%	7.6%	5.5%	3.7%	2.8%	2.2%	1.4%	0.8%
Two-way	0.4%	0.2%	0.1%	0.2%	0.4%	1.1%	2.7%	4.4%	5.9%	6.6%	7.4%	7.9%	8.0%	7.5%	7.8%	8.6%	8.9%	8.0%	5.1%	3.1%	2.2%	1.7%	1.1%	0.6%
Heavy Vehicles																								
Northbound	0.7%	0.9%	1.2%	1.5%	2.9%	3.1%	5.5%	7.3%	7.5%	7.4%	6.8%	7.3%	7.2%	7.5%	7.2%	6.4%	5.9%	4.4%	2.5%	1.5%	1.5%	1.3%	1.2%	1.1%
Southbound	1.5%	1.3%	1.4%	1.1%	2.4%	3.5%	6.5%	7.4%	6.4%	7.0%	7.9%	7.7%	6.4%	6.1%	6.3%	6.1%	5.7%	3.8%	3.3%	2.3%	2.1%	1.6%	1.3%	1.0%
Two-way	1.1%	1.1%	1.3%	1.3%	2.6%	3.3%	6.0%	7.3%	7.0%	7.2%	7.4%	7.5%	6.8%	6.8%	6.8%	6.3%	5.8%	4.1%	2.9%	1.9%	1.8%	1.5%	1.3%	1.1%
All Vehicles																								
Northbound	0.3%	0.2%	0.3%	0.4%	0.8%	1.5%	3.1%	4.8%	5.8%	6.9%	7.2%	8.0%	8.1%	7.9%	8.3%	8.9%	8.9%	7.9%	4.4%	2.4%	1.5%	1.2%	0.8%	0.5%
Southbound	0.6%	0.4%	0.3%	0.3%	0.5%	1.2%	3.1%	4.7%	6.4%	6.5%	7.5%	7.8%	7.7%	7.0%	7.1%	7.7%	8.2%	7.1%	5.2%	3.6%	2.7%	2.1%	1.4%	0.9%
Two-way	0.5%	0.3%	0.3%	0.3%	0.7%	1.3%	3.1%	4.7%	6.1%	6.7%	7.4%	7.9%	7.9%	7.4%	7.7%	8.3%	8.5%	7.5%	4.8%	3.0%	2.1%	1.6%	1.1%	0.7%



Princes Highway - Berry Bypass
Annual Average Daily Traffic (AADT) | Two-way | All Vehicles

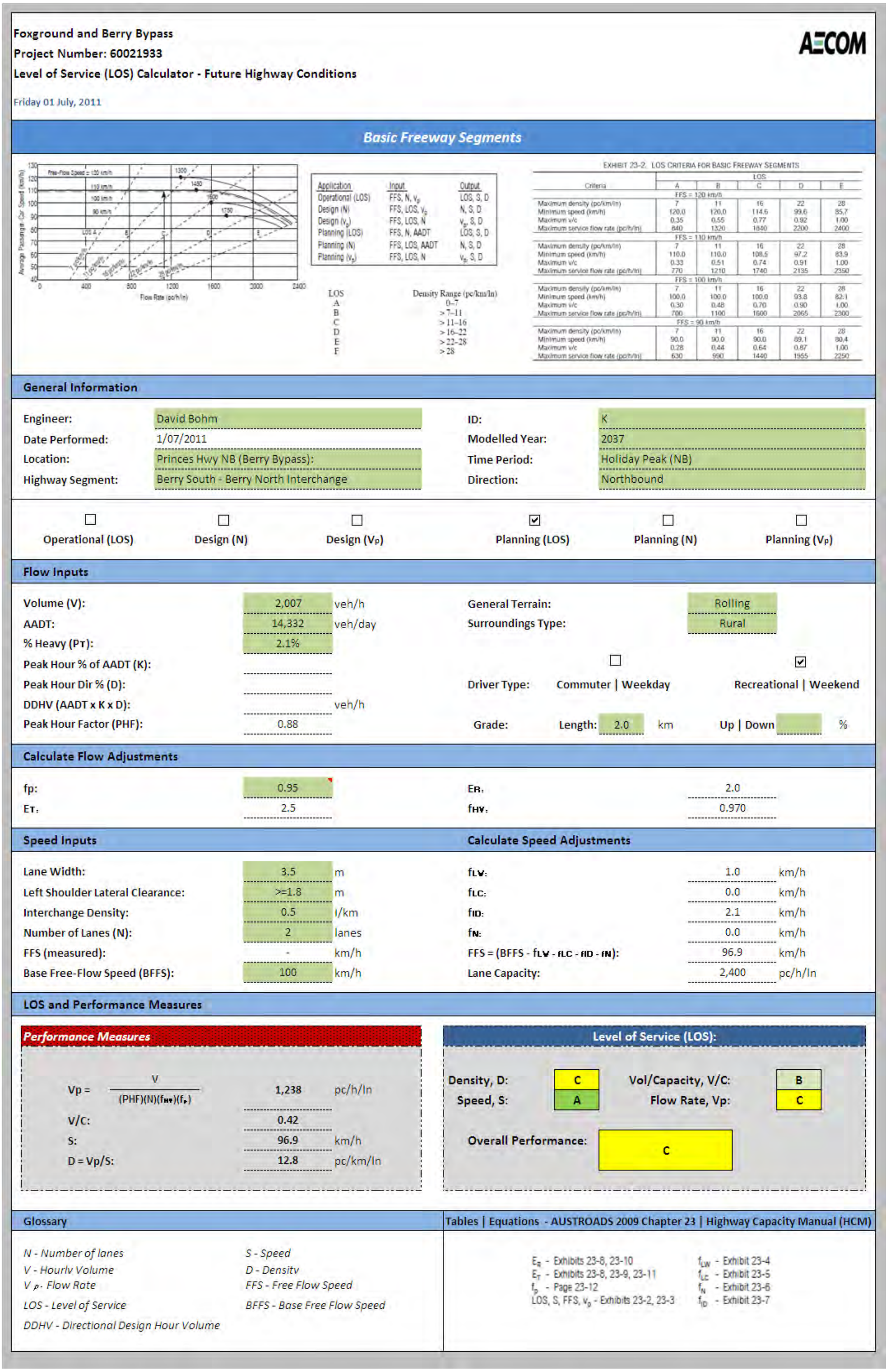


Princes Highway - Berry Bypass
2037 AADT Daily Profile | Southbound | All

Appendix D

Midblock level of service (LoS) model – freeways (example location)

Midblock level of service (LoS) model – freeways (example location)



Foxground and Berry Bypass
Project Number: 60021933
Level of Service (LOS) Calculator - Future Highway Conditions

Friday 01 July, 2011

AECOM

Basic Freeway Segments

Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

LOS	Density Range (pc/km/ln)
A	0–7
B	> 7–11
C	> 11–16
D	> 16–22
E	> 22–28
F	> 28

EXHIBIT 23-2. LOS CRITERIA FOR BASIC FREEWAY SEGMENTS

Criteria	LOS				
	A	B	C	D	E
FFS = 120 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	120.0	120.0	114.6	99.6	85.7
Maximum v/c	0.35	0.55	0.77	0.92	1.00
Maximum service flow rate (pc/h/ln)	840	1320	1840	2200	2400
FFS = 110 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	110.0	110.0	108.5	97.2	83.9
Maximum v/c	0.33	0.51	0.74	0.91	1.00
Maximum service flow rate (pc/h/ln)	770	1210	1740	2135	2350
FFS = 100 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	100.0	100.0	100.0	93.8	82.1
Maximum v/c	0.30	0.48	0.70	0.90	1.00
Maximum service flow rate (pc/h/ln)	700	1100	1600	2065	2300
FFS = 90 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	90.0	90.0	90.0	89.1	80.4
Maximum v/c	0.28	0.44	0.64	0.87	1.00
Maximum service flow rate (pc/h/ln)	630	990	1440	1955	2250

General Information

Engineer:	David Bohm	**ID:**	K
Date Performed:	1/07/2011	**Modelled Year:**	2037
Location:	Princes Hwy NB (Berry Bypass):	**Time Period:**	Holiday Peak (NB)
Highway Segment:	Berry South - Berry North Interchange	**Direction:**	Northbound

☐ **Operational (LOS)** ☐ **Design (N)** ☐ **Design (Vₚ)** ☑ **Planning (LOS)** ☐ **Planning (N)** ☐ **Planning (Vₚ)**

Flow Inputs

Volume (V):	2,007	veh/h	**General Terrain:**	Rolling
AADT:	14,332	veh/day	**Surroundings Type:**	Rural
% Heavy (PT):	2.1%			
Peak Hour % of AADT (K):				
Peak Hour Dir % (D):			**Driver Type:**	☐ **Commuter | Weekday** ☑ **Recreational | Weekend**
DDHV (AADT x K x D):		veh/h		
Peak Hour Factor (PHF):	0.88		**Grade:**	**Length:** 2.0 km **Up | Down** %

Calculate Flow Adjustments

fp:	0.95	**ER:**	2.0
ET:	2.5	**fHV:**	0.970

Speed Inputs / Calculate Speed Adjustments

Lane Width:	3.5	m	**fLW:**	1.0	km/h
Left Shoulder Lateral Clearance:	>=1.8	m	**fLC:**	0.0	km/h
Interchange Density:	0.5	i/km	**fID:**	2.1	km/h
Number of Lanes (N):	2	lanes	**fN:**	0.0	km/h
FFS (measured):	-	km/h	**FFS = (BFFS - fLW - fLC - fID - fN):**	96.9	km/h
Base Free-Flow Speed (BFFS):	100	km/h	**Lane Capacity:**	2,400	pc/h/ln

LOS and Performance Measures

Performance Measures

$$Vp = \frac{V}{(PHF)(N)(f_{HV})(f_p)}$$ **1,238** pc/h/ln

V/C:	0.42	
S:	96.9	km/h
D = Vp/S:	12.8	pc/km/ln

Level of Service (LOS):

Density, D:	**C**	**Vol/Capacity, V/C:**	**B**
Speed, S:	**A**	**Flow Rate, Vp:**	**C**

Overall Performance: **C**

Glossary

N - Number of lanes
V - Hourly Volume
V ₚ - Flow Rate
LOS - Level of Service
DDHV - Directional Design Hour Volume
S - Speed
D - Density
FFS - Free Flow Speed
BFFS - Base Free Flow Speed

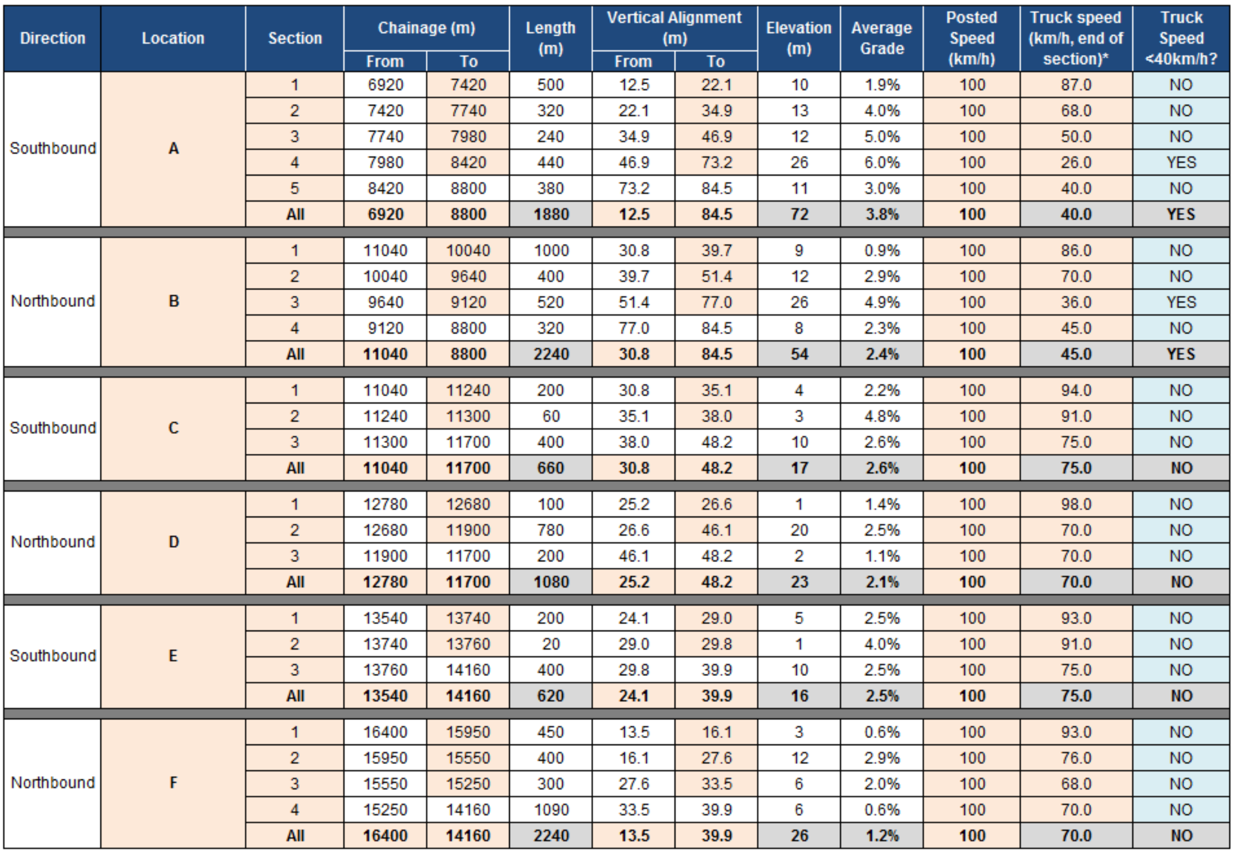
Tables | Equations - AUSTROADS 2009 Chapter 23 | Highway Capacity Manual (HCM)

E_R - Exhibits 23-8, 23-10
E_T - Exhibits 23-8, 23-9, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

Appendix E

Climbing lane assessment locations

Climbing lane assessment locations



Direction	Location	Section	Chainage (m)		Length (m)	Vertical Alignment (m)		Elevation (m)	Average Grade	Posted Speed (km/h)	Truck speed (km/h, end of section)*	Truck Speed <40km/h?
			From	To		From	To					
Southbound	A	1	6920	7420	500	12.5	22.1	10	1.9%	100	87.0	NO
		2	7420	7740	320	22.1	34.9	13	4.0%	100	68.0	NO
		3	7740	7980	240	34.9	46.9	12	5.0%	100	50.0	NO
		4	7980	8420	440	46.9	73.2	26	6.0%	100	26.0	YES
		5	8420	8800	380	73.2	84.5	11	3.0%	100	40.0	NO
		All	**6920**	**8800**	**1880**	**12.5**	**84.5**	**72**	**3.8%**	**100**	**40.0**	**YES**
Northbound	B	1	11040	10040	1000	30.8	39.7	9	0.9%	100	86.0	NO
		2	10040	9640	400	39.7	51.4	12	2.9%	100	70.0	NO
		3	9640	9120	520	51.4	77.0	26	4.9%	100	36.0	YES
		4	9120	8800	320	77.0	84.5	8	2.3%	100	45.0	NO
		All	**11040**	**8800**	**2240**	**30.8**	**84.5**	**54**	**2.4%**	**100**	**45.0**	**YES**
Southbound	C	1	11040	11240	200	30.8	35.1	4	2.2%	100	94.0	NO
		2	11240	11300	60	35.1	38.0	3	4.8%	100	91.0	NO
		3	11300	11700	400	38.0	48.2	10	2.6%	100	75.0	NO
		All	**11040**	**11700**	**660**	**30.8**	**48.2**	**17**	**2.6%**	**100**	**75.0**	**NO**
Northbound	D	1	12780	12680	100	25.2	26.6	1	1.4%	100	98.0	NO
		2	12680	11900	780	26.6	46.1	20	2.5%	100	70.0	NO
		3	11900	11700	200	46.1	48.2	2	1.1%	100	70.0	NO
		All	**12780**	**11700**	**1080**	**25.2**	**48.2**	**23**	**2.1%**	**100**	**70.0**	**NO**
Southbound	E	1	13540	13740	200	24.1	29.0	5	2.5%	100	93.0	NO
		2	13740	13760	20	29.0	29.8	1	4.0%	100	91.0	NO
		3	13760	14160	400	29.8	39.9	10	2.5%	100	75.0	NO
		All	**13540**	**14160**	**620**	**24.1**	**39.9**	**16**	**2.5%**	**100**	**75.0**	**NO**
Northbound	F	1	16400	15950	450	13.5	16.1	3	0.6%	100	93.0	NO
		2	15950	15550	400	16.1	27.6	12	2.9%	100	76.0	NO
		3	15550	15250	300	27.6	33.5	6	2.0%	100	68.0	NO
		4	15250	14160	1090	33.5	39.9	6	0.6%	100	70.0	NO
		All	**16400**	**14160**	**2240**	**13.5**	**39.9**	**26**	**1.2%**	**100**	**70.0**	**NO**

Figure E1: Detailed truck speed analysis

(Source: AECOM)

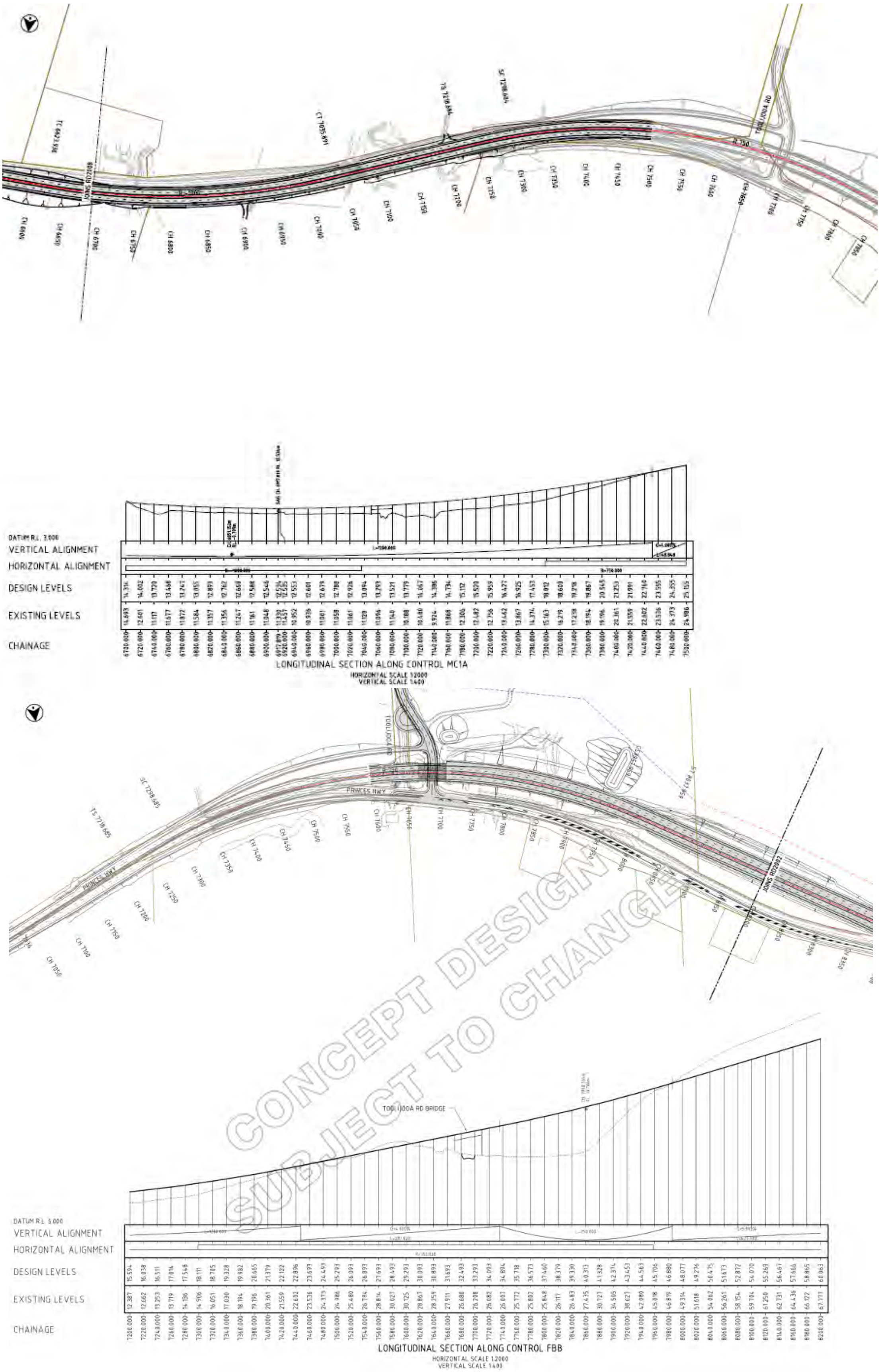


Figure E2: Location A - CH6920-8800 (beginning 800 metres east of Toolijooa Road), southbound

(Source: AECOM)

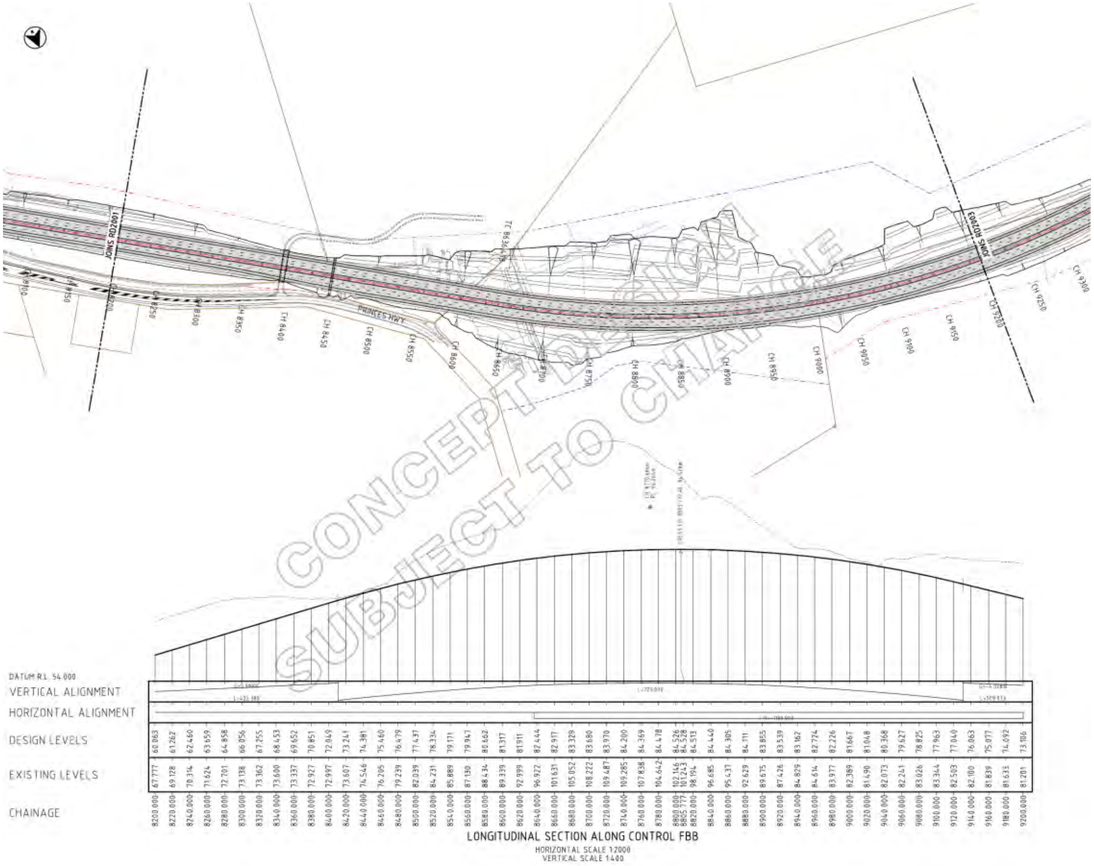


Figure E2 (con't): Location A - CH6920-8800 (beginning 800 metres east of Toolijooa Road), southbound

(Source: AECOM)

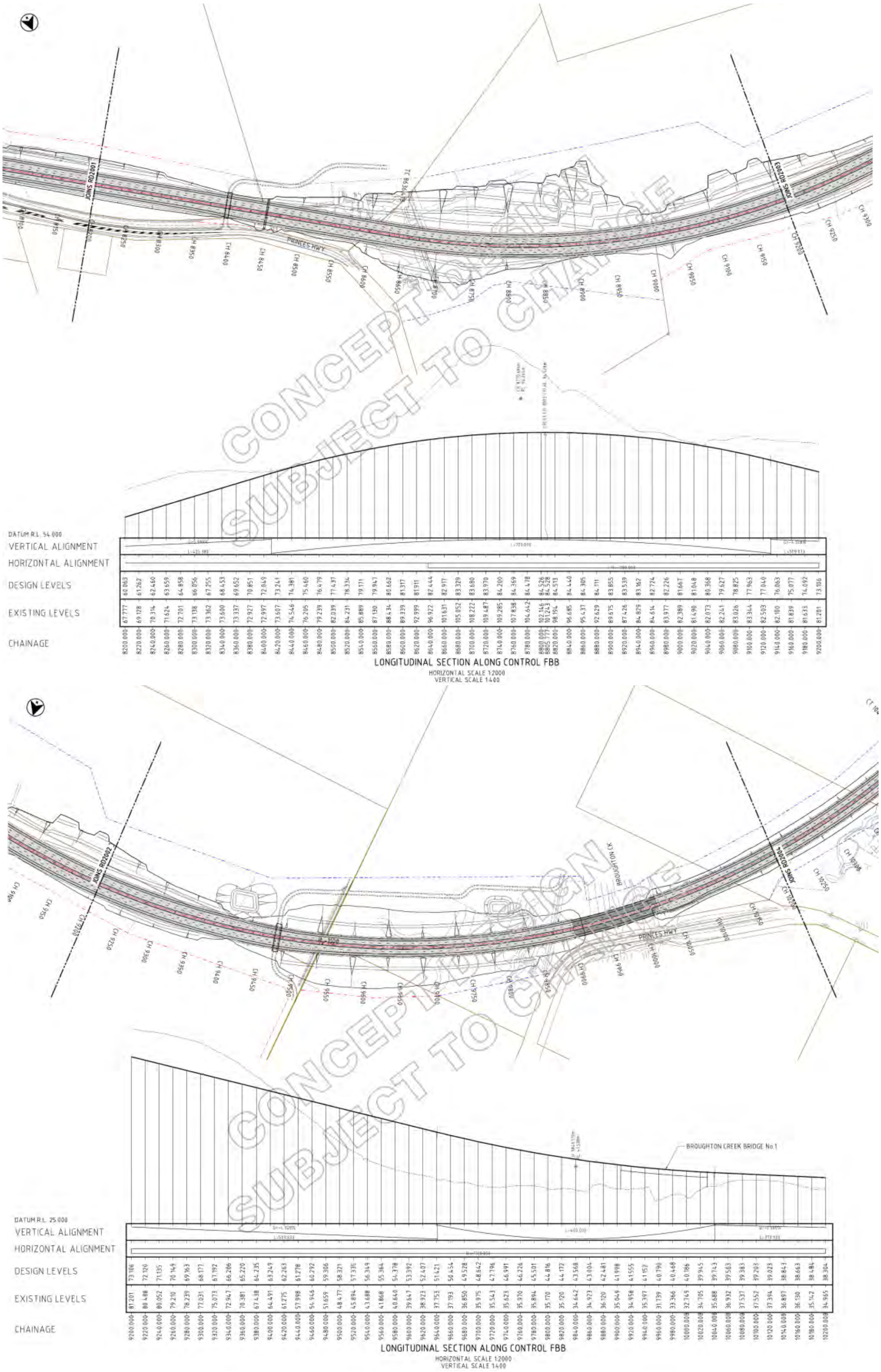


Figure E3: Location B - CH11040-8800 (beginning one kilometre east of Austral Park Road), northbound

(Source: AECOM)

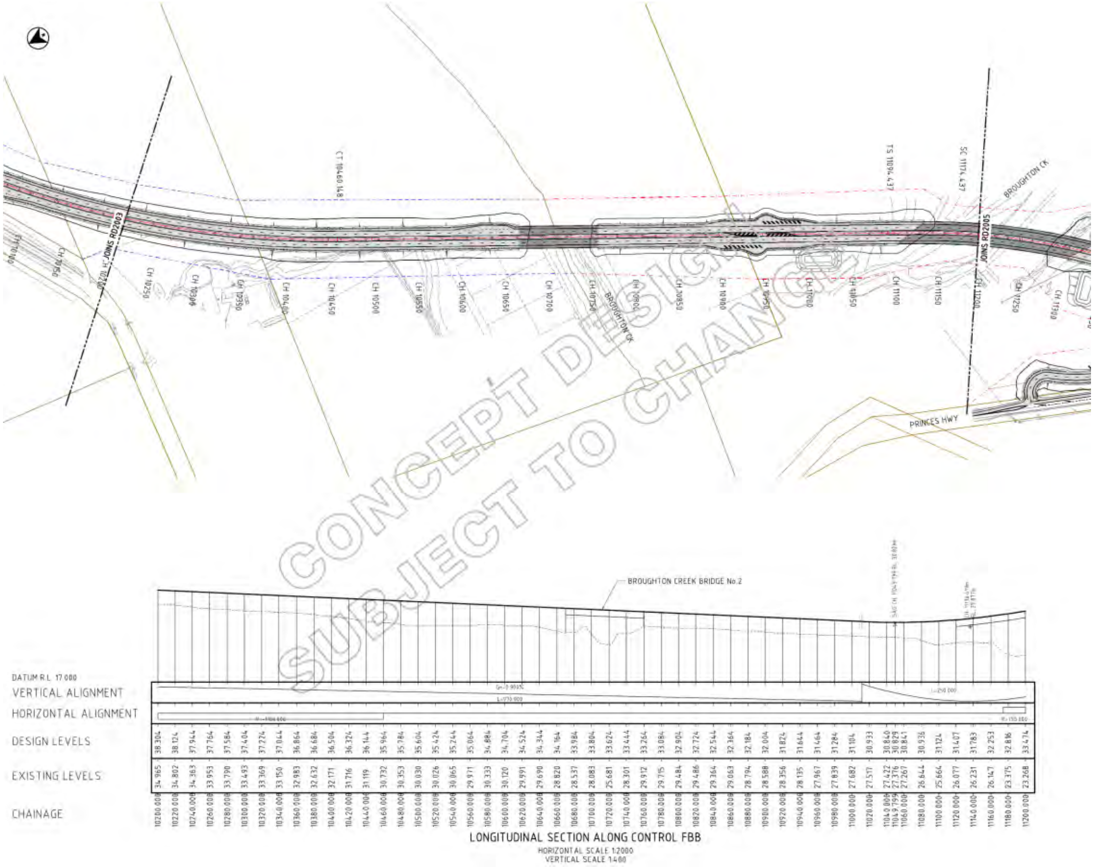


Figure E3 (con't): Location B - CH11040-8800 (beginning one kilometre east of Austral Park Road), northbound

(Source: AECOM)

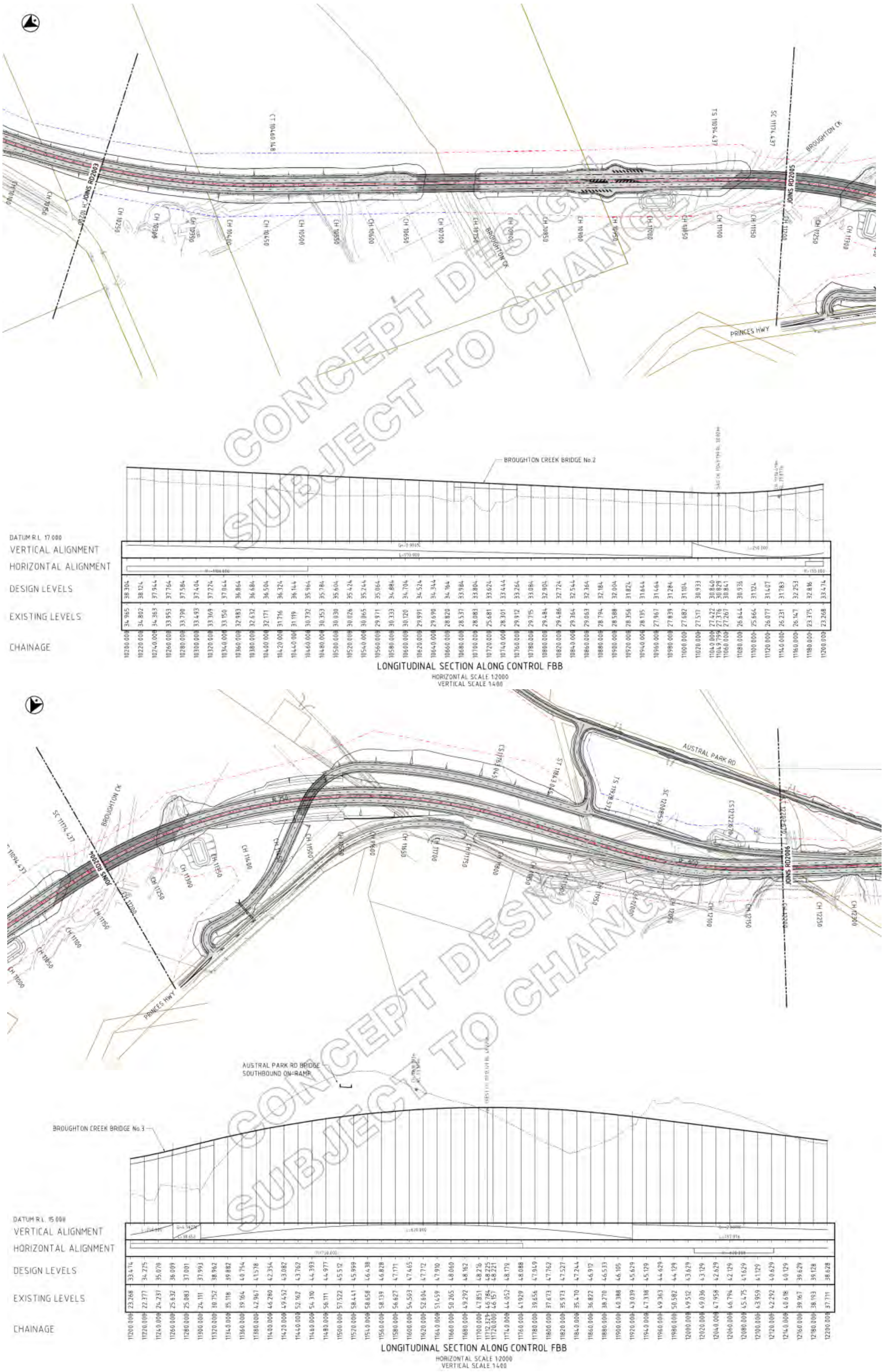


Figure E4: Location C - CH11040-11700 (beginning one kilometre east of Austral Park Road), southbound

(Source: AECOM)

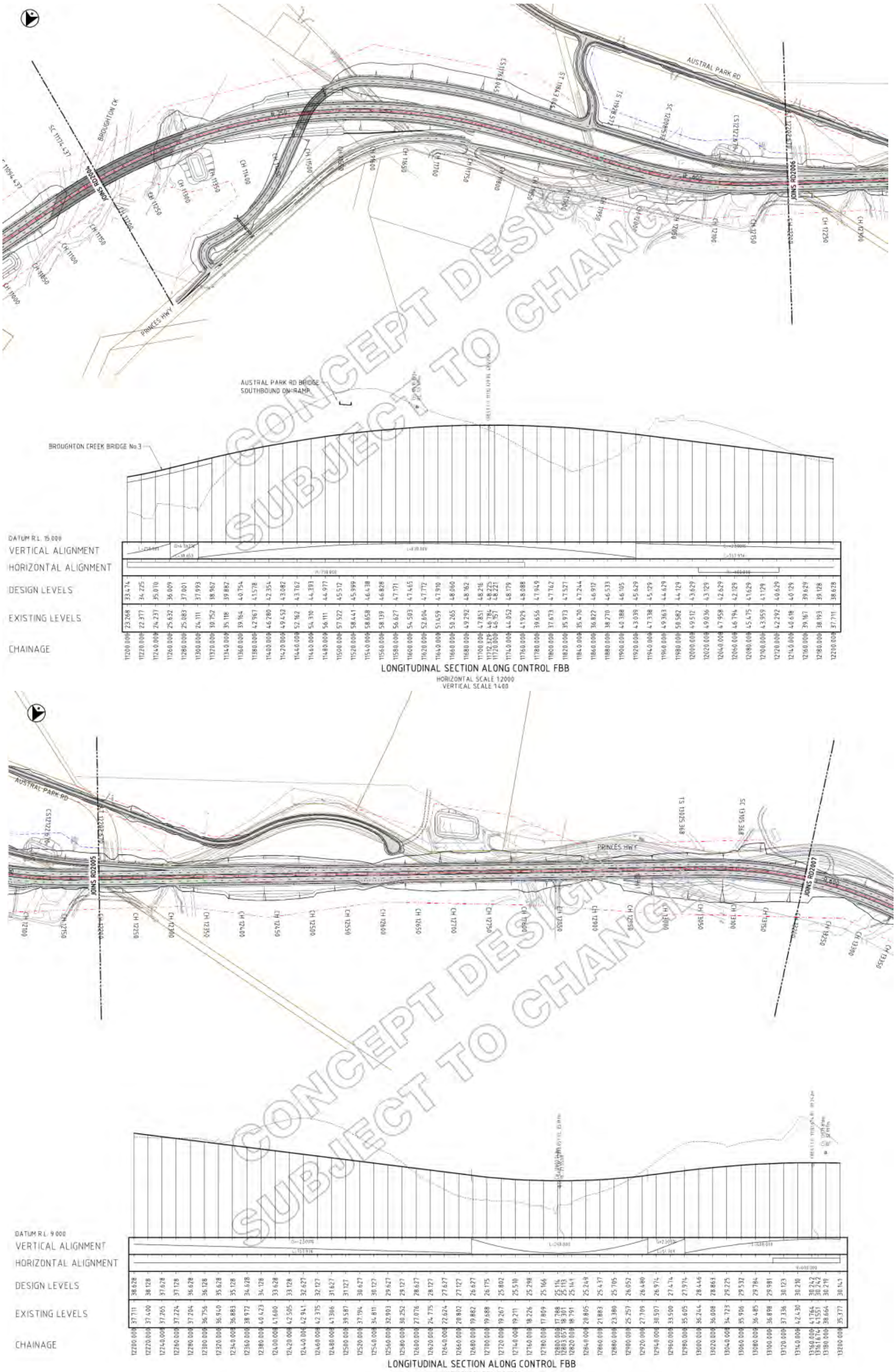


Figure E5: Location D - CH12780-11700 (beginning 500 metres west of Austral Park Road), northbound

(Source: AECOM)

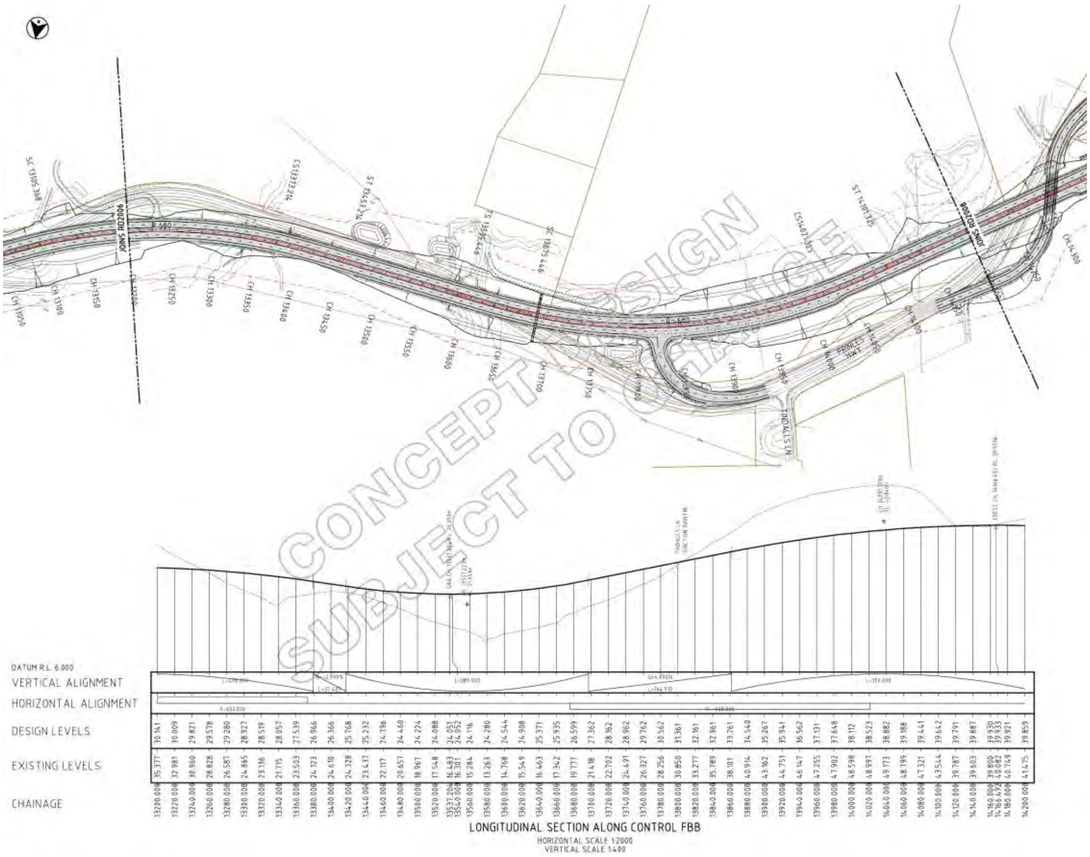


Figure E6: Location E - CH13540-14160 (beginning 400 metres east of Tindalls Lane), southbound

(Source: AECOM)

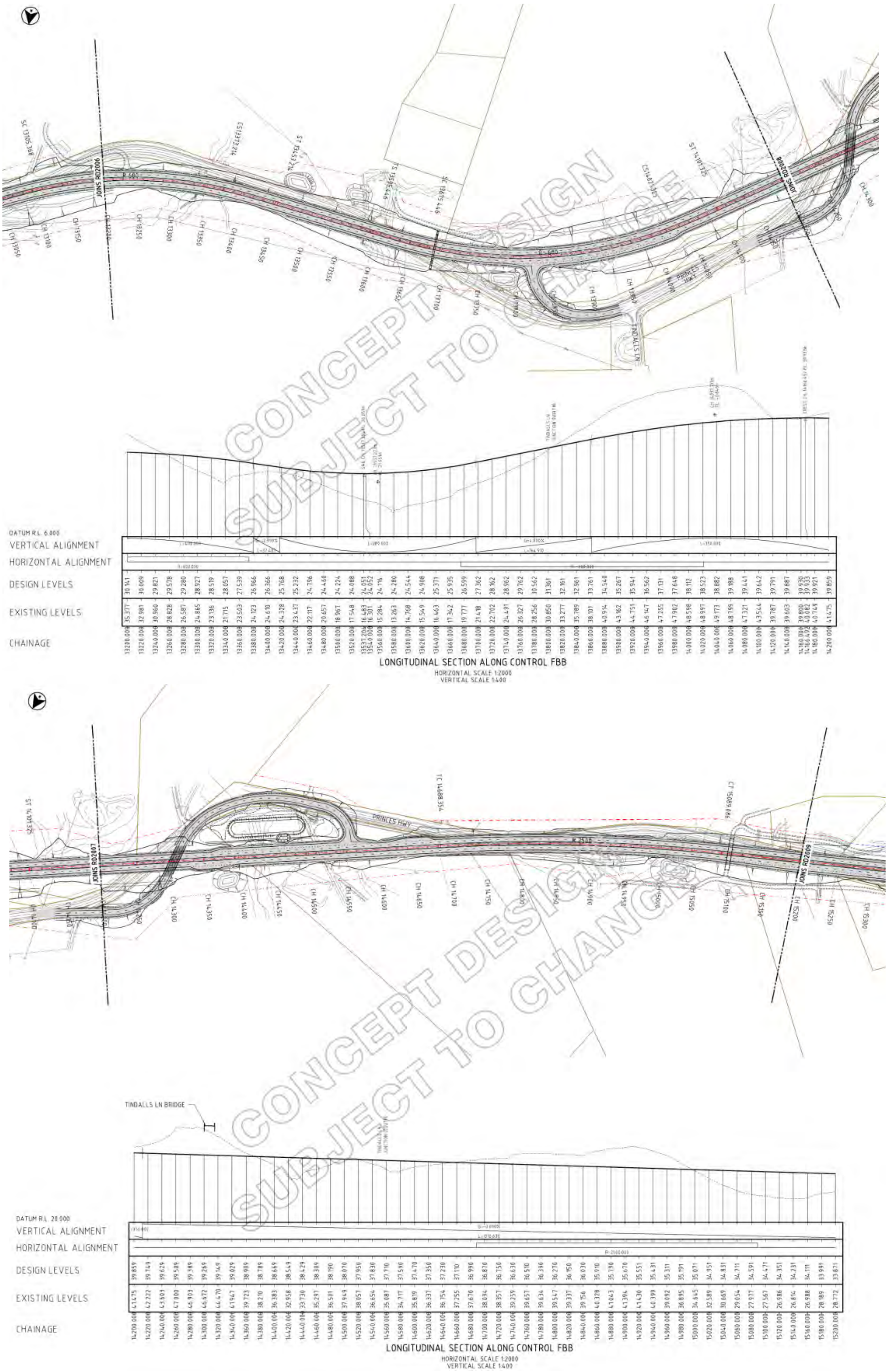


Figure E7: Location F - CH16400-14160 (beginning 400 metres west of Woodhill Mountain Road), northbound

(Source: AECOM)

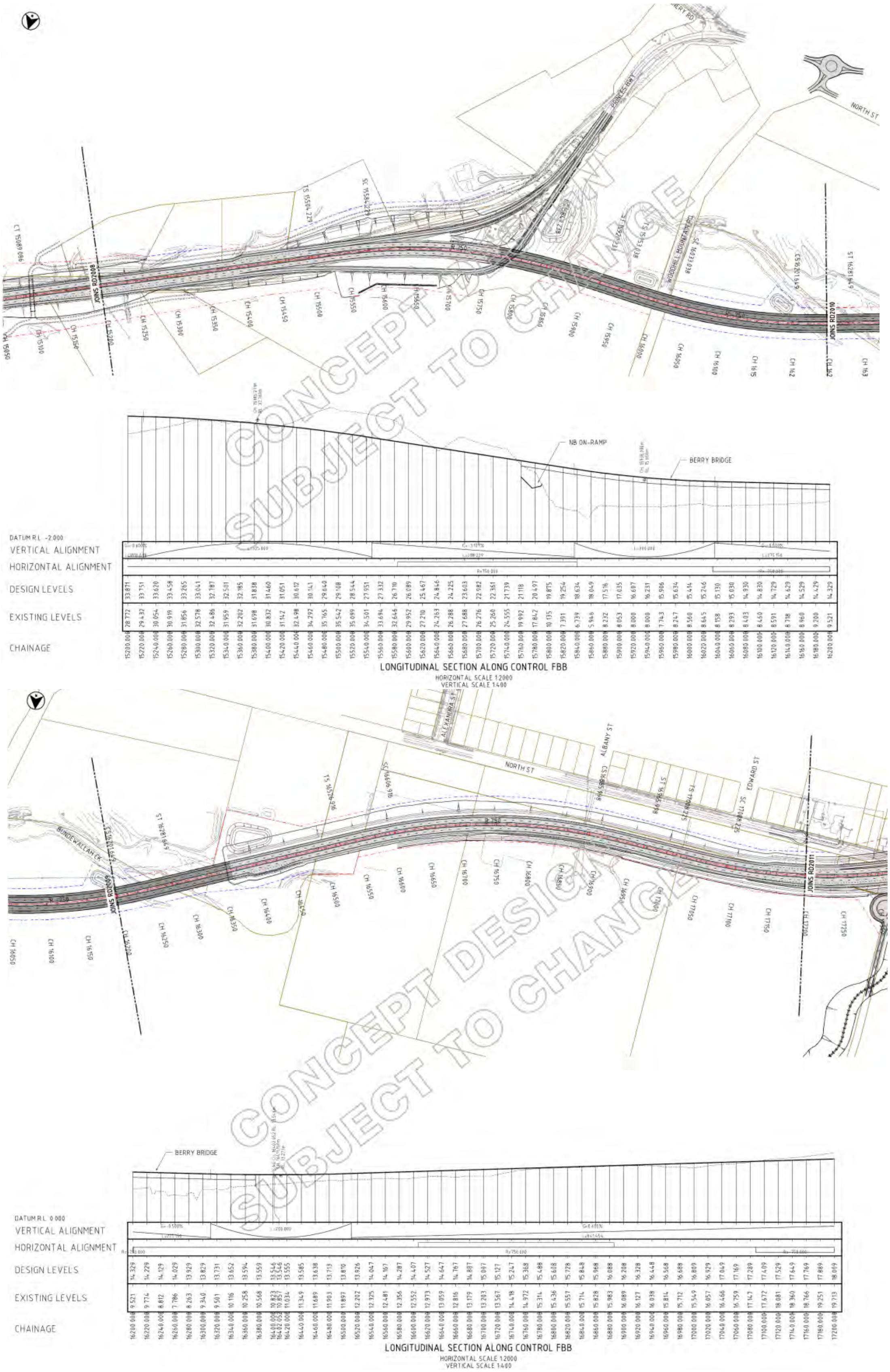
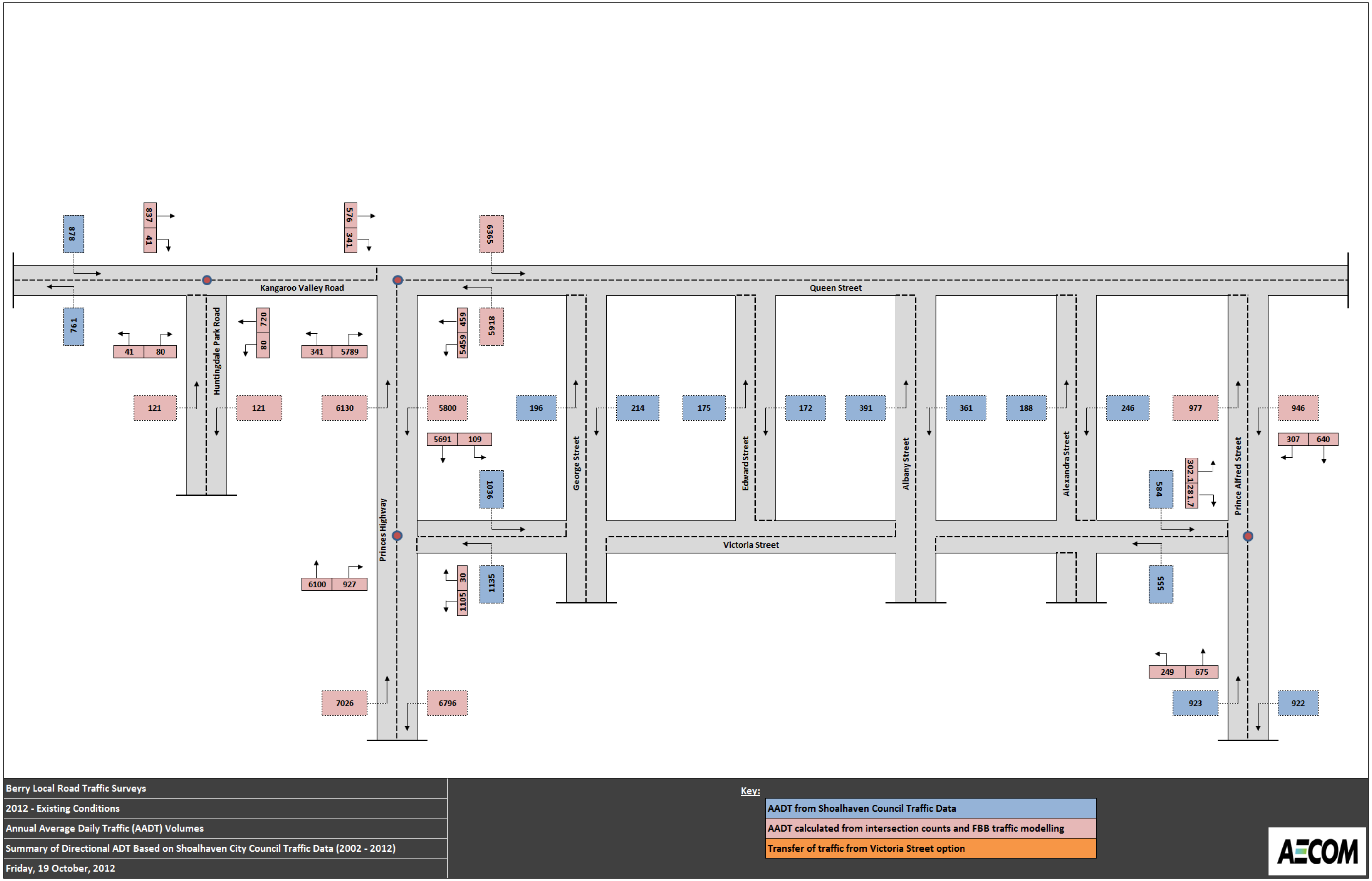


Figure E7 (con't): Location F - CH16400-14160 (beginning 400 metres west of Woodhill Mountain Road), northbound

(Source: AECOM)

Appendix F

Victoria Street design options - annual average daily traffic (AADT) flow diagrams



Berry Local Road Traffic Surveys

2012 - Existing Conditions

Annual Average Daily Traffic (AADT) Volumes

Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)

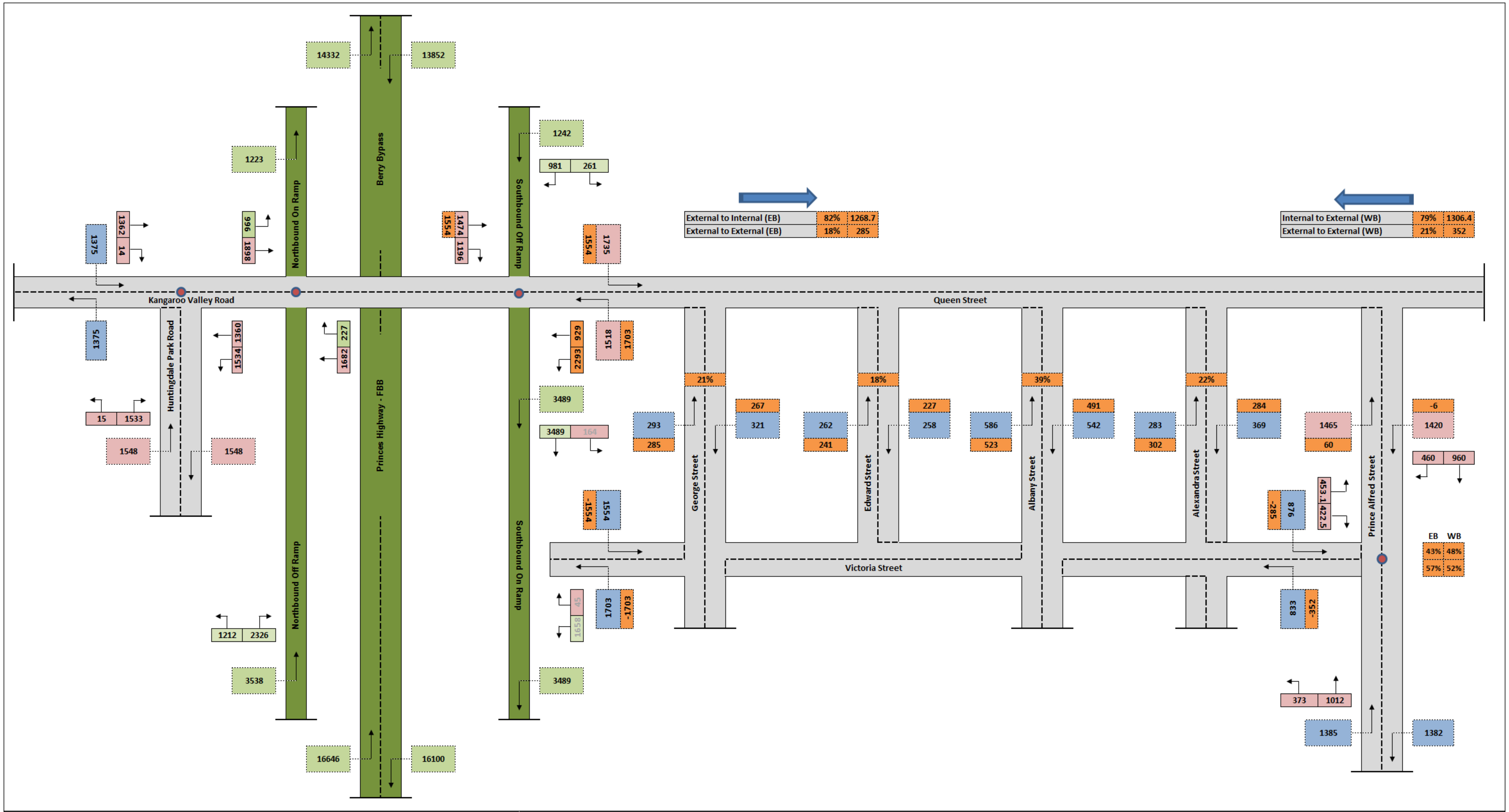
Friday, 19 October, 2012

Key:

- 🟦 AADT from Shoalhaven Council Traffic Data
- 🟥 AADT calculated from intersection counts and FBB traffic modelling
- 🟧 Transfer of traffic from Victoria Street option

AECOM

Figure F1: 2012 Existing Conditions – AADT flow diagram
(Source: AECOM)



Berry Local Road Traffic Surveys

2037 - Victoria St Closed | One-way Southbound On-Load Ramp

Annual Average Daily Traffic (AADT) Volumes

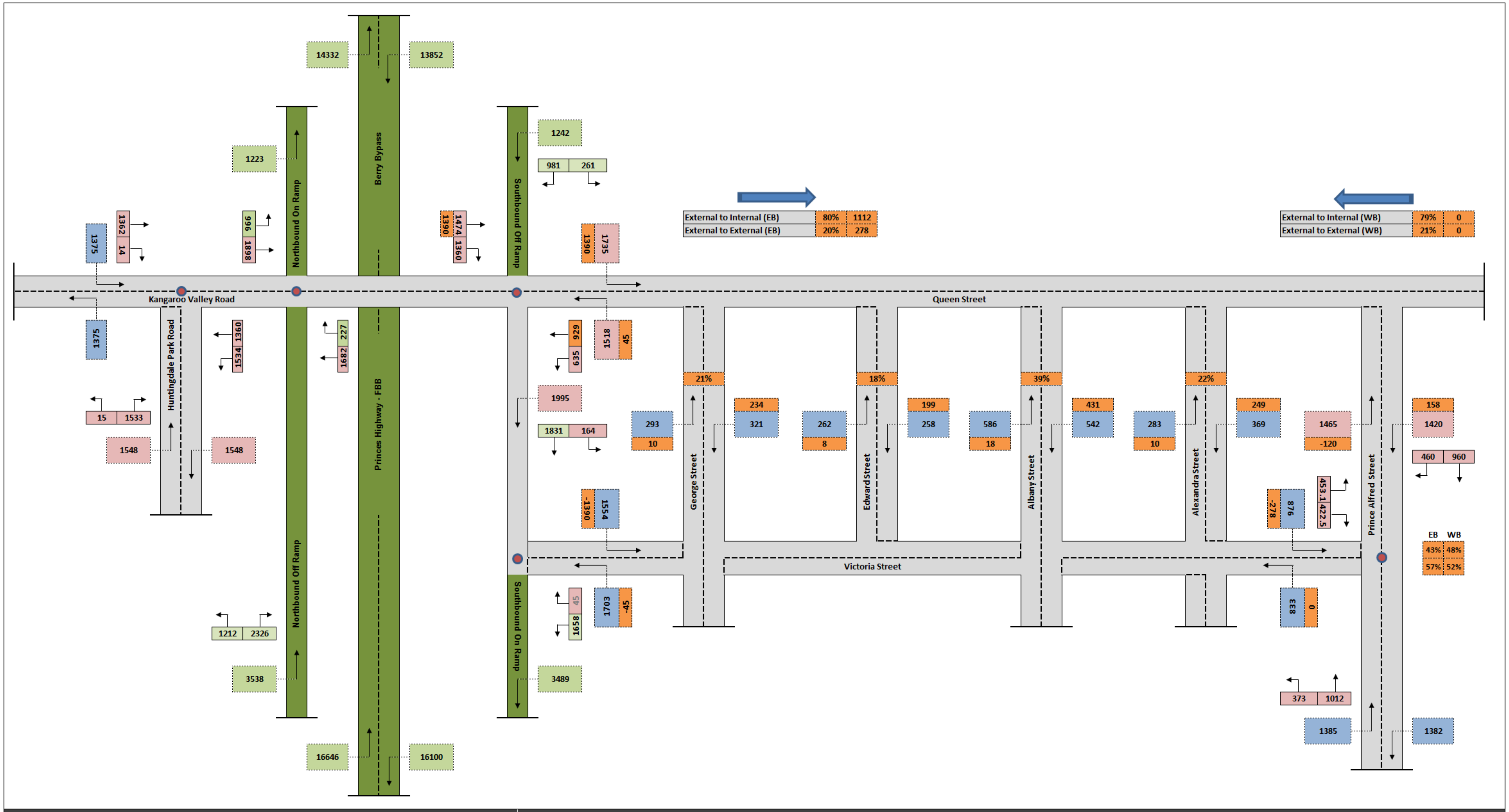
Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)

Friday, 19 October, 2012

Key:

AADT from Shoalhaven Council Traffic Data
AADT calculated from intersection counts and FBB traffic modelling
Transfer of traffic from Victoria Street option

Figure F2: 2037 Option 1 Victoria Street closed and one-way southbound on ramp – AADT flow diagram
(Source: AECOM)



Berry Local Road Traffic Surveys

2037 - Victoria St Open | One-way connection between Victoria Street and Queen Street

Annual Average Daily Traffic (AADT) Volumes

Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)

Monday, 22 October, 2012

Key:

- AADT from Shoalhaven Council Traffic Data
- AADT calculated from intersection counts and FBB traffic modelling
- Transfer of traffic from Victoria Street option

AECOM

Figure F3: 2037 Option 2 Victoria Street open and one-way southbound on ramp – AADT flow diagram
(Source: AECOM)

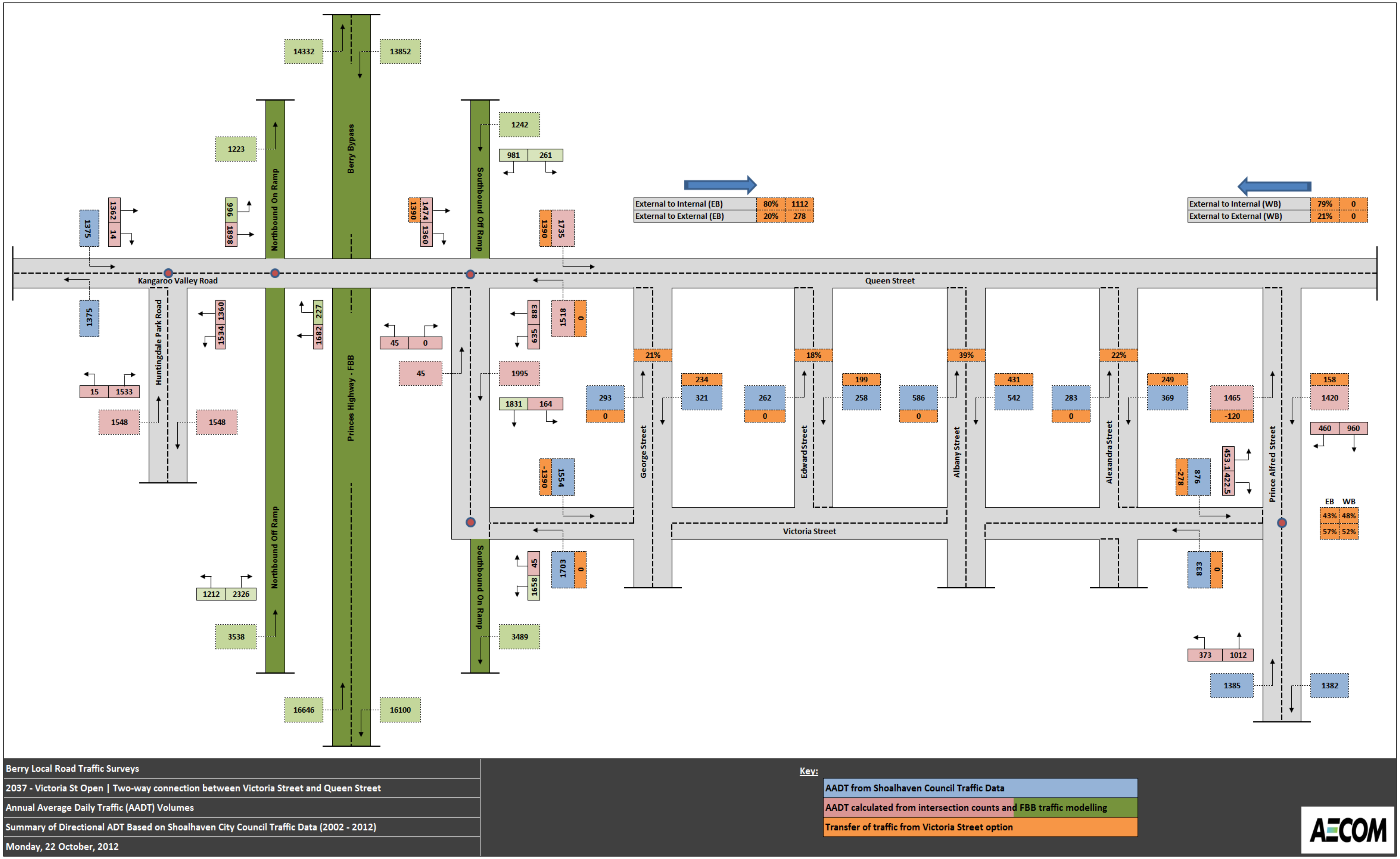
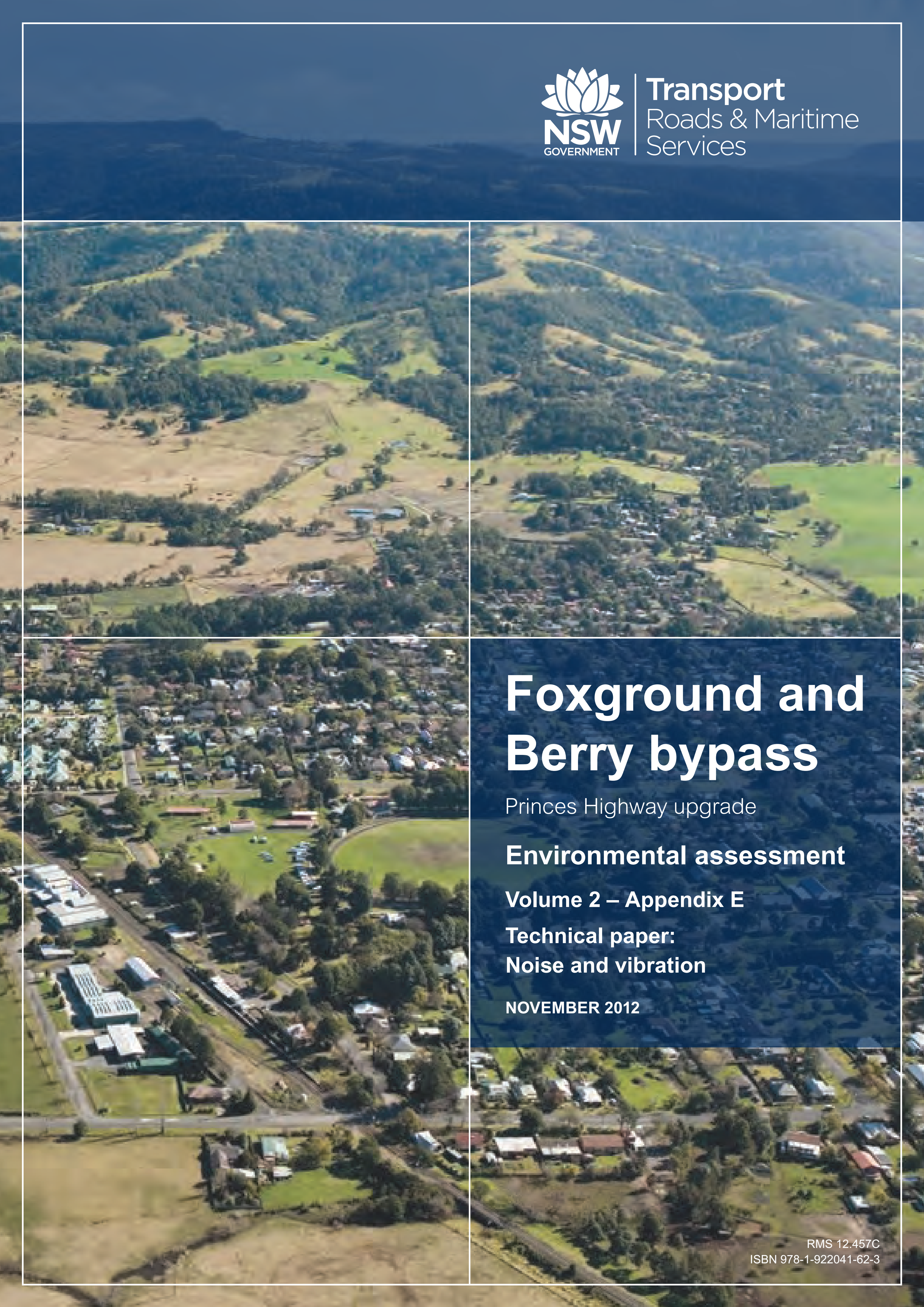


Figure F4: 2037 Option 3 Victoria Street open and two-way southbound on ramp – AADT flow diagram
(Source: AECOM)



NSW GOVERNMENT
Transport
Roads & Maritime
Services

Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 2 – Appendix E

Technical paper:
Noise and vibration

NOVEMBER 2012

RMS 12.457C
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Foxground and Berry bypass

Prepared for

Roads and Maritime Services

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, Australia

November 2012

Executive summary

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

Existing environment

The different noise environments currently experienced throughout the project area are described and 591 noise sensitive receivers identified.

Attended and unattended ambient noise measurements have been undertaken to define the construction noise management levels (NMLs) and calibrate the SoundPLAN traffic noise model. The attended noise measurements were undertaken to define the dominant noise source(s) at each location and confirm the suitability of the measurement location.

The unattended noise measurements were undertaken at ten locations throughout the project area. Simultaneous traffic counts were undertaken to measure the traffic volumes at the time of the noise measurements. The results of the unattended noise logging provided correlation with the SoundPLAN model within the accuracies of the Calculation of Road Traffic Noise (CoRTN) algorithm.

Noise criteria

The construction noise management levels were derived from the unattended background noise logging results.

The predicted operational noise from the project has been assessed in accordance with the Road Noise Policy (RNP) (EPA, 2011) and the Environmental Noise Management Manual (ENMM) (RMS, 2001). Appropriate criteria provided in these documents have been used as the basis for the noise impact assessment.

Noise and vibration impact assessment

Standard construction activities including site establishment, earthworks, piling, bridgeworks and paving activities were assessed in accordance with the Interim Construction Noise Guideline (ICNG, 2009). Both typical and worst case noise levels were predicted for the construction noise assessment. Predicted noise levels were found to exceed the NMLs, but generally remain below the ‘highly affected’ noise level.

Works undertaken within the ancillary facilities were also found to exceed the noise management levels. Extended working hours north of the Berry township have been proposed in this report. As work practices would not differ from those during standard work hours, the predicted noise levels are the same. However, the NMLs are typically 5 dB(A) to 10 dB(A) more stringent during the evening and night-time periods, due to lower background noise levels and a more stringent criteria in the ICNG for out of standard hours works. The potential exceedance of the NMLs would therefore increase accordingly.

Particularly noisy equipment has been identified and respite periods have been recommended where extended periods of work would be scheduled.

Extended hours of work have been recommended in order to increase construction efficiency. Five construction scenarios have been selected and have been recommended for extended hours works based on importance and impacts.

Some out of hours work (separate to the extended hours work) would be required for this project. This work is typically not noise intensive, and it is generally impractical to be undertaken during standard work hours due to safety and inconvenience to Princes Highway traffic. Activities including material deliveries and works that would have a major effect on traffic flows can typically be expected during out of hours work periods.

Blasting would be required along the Toolijooa Ridge to produce a cutting to accommodate the alignment. Appropriate blasting criteria in accordance with the relevant guidelines have been recommended. Higher limits have also been proposed contingent on the approval of the affected residents, and the employment of safe work practices. The aim of the higher blasting limits is to reduce the number of blasts and the overall construction timeframe and consequent impacts on the community.

A community engagement framework has been recommended to ensure noise impacted residents would be consulted satisfactorily. The highest consideration should be given to the closest and most affected noise sensitive receivers.

There are currently no proposed or current works that would be undertaken concurrently with the construction of this project. As such sensitive receivers are unlikely to be impacted by the cumulative impacts of construction noise.

The applicable operational noise criteria would be exceeded at 164 receivers, of which 18 receivers are considered to be acutely affected as a direct result of the new road alignment.

Maximum noise levels currently exceed the recommended limits, and are predicted to continue to do so in the future at most locations. The levels may be lower along the new sections of highway due to a reduction in gradients lessening the tendency for trucks to require engine braking and high engine noise. However, receivers that are exposed to a new road would experience a similar number of noise events exceeding the sleep disturbance guideline similar to that currently experienced on existing sections of the Princes Highway.

Mitigation

Recommended construction noise mitigation and management measures have been provided in this report to be included in the construction practices wherever practicable. These measures would be further clarified in the construction noise and vibration management plan (CNVMP) to be developed by the contractor and based on detailed design.

Construction safe working distances have been recommended to ensure that receivers would not be not adversely impacted by vibration as a result of the project. Vibration monitoring should be undertaken within the recommended safe working distances to ensure that the appropriate criteria are not exceeded.

Operational noise mitigation measures in the form of a low noise pavement, a four metre noise protection barrier (subject to detailed design in consultation with the community) to the north of North Street, a four metre noise protection barrier (subject to detailed design in consultation with the community) on the on north bound exit ramp alongside Huntingdale Park Road, and 20 architectural property treatments have been recommended.

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1 Introduction

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

The Director-General of the NSW Department of Planning and Infrastructure required that the noise and vibration assessment address a number of matters. These are the Director-General's requirements (DGRs) which are outlined in **Table 1-1** and cross referenced to relevant sections in the report in which they are addressed.

Table 1-1 Director-General's requirements

DGR reference	Report section
A construction noise and vibration assessment including construction noise, batch plants and blasting impacts. Clearly identify nearest sensitive receivers and assess construction noise/vibration generated by representative construction scenarios focussing on high noise generating works.	Sections 1.2, 2.3, Appendix B, 3.1, 3.2, 3.3, 3.4, 4.1, 4.8, 4.9, 4.10
Where work hours outside of standard construction hours are proposed, clear justification and detailed assessment of these work hours must be provided including alternatives considered and mitigation measures proposed.	Sections 1.2.2, 1.2.3, 4.2.4, 5.1
The assessment must further consider any cumulative impacts during construction, having regard to any other developments (both existing and approved) in the locality	Sections 4.5
An operational road traffic noise assessment including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers;	Sections 4.11,4.11.6,4.11.9, 5.2
The assessment(s) must take into account the following guidelines as relevant: Interim Construction Noise Guideline (DECC, 2009), *Road Noise Policy (DECCW, 2011), Environmental Noise Management Manual (RTA, 2001),* Assessing Vibration: A Technical Guidelines (DEC, 2006); and *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).*	Sections 3.1, 3.5

1.1 Overview of the proposed works

The project would involve widening and realigning a section of the Princes Highway, located within the Kiama and Shoalhaven local government areas (LGAs). The project starts at about the junction of Toolijooa Road and the Princes Highway and finishes at about the junction of Schofield's Lane and the Princes Highway, south of Berry. The total length of the project is 11.6 kilometres.

The project comprises the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.
- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road, referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around190 metres long and 13 metres in height.
  - A bridge at Berry, an 18 span concrete structure around 600 metres long and up to 12 metres in height.
- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.

- Eight underpasses including roads, drainage structures and fauna underpasses:
    - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
    - Property access and fauna underpass in the vicinity of Toolijooa Ridge at chainage 8400.
    - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
    - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
    - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12770.
    - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
    - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13700.
    - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100.
- Modifications to local roads, including Toolijooa Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.
- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for direct property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent ancillary facility site for general road maintenance.

Construction activities as part of the project would include the following:

- Site preparation and establishment works.
- Temporary construction facilities, including construction compounds, stockpile sites, creek crossings, sediment control basins and haulage roads.
- Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks.
- Earthworks and bridge construction.
- Pavement construction.
- Drainage construction.
- Street furniture installation.
- Site restoration.

The project and the key features of the project are shown in **Figure 1-1**.

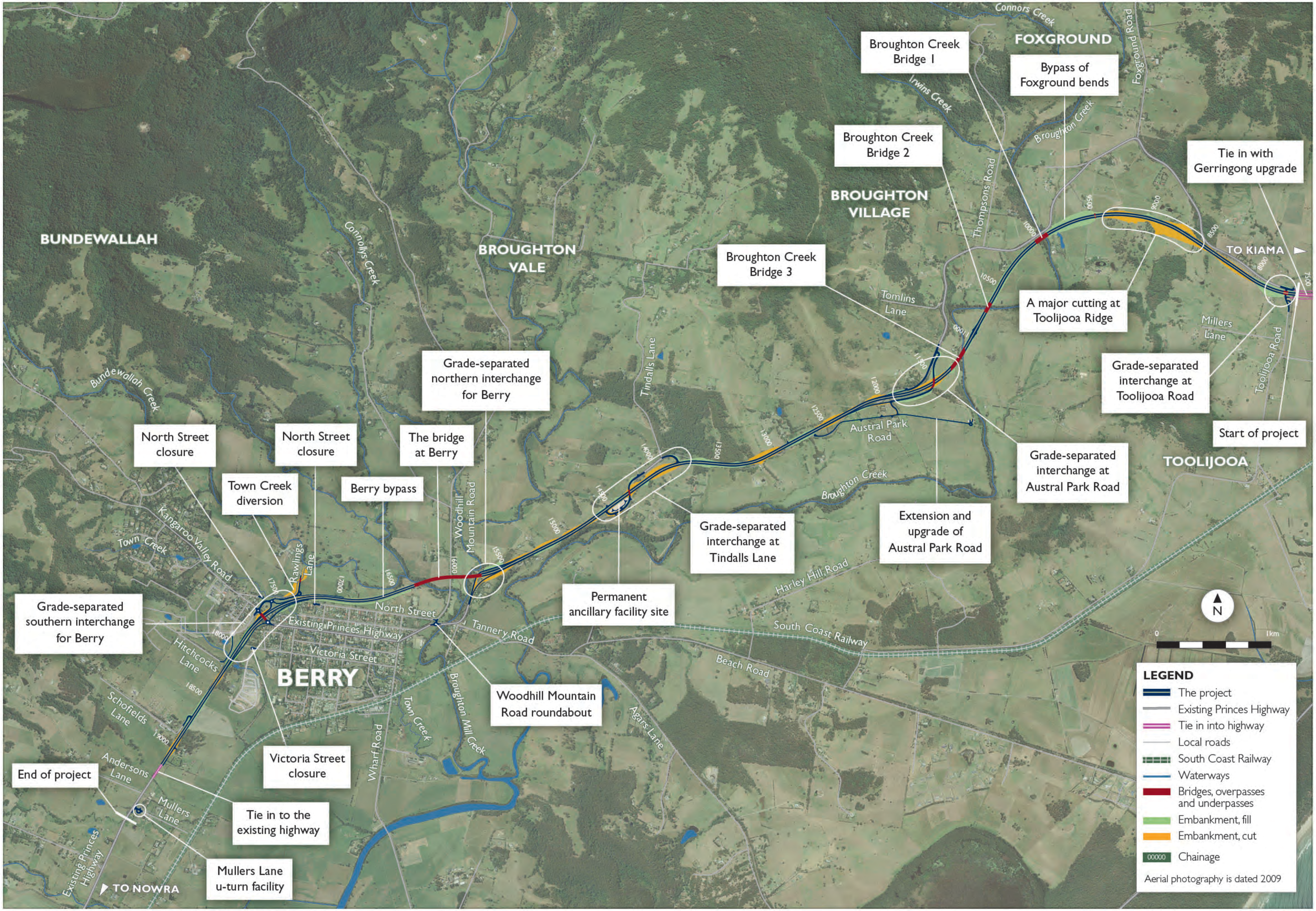

Figure 1-1: Foxground and Berry bypass project area

This report has been prepared to supplement the environmental assessment for the proposal and presents the findings of the noise and vibration impact assessment and the results of an investigation into feasible and reasonable construction and operation noise mitigation methods.

The scope of the construction noise and vibration assessment is as follows:

- Utilisation of background noise measurements to establish the construction noise management levels (NMLs) in accordance with the Interim Construction Noise Guideline (ICNG).
- Identification of noise sensitive catchment areas likely to be affected by construction noise and vibration.
- Calculation of noise and vibration levels likely to be associated with the construction works at sensitive receptors and evaluation of the extent of resulting impacts.
- Consideration of the impacts that may result from the proposed construction and mitigation measures to reduce adverse impacts where appropriate.

The scope of the operational road traffic noise assessment on existing residences is as follows:

- Identification of appropriate operational noise criteria in accordance with the *Road Noise Policy* (RNP) and the *Environmental Noise Management* Manual (ENMM).
- Modelling of road traffic noise levels with existing (2011) road traffic volumes (the road traffic volumes and noise levels in 2011 were selected as the existing baseline).
- Calibration of the existing road traffic noise model with site noise measurements.
- Modelling of road traffic noise levels for both the ‘build’ and ‘no build’ scenarios for the year of opening and design year.
- The establishment of a ‘build’ and ‘no build’ scenario for both programmed year of opening and 10 years after opening.
- Provision of general feasible and reasonable noise control recommendations where the operational noise criteria are exceeded.

The acoustic terminology used in this report is explained in Appendix A.

1.2 Construction working hours

1.2.1 Standard working hours

The bulk of construction activities would take place within standard working hours, which are from 7am to 6pm, Monday to Friday and 8am to 1pm Saturday, with no work on Sunday or public holidays. However, certain activities would be required to take place during the evening and night time periods due to:

- Technical considerations, such as the need to meet particular quality specifications for placement of concrete pavement.
- Safety and traffic management considerations.

Details of the out of hours work procedure and justification for specific activities are provided in Section 4.2.4.

1.2.2 Extended working hours

The RMS is proposing to undertake extended working hours for the duration of the project in order to reduce the construction period, minimise the overall impacts of construction works on sensitive receivers adjacent to the alignment and to provide increased flexibility in recovery from rain or other typical delay events in the construction period. Extended working hours would provide the following benefits:

- Increase the efficiency of the construction work and reduce the construction timeframe wherever possible.
- Provide the contractor with the opportunity to make up any lost time during construction that may be caused by inclement weather or other unforeseen delays.
- Minimise the significant disruption to the transport system and local environment that may occur if construction of the project takes longer than expected to complete.

Extended working hours would consist of an additional hour at the start and end of each working day (6am to 7am and 6pm to 7pm Monday to Friday; plus 1pm to 5pm on Saturday) and would typically comprise of activities with low noise impact including deliveries, site access, refuelling, office works, foot - based activities and possibly work in ancillary facility sites. Additional time at the start and finish of each working day is generally considered to be an appropriate 'trade-off' to minimise construction delays and complete the project as quickly as possible. These additional hours would be limited to the area between the northern Berry interchange and Toolijooa Road. RMS is not intending to apply extended working hours to the area around Berry. Details of the areas where extended work hours are proposed and the preliminary consultation undertaken with the affected community are provided in Section 4.6.

1.2.3 Out of hours works

Some out of hours work would be required due to safety, engineering and timetable feasibility issues. Works that would be undertaken out of hours would typically include:

- Bridge works - lifting and setting of girders over existing roads. Work would typically be undertaken at night when required to reduce the inconvenience to traffic on the Princes Highway, which would need to be closed to allow works to be undertaken safely for both workers and traffic.
- Existing and new road tie-in works - this work would need to be undertaken at night to reduce the inconvenience to road traffic and the highway would need to be closed to allow this work to be undertaken safely for both traffic and workers. Tie-in road works would be required at the beginnings and ends of the new road alignment.
- Utility adjustments - utility adjustments typically need to be undertaken during out of hours work periods to minimise the impact on utility operations, road traffic and to improve the safety of workers involved.
- Refuelling and maintenance operations to plant and machinery.

2 Existing environment

2.1 Overview

The study area extends from the junction of Toolijooa Road and the Princes Highway, south of Gerringong to the junction of the Princes Highway and Schofields Lane, south of Berry. Defining features include Toolijooa Ridge, the Broughton Creek floodplain and the Foxground bends area. The study area incorporates a mix of land uses including pastureland and agricultural properties, rural residential areas and the town of Berry with its associated urban residential, recreational, commercial and light industrial areas.

2.2 Existing noise environments

There are a number of distinct existing noise environments in the study area that would be affected by the project in different ways. Some areas currently experience low levels of noise associated with their rural agricultural setting and others are currently exposed to higher levels of noise due to their proximity to the existing highway. Depending on their location and current land use, these areas may either experience an increase or decrease in existing noise levels, or would be exposed to new noise levels associated with the construction and operation of the project.

2.2.1 Rural areas

The area to the north of Berry is dominated by large agricultural properties, pastureland and scattered rural residences. Generally, noise levels experienced by properties in this area would be relatively low, except where they are located in close proximity to existing traffic and are exposed to existing traffic noise.

The existing poor road geometry between Toolijooa Road and Tindalls Lane, and in particular in the Foxground Bends area, affects the travel efficiency of traffic in both directions. Heavy vehicles are particularly affected and noise levels at properties close to the existing highway are high at times due to the braking and acceleration of vehicles on existing steep grades and sharp bends.

2.2.2 Berry

The most significant source of noise within Berry is the existing highway as it forms the main street through the town and is named Queen Street. The highway is utilised by heavy and light vehicle through traffic and local traffic and there are different noise environments within town that experience varying noise levels depending on their proximity to the existing highway.

Existing noise levels through the main commercial area are very high at times as both heavy and light vehicles travel through town in both directions along the existing highway. As well as the commercial properties in Berry, there are also a number of residential properties fronting the highway that experience a high level of noise associated with the highway traffic. Noise associated with existing traffic along Queen Street also affects surrounding residences and businesses that do not have a direct frontage to the highway.

2.2.3 Berry recreational areas

There are a number of formal and informal recreational areas in Berry that generally experience a low level of background noise associated with the existing highway, with those furthest from the highway experiencing lower noise levels.

The closest recreational facility in town to the existing highway is Mark Radium Park, located at the south western end of town between Victoria Street and the highway. The area is used by the local community and by visitors as a stopping off point. The park is directly adjacent to the existing highway and is affected by noise from traffic entering and leaving the 50 kilometre per hour speed zone associated with town. The change of speed zone and local grade both increase the existing noise levels at this location as vehicles speed up or slow down according to the change in speed zone. This is particularly noticeable for heavy vehicles that often require the use of exhaust brakes to slow down.

The Berry community sports and recreation ground is located at the eastern end of North Street close to the intersection of Woodhill Mountain Road and the Princes Highway. It provides a variety of facilities including a general sports ground, tennis courts, a skate park and a local pony riding club. There is also a Camp Quality memorial park located in the vicinity between the sports ground and Bundewallah Creek. This location currently experiences low levels of background noise and is largely unaffected by the existing highway. Other recreational facilities in town are located further away from the existing highway and would largely experience low levels of background noise.

2.2.4 North of Berry precinct

The area to the north of Berry is characterised by Berry's rural agricultural landscape and is dominated by pastureland and dairy farming properties directly to the north of North Street. Noise generating activities are quite limited and residential properties along North Street currently experience a low noise environment and are largely unaffected by the existing highway traffic.

Traffic volumes along North Street are relatively low. Vehicle movements are dominated by light vehicles accessing local residences and some heavy vehicle and farm machinery movements associated with the two large agricultural properties on the northern side of North Street. The low volumes of traffic encourage pedestrian and recreational access along North Street, which is used both as an informal walking circuit and access to and from the sports ground at the eastern end. There are a number of noise sensitive receivers including churches and other community facilities along the southern side of North Street.

2.2.5 Huntingdale Park Estate and Kangaroo Valley Road

Kangaroo Valley Road and the residential development area of Huntingdale Park Estate are located at the south western end of town. This area is considered to be the main development area for the growth of Berry and is dominated by residential properties, with a cemetery located opposite the junction of Kangaroo Valley Road and North Street. The area currently experiences a relatively quiet noise environment primarily limited to light vehicle local access traffic noise.

There is currently a small buffer distance between the houses within the estate that front Huntingdale Park Road and the existing highway, as it passes in a cutting to the south west, adjacent to Mark Radium Park. These houses are currently protected to some degree from noise impacts associated with the existing highway traffic by this buffer area.

2.3 Noise sensitive receivers

Aerial photographs and overlays showing the road and the 591 noise sensitive receiver locations are presented in Appendix B. Receivers have generally been labelled from right to left. The noise sensitive receivers near the proposal comprise isolated rural houses and the low density urban area of Berry and surrounds. All six noise catchment areas are identified in Appendix C.

2.4 Background noise monitoring

Background noise monitoring was undertaken at 10 locations throughout the project area to determine existing background noise levels (which are used to define the construction noise criteria) and to measure average noise levels from the existing roads (to calibrate the operational noise model).

The locations for the noise logging were chosen through examination of aerial photography and site inspections. Attended noise measurements were also undertaken at each noise logging location. The background noise logging locations are illustrated in Appendix D. The noise logging results are provided graphically in Appendix E.

A noise logger measures the noise level over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, L_{Amax} and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for one per cent, 10 per cent and 90 per cent of the sample period respectively. The L_{Amax} is indicative of maximum noise levels due to individual noise events. The L_{A90} is taken as the background noise level. The L_{Aeq} is the energy averaged noise level over a defined period.

The results of the noise monitoring have been processed in accordance with the procedures contained in the ICNG, the INP and the RNP.

The assessment background level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired for each period of interest – daytime, evening and night time – for each 24 hour period. The background noise level or rating background level (RBL) representing the day (7am to 6pm), evening (6pm to 10pm) and night-time (10pm to 7am) assessment periods is the median of individual ABLs determined over the entire monitoring duration. The RBL is representative of the average minimum background sound level (in the absence of the source under consideration), or simply the background level. The L_{Aeq} is essentially the average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

A description of each location and site comments is provided in **Table 2-1**. The RNP requires receivers up to 600 metres from the alignment to be considered. The noise loggers have therefore been located at varying distances from the existing alignment up to 600 metres. This allows the accuracy of the model to be confirmed over the extent of the project.

Table 2-1: Noise logging locations

Logger	Serial number	Address	Comments
BG1	194636	46 Princes Highway, Broughton Village	40 m from existing alignment
BG2	194802	10 Austral Park Road, Broughton	460 m from existing alignment
BG3	194677	200 Princes Highway, Berry	165 m from existing alignment
BG4	8199	111 Princes Highway, Berry	270 m from existing alignment
BG5	194643	132 North Street, Berry	5 m from North Street
BG6	194525	92 North Street, Berry	5 m from North Street
BG7	194688	2 The Gables, Berry	5 m from Kangaroo Valley Road
BG8	194663	Andersons Lane, Berry	100 m from existing alignment
BG9	194687	Andersons Lane, Berry	300 m from existing alignment
BG10	194678	Andersons Lane, Berry	600 m from existing alignment

2.5 Background noise monitoring results

The background noise monitoring results are provided in **Table 2-2**. These noise levels are used to define the appropriate construction NMLs for each location, consistent with the ICNG.

Table 2-2: Background noise levels dB(A)

Noise logging location	**Rating background level dB(A)**		
	Day (7am to 6pm) L_{A90}	**Evening (6pm to 10pm) L_{A90}**	**Night (10pm to 7am) L_{A90}**
BG1	48	40	40[1]
BG2	40	41 (40)[2]	40
BG3	41	39	38
BG4	41	39	37
BG5	35	37 (35)[2]	35
BG6	36	36	35
BG7	37	37	37
BG8	44	41	33
BG9	41	39	35
BG10	38	36	33

Note 1: Night time L_{A90} has been adjusted to the lower evening L_{A90}.
Note 2: The numbers in brackets indicated the RBL with the INP adjustments included

The noise levels provided in **Table 2-2** are typical of an arterial road or highway operating through a rural area.

Additional attended noise measurements were undertaken at each noise logger location. The attended noise measurements confirmed that at each location the road was the dominant noise source. Noise measurements were typically undertaken during the most sensitive period (night-time) to ensure that the road would always be the dominant noise source.

2.6 Operational road noise monitoring results

The average noise levels provided in **Table 2-3** are, in each case, controlled by road noise. These results are used to verify the road noise model.

Logging results for locations close to the Princes Highway show a close correlation with traffic flow figures. Where traffic flows decrease significantly at night, background noise levels drop accordingly, suggesting that traffic noise is the dominant noise source in the area.

Noise levels for locations BG5, BG6 and BG7 drop significantly during night time. This can be attributed to local traffic flows. Local traffic travelling from the north of Berry through to Kangaroo Valley Road often use North Street to avoid the traffic of Queen Street. During night time, local traffic is minimal, hence a larger than usual drop in recorded noise levels is observed in this area.

Table 2-3: Day and night time road traffic noise levels

Noise logging location	Ambient road noise level L_{Aeq} (dB(A))	
	Day ($L_{Aeq\ (15h)}$)	Night ($L_{Aeq\ (9h)}$)
BG1	60	56
BG2	50	48
BG3	53	49
BG4	53	44
BG5	58	46
BG6	56	46
BG7	63	52
BG8	56	54
BG9	52	48
BG10	49	44

3 Noise and vibration criteria

3.1 Construction noise

The ICNG is used in construction noise assessments. This document supersedes the OEH's previous publication the *Environmental Noise Control Manual* (ENCM) and has been used as the basis for establishing construction noise management levels.

NML's must be set for the daytime and out of standard hours periods and must be met where feasible and reasonable. Work that is proposed outside of standard working hours, as defined in the ICNG, generally requires strong justification.

The ICNG recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the environmental impact assessment process'. A quantitative assessment, based on a likely 'worst case' construction scenario and a 'representative' scenario, has been carried out for the project.

Predicted noise levels at nearby noise sensitive receivers (eg residences, schools, hospitals, places of worship, passive and active recreation areas) are compared to the levels provided in Section 4 of the ICNG. Where an exceedance of the NMLs is predicted, the ICNG advises that the proponent should apply all feasible and reasonable work practices to minimise the noise impact.

NMLs for residential receivers are derived using the information in **Table 3-1** (excerpt from the ICNG).

The ABL is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or RBL representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration.

Table 3-1: Noise at residences using quantitative assessment, extract from the ICNG

Time of day	Noise management level L_{Aeq} (15min)*	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than five dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 (ICNG).

** Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 meters above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

3.2 Noise catchment areas

The study area has been divided into six distinct Noise Catchment Areas (NCA's), representing the differing background noise levels measured at each location. A description of the location of each catchment area is provided below in **Table 3-2**. The locations are also provided graphically in Appendix C. The community generally expects greater control of noise during the more sensitive evening and night time periods. Therefore, where measured noise levels are higher during evening and night time periods, the RBL has been reduced to the more stringent level measured in the day.

Table 3-2: Noise catchment areas

NCA		Chainage	Representative logger	Notes
NCA1	Start	75000	BG2	BG2 is considered to be more representative of this NCA and provides a more conservative assessment.
	End	11100		
NCA2	Start	11100	BG2	
	End	13500		
NCA3	Start	13500	BG3	
	End	14900		
NCA4	Start	14900	BG4	
	End	16400		
NAC5	Start	16400	BG5	Representative of receivers on North Street and marginally more conservative than BG6.
	End	18100		
NAC6	Start	18100	BG10	Representative of receivers surrounding the proposed stockpiling site.
	End	18300		

The construction NML's for the NCA's are provided below in **Table 3-3**.

Table 3-3: Noise catchment areas noise assessment levels

NCA	Period	Rating background level (RBL)*	Noise management levels (NML)**
NCA1	Day	40	50
	Evening	40	45
	Night	40	45
NCA2	Day	40	50
	Evening	40	45
	Night	40	45
NCA3	Day	41	51
	Evening	39	44
	Night	38	43
NCA4	Day	41	51
	Evening	39	44
	Night	37	42
NCA5	Day	35	45
	Evening	35	40
	Night	35	40
NCA6	Day	38	48
	Evening	36	41
	Night	33	38

**Details of RBLs are provided in Table 3-1*
*** Details on NMLs are provided in Table 3-3*

The DP&I required that extended construction work hours be assessed in accordance with the INP shoulder periods. The morning shoulder periods are considered to be 6am to 7am Monday to Friday and 8am to 9am Saturdays.

The RBL is considered to be the mid-point between the night-time and daytime RBL. The NML is the RBL + 5dB(A).

The assessment period RBL and NML is provided in Table 3-4. Noise levels are between 0 dB(A) and 3 dB(A) less stringent than the night-time NMLs.

Table 3-4: Noise catchment areas noise assessment levels

NCA	Period	Mid point in Rating Background Levels (RBL)*	Noise management levels (NML)**
NCA1	Morning Shoulder	40	45
NCA2	Morning Shoulder	40	45
NCA3	Morning Shoulder	40	45
NCA4	Morning Shoulder	39	44
NCA5	Morning Shoulder	35	40
NCA6	Morning Shoulder	36	41

**Details of RBLs are provided in Table 3-1*
*** Details of NMLs are provided in Table 3-3*

NML's recommended by the ICNG for other sensitive land uses, such as schools, hospitals or places of worship are shown in **Table 3-4**. Sensitive land uses identified for this project include the following:

- 69 Albert Street, Berry – Place of Worship (numerous buildings on this property, all of which have been assessed).
- Camp Quality and Berry Sporting Complex, Woodhill Mountain Road – Active Recreation Area.

Table 3-4: Construction NMLs– sensitive land uses other than residential, excerpt from ICNG

Land use	Management level, L_{Aeq} (15 min) (applies when properties are in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended "maximum" internal levels in AS2107 for specific uses.

3.2.1 Sleep disturbance

The ICNG requires a sleep disturbance analysis to be undertaken where construction works are planned to extend over more than two consecutive nights. The ICNG makes reference to the NSW Environment Criteria for Road Traffic Noise (EPA, 1999) (ECRTN), now superseded by the RNP, for assessment of sleep disturbance. However the RNP refers to the ECRTN as being the most appropriate assessment. As such the ECRTN will be referenced for sleep disturbance.

The policy states that for night-time activities, the $L_{A1(60\ Second)}$ noise levels should be calculated and compared with the RBL plus 15 dB(A) as the sleep disturbance screening criterion. In order to determine the likelihood of potential sleep disturbance, the predicted $L_{A1(60\ Second)}$ noise levels and number of expected $L_{A1(60\ Second)}$ noise events should be assessed based on the ambient noise environment during the night-time period. Further analysis is recommended where the screening criterion is exceeded.

The ECRTN contains an assessment of sleep disturbance which represents the EPA's advice on the subject of sleep disturbance due to noise events. Having considered the results of four research papers by Pearson et al (1995), Bullen et al (1996), Griefahn (1992) and Finegold et al (1994), Section B5 of Appendix B concludes with the statement, *'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'*. Given that a building with an open window provides up to 10 dB(A) noise attenuation from outside to inside, it is reasonable to assume that external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

3.2.2 Construction road traffic noise

The RNP does not provide direct reference to an appropriate criteria to assess the noise arising from traffic generated during the construction period. Typically, the criteria applicable for traffic movements generated during the construction phase of the project is limiting the increase in existing road traffic noise to two dB(A).

3.3 Construction vibration

The relevant standards/guidelines used for assessing construction vibration are summarised in **Table 3-5**

Table 3-5: Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures
Human comfort (tactile vibration) (*)	NSW Department of Environment, Climate Change and Water document "Assessing Vibration: A Technical Guideline"
Human comfort (regenerated noise)	NSW Department of Environment, Climate Change and Water document "Interim Construction Noise Guideline"

(*) These documents are based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the DECCW still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

3.3.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

The German Standard DIN 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures, provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in **Table 3-6**. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 3-6: DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	Vibration velocity in mm/s			
		At foundation At a frequency of		Plane of floor of uppermost storey	
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

3.3.2 Human comfort

In general, human response to vibration is a complex phenomenon. There are wide variations in vibration tolerance of humans. Accordingly, acceptance goals for human comfort are hard to define and quantify. Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (eg workshop, office or residence) and the character of vibration (eg continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual’s perception.

Any construction vibration assessment for work which does not include blasting is to include human comfort for construction in accordance with the guideline, Assessing Vibration: A Technical Guideline (DECC 2006), which refers to BS 6472:1992 ‘Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)’. BS 6472:1992 has been recently superseded by BS 6472:2008, however, the EPA has advised that the 1992 standard should be used rather than the newer 2008 standard.

3.3.3 Tactile vibration

The procedure outlined in the OEH document “Assessing Vibration: A Technical Guideline” (DECCW, 2006) has been used in this assessment. The recommended procedures in this guideline are based on British Standard BS 6472:1992 “*Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*”.

The guideline distinguishes between continuous, intermittent and impulsive vibration and provides a set of different vibration goals for each of these activities (**Table 3-7**).

Table 3-7: Examples of types of vibration

Continuous	Impulsive(*)	Intermittent
Continuous uninterrupted for a defined period (usually throughout daytime and/or night-time	**A rapid build up to a peak followed by a damped decay. The duration is typically less than 2 seconds.**	**Defined as interrupted periods of continuous vibration or repeated periods of impulsive vibration.**
Steady road traffic, continuous construction activity (eg tunnel boring), machinery	Activities that create up to three distinct vibration events in an assessment period (eg occasional dropping of heavy equipment)	Trains, rock breakers, impact pile driving

1) (*) Blast vibration to be assessed in accordance with ANZECC (1990).

3.3.4 Continuous and impulsive vibration

Preferred and maximum vibration levels for different receivers for continuous and impulsive vibration are provided in **Table 3-8** and **Table 3-9**.

Table 3-8: Preferred and maximum weighted root mean square (rms) vibration levels for continuous vibration acceleration (m/s^2) in the vertical direction

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.005	0.010	0.005	0.010
Residences	0.010	0.020	0.007	0.014
Offices, schools, educational institutions and places of worship	0.020	0.040	0.020	0.040
Workshops	0.040	0.080	0.040	0.080

Note 1: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above.

Table 3-9: Preferred and maximum weighted root mean square (rms) vibration levels for impulsive vibration acceleration (m/s^2) in the vertical direction

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas	0.005	0.010	0.005	0.010
Residences	0.30	0.60	0.100	0.200
Offices, schools, educational institutions and places of worship	0.640	1.280	0.640	1.280
Workshops	0.640	1.280	0.640	1.280

The OEH guideline, ‘Assessing vibration: a technical guideline’ states:

“There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration”.

3.3.5 Intermittent vibration

The assessment of intermittent vibration outlined in the OEH guideline is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

The VDV (ie eVDV) of an individual event can be estimated by:

> $eVDV=1.4 \times a_{RMS} \times t^{0.25}$, where a_{RMS} is the weighted rms acceleration in m/s^2, and t is the cumulative time in seconds. The above formula might not accurately represent the vibration dose if the crest factor exceeds 6 (see the OEH guideline (DECCW, 2006) for detailed assessment procedures).

Where there are repeated vibration events of variable magnitude the total vibration dose for the relevant period may be obtained by summing the N individual vibration doses using following formula:

$$\mathbf{VDV} = \sqrt[4]{\left(\sum_{i=1:N} \mathbf{VDV}_i^4\right)}$$

> where VDV_i is the individual vibration dose.

Maximum and preferred VDVs for construction activities are listed in **Table 3-10**.

Table 3-10: Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$) during construction activities

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

3.3.6 Ground-borne noise

Vibration generated by activities such as compacting or drilling may enter buildings via the ground. This causes the floors, walls and ceilings to vibrate and to radiate noise. This noise is commonly referred to as structure or ground-borne noise or regenerated noise. Ground-borne noise is typically low frequency and if audible is perceived as a ‘rumble’.

In general, ground-borne noise level values are relevant only where they are higher than the airborne noise from the construction activities. Regenerated noise levels would typically be masked by air-borne noise associated with the construction activities.

The ground-borne NMLs as outlined in the ICNG are employed (**Table 3-11**). The ground-borne noise levels are applicable during the evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

Table 3-11: Recommended ground-borne noise goals for construction activities

Time	Ground-borne noise goals
Evening (6pm to 10pm)	40 dB(A) $L_{Aeq\ (15\ min)}$
Night-time (10pm to 7am)	35 dB(A) $L_{Aeq\ (15min)}$

3.4 Blasting noise and vibration

The Australian and New Zealand Environment Conservation Council (ANZECC) document ‘Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration’ (ANZEC, 1990) provides criteria designated to minimise annoyance and discomfort at sensitive receivers as a result of blasting works. The criteria provided in this section are only applicable to annoyance and discomfort from blasting. Building damage criteria is provided in Section 3.3.1. Furthermore the document states that the criteria provided is for guidance only and may be varied to suit local site conditions.

Provided in **Table 3-12** is a summary of the airblast overpressure limits.

Table 3-12: Airblast overpressure criteria

Airblast overpressure (dB(Lin Peak))	Allowable exceedance
115	5% of total number of blasts over a 12 month period
120	Never

Provided in **Table 3-13** is a summary of the peak particle velocity vibration limits.

Table 3-13: Peak particle velocity criteria

Peak particle velocity (mm/s)	Allowable exceedance
5	5% of total number of blasts over a 12 month period
10	Never

Australian Standard AS2107.2 '*Explosives – Storage and use Part 2: Use of explosives'* recommends that if the prescribed limits in **Table 3-12** and **Table 3-13** cannot be achieved, an agreement may be reached with the land owner permitting higher levels. The guideline also recommends that blasting should generally take place no more than once per day.

3.5 Operational noise criteria

The RNP was released in July 2011. It provides the appropriate operational noise criteria for both redeveloped existing roads and new roads.

Provided below in **Table 3-14** are the applicable noise criteria for this project.

Table 3-14: Road traffic noise assessment criteria for residential land use

Road category	Type of project/land use	Assessment criteria dB(A)	
		Day (7am – 10pm)	**Night (10pm – 7am)**
Freeway/ arterial/sub -arterial	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors New residential developments affected by noise from existing freeways/ arterial/ sub-arterial roads	$L_{Aeq(15hour)}$ 55 (external)	$L_{Aeq(9hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeways/ arterial/ sub-arterial roads Existing residences affected by additional traffic on existing freeways/ arterial/ sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by noise from new local road corridors Existing residences affected by noise from redevelopment of existing local roads Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Noise criteria for other land use are provided in **Table 3-15**.

To determine if each sensitive receiver is subject to the 'new road' or 'redeveloped road' criteria, the ENMM procedure set out in Practice Note i of the ENMM has been followed.

A sensitive receiver has been considered to be subject to noise exposure to a new road where there is no existing road traffic noise exposure or if the receiver is subject to a new source of road traffic noise.

A receiver is subject to existing road traffic noise exposure if the existing noise levels exceed a daytime $L_{Aeq(15hour)}$ of 55 dB(A) or a night-time $L_{Aeq(9hour)}$ of 50 dB(A).

A receiver is considered to be subject to a new source of road traffic noise if the project would develop any of the following:

- A new road where a road of the same category did not previously exist.
- A new road within an existing but previously undeveloped road corridor.
- An alignment or realignment producing noise at a receptor from a different direction that increases noise levels at any exposed facade by two dB(A) or more.

The RNP requires the consideration of two scenarios, the ‘no build’ option and the ‘build’ option. The ‘no build’ option represents the scenario if the project was not to proceed. The ‘build’ option represents the scenario if the project was to proceed. Each of these scenarios must be considered for two time periods, the year of opening and the design year, typically ten years after opening.

The RNP also requires the ‘relative increase’ to be considered. The relative increase is the difference in noise levels between the ‘build’ and ‘no build’ scenarios. The relative increase criteria are provided below in **Table 3-16**. The relative increase criteria are only applicable to residential land uses.

Table 3-15: Road traffic noise assessment criteria for non-residential land use

Existing sensitive land use	Assessment criteria		Additional considerations
	Day (7am – 10pm)	Night (10pm – 7am)	
School classrooms	$L_{Aeq(1hour)}$ 40 (internal)	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the ‘maximum’ levels shown in Australian Standard 2107:2000 (Standards Australia 2000)
Hospital wards	$L_{Aeq(1hour)}$ 35 (internal)	$L_{Aeq(1hour)}$ 35 (internal)	
Places of worship	$L_{Aeq(1hour)}$ 40 (internal)	$L_{Aeq(1hour)}$ 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see point 5) may be applied.
Open space (active use)	$L_{Aeq(15hour)}$ 60	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants,

Existing sensitive land use	Assessment criteria		Additional considerations
	Day (7am – 10pm)	Night (10pm – 7am)	
Open space (passive use)	$L_{Aeq(15hour)}$ 55	-	making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, eg school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
Child care facilities	Sleeping rooms $L_{Aeq(1hour)}$ 35 Indoor play areas $L_{Aeq(1hour)}$ 40 (internal) Outdoor play areas $L_{Aeq(1hour)}$ 55 (external)		Multi-purpose spaces, eg shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities.

Table 3-16: Relative increase criteria for residential land uses

Road category	Type of project/ development	Total traffic noise level increase dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/ arterial/ sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq(15hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq(9hour)}$ +12 dB (external)

A new road must be designed to meet the noise criteria in **Table 3-14, Table 3-15** and **Table 3-16**.

4 Impact assessment

4.1 Construction noise and vibration

The construction noise and vibration assessment has been separated into two separate components, the construction of the main alignment and noise and vibration impacts associated with the operations of ancillary facilities. The cumulative noise impact has also been considered.

The bulk of construction activities would take place from 7am to 6pm, Monday to Friday and 8am to 1pm Saturday, with no work on Sunday or public holidays. However, certain activities would be required to take place during the evening and night time periods due to:

- Technical considerations (such as the need to meet particular quality specifications for placement of concrete pavement).
- Safety and traffic management considerations.

Details on the out of hours work procedure and justification for specific activities are provided in Section 4.7.

Extended working hours are considered in Section 4.6.

4.2 Main alignment construction works

Sources of construction noise and vibration would comprise a range of heavy vehicles, plant and equipment and hand tools. Based on the typical sound power levels (SWL) for these sources, noise level predictions have been undertaken for the individual construction activities. These predictions and working hours are provided in **Table 4-2** to **Table 4-7.**

4.2.1 Construction activities and equipment

The construction of the project would consist of five main construction activities. These activities are provided below in **Table 4-1**.

A noise source may exhibit a range of particular characteristics that increase annoyance, such as tones, impulses, low frequency noise and intermittent noise. Where this is the case, an adjustment is applied to the source noise level received at the assessment point to account for the additional annoyance caused by the particular characteristics. The adjustments have been applied to the activities in **Table 4-1.**

Table 4-1: Construction scenarios and equipment

Activity	Typical equipment used	Typical and maximum SWL dB(A)
Site Establishment /Landscaping	**Typical SWL[1]**	**105 - 110**
	Chainsaws	110 - 118
	Mulching plant and chipper	113 - 121
	Cranes	104 - 112
	Generators	101 - 109
	Bobcat	104 - 112
	Powered hand tools	108 - 116
	Air compressor	109 - 117

Activity	Typical equipment used	Typical and maximum SWL dB(A)
	Spoil	95 - 103
	Material	95 - 103
	Excavators	99 - 107
Earthworks	**Typical SWL[1]**	**112 - 120**
	Compactors	104 - 112
	Grader	103 - 111
	Multi-tyred and vibratory rollers	97 - 105
	Concrete trucks	105 - 113
	Concrete vibrator	97 - 105
	Asphalt paving plant	112 - 120
	Backhoe	103 - 111
	Sweeper	104 - 112
	Compressor	109 - 117
	Generators	101 - 109
	Rock crushing	112 - 120
	Road trucks	95 - 103
Piling	Impact driven piling rig	124 – 134
	Bored piling rig	100 – 110
Bridge Works	**Typical SWL[1]**	**112 - 120**
	Cranes	104 - 112
	Piling rigs	103 - 111
Paving	**Typical SWL[1]**	**113 - 118**
	Compactor	104 - 112
	Jackhammers	108 - 116
	Multi-tyred vibratory roller	97 - 105
	Concrete truck	105 - 113
	Concrete vibrator	97 - 105
	Asphalt paving plant	112 - 120
	Backhoe	108 - 116
	Concrete saw	111 - 119
	Profiler	108 - 116
	Sweeper	104 - 112
	Compressor	109 - 117
	Generator	101 - 109
	Road trucks	95 - 103

Note 1: The Typical SWL is for a 'typical site'. It represents a range of the equipment listed at various distances around the site with varying duty cycles. The levels have been refined from predictions and measurements undertaken at similar sites over many different projects. The typical levels are not a summation of all the equipment listed in this table.

4.2.2 Construction noise modelling

Noise modelling has been undertaken for the scenarios provided in **Table 4-1**. Noise modelling was undertaken using SoundPLAN V7.0. The noise modelling was used to calculate typical and worst case construction noise levels along the entire alignment.

4.2.3 Standard hours works

The Standard Hours Work noise modelling results are provided in **Table 4-2** to **Table 4-7** and a summary of the Out of Hours Work modelling results is provided in **Table 4-8** to **Table 4-11**. The tables indicate typical and maximum noise levels at the affected receivers. The results are also provided graphically in Appendix F.

Table 4-2: Standard hours work predicted noise- establishment/landscaping works

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected
NCA1	50	60	3	0	65	4	0
NCA2	50	58	3	0	63	9	0
NCA3	51	51	0	0	56	2	0
NCA4	51	63	12	0	68	15	0
NCA5	45	65	150	0	70	270	0
NCA6	48	57	7	0	62	21	0

Note 1: Highly noise affected is considered to be 75 dB(A)

The predicted noise levels in **Table 4-2** indicate that 175 receivers would be impacted from typical works and 321 receivers would be impacted as a result of worst case noise levels during site establishment and landscaping works.

Table 4-3: Standard hours work predicted noise - earthworks

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1
NCA1	50	67	4	0	75	12	0
NCA2	50	65	10	0	73	18	0
NCA3	51	58	4	0	66	9	0
NCA4	51	70	15	0	78	32	3
NCA5	45	72	315	0	80	456	11
NCA6	48	64	21	0	72	22	0

Note 1: Highly noise affected is considered to be 75 dB(A)
NML – Noise management level

The predicted noise levels in **Table 4-3** indicate that 369 receivers would be impacted from typical works and 549 receivers would be impacted as a result of worst case noise levels during earthworks. An additional 14 receivers would be significantly affected as a result of worst case noise levels.

Table 4-4: Standard hours work predicted noise - bored piling

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1
NCA1	50	55	1	0	65	4	0
NCA2	50	53	0	0	63	9	0
NCA3	51	46	0	0	56	2	0
NCA4	51	58	4	0	68	15	0
NCA5	45	60	43	0	70	270	0
NCA6	48	52	1	0	62	21	0

Note 1: Highly noise affected is considered to be 75 dB(A)

The predicted noise levels in **Table 4-4** indicate that 49 receivers would be impacted from typical works and 321 receivers would be impacted as a result of worst case noise levels during bored piling activities.

Table 4-5: Standard hours work predicted noise - impact piling

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1
NCA1	50	79	16	1	89	22	3
NCA2	50	77	16	0	87	16	4
NCA3	51	70	10	0	80	14	2
NCA4	51	82	34	4	92	39	13
NCA5	45	84	457	12	94	458	95
NCA6	48	76	22	0	86	22	6

Note 1: Highly noise affected is considered to be 75 dB(A)

The predicted noise levels in **Table 4-5** indicate that 555 receivers would be impacted from typical works and 571 receivers would be impacted as a result of worst case noise levels during impact piling activities. An additional 17 receivers would be significantly impacted from typical works and 571 receivers would be significantly impacted as a result of worst case noise.

Table 4-6: Standard hours work predicted noise – bridge works

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1
NCA1	50	64	2	0	72	10	0
NCA2	50	63	6	0	71	8	0
NCA3	51	51	0	0	59	3	0
NCA4	51	72	6	0	80	28	2
NCA5	45	71	152	0	79	427	1
NCA6	48	43	0	0	51	8	0

Note 1: Highly noise affected is considered to be 75 dB(A)

The predicted noise levels in **Table 4-6** indicate that 166 receivers would be impacted from typical works and 484 receivers would be impacted as a result of worst case noise levels during bridge works. An additional three receivers would be significantly impacted as a result of worst case noise levels.

Table 4-7: Standard hours work predicted noise – paving

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected 1
NCA1	50	78	4	0	83	10	0
NCA2	50	73	10	0	81	16	0
NCA3	51	66	4	0	74	7	0
NCA4	51	78	15	0	86	23	0
NCA5	45	80	338	0	88	455	0
NCA6	48	72	21	0	80	21	0

Note 1: Highly noise affected is considered to be 75 dB(A)

The predicted noise levels in **Table 4-7** indicate that 392 receivers would be impacted from typical works and 532 receivers would be impacted as a result of worst case noise levels during paving works. An additional three receivers would be significantly impacted as a result of worst case noise levels.

It is important to consider that this assessment is representative of the worst case 15 minute period of construction activity and does not necessarily represent the noise impact at noise sensitive receivers for an extended period of time. Particularly noisy activities, such as rock breaking and use of concrete saws, are likely to persist for only a fraction of the overall construction period. Clear communication to potentially affected receivers of when these activities will be taking place is recommended.

The ICNG states that where a construction noise impact level of greater than 75 dB(A) is predicted a receiver must be considered ‘highly noise affected’ and afforded additional consideration. The receivers where noise levels exceed 75 dB(A) can be identified on the noise contours provided in Appendix F. These receivers would receive additional consultation with regards to specific timing and impacts of construction works. Respite periods should also be programmed for these receivers wherever practicable.

4.2.4 Morning shoulder works

The morning shoulder works noise modelling results are provided in **Table 4-8** to **Table 4-13**. The tables indicate typical and maximum noise levels at the affected receivers. The results are also provided graphically in Appendix F.

Considering the same works would take place in the morning shoulder period as the standard work hours, the predicted noise levels are identical. The exceedances have increased due to a difference in the noise criteria.

Extended hours work would occur north of Berry township, generally between Toolijooa Road and Tindalls Lane. Therefore works would predominantly be expected to occur in NCA1 to NCA3, as such a shoulder period assessment has been undertaken for these catchment areas. An assessment of NCA4 has also been included as extended hours may also include bridge works and as works occurring in NCA3 may be audible in NCA4.

As described in Section 4.6, activities undertaken during the morning extended hours period would generally be limited to low noise generating activities. Activities such as piling and earthworks have been included in this assessment to present a worst case scenario.

Table 4-8: Extended hours work predicted noise- establishment/landscaping works

NCA	NML dB(A)	Typical works		Worst case	
		Predicted noise level dB(A)	Receivers exceeding NMLs	Predicted noise level dB(A)	Receivers exceeding NMLs
NCA1	45	60	4	65	8
NCA2	45	58	9	63	13
NCA3	45	51	3	56	6
NCA4	44	63	15	68	18

The predicted noise levels in **Table 4-8** indicate that 31 receivers would be impacted from typical works and 45 receivers would be impacted as a result of worst case noise levels during site establishment and landscaping works.

Table 4-9: Extended hours work predicted noise - earthworks

NCA	NML dB(A)	Typical works		Worst case	
		Predicted noise level dB(A)	Receivers exceeding NMLs	Predicted noise level dB(A)	Receivers exceeding NMLs
NCA1	45	67	11	75	22
NCA2	45	65	14	73	16
NCA3	45	58	7	66	13
NCA4	44	70	29	78	39

The predicted noise levels in **Table 4-9** indicate that 61 receivers would be impacted from typical works and 90 receivers would be impacted as a result of worst case noise levels during earthworks.

Table 4-10: Extended hours work predicted noise - bored piling

NCA	NML dB(A)	Typical works		Worst case	
		Predicted noise level dB(A)	Receivers exceeding NMLs	Predicted noise level dB(A)	Receivers exceeding NMLs
NCA1	45	55	3	65	8
NCA2	45	53	3	63	13
NCA3	45	46	1	56	6
NCA4	44	58	12	68	18

The predicted noise levels in **Table 4-10** indicate that 19 receivers would be impacted from typical works and 45 receivers would be impacted as a result of worst case noise levels during bored piling activities.

Table 4-11: Extended hours work predicted noise - impact piling

NCA	NML dB(A)	Typical works		Worst case	
		Predicted noise level dB(A)	Receivers exceeding NMLs	Predicted noise level dB(A)	Receivers exceeding NMLs
NCA1	45	79	22	89	22
NCA2	45	77	16	87	16
NCA3	45	70	14	80	14
NCA4	44	82	39	92	39

The predicted noise levels in **Table 4-11** indicate that 91 receivers would be impacted from typical works and 91 receivers would be impacted as a result of worst case noise levels during impact piling activities.

Table 4-12: Extended hours work predicted noise – bridge works

NCA	NML dB(A)	Typical works		Worst case	
		Predicted noise level dB(A)	Receivers exceeding NMLs	Predicted noise level dB(A)	Receivers exceeding NMLs
NCA1	45	64	11	72	22
NCA2	45	63	14	71	16
NCA3	45	51	7	59	13
NCA4	44	72	29	80	39

The predicted noise levels in **Table 4-12** indicate that 61 receivers would be impacted from typical works and 90 receivers would be impacted as a result of worst case noise levels during bridge works.

Table 4-13: Extended hours work predicted noise – paving

NCA	NML dB(A)	Typical works		Worst case	
		Predicted noise level dB(A)	Receivers exceeding NMLs	Predicted noise level dB(A)	Receivers exceeding NMLs
NCA1	45	78	12	83	21
NCA2	45	73	14	81	16
NCA3	45	66	8	74	13
NCA4	44	78	32	86	39

The predicted noise levels in **Table 4-13** indicate that 66 receivers would be impacted from typical works and 89 receivers would be impacted as a result of worst case noise levels during paving works.

It is important to consider that this assessment is representative of the worst case 15 minute period of construction activity and does not necessarily represent the noise impact at noise sensitive receivers for an extended period of time. Particularly noisy activities, such as rock breaking and use of concrete saws, are likely to persist for only a fraction of the overall construction period. Clear communication to potentially affected receivers of when these activities will be taking place is recommended.

4.2.5 Out of hours works

Provided below in **Table 4-14** to **Table 4-17** is a summary of the predicted typical and maximum noise levels during out of hours work (including the proposed extended hours discussed in Section1.2.2. Earthworks are proposed north of Berry township spanning NCA1 to NCA4. Although a fair proportion of bridge works could be undertaken during standard work hours, some would need to be undertaken during out of hours work periods for safety and road traffic considerations. Extended work hours are not proposed south of NCA4, however predicted noise levels and numbers of affected receivers have been provided in the event that out of hours works are required for safety, traffic efficiency or emergency reasons.

Table 4-14: Evening work predicted noise - earthworks

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected[1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected[1]
NCA1	45	67	11	0	75	22	0
NCA2	45	65	14	0	73	16	0
NCA3	44	58	8	0	66	13	0
NCA4	44	70	29	0	78	39	3
NCA5[2]	40	72	443	0	80	458	11
NCA6[2]	41	64	21	0	72	22	0

Note1: *Highly noise affected is considered to be 75 dB(A)*
Note2: *Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.*

Table 4-15: Night-time work predicted noise - earthworks

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected[1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected[1]
NCA1	45	67	11	0	75	22	0
NCA2	45	65	14	0	73	16	0
NCA3	43	58	9	0	66	13	0
NCA4	42	70	34	0	78	39	2
NCA5[2]	40	72	443	0	80	458	5
NCA6[2]	38	64	22	0	72	22	0

Note1: *Highly noise affected is considered to be 75 dB(A)*
Note2: *Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.*

Table 4-16: Evening work predicted noise – bridge works

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]
NCA1	45	67	6	0	75	19	0
NCA2	45	65	7	0	73	9	0
NCA3	44	58	2	0	66	7	0
NCA4	44	70	25	0	78	36	2
NCA5[2]	40	72	353	0	80	457	1
NCA6[2]	41	64	5	0	72	18	0

Note1: Highly noise affected is considered to be 75 dB(A)
Note2: Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.

Table 4-17: Night-time work predicted noise – bridge works

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]
NCA1	45	67	6	0	75	19	0
NCA2	45	65	7	0	73	9	0
NCA3	43	58	3	0	66	9	0
NCA4	42	70	30	0	78	38	2
NCA5[2]	40	72	353	0	80	457	1
NCA6[2]	38	64	14	0	72	21	0

Note1: Highly noise affected is considered to be 75 dB(A)
Note2: Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.

The noise levels provided above do not include mitigation measures and therefore provide a conservative assessment of the potential noise impacts from the proposed construction activities. Recommendations for noise mitigation are provided in Chapter 5.

4.2.5 Sleep disturbance

Noise levels related to sleep disturbance ($L_{A1(60\ sec)}$) are typically five dB(A) to eight dB(A) higher than those provided in **Table 4-15** and **Table 4-17.**

Construction works would generally not be undertaken during night-time work periods hence the likelihood for sleep disturbance is low. However, sleep disturbance may occur for any work that is required out of hours. There are currently no specific details available on what works would occur during the night-time period and what equipment would be used. Further information and mitigation would be provided during the detailed design stage to ensure that the potential impacts on affected receivers is minimised.

4.3 Specific works

The preceding section provided general information for typical and worst-case noise levels at sensitive receivers. Provided in this section is detailed information for specific construction scenarios, including estimated duration of works and with a focus on high noise generating works as required by the DGRs. The final duration of specific activities will depend on the plant and methodology utilised in the construction phase.

Typical and maximum noise levels for each scenario have been found to be very similar. Noise levels were initially calculated for each works type and found to be within ±2 dB(A). On the basis that a difference of two dB(A) is typically considered indiscernible and the actual noise levels may vary depending on the specific plant used by the contractor, there was deemed to be no benefit to model each work activity within each location.

The work activities and estimated durations are provided below in **Table 4-18**. Noise contours are provided in Appendix G. Typical noise levels have been modelled at 112 dB(A) and represent a small number of machinery operating simultaneously (such as a dump truck, an excavator and a couple of haul trucks idling). Maximum (or worst-case) noise levels have been modelled at 120 dB(A), representing larger numbers of equipment undertaking noise intensive work for long durations. Work activities that are considered to be noise intensive are presented in bold.

Table 4-18: Work activities and duration

Work activities	Duration
Toolijooa tie-in, Ch7600 Toolijooa Road	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	1 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	1 month
Earthworks	**2 months**
Pavement construction	2 weeks
Drainage construction	2 weeks
Street furniture installation	2 weeks
Site restoration	2 weeks

Work activities	Duration
Toolijooa interchange, Ch 7700 **Toolijooa Road**	
Site preparation and establishment	**3 months**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 month
Earthworks and bridge construction	**8 months**
Pavement construction	1 month
Drainage construction	2 weeks
Street furniture installation	2 weeks
Site restoration	1 month
Toolijooa cutting Ch8450 - Ch9400 **West of Toolijooa Road, east of Foxground Road**	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	1 month
Pre-drilling, blasting, crushing, earthworks	**12 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	1 month
Site restoration	2 months
Toolijooa fill embankment, Ch 9450 – Ch 9850 **West of Toolijooa Ridge, east of Broughton Creek**	
Site preparation and establishment	**2 weeks**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 weeks
Earthworks	**9 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	1 month
Site restoration	2 months

Work activities	**Duration**
Broughton Creek bridge #1, #2, #3 Ch 10000, Ch 10750, Ch 11200 Broughton Creek	
Site preparation and establishment	**2 weeks**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	1 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	1 month
Earthworks and bridge construction	**7 months**
Pavement construction	1 month
Drainage construction	2 weeks
Street furniture installation	2 weeks
Site restoration	1 month
Broughton Creek fill embankment Ch 10050 – 10650, Ch 10800 – 11100	
Site preparation and establishment	**2 weeks**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 weeks
Earthworks	**9 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	1 month
Site restoration	2 months
Broughton Creek fill embankment, Ch 10050 – 10650, Ch 10800 – 11100 Broughton Creek floodplain	
Site preparation and establishment	**2 weeks**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 weeks
Earthworks	**9 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	1 month
Site restoration	2 months

Work activities	Duration
Austral Park interchange Ch 11700 **Austral Park Road**	
Site preparation and establishment	**3 months**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 month
Earthworks and bridge construction	**8 months**
Pavement construction	1 month
Drainage construction	2 weeks
Street furniture installation	2 weeks
Site restoration	1 month
Austral Park southbound heavy vehicle rest area Ch 12500 **Intersection of Austral Park Road and Princes Highway**	
Site preparation and establishment	**2 weeks**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 weeks
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 weeks
Earthworks	**2 months**
Pavement construction	1 month
Drainage construction	2 weeks
Street furniture installation	2 weeks
Site restoration	1 month
General realignment Ch 12750 – 13750 **West of Austral Park Road, east of Tindalls Lane**	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	3 months
Earthworks	**9 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	2 months
Site restoration	2 months

Work activities	Duration
Tindalls Lane interchange Ch 13800 – 14600 **Intersection of Tindalls Lane and Princes Highway to 700m west of Tindalls Lane**	
Site preparation and establishment	**3 months**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 month
Earthworks and bridge construction	**8 months**
Pavement construction	1 month
Drainage construction	2 weeks
Street furniture installation	2 weeks
Site restoration	1 month
North Berry interchange, Ch 15450 – 15800 **Near David Berry Memorial Park**	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	3 months
Earthworks and bridge construction	**12 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	2 months
Site restoration	2 months
Bridge at Berry, Ch 15800 – 16400 **Launches off ridge at David Berry Memorial Park and lands west of the sports grounds**	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	2 months
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	3 months
Earthworks and bridge construction	**12 months**
Pavement construction	2 months
Drainage construction	2 months
Street furniture installation	2 months
Site restoration	2 months

Work activities	Duration
Berry roundabout, Ch 16000 Intersection of Princes Highway and Tannery Road	
Site preparation and establishment	**1 week**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	1 week
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	1 week
Earthworks	**2 weeks**
Pavement construction	1 week
Drainage construction	1 week
Street furniture installation	1 week
Site restoration	1 week
Berry embankment works, Ch 16400 – 17200 North of North Street	
Site preparation and establish	**2 months**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	1 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	1 month
Earthworks	**3 months**
Pavement construction	1 month
Drainage construction	1 month
Street furniture installation	1 month
Site restoration	1 month
Kangaroo Valley Road interchange, Ch 17200 – 18250 Kangaroo Valley Road Cul-de-sac of North Street	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	1 month
Earthworks and bridge construction	**8 months**
Pavement construction	1 month
Drainage construction	1 month
Street furniture installation	1 month
Site restoration	6 weeks

Work activities	Duration
General alignment works to Mullers Lane Ch 18250 – 19600 **South of Victoria Street to Mullers Lane**	
Site preparation and establishment	**1 month**
Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads	1 month
Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks	2 months
Earthworks	**6 months**
Pavement construction	1 month
Drainage construction	1 month
Street furniture installation	1 month
Site restoration	1 month

4.4 Ancillary facilities

Typical works undertaken within ancillary facilities would include site establishment and landscaping, stockpiling, earthworks, pavement construction, drainage construction, casting yard, street furniture installation and site restoration. There are no batch plants planned within the ancillary facilities or within the project extents. The equipment used would be similar to the scenarios listed in **Table 4-1**, specifically site establishment and landscaping, earthworks, paving and bridgeworks. Based on this information the typical sound power level from ancillary facilities would be 112 dB(A) while the maximum sound power level would be 120 dB(A).

The noise criteria for the ancillary facilities are dependent on which NCAs the nearest receivers are located in. Provided below in **Table 4-19** is a summary of the potentially most affected receivers surrounding each compound and predicted typical and worst case noise levels for each. Noise contours for the operations of the ancillary facilities are provided in Appendix F.

Table 4-19: Compound noise management levels

Receiver number	Distance (m)	NCA	Predicted noise levels dB(A)		Standard hours NML dB(A)	Out of hours NML dB(A)	
			Typical	Worst case		Evening	Night-time
Compound 1							
1	89	NCA1	58	66	50	46	45
3	45	NCA1	61	69	50	46	45
4	457	NCA1	43	51	50	46	45
5	190	NCA1	51	59	50	46	45
Compound 2							
9	210	NCA1	51	59	50	46	45
10	185	NCA1	52	60	50	46	45
11	185	NCA1	51	59	50	46	45
Compound 3							
12	123	NCA1	40	48	50	46	45
14	109	NCA1	58	66	50	46	45
16	394	NCA1	43	51	50	46	45
Compound 4							
19	328	NCA1	45	53	50	46	45
20	340	NCA1	46	54	50	46	45
23	285	NCA1	46	54	50	46	45
25	575	NCA2	40	48	50	46	45
Compound 5							
30	380	NCA2	45	53	50	46	45
31	240	NCA2	50	58	50	46	45
32	220	NCA2	51	59	50	46	45
33	50	NCA2	63	71	50	46	45
34	165	NCA2	54	62	50	46	45
35	350	NCA2	46	54	50	46	45
36	0	NCA2	78	86	50	46	45
38	335	NCA2	46	54	50	46	45
Compound 6							
41	180	NCA2	51	59	50	46	45
46	200	NCA2	51	59	50	46	45
48	40	NCA2	65	73	50	46	45
51	70	NCA3	61	69	51	44	43
52	200	NCA3	51	59	51	44	43
53	77	NCA3	58	66	51	44	43
56	147	NCA4	53	61	51	44	42
57	267	NCA4	50	58	51	44	42

Receiver number	Distance (m)	NCA	Predicted noise levels dB(A)		Standard hours NML dB(A)	Out of hours NML dB(A)	
			Typical	Worst case		Evening	Night-time
Compound 7							
66	235	NCA4	49	57	51	44	42
69	142	NCA4	52	60	51	44	42
71	38	NCA4	62	70	51	44	42
73	38	NCA4	63	71	51	44	42
92	170	NCA4	53	61	51	44	42
93	270	NCA4	48	56	51	44	42
Compound 8							
435	35	NCA5	72	80	45	42	40
452	30	NCA5	66	74	45	42	40
462	26	NCA5	75	83	45	42	40
466	26	NCA5	77	85	45	42	40
467	28	NCA5	76	84	45	42	40
476	31	NCA5	64	72	45	42	40
Compound 9							
561	57	NCA6	58	66	48	41	38
562	57	NCA6	55	63	48	41	38
564	60	NCA6	56	64	48	41	38

The predicted noise levels indicate that activities within the site compounds are likely to exceed the appropriate NMLs. All reasonable and feasible noise mitigation and management measures should be considered and detailed by the contractor in the Construction Noise and Vibration Management Plan (CNVMP).

4.5 Cumulative impact

Simultaneous noise from a site compound and works on the main alignment has the potential to increase noise levels at sensitive receivers. Noise levels as a result of the cumulative impact could increase by as much as three dB(A) higher than the maximum noise level of the site compound works and alignment works. Although three dB(A) is generally not considered significant, as far as possible the cumulative impact of noise should be managed by the contractor to ensure that the potential for adverse comment at sensitive receivers is minimised.

Construction of the project, if approved by the Minister for Planning, is forecast to commence in 2015 with the project opening to traffic in 2017.

In addition to this project, the Princes Highway upgrade program in the immediate region also includes the Gerringong upgrade and the proposed Berry to Bomaderry upgrade, which are located at the northern and southern ends of the project respectively.

The detailed design and construction of the Gerringong upgrade is currently underway following approval of the project under Part 5 of the EP&A Act, with the upgraded highway opening to traffic in 2014.

The Berry to Bomaderry proposal is only in its planning stage. In the event that the proposal moves forward to the assessment and approval stage, construction may be underway in 2017, with this section of the upgraded highway open to traffic by 2019.

A review of the major projects register, administered by the NSW Department of Planning and Infrastructure (DP&I), indicates that, at the time of writing, no other major projects in the Shoalhaven and Kiama LGAs have been recently approved and/or are likely to be under construction at the same time as the project.

The North Nowra Link Road (NNLR) is a major project in the region that is currently being assessed by the DP&I as a concept plan under Part 3A of the EP&A Act. The link road is proposed to relieve traffic congestion at the Illaroo Road and the Princes Highway intersection by providing an alternative access to the Princes Highway, as well as to provide network capacity for future growth in North Nowra and Bomaderry.

The concept plan provides a comparative assessment of three route options through and/or adjacent to the Bomaderry Creek Regional Park, and seeks approval of the preferred route. The environmental assessment for the concept plan was publicly exhibited by the then NSW Department of Planning between 16 February 2011 and 18 March 2011. At the time of writing, Shoalhaven City Council (the proponent) was reviewing submissions received during the public exhibition period. Construction of the project may coincide with this project, should the Minister for Planning (or his delegate) determine to approve the concept plan.

4.5.1 Assessment of potential impacts

The Princes Highway upgrade works would largely be undertaken sequentially, however as at this early stage of the project it is not possible to eliminate the potential for some overlap of construction, a worst case scenario has been assumed for the Gerringong upgrade to the north and this project. Notwithstanding, this could increase noise levels by as much as three dB(A) above the maximum noise level. This is not generally considered to be a significant increase, but would be considered in any mitigation strategies (should this eventuate).

Given the current status of the proposed Berry to Bomaderry upgrade, any associated cumulative impacts from this proposal are not able to be accurately predicted. As such, for the Berry to Bomaderry upgrade, the onus will be on the environmental assessment for that proposal to assess and rectify any potential cumulative impacts with the project.

4.6 Extended work hours

Due to the scale of the project and the potential benefits of reducing the period of construction and improving the capacity to recover from wet weather or other delays, extended working hours are proposed. Minimising the construction period would also minimise the overall impacts of construction works on sensitive receivers adjacent to the alignment. Extended working hours would be highly beneficial for works surrounding the Toolijooa cut and a number of major bridge structures, away from the township of Berry.

The ICNG permits five types of work that may be undertaken outside normal construction hours. These are:

- Deliveries of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads.
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours.
- Public infrastructure works that shorten the length of the project and are supported by the affected community.
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

For this project, approval is sought for extended working hours to shorten the length of the project construction and improve the capacity to recover lost construction capability due to wet weather or other delays. Extended work hours would be limited to:

- Between 6am and 7pm Monday to Friday for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Between 8am and 5pm on Saturdays for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Outside of known likely major traffic peaks (such as the Friday evening prior to a public holiday long weekend).

Extended construction hours at the start and finish of each working day are considered to be in the public interest as it would:

- Shorten the overall construction period by approximately 3 months or 10 per cent. This would minimise the disruption to the Princes Highway and improve access to the NSW south coast. It would also minimise impacts to local businesses that may be experienced during the construction period.
- Reduce the publics' exposure to a substandard and inefficient road, reducing the potential for crashes.
- Potentially reduce the overall cost of construction.

Activities during the morning extended period hours would typically comprise of low noise impacts including deliveries, site access, refuelling, office works, foot-based activities and work in ancillary activities.

The potential noise impact for extended work hours has been considered in Section 4.2.4. Extended work hours would be programmed and managed in accordance with the processes recommended in this report to minimise the noise and vibration impact on individual receivers. Consultation with potentially affected residents has already commenced.

Extended working hours construction noise consultation

The ICNG states that *"a strong justification would typically be required for works outside the recommended standard hours"*. However in some situations, and with community negotiation, the ICNG also considers that approval for out of hours work can be granted.

Targeted community consultation has been undertaken with property owners potentially affected by these extended hours from Toolijooa Road to the northern Berry interchange in September 2011 and January 2012. A total of 58 properties from Toolijooa Road to the northern Berry interchange were identified as being potentially impacted by construction noise and therefore may be subject to potential impacts associated with works during extended hours. Of these properties, nine are owned by RMS and existing tenants were contacted by the leasing agent with one tenant contacting the project team for further feedback. For the remaining 49 privately owned properties, telephone calls were made to 44 properties. The remaining five properties did not have a telephone number listed. Letters were sent to all 49 private property owners.

A total of 34 of the property owners contacted requested an interview with the project team to discuss potential impacts or seek clarification regarding the proposed extended working hours. A summary of the comments and feedback recorded during these interviews is included in Chapter 6 and Appendix C of the environmental assessment. Discussions included a general summary of the standard working hours and what the extended hours would mean for each property. Information on the likely work activities that may be undertaken during extended hours was based on current information and the potential construction scenarios. Property owners were also informed about the likely complaints management procedures, EPL conditions and project conditions of consent that would likely be put in place during construction and the team noted that consultation would be ongoing as the project progresses through detailed design and construction.

Feedback received during the consultation demonstrated that with the appropriate construction programming in place and the consideration of periods of respite during the day, there is general support overall for the application of extended working hours, as it provides a way to potentially shorten the construction period.

Although feedback was generally supportive of extended construction hours, a number of property owners raised concerns relating to potential disruptions to cattle movements, distribution or grazing patterns within the property that may be required to separate livestock from loud noise associated with construction or loud noise events (including blasts) that may disturb livestock, including horses. It was noted that these issues, and other concerns relating to possible personal events such as weddings or birthdays on the property, would be discussed in more detail prior to and during construction through the ongoing project consultation. Of the 33 consultation interviews undertaken, three property owners expressed some concern over extended working hours in the morning and evening and one was concerned about work being undertaken on Saturday afternoons.

4.7 Out of hours work activities

Some out of hours work would be required due to safety, engineering and timetable feasibility issues. The work packages required for out of hours are summarised below. All feasible and reasonable mitigation measures would be implemented by the contractor to ensure that the potential for adverse impact on the local community is minimised. Detailed information on the mitigation measures that would be implemented would be provided by the construction team in the form of a CNVMP.

4.7.1 Bridge works - lifting and setting of girders over existing roads or demolition

The only bridge that would require out of work hours is located near Tindalls Lane. The Princes Highway would need to be closed to allow this work to be undertaken safely for both traffic and workers. There are no other bridges to be constructed on the existing alignment.

4.7.2 Existing and new road tie-in works

Tie-in roadworks would be required at the beginning and end of new road alignments, where the new road alignment joins an existing road. This work would need to be undertaken at night to reduce the inconvenience to road traffic. The Princes Highway or local roads where appropriate, would need to be closed to allow this work to be undertaken safely for both traffic and workers.

4.7.3 Utility adjustments

Utility adjustments typically need to be undertaken during out of hours work periods to minimise the impact on utility operations and road traffic and to improve the safety of workers involved. The details of utility adjustments are not certain at this stage and would be clarified in the CNVMP.

4.7.4 Refuelling operations and maintenance

To maximise the plant and machinery operations during the recommended standard hours, and thus reduce the overall duration of the project, refuelling operations of plant and machinery are proposed between 5am and 7am in the morning Monday to Saturday or between 6pm to 9pm Monday to Friday or 1pm to 9pm Saturday.

This work would be undertaken in accordance with the Out of Hours Work Procedure that would be provided in the CNVMP, and away from sensitive receptors receivers and such that the noise emissions are shielded or directed away from sensitive receivers where possible.

Reversing has been identified as the single loudest activity during refuelling and the vehicles undertaking this work would be fitted with less annoying ‘smart’ reversing alarms, subject to approval by the site Safety Manager.

4.7.5 Inaudible out of hours works

Some construction activities would also be undertaken outside of the standard and extended construction hours without approval in the following circumstances:

- The works do not exceed the noise management levels.
- For delivery of materials required outside these hours by the Police or other relevant authorities for safety reasons.
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

4.8 Construction road traffic noise

Most spoil would be moved on internal haul routes, reducing the number of heavy vehicle movements on local roads. However the construction works would increase both light and heavy vehicle movements on the Princes Highway. Given that 3 per cent of traffic is predicted to shift to the ‘Sandbank’ route during the construction period, the additional traffic would be partially offset by a small reduction in local traffic. Provided below in **Table 4-20** is a summary of the increase in traffic movements during the daytime (exclusive of the 3 per cent traffic shift for a conservative assessment). An increase in construction traffic during the night-time period is not predicted for this project.

Table 4-20: Construction road traffic

Route | Direction	Daily total	15 Hour (7am - 10pm)		
		Light	Heavy	% Heavy
Existing traffic				
Princes Highway northbound	4,664	3,700	514	12
Princes Highway southbound	4,630	3,689	502	12
Existing traffic with construction movements				
Princes Highway northbound	4,782	3,765	567	13
Princes Highway southbound	4,748	3,754	555	13

The increase in noise from additional traffic associated with the construction of this project is likely to be less than 0.5 dB(A). Considering the predicted increase in noise is well below two dB(A), the impact from the additional traffic associated with the construction works is not considered to be significant.

4.9 Construction vibration

Vibration intensive works may occur during each phase of the project. The safe working distances that relate to cosmetic/structural damage and human discomfort for the proposed works are presented in **Table 4-21**.

Depending on the construction equipment that is used, the safe working distances provided in **Table 4-21** may be exceeded. The construction equipment used in the works should be planned to ensure that the safe working distances are not breached wherever possible. If these distances are breached, alternative equipment and vibration monitoring should be implemented. This is discussed in more detail below.

The primary form of mitigation of vibration should be ensuring vibration intensive works do not occur within the safe working distance outlined in **Table 4-21**. If vibration intensive works are planned within the safe working distances identified, alternative equipment should be identified to ensure these distances are not exceeded.

Table 4-21: Recommended safe working distances for vibration intensive plant

Plant	Rating/description	Safe working distance	
		Cosmetic damage (metres)	Human response (metres)
Vibratory roller	< 50 kN (Typically 1-2t)	5	15-20
	< 100 kN (Typically 2-4t)	6	20
	< 200 kN (Typically 4-6t)	12	40
	< 300 kN (Typically 7-13t)	15	100
	> 300 kN (Typically 13-18t)	20	100
	> 300 kN (> 18 t)	25	100
Small hydraulic hammer	(300 kg – 5-12t excavator)	2	7
Medium hydraulic hammer	(900 kg – 12-18t excavator)	7	23
Large hydraulic hammer	(1,600 kg – 18-34t excavator)	22	73
Vibratory pile driver	Sheet piles	2–20	20
Pile boring	≤ 800 mm	2	N/A
Jackhammer	Handheld	1 nominal	Avoid contact with structure

Further mitigation of vibration would not be required provided that the safe working distances in **Table 4-21** are adhered to.

In some circumstances, construction activity within the safe working distance cannot be avoided due to the work required and the prevalent geological site conditions. These conditions may not be fully understood until work has commenced, resulting in a potential change in operating equipment. If vibration intensive plant is to be used within the safe working distance for cosmetic damage, works should not proceed until attended vibration measurements are undertaken. A permanent vibration monitoring system should be installed, to warn operators (via flashing light, audible alarm, short message service (SMS) etc) when vibration levels are approaching the cosmetic damage objective. It may also be advisable to carry out dilapidation surveys of the affected properties.

4.10 Blasting assessment

A list of the nearest sensitive receivers to the proposed blasting is provided below in **Table 4-22**. The nearest receiver must comply with the appropriate noise and vibration criteria. By ensuring that the nearest receivers have been considered adequately, all other receivers would comply with the appropriate criteria.

Table 4-22: Sensitive receivers

Receiver	Offset distance (m)
14	450
12	450
11	300
9	260

To predict overpressure and PPV levels, the equations are highly dependent on local site conditions and the nature of the blast. The maximum offset distances calculated under 'typical' conditions are provided below for confined blasts. It is recommended that smaller test blasts are undertaken initially to determine the correct constants that should be employed for this project. This should allow for a higher certainty in the prediction of overpressure and PPV levels.

The offset distances provided below in **Table 4-23** have been calculated to ensure compliance with the criteria in **Table 3-12** and **Table 3-13**.

Table 4-23: Overpressure and blast limits

Criteria	Charge offset distance		
	1 kg	5 kg	10 kg
Overpressure[1]	550 m	900 m	1150 m
PPV[2]	30 m	67 m	95 m

Note1: K_a=100, a= -1.45
Note2: K_a=1140, a= -1.6

Based on the offset distances provided in **Table 4-23**, the results indicate that although vibration limits would be complied with, overpressure is likely to exceed the appropriate limits. It is likely that as the project proceeds, the noise levels would be attenuated by the deepening cut. As such noise levels will gradually decrease. On this basis, the blast size is likely to be able to be increased as the works progress. Blasts should be monitored closely to determine the insertion loss the cut is providing.

Blast shields or similar should be used to reduce noise levels and minimise the likelihood of exceedance. If the noise criteria cannot be met at sensitive receivers, the residents may need to be relocated during the blast operations.

To improve productivity of the construction, and hence reduce both the number of blasts and the duration of construction, it is considered reasonable to exceed overpressure and blast limits should the written consent of local residents be attained. With the consent of local residents, recent major road upgrade projects have used the criteria provided in **Table 4-24**.

Table 4-24: Secondary overpressure and peak particle velocity criteria

Criteria	Maximum allowable level
Overpressure	125 dB(Lin)
PPV	15mm/s

The limits recommended above in **Table 4-24** comply with the structural damage criteria in DIN4150. On the basis that these limits have been implemented successfully in the past without incident, it is recommended that these conditions also be considered for this project.

Provided in **Table 4-25** are the maximum offset distances incorporating the criteria identified in **Table 4-24**.

Table 4-25: Overpressure and blast limits

Criteria	Charge offset distance (metres)		
	1 kg	5 kg	10 kg
Overpressure[1]	240	410	520
PPV[2]	15	34	48

Note1: K_a=100, a= -1.45
Note2: K_a=1140, a= -1.6

4.11 Operational noise assessment

4.11.1 Modelling methodology

Noise emission levels from the road were calculated using SoundPLAN software, which implements the Calculation of Road Traffic Noise (CoRTN) algorithm. The UK Department of Transport devised the CoRTN algorithm and with suitable corrections, this method has been shown to give accurate predictions of traffic noise levels under Australian conditions.

The noise model for this project incorporated the following features:

- Traffic volume and/or percentage of cars on the roadway.
- Traffic volume and/or percentage of medium / heavy trucks on the roadway.
- Correction for pavement surface.
- Corrections for roadway gradient.
- Road chainage and three dimensional coordinates of traffic lanes and topographic features imported from electronic data (DXF format).
- Three dimensional receiver coordinates, calculated at the most affected storey.
- Intervening ground absorption.
- Roadside or topographic barriers.
- Contributed noise from other traffic sources to determine the cumulative noise impact.
- 2.5 dB(A) correction for facade effects.
- A sensitivity factor of one dB(A) has been applied to the design year noise model.
- Verification factor of -1.7 dB(A) for day-time noise levels and +0.5 dB(A) for night-time noise levels.
- Noise sensitive receivers were identified from aerial photographs and are presented in Appendix B. The height and number of floors of the identified receivers was identified from Google Street View where possible.

To determine the most affected facade, noise levels were calculated at each facade of every identified sensitive receiver. All facades were assessed against the criteria, however only the most affected facade has been reported.

The calibration noise model incorporated measured traffic volumes on the Princes Highway and all major roads around town.

Both daytime and night-time noise levels were predicted for the year of opening (2017), the design year (10 years after opening - 2027). The design year was also modelled with a low noise pavement (stone-mastic asphalt) and a variety of test barriers.

Three models were developed for both the year of opening scenario and the design year scenario. The first two models were the ‘no build’ scenario and the ‘build’ scenario which incorporated all local roads, the main alignment and interchanges. The models were used to assess the increase in noise. The ‘build’ scenario was also used to assess noise levels for the redeveloped road noise criteria. The last model incorporated the main alignment and interchanges only and was used to assess the noise as a result of the project for receivers subject to the criteria for a new road.

4.11.2 Traffic volumes

The existing traffic volumes were obtained from traffic count data recorded at various positions along the Princes Highway, Berry. Appendix H contains a summary of the traffic data used to calibrate the noise model. Predicted traffic volumes (2017 and 2027) for both the proposal and for the existing road were sourced from traffic modelling undertaken by AECOM and are summarised in Appendix H.

4.11.3 Ground absorption

The ground absorption was set at 0.5 for the modelled area. This provided the best correlation with measured data and, based on AECOM’s previous experience, is typical for rural locations in NSW.

4.11.4 Traffic source strings

A three source height model was utilised throughout the modelling with individual source strings for each lane of traffic. The source height was set at 0.5 metres for light vehicles and 1.5 metres and 3.6 metres for heavy vehicle engines and exhausts respectively (including the default 0.5 metres height assumed by the implementation of CoRTN within SoundPLAN). Source corrections of 0.6 dB(A) and -8.6 dB(A)) were applied to the heavy vehicle engine and exhaust strings respectively to take in to account the relative source contributions of the engine and exhaust in the three source height model.

4.11.5 Road surfaces

The existing road surface was modelled as dense grade asphalt in the CoRTN model for both the existing future and design year models. No correction factor has been used for dense grade asphalt road surface.

Stone mastic asphalt was also considered as a low noise pavement option. The correction factors used was -2.2 dB(A) for light vehicles and -4.3 dB(A) for heavy vehicles.

4.11.6 Reflections of barriers

Barriers have the potential to reflect noise to a receiver on the opposite side of the carriageway. The maximum increase in noise would typically be in the range of one dB(A) to two dB(A), dependent on the arrangement of the source, barrier and receivers. Reflections are typically included in the SoundPLAN noise modelling; however for the avoidance of doubt and to provide a conservative assessment, a correction factor of +2 dB(A) has been included for receivers that may be exposed to an increase in noise as a result of reflection.

The receivers that may be potentially impacted are located to the north of North Street. The impact of reflections from the proposed Huntingdale Park Road noise barrier were considered by analysing the future impact on receivers currently located on Queen Street, opposite Huntingdale Park Road.

The noise levels would be controlled by noise from the main alignment. Reflections from the Huntingdale Park Road noise barrier due to traffic on that road were found not to increase noise levels. Additionally due to the distance of the reflection path between the main alignment, the proposed Huntingdale Park Road noise barrier and the receivers on Queen Street, reflections from the main alignment were also found not to impact overall noise levels. On this basis the impact of reflections from the Huntingdale Park Road noise barrier were considered to be negligible and would not impact sensitive receivers. A correction factor was not included for receivers located on Queen Street.

4.11.7 Noise model calibration

Standard corrections are typically applied when using the CoRTN in Australia to account for Australian conditions. These correction factors of -1.7 dB(A)[1] and +0.5 dB(A)[2] have been applied to the daytime and night-time predicted noise results respectively.

Noise logging was undertaken over a period of two weeks at ten locations to verify the noise model. Traffic flow monitoring was undertaken simultaneously to determine the traffic flows at each location over the same time periods.

The noise logging results and noise model predictions have been provided in **Table 4-26**. The noise logger locations are provided in Appendix D.

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[1] *An evaluation of the U.K. DoE traffic noise prediction method: final report of the NAASRA Working Group on Traffic Noise Prediction Evaluation / by R.E. Saunders...[et al.] Vermont South, Vic. : Australian Road Research Board, 1983.*

[2] *Based on AECOM experience*

Table 4-26: Noise model calibration

Noise logger	Daytime noise level dB(A)			Night-time noise level dB(A)		
	Measured	Predicted with standard correction	Difference	Measured	Predicted with standard correction	Difference
BG1	62	64.1	2.1	58.4	59.2	0.8
BG2	52.2	51.5	-0.7	49.3	46.6	-2.7
BG3	55.9	54.7	-1.2	51.2	49.8	-1.4
BG4	55.9	53.8	-2.1	46.7	48.6	1.9
BG5	58.4	58.0	-0.4	48.9	48.7	-0.2
BG6	58.1	57.6	-0.5	48.1	48.2	0.1
BG7	65.6	61.8	-3.8	54.8	50.8	-4
BG8	58.9	61.3	2.4	56.5	56.1	-0.4
BG9	54.3	55.6	1.3	50.7	50.2	-0.5
BG10	51.4	51.4	0	46	46	0

The results in **Table 4-26** indicate that disregarding BG7, measured noise levels during the daytime period vary between -1.6 dB(A) to +2.4 dB(A). Rounding results to the nearest decibel results in an accuracy of ±2 dB(A). This calibration is within CoRTNs documented accuracy of ±3 dB(A) at a distance of 600 metres.

The predicted night-time levels (disregarding BG7) are within -2.7 dB(A) and +1.9 dB(A). Rounding results to the nearest decibel results in an accuracy of ±2 dB(A). This calibration is within CoRTNs documented accuracy of ±3 dB(A) at a distance of 600 metres.

BG7 was located near a corner that appears to have a high number of cars accelerating past it. This has resulted in much higher measured noise levels during the daytime and night-time period so has not calibrated sufficiently.

The predicted noise levels indicate that the impact of the daytime and night-time periods are quite close. As such, both time periods would be assessed in detail to ensure that no receivers are missed as a result of focusing on only one period.

4.11.8 Operational noise assessment

The results of the operational noise modelling are presented in Appendix I and Appendix J.

A total of 108 receivers exceed the appropriate noise criteria during the daytime period of which 7 are considered to be ‘acute’ ($L_{Aeq(15hour)}$ is 65 dB(A) or greater) as a result of the project. During the night-time period 131 receivers exceed the appropriate noise criteria of which 16 are considered to be ‘acute’ ($L_{Aeq(9hour)}$ is 60 dB(A) or greater) as a result of the project.

The numbers above indicate that the night-time period is generally more stringent than the daytime results. However both time periods have been considered in the assessment of the results.

Overall, 164 receivers exceed the appropriate noise criteria, of which 18 are considered to be ‘acute’ as a result of the project.

Results for receivers that would be impacted by the project are provided graphically in the following pages. A small increase in noise of typically between one dB(A) and two dB(A) is predicted between the year of opening and 10 years after opening, with a small number of receivers experiencing an increase of greater than two dB(A) .

The designation of the ‘redeveloped’ and ‘new road’ noise criteria to sensitive receivers along the project is consistent with Practice Note i of the ENMM as discussed in Section 3.4. Typically the ‘redeveloped’ criteria apply where the road will not deviate significantly from the existing alignment.

Sensitive receivers that have been assigned the ‘new road’ noise assessment criterion are those that would be exposed to a new source of road traffic noise or where the sensitive receiver is not currently exposed to road traffic noise. Examples for this project include sensitive receivers that are typically located along the off line sections of the project near Toolijooa Ridge and near the Berry bypass.

Receivers predicted to exceed criteria are shown in **Figure 4-1**, **Figure 4-2** and **Figure 4-3**.

Figure 4-1: Receivers predicted to exceed criteria in areas from Toolijooa Road interchange to just east of the Austral Park Road interchange

Figure 4-2: Receivers predicted to exceed criteria in areas between Austral Park Road interchange and Tindalls Lane interchange

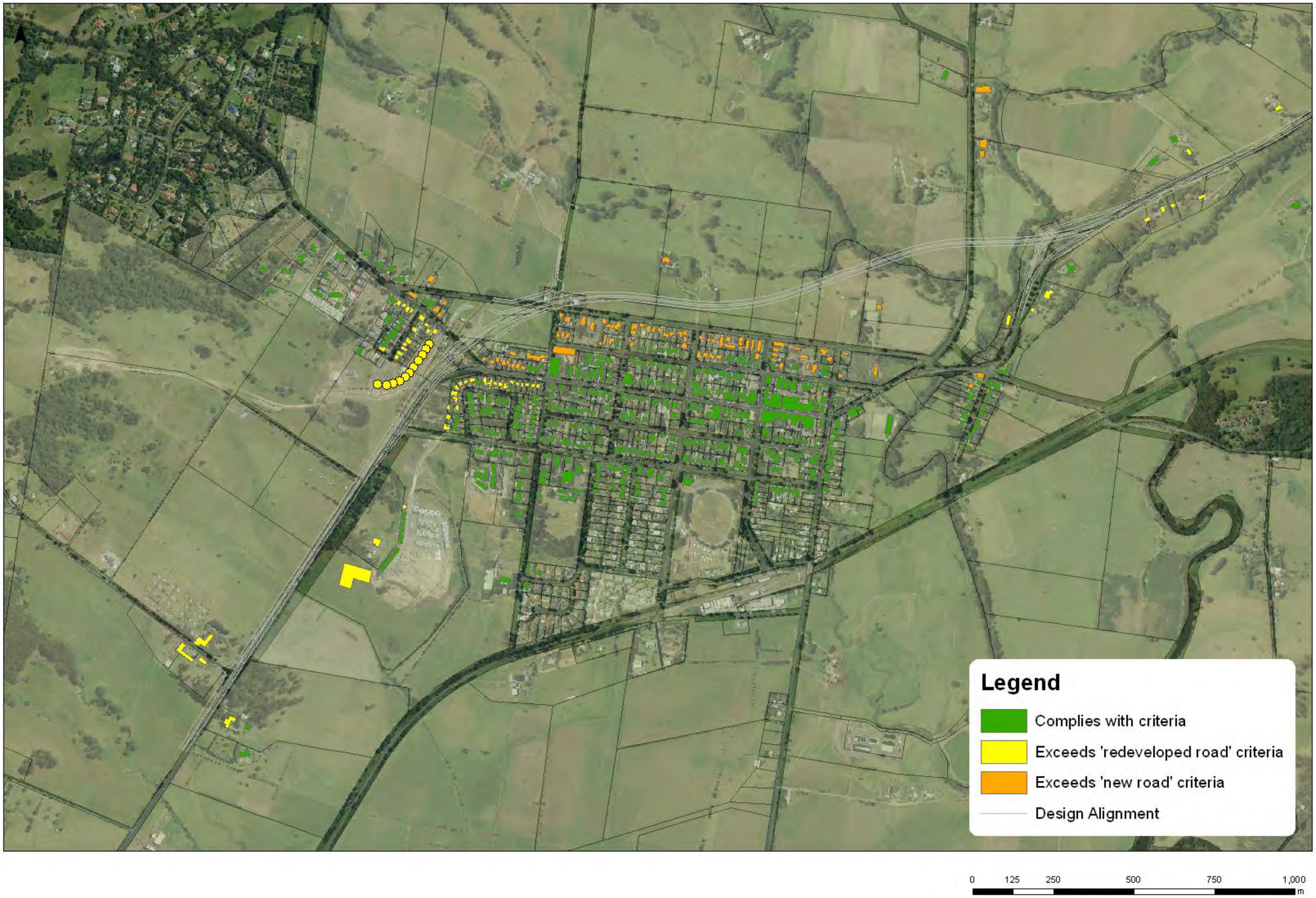


Figure 4-3: Receivers predicted to exceed criteria in areas between Tindalls Lane interchange and Berry bypass

4.11.9 Queen Street and Closure of Victoria Street

A considerable number of receivers along Queen Street are currently acutely affected by noise associated with traffic on the existing highway (Queen Street). Noise levels emitted from the new alignment (located to the north of Berry) comply with the appropriate noise criteria. The project would redirect a significant amount of existing and future traffic from Queen Street to the new alignment, which would result in appreciable decreases in noise levels at receivers on Queen Street. As discussed previously noise generated by new alignment comply with the appropriate noise criteria. As receivers would not be impacted directly by the project, and noise levels would appreciably reduce as a result of this project, RMS considers that the receivers on Queen Street are not considered to be eligible for noise mitigation.

The closure of Victoria Street would result in a redistribution of some local road traffic and an increase in traffic along north-south running local roads including Prince Alfred Street, Alexandra Street, Albany Street, Edward Street and George Street. The increase in traffic would be predominantly local traffic accessing the new bypass and would generally be restricted to the sections of these local roads between Victoria Street and Queen Street.

An assessment of these local roads has been conducted in accordance with the RNP. The results of the assessment show that receivers located along the north-south running local roads are currently dominated by noise from Queen Street during the peak hour traffic flows and this would continue should the project proceed. Given that the traffic along Queen Street is predicted to decrease to 33 per cent of the existing traffic flows following the opening of the project, most receivers would experience a reduction in overall noise levels. A small number of receivers located further from and therefore less affected by traffic noise on Queen Street, would experience an increase in noise levels associated with the closure of Victoria Street during peak hour flows. The level of increase is expected to be less than 2 dB(A) which is typically considered indiscernible.

It is important to note that some receivers are currently experiencing noise levels well above the relevant criteria, and would continue to do so in the future. The noise at these receivers emanates from traffic movements on Queen Street, rather than the local road on which the receiver is located. With the proposed changes to Victoria Street, noise levels would continue to be controlled by movements on Queen Street.

Predicted noise levels results for some of the impacted receivers are presented below in **Table 4-27**. To be eligible for the consideration of noise mitigation the noise levels at the receivers must exceed an $L_{Aeq(1hour)}$ of 55 dB(A) and increase by more than 2.0 dB(A).

Table 4-27: Berry local road indicative results

Receiver	Most affected facade	Noise criteria dB(A)	2027 LAeq(1hour) Predicted Noise Levels – dB(A)		
			‘No Build’	‘Build’	Increase
132	N	55	66	65	-0.9
174	E	55	60	59	-0.9
244	N	55	62	62	0
332	W	55	60	60	-0.7
336	E	55	62	60	-1.4
402	E	55	60	58	-2.5
420	E	55	62	61	-1.4

Although the receivers in **Table 4-27** exceed the 55 dB(A) criteria, they do not increase by more than 2 dB(A) as a result of the project and hence are not eligible for mitigation.

As with those receivers on Queen Street discussed above, the project would redistribute a significant number of traffic movements away from sensitive receivers on local roads, that are currently affected by traffic noise on Queen Street, to the new alignment (located to the north of Berry). This would result in a reduction in noise levels for these sensitive receivers. There remain exceedances of the appropriate noise criteria; however these exceedances are owing to existing background levels which would be alleviated somewhat by the project. Considering the project would not directly impact local roads and noise levels associated with the bypass would comply with the local road noise criteria, receivers are not considered eligible for noise mitigation.

4.11.10 Other land uses

The Berry Sportsground, Berry Riding Club and Camp Quality Memorial Park are all located to the north of Berry and would be located directly adjacent to the proposed alignment. These locations can be considered ‘Open Space (active use)’ for the Sports Ground and Berry Riding Club and ‘Open Space (passive use)’ for Camp Quality Memorial Park as described by the RNP. The noise criteria are only applicable when the space is in use. For playing fields this would typically be outside standard working hours, usually during evenings and weekends. However considering the playing field, riding club and Camp Quality Memorial Park can be used anytime, the receivers have been assessed as operating during the day with typical traffic that has been used throughout the remainder of the project.

The $L_{Aeq(15hour)}$ noise level at the tennis courts is predicted to be 59 dB(A). Hence the predicted noise levels comply with the criteria of $L_{Aeq(15hour)}$ 60 dB(A) for ‘Open Space (active use)’ and exceed the criteria of $L_{Aeq(15hour)}$ 55 dB(A) for ‘Open Space (passive use)’. Noise mitigation should be considered for Camp Quality Memorial Park, where reasonable and feasible.

Mark Radium Park (receiver 588) is located to the west side of the Berry township, to the east of the existing and proposed alignment. This location is considered ‘Open space (passive use)’ as described by the RNP. The noise criteria is only applicable when in use. The $L_{Aeq(15hour)}$ noise level at the centre of the park is predicted to be 62 dB(A). The predicted noise levels will exceed the 55 dB(A) criteria by 7 dB(A) when in use.

Berry Uniting Church is represented as receivers 116, 117 and 119 in this assessment, Saint Patrick’s Catholic Church is represented as receiver 367. A place of worship has a noise criteria with an internal $L_{Aeq(1hour)}$ parameter of 40 dB(A), to be assessed when in use. Hourly traffic predictions while the church is operational have not been undertaken, however a screening assessment has been undertaken to determine the potential impact on the church.

$L_{Aeq(15hour)}$ noise level at the most affected church building is predicted to be 60 dB(A) for Berry Uniting Church and 61 dB(A) for Saint Patrick’s Catholic Church at the facade of the building. Assuming that each hour results in an equal contribution means that the $L_{Aeq(1hour)}$ is equal to the $L_{Aeq(15hour)}$. The facade reflection that has been included in the prediction is equivalent to 2.5 dB(A). For typical buildings the external to internal noise reduction is generally assumed to be 10 dB(A) with windows open and 20 dB(A) with windows closed. The building has not been inspected so the conservatively 10 dB(A) noise reduction has been assumed. These corrections result in an estimation of 47 dB(A) for Berry Uniting Church and 48 dB(A) for Saint Patrick’s Catholic Church. This exceeds the noise criteria by 7 dB(A) and 8 dB(A) for the two Churches, hence noise mitigation would be considered for these receivers.

The Bupa Care Services – Aged Care Facility has been assessed in accordance with the RNP, against the residential criteria. The maximum $L_{Aeq(9hour)}$ noise level predicted on the site of the Bupa Care Services is 58 dB(A). The predicted noise level exceeds the ‘redeveloped road’ criteria of 55 dB(A). However, there is no significant increase in noise levels as a result of the project. Therefore the Bupa Care Services – Aged Care Facility is not eligible for mitigation.

4.11.11 Meteorological effects

Meteorological effects have been assessed in accordance with the INP, as required by the DGRs. There is no requirement to meet the noise criteria under adverse weather conditions. As such the effectiveness of noise mitigation with weather effects has not been considered here.

Weather data has been sourced from the Bureau of Meteorology, incorporating the closest weather station at Gerroa, NSW. The weather data comprises the period of January 2000 to January 2001.

The occurrence of temperature inversions was considered to determine if they represented a significant feature of the area. Between 6pm and 7am during the winter months of June, July and August temperature inversions were found to occur for about 47 per cent of the total time. On this basis and consistent with the INP, temperature inversions are considered to be a feature of the area.

The noise propagation algorithm CONCAWE provides guidance to the potential impact of temperature inversion. This high level assessment has considered the dominant frequency of road traffic noise only at about one kHz. A temperature inversion typically falls under the Pasquill Stability Category F, with a wind speed of three metres per second results in a Meteorological Category 6.

Provided below in **Table 4-28** is the likely increase in noise as a result of temperature inversions.

Table 4-28: Temperature inversion influence on noise levels

Distance to receiver (m)	Increased noise levels as a result of temperature inversions dB(A)
100	0.4
200	3.6
300	4.5
400	4.9
500	5
1000	5

The INP considers wind effects to be assessed when source-to-receiver wind speeds of three metres per second or below occur for at least 30 per cent of the assessment period in any season. The occurrences of wind speeds of up to three metres per second for each season are provided in Appendix K.

The INP requires wind effects to be modelled at the highest measured wind speed. For all locations receivers that are wind affected were modelled at three metres per second, this represents a conservative approach. A summary of the modelling requirements is provided graphically in **Figure 4-4**.

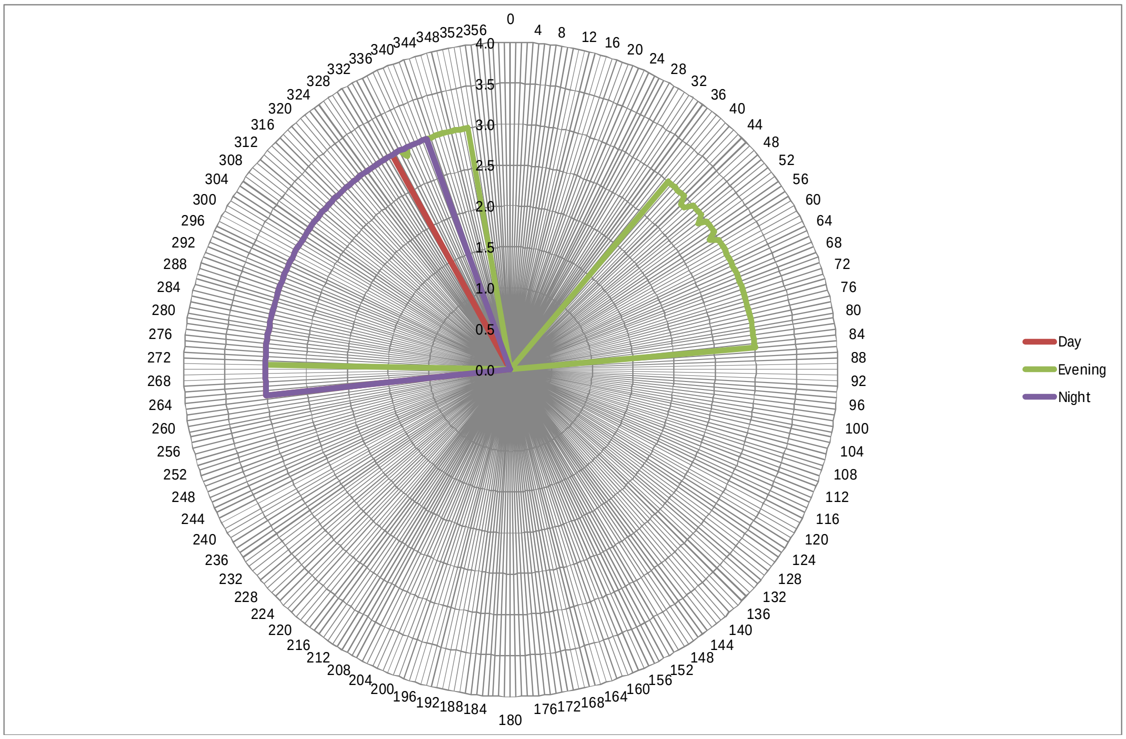


Figure 4-4: Wind speed and direction modelling

Considering the alignment generally runs east to west (rather than north to south), the figure above indicates that receivers located towards the south of the alignment would be adversely impacted as a result of wind affects.

The noise propagation algorithm CONCAWE provides guidance to the potential impact of wind effects. This high level assessment has considered the dominant frequency of road traffic noise only at about one kHz. The CONCAWE algorithm provides noise attenuation curves for vector wind speeds greater than one metre per second.

Table 4-29 shows the likely increase in noise as a result of wind. Note that the noise levels provided below are not intended to be used in addition to those provided in **Table 4-28**.

Table 4-29: Wind effects influence on noise levels

Distance to receiver (m)	Increased noise levels as a result of vector winds > 1m/s dB(A)
25	2.2
50	2.8
100	3.4
200	4
300	4.4
400	4.6
500	4.8
1000	5.4

The results in **Table 4-28** and **Table 4-29** indicate that noise levels at sensitive receivers could increase by as much as five dB(A) as a result of temperature inversions and wind effects.

4.11.12 Maximum noise levels

The RNP includes a review of international sleep arousal research and concludes that at our current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance.

The emergence of noise levels has been considered at two locations, BG9 and BG6. These locations are considered to be typical of existing receivers north and south of Berry located on the existing alignment. Provided below are illustrations of the hourly median and maximum emergence levels.

The above noise logger indicates that typical noise levels meet the emergence criteria, with hourly maximum emergence levels exceeding the emergence criteria (of 15 dB(A)) by more than five dB(A) (refer to **Figure 4-5**). As such the sleep disturbance noise goals would be exceeded more than two to three times in one night and are considered to be regular events.

BG6 noise logger indicates that typical noise levels exceed the emergence criteria by as much as five dB(A) (refer to **Figure 4-6**). Hourly maximum emergence levels regularly exceed the emergence criteria (of 15 dB(A)) by at least five dB(A) . On the basis of these results, the sleep disturbance noise goals can be considered to be exceeded more than two to three times in one night and are considered to be regular events.

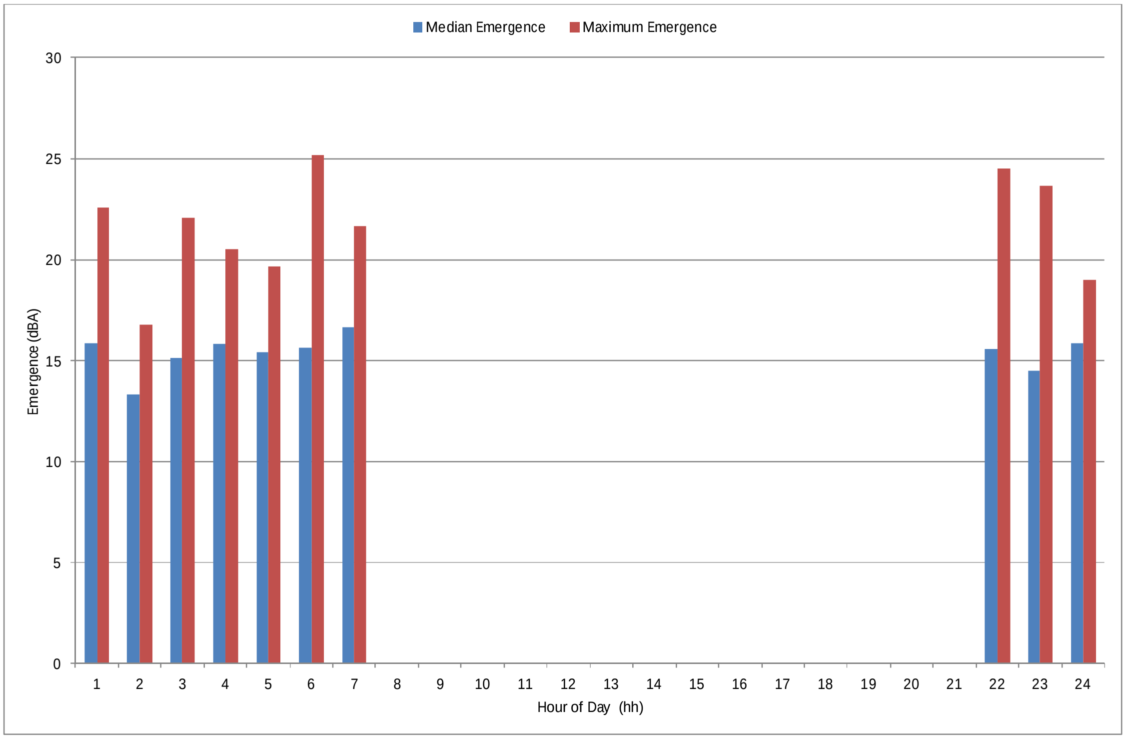


Figure 4-5: Logger BG9 – 10 Austral Park Road, Broughton

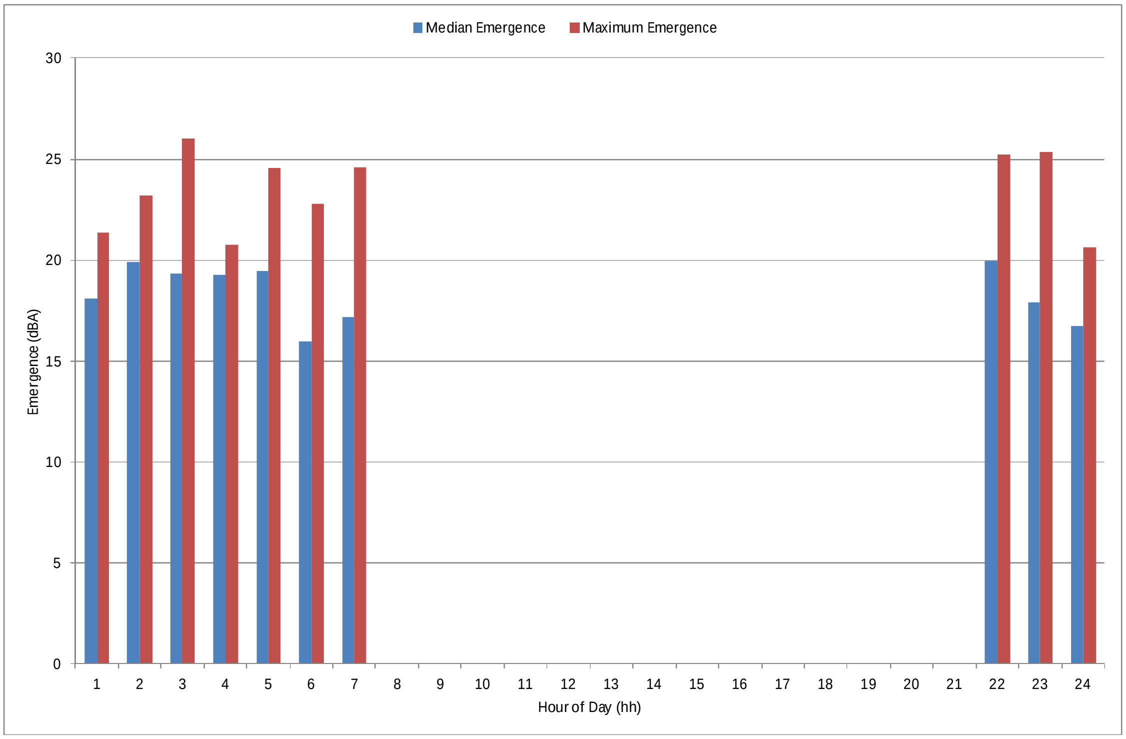


Figure 4-6: **Logger BG6 – Andersons Lane, Berry**

These results indicate that sleep disturbance is likely to be an existing issue for the local area.

For receivers where the proposed road would not move closer to them, the emergence is likely to decrease in the future. As traffic volumes increase, the $L_{Aeq(1hr)}$ noise levels would also increase, however as the road is not moving closer maximum noise levels would not increase. As the difference between these levels decrease (resulting in a decrease in emergence), the potential for sleep disturbance is likely to become less prominent.

The proposed alignment would also decrease the gradient in some areas, and reduce the undulating nature of the existing alignment. This should reduce the use of truck engine braking and high engine revs, reducing maximum noise levels.

However receivers exposed to a new road would still be likely to receive emergence levels greater than 15 dB(A). Maximum noise levels decay from the source at twice the rate than average noise levels. On this basis, receivers located further from the alignment are theoretically likely to have lower emergence levels.

The RNP does not provide any requirements to meet maximum noise levels criteria. A cost-benefit analysis was undertaken for the noise proposed barrier, however the ENMM does not require maximum noise levels to be considered in this assessment.

5 Mitigation

5.1 Construction noise mitigation

Under the existing EPA policy a CNVMP is typically required to be prepared by the Contractor prior to construction commencing.

The CNVMP should detail the ‘best practice’ construction methods to be used, presenting a feasible and reasonable approach. The CNVMP should identify the extent of the noise sensitive receivers affected and assess the impact on the community. The CNVMP should detail any community relation programs that are planned eg prior notification for particularly noisy activities, letter box drops regarding out of hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The ICNG defines what is considered to be feasible and reasonable as follows:

Feasible

A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

Reasonable

Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Guidance on noise control measures is provided in AS2436-2010: Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites. Provided in this standard are practical noise reduction opportunities for various equipment. **Table 5-1** shows mitigation and management measures to limit the noise impact from various construction equipment used on projects similar to this.

Table 5-1: Noise sources and possible mitigation and management solutions, AS2436-2010 Table C1

Machine	Source of noise	Possible remedies		Possible alternatives
Pneumatic concrete breaker and tools	Tool	Fit a muffler that will reduce the noise without impairing efficiency	Use the breaker inside a portable acoustic enclosure	Use rotary drill and burster. Hydraulic and electric tool are also available. A thermic lance can be used to burn holes in concrete and to cut through large sections of concrete, any reinforcement helps the burning process for breaking large areas of concrete, equipment which breaks concrete by bending could be used.
	Bit	Use dampened bit to eliminate ‘ringing’. Little noise once surface is broken.		
	Air line	Leaks in air lines should be sealed		
	Motor	Fit muffler to pneumatic saws.		

Machine	Source of noise	Possible remedies		Possible alternatives
Power saws	Vibration of blade or material being cut	Keep saw sharp. Use a damped blade. Clamp material while cutting with packing if necessary		
Rotary drills diamond drilling and boring	Drive motor and bit	Use machine inside an acoustic enclosure		Thermic lance Thermal oxy-torch
Riveters	Impact on rivet	Enclosure working area in acoustic screen		Design for high tensile steel bolts instead of rivets
Explosive powered tools	Explosion of cartridge	Use a sound reduced gun		Drilled fixings
Pumps	Engine pulsing	Enclosure in acoustic screen (allowing for engine cooling and exhaust)		
Batching plant	Engine	Fit more efficient silencer on diesel or petrol engine. Enclose engine	Locate static mixing plant as far as possible from those likely to be inconvenienced by the noise	Use electric motor in preference to diesel or petrol engine
Concrete mixer	Filling	Do not let aggregates fall from an excessive height		
	Cleaning	Do not hammer the drum		
Hammer	Impact on nail			Screws
Electric impact chisel	Impact			Rotary hand milling machine
Materials handling	Impact of material	Do not drop materials from a height. Screen dropping zones especially on conveyor system.		Cover surface with resilient material or unload elsewhere
Steam cleaning	Escaping of jet stream	Pass escaping steam through silencer or screen the outlet zone		

Table 5-2 lists mitigation and management measures to achieve potential noise reductions for various items of construction equipment used on similar projects.

Table 5-2: Typical examples of noise reduction, AS2436-2010 Table C2

Type of machine	Typical treatment	Typical reduction in total A-weighted sound pressure level L_{pA} after treatment dB
Diesel concrete mixer	Acoustic silencer	5
	Enclosure of the engine	7
Tracked loading shovel	Better silencer	10
Pneumatic concrete breaker	Muffler and screen	20
	Hydraulic System	25
Pneumatic breaker	Fabric muffler	6
	Rubber silencer	6
Diesel compressor	Silencer and enclosure	20
Crawler mounted rock drill	Silencer and enclosure	20
0.5 t pneumatic hoist	Diffuser	20
Piling, Sheet	Screen drop hammer driver	20
Piling impact	Resilient pad (dolly) between pile and hammerhead	10

The likely attenuation that can be provided from various noise control measures are set out in **Table 5-3** below.

Table 5-3: Relative effectiveness of various forms of noise control, AS2436-2010 Table C3

Control by	Nominal noise reduction possible, in total A-weighted sound pressure level L_{pA} dB
Distance	Approximately 6 for each doubling of distance
Screening	Normally 5 to 10, maximum 15
Enclosure	Normally 15 to 25, maximum 50
Silencing	Normally 5 to 10, maximum 20

Receivers potentially affected by construction noise would be consulted regarding specific timing and impacts of construction works. Respite periods should also be programmed for these receivers where practicable.

5.1.1 Ancillary facilities

Without knowing the exact location, orientation and source height of the equipment to be used in each ancillary facility, it is difficult to determine the appropriate height of noise barriers and mounds to attenuate noise levels. Noise barriers and mounds should be considered by the contractor once details on the specific location and nature of ancillary facilities are finalised. Additional mitigation measures that would be included in the CNVMP and operation of the ancillary facilities are provided in Section 5.1.3.

5.1.2 Community engagement framework

All residents where noise from the proposed works are expected to exceed the NMLs should be consulted about the project, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the residents should include:

- Programmed times and locations of construction work.
- The hours that the proponent proposes.
- Construction noise, vibration and air quality impact predictions.
- Construction noise, vibration and air quality mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration would be detailed in the Community Involvement Plan for the construction phase of the project and would include a 24 hour hotline and complaints management process.

Specific details of all out of hours work required will be provided to the EPA as part of the CNVMP.

5.1.3 Specific noise mitigation

Additional noise amelioration practices are provided below that should be included in the CNVMP.

- Noise intensive construction works should be carried out during standard construction hours wherever practicable.
- Schedule noisy activities that cannot be undertaken during standard construction hours to as early as possible during the evening and/or night-time periods.
- Appropriate plant should be selected for each task, to minimise the noise impact.
- Deliveries should be carried out during standard construction hours where practical and safe to do so.
- Non-tonal reversing alarms should be fitted on all construction equipment where possible.
- If it is safe, plan for and conduct night-time activities in such a manner as to eliminate or minimise the need for audible warning alarms.
- Maximise the offset distance between noisy plant items and nearby residential receivers.
- Orientate noisy equipment away from residential receivers.
- Position site access points and roads as far as practicable away from residential receivers.
- Use structures or enclosures to shield residential receivers from noise sources where practicable.
- Trucks should travel via internal haul routes and major roads and routes where practicable and not be allowed to queue near residential dwellings.
- Consider respite periods during times of noise intensive works where sensitive receivers would be adversely impacted for extended periods. These could include late start and/or early finishes.

- Wherever practicable, noise intensive works should be planned in the following order of priority to minimise the potential impacts on sensitive receivers:
  - Standard working hours.
  - Extended working hours.
  - Evening working hours.
  - Night time working hours.
- To reduce the total number of blasts it is proposed that multiple simultaneous blasts be undertaken for this project. Simultaneous blasts would not increase the perceived number of blasts in one day, hence would be unlikely to increase the annoyance of potentially impacted receivers.
- Bored piling should be used in place of impact piling wherever possible. Additionally, impact piling should only be undertaken during standard work hours.

5.1.4 Road traffic noise mitigation measures

Operations such as idling trucks for long periods alongside sensitive receivers have the potential to adversely impact sensitive receivers. As such the following mitigation measures should be employed to minimise the potential impact on sensitive receivers:

- Deliver materials and remove spoil during standard construction hours wherever practicable.
- Avoid idling trucks alongside sensitive receivers.
- Plan deliveries and spoil removal to ensure a consistent and minimal number of trucks arrive at site at any one time.
- Where practical consider traffic management practices to minimise reversing as far as practicable and arrange for construction vehicles and mobile plant to reverse predominantly away from noise-sensitive properties.
- Where practical, stage traffic movements that occur from any one location if there is potential for traffic movements to pass by noise sensitive receiver properties.

5.2 Operational noise mitigation

Where feasible and reasonable, noise levels from redeveloped and new roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land-use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

The hierarchy of noise mitigation is firstly to consider at-source noise mitigation measures such as road design and traffic management, then the use of quieter pavements. If these measures cannot be designed to meet the noise criteria the use of ‘in corridor’ mitigation measures should be considered, which are generally noise barriers and mounds. Finally, if the applicable noise criteria cannot be met by using a combination of all these methods, at-receiver mitigation measures can be considered such as architectural treatments and property boundary walls.

To be eligible for the consideration of additional noise mitigation from a ‘redeveloped road’ the predicted noise levels at the receiver must either:

- Exceed the applicable noise criteria and be significantly affected by the project.
- Be considered to be ‘acute’.

For a receiver to be eligible for the consideration of mitigation under the ‘new road’ criteria, the predicted noise levels must exceed the applicable noise criteria.

The ENMM provides guidance on the significance of impact:

‘A “significant contribution to road traffic noise exposure” from a road development or upgrading proposal is defined as an increase in road traffic noise at any exposed façade of more than 2 dB(A) compared to the road traffic noise level from the existing road.’

When assessing feasible and reasonable mitigation measures for a redeveloped road, an increase of up to two dB(A) represents a minor impact where it is generally not considered feasible and reasonable to provide additional mitigation. An increase of greater than two dB(A) (considered to be 2.1 dB(A) or greater), would require consideration of all feasible and reasonable mitigation measures.

A receiver is considered acutely affected if the predicted noise levels are equal to or greater than a daytime $L_{Aeq(15hour)}$ of 65 dB(A) or a night-time $L_{Aeq(9hour)}$ of 60 dB(A).

On this basis a total of 85 receivers during the daytime period and 113 receivers during the night-time period are eligible for the consideration of noise mitigation. Some of these receivers are eligible for consideration of mitigation under both the daytime and night-time criteria. A total of 114 receivers are eligible for the consideration of noise mitigation. These receivers have been summarised in Appendix I.

When designing noise mitigation, the target noise level is the lowest applicable noise criteria or controlling criterion, however it may not be feasible and reasonable to achieve these levels.

For this project, all road design and traffic management options have been exhausted. As such the next form of noise mitigation to be considered is a low noise surface.

Additional noise modelling has been undertaken assuming a low-noise pavement for the entire alignment. A low-noise surface in the form of stone mastic asphalt was modelled. The road surface corrections implemented for stone mastic asphalt were -2.2 for cars and -4.3 for trucks tyres. The results for the low-noise pavement are provided in Appendix I.

When the proposed noise mitigation reduces noise levels to within 2 dB(A) or less of the noise criteria at any individual receiver, it is not considered reasonable to provide additional noise mitigation at that residence.

The results indicate that with a low-noise pavement, a total of 67 receivers are significantly affected as a result of this project. A total of fifteen of these receivers would be isolated, located in groups of three or less. The ENMM stipulates that where reasonable and feasible, architectural treatment should be offered to isolated receivers that exceed the noise criteria and are located in groups of three or less. Receivers that are located in larger groups may be considered for a noise barrier.

A noise barrier (the next form of noise mitigation in the hierarchy) was considered for receivers located within the Berry township to reduce noise levels to the applicable noise criteria.

Modelling combining low-noise pavement and a noise barrier to the north of the Berry township and a noise barrier on the northbound off-ramp (adjacent to Huntingdale Park Road) resulted in 20 receivers remaining significantly affected. The noise barrier assessments are provided below. fifteen of these receivers are isolated as single residences.

5.2.1 North Street noise barrier assessment

Provided below is an assessment of a noise barrier, consistent with the requirements of Practice Note iv of the ENMM. The location of the noise barrier is presented in Appendix L.

Define the road traffic noise catchment area

The noise catchment area has been separated into a single group located along North Street.

Calculate existing and future noise levels, including changes in noise levels

The predicted noise levels are provided in Appendix I and Appendix J.

Identify all the options

All alternative feasible and reasonable traffic management and other road design opportunities for reducing traffic noise have been exhausted. A low-noise pavement is already included in the design at this location. A realignment of the road and more stringent limits on traffic flow speeds would have minimal effectiveness and cannot be considered either feasible or reasonable for this catchment area.

Analyse the barrier height and other road treatment options

There are more than three affected residences grouped together, so noise barrier options need to be considered.

Design a range of barrier options

A comparison of noise reductions for a range of barrier heights has been carried out for the most affected residences located on North Street. The graph provided in **Figure 5-1** shows the relation between barrier height and resulting noise levels for the design year (2027).

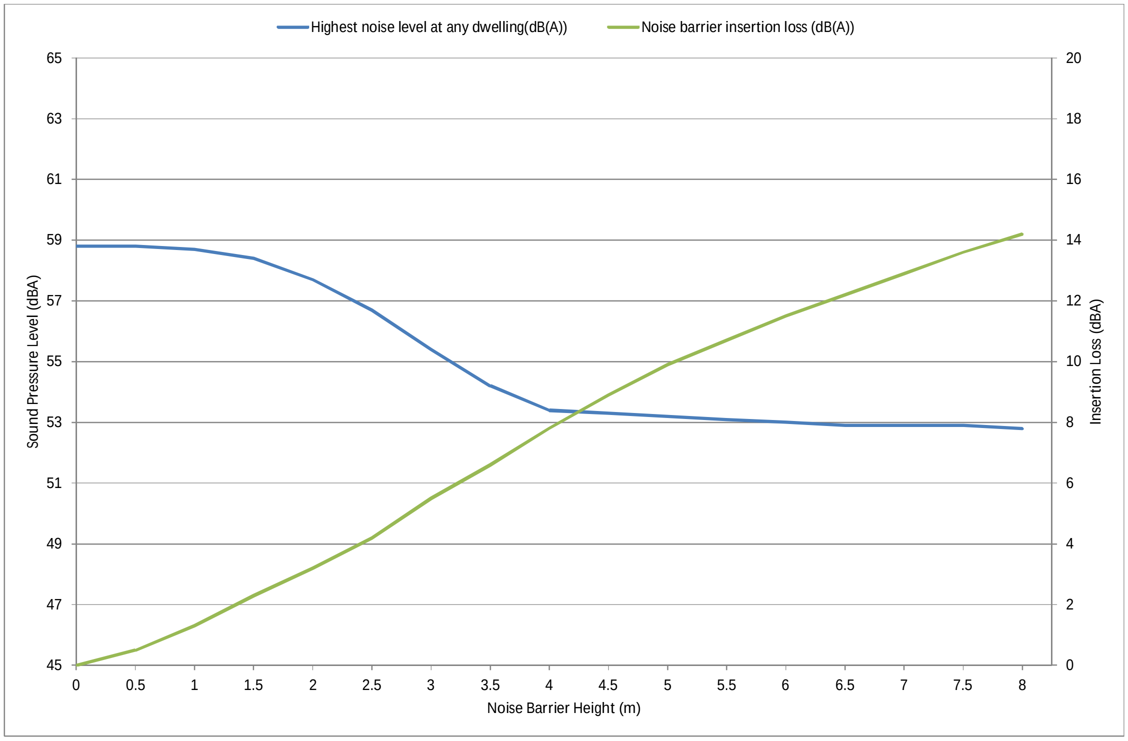


Figure 5-1: Maximum insertion loss

The graph provided in **Figure 5-1** shows the maximum insertion loss (reduction in noise by inserting a barrier between the source and receiver) at any receiver and the maximum sound pressure level at any receiver. Specific receivers may not be the same for the different barrier heights, hence the decrease in insertion loss is not necessarily consistent with the maximum noise level.

The graph provided in **Figure 5-1** indicates that the minimum insertion loss of at least five dB(A) is achieved at a three metre barrier height and at least 10 dB(A) is achieved at a five metre barrier height. Hence the noise barriers could be considered viable in this instance.

The 'target barrier' is the barrier that achieves compliance with the appropriate noise criteria at all sensitive receivers. The noise criteria for these receivers is 50 dB(A). The graph provided in **Figure 5-1** indicates that the 'target barrier' (the minimum barrier required to achieve the applicable noise criteria at all receiver locations) is greater than 8 m. However, allowing an exceedance at the four most affected receivers, the 'target barrier' would be four metres in height.

The Total Noise Benefit (TNB), the Marginal Benefit Value (MBV) and the Total Noise Benefit per Unit Area (TNBA) are illustrated in **Figure 5-2**. The TNB is the sum of the noise reduction provided by the barrier. The MBV is the increase in TNB, divided by the increase in barrier height. The TNBA is the TNB divided by the total area of the barrier.

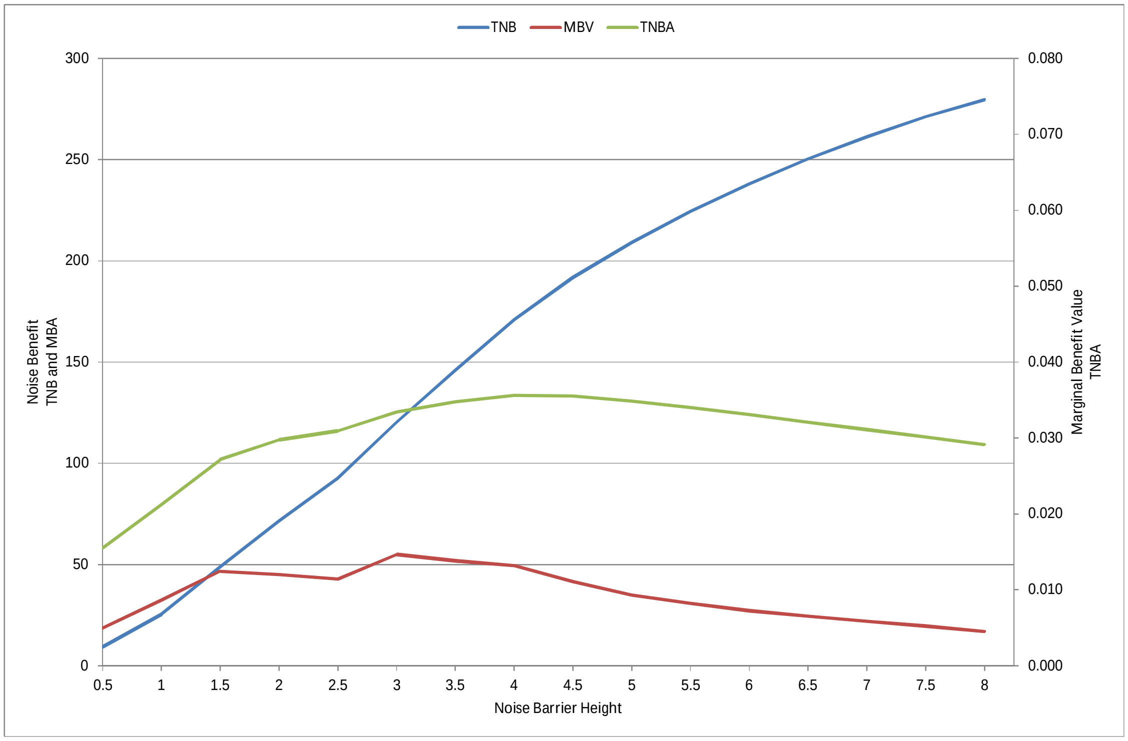


Figure 5-2: **Noise benefit**

The 'assessed barrier' (three metre barrier height) is the barrier option selected after considering the TNB, MBV and TNBA. In this instance the MBV peaks at three metres and the TNBA peaks at four metres. As such the 'assessed barrier' is considered to be three metres for this scenario.

For this project, the community has expressed a desire to have lower noise barriers to maintain the existing views from the town towards the north. As such the cost effectiveness of lower noise barriers will be considered.

If the ‘assessed barrier’ (three metre barrier height) option was chosen, twenty nine receivers would exceed the RNP noise targets. Twenty of these exceedances would exceed the RNP noise targets by up to 2 dB(A), with thirteen receivers exceeding by more than 2 dB(A).

The ENMM considers that where noise mitigation has been already provided (in this case a low-noise pavement and a noise barrier), it is not considered feasible and reasonable to provide additional noise mitigation such as architectural treatments for receivers that are not subject to a significant impact (an exceedance of the RNP criteria by more than 2 dB(A)).

As such, if the ‘assessed barrier’ was chosen, only thirteen receivers impacted by the proposed North Street barrier would be eligible for additional noise mitigation (in this case architectural treatments).

To assess the additional costs, architectural treatments in the form of mechanical ventilation has conservatively been assumed to be $20,000. Based on similar projects the additional cost of noise barriers has been calculated at $500 per square meter. On this basis the cost of the architectural treatments would be $260,000 and the cost of the additional one metre for the length of the wall (1200 metres) is approximately $600,000.

The cost of the ‘assessed barrier’ is approximately $693 per dB(A) reduction per residence. The cost of the ‘target barrier’ is $363 per dB(A) reduction per residence. The ENMM states that:

“If the cost per dB(A) reduction per residence of the “assessed barrier” option is within 25 per cent of the cost per dB(A) reduction per residence for the “target barrier” option, but the increased benefit would be only 2 dB(A) or less, the “assessed barrier” option would normally be preferred (again, this is before any consideration of aesthetics and community views). In these circumstances the provision of additional architectural treatments would normally not be cost-effective.”

For this situation the ENMM puts emphasis on the ‘community views. As such, the community should be consulted to determine if they would prefer a four metre noise barrier that would provide adequate noise mitigation to meet the noise criteria, or if they are willing to accept an indiscernible increase in noise and prefer a noise barrier one metre shorter.

In absence of community input the four metre noise barrier has been included as the preferred option. This may change once the community has been adequately consulted or following detailed design, in which case this report will be updated.

5.2.1 Kangaroo Valley Road northbound off-ramp

A noise barrier was assessed for the Kangaroo Valley northbound off - ramp consistent with the requirements of Practice Note iv of the ENMM. The location of the noise barrier is presented in Appendix L.

Define the road traffic noise catchment area

The noise catchment area has been separated into a single group located along Huntingdale Park Road.

Calculate existing and future noise levels, including changes in noise levels

The predicted noise levels are provided in Appendix I and Appendix J.

Identify all the options

All alternative feasible and reasonable traffic management and other road design opportunities for reducing traffic noise have been exhausted. A low-noise pavement is already included in the design at this location. A realignment of the road and more stringent limits on traffic speeds would have minimal effectiveness and cannot be considered either feasible or reasonable for this catchment area.

Analyse the barrier height and other road treatment options

There are more than three affected residences grouped together, so noise barrier options need to be considered.

Design a range of barrier options

A comparison of noise reductions for a range of barrier heights has been carried out for the most affected residences located on Huntingdale Park Road. **Figure 5-3** shows the relation between barrier height and resulting noise levels for the design year (2027).

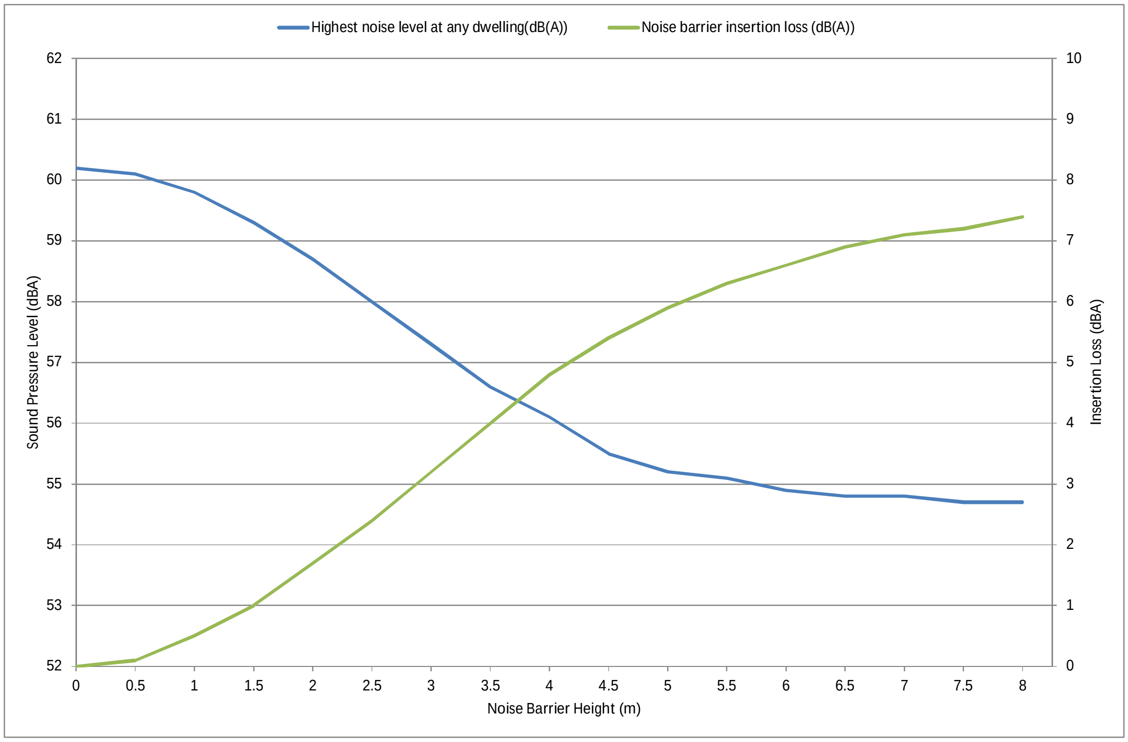


Figure 5-3: Maximum insertion loss

Figure 5-3 shows the maximum insertion loss at any receiver and the maximum sound pressure level at any receiver. Over the varying barrier heights the specific receiver may not be the same, hence the decrease in insertion loss is not necessarily consistent with the maximum noise level.

The graph shows a minimum insertion loss of at least five dB(A) is achieved at a barrier height of four metres and metres. A 10 dB(A) insertion loss is not achieved. Hence a four metre and 4.5 metre noise barrier can be considered viable for this location.

The ‘target barrier’ is the barrier that achieves compliance with the appropriate noise criteria at all sensitive receivers. The noise criteria for these receivers is 55 dB(A). The graph provided in **Figure 5-3** indicates that the ‘target barrier’ (the minimum barrier required to achieve the applicable noise criteria at all receiver locations) is four metres.

Figure 5-4 illustrates the TNB, the MBV and the TNBA.

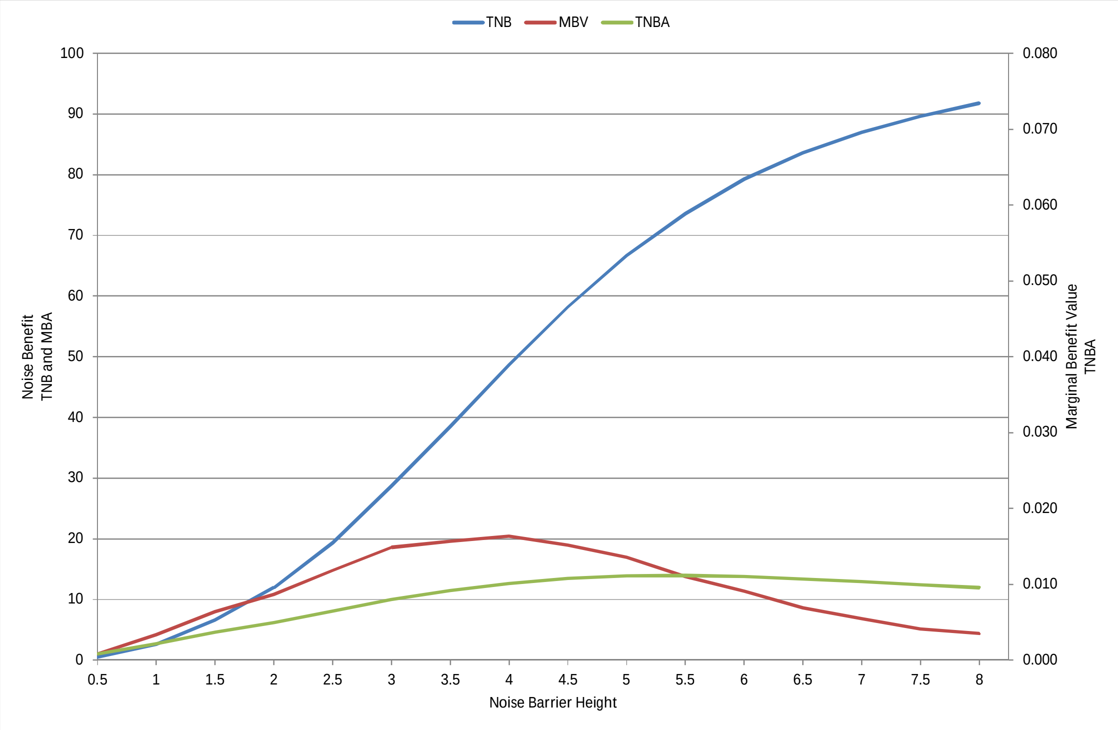


Figure 5-4: Noise benefit

As discussed previously, the ‘assessed barrier’ is the barrier option selected after considering the TNB, MBV and TNBA. In this instance the MBV peaks at four metres and the TNBA continues increasing until six metres. Given that the ‘assessed barrier’ does not achieve the minimum insertion loss requirement, the shortest barrier to achieve this is selected. In this scenario, a four metre barrier has been selected.

Considering the ‘assessed barrier’ and ‘target barrier’ are the same height, and given they do not achieve the minimum insertion loss, a four metre noise barrier is recommended for the Kangaroo Valley Road northbound off-ramp.

5.2.2 Other land uses

The Camp Quality Memorial Park required further mitigation above the proposed dense graded asphalt (DGA). With the low-noise pavement and the noise proposed barrier the $L_{Aeq(15hour)}$ noise levels are predicted to be 55 dB(A). Hence the predicted noise levels comply with the criteria of $L_{Aeq(15hour)}$ 55 dB(A).

With the additional low noise pavement, noise levels are reduced at Mark Radium Park. The $L_{Aeq(15hour)}$ noise level at the centre of the park is predicted to be 60 dB(A), a reduction of two dB(A). Given the park is used for passive recreation, the park will experience exceedances of the 55 dB(A) criteria by five dB(A) when in use.

However, for the provision of noise mitigation, the ENMM requires the proposed mitigation to be considered both reasonable and feasible. Although it would be considered feasible to build noise mitigation to reduce noise levels within the park, the ENMM recommends buffer zones as the primary mitigation measure for recreation areas, which is not considered reasonable or feasible for this project. As such, additional noise mitigation is not recommended for Mark Radium Park.

With the additional low noise pavement and proposed noise barriers, noise levels are significantly reduced at both Berry Uniting Church and Saint Patricks Catholic Church. The $L_{Aeq(15hour)}$ noise level at the most affected church building is predicted to be 53 dB(A) and 52 dB(A) at the facade of the building, a reduction of 7 dB(A) and 9 dB(A) respectively. Including the corrections for facade reflections and external to internal losses, the $L_{Aeq(1hour)}$ noise levels are predicted to be 40 dB(A) and 39 dB(A). The noise levels are equal and below the criteria, hence compliance is achieved.

Although compliance would only just be achieved, additional mitigation is not warranted at this stage. However assumptions have been made about the noise levels from the road during the operation of the church, and external to internal noise losses. It is recommended that further analysis is undertaken at the opening of the project to ensure that the internal noise levels within the church are compliant with the criteria and services are not adversely affected as a result of the new road. If for some reason the church does not achieve the internal noise criteria, mitigation in the form of upgraded doors, glazing and seals would be sufficient to meet the required noise levels.

The maximum $L_{Aeq(9hour)}$ noise level predicted on the site of the Bupa Care Services – Aged care Facility with low-noise pavement is 56 dB(A). The predicted noise level exceeds the ‘redeveloped road’ criteria of 55 dB(A). However, there is no significant increase in noise levels as a result of the project. Therefore the Bupa Care Services – Aged Care Facility is not eligible for further mitigation.

5.2.3 Recommended noise mitigation

Road traffic noise contours of the design year incorporating the recommended noise mitigation are presented in Appendix J.

Mitigation in the form of a low-noise pavement, two noise barriers, and a small number of architectural treatments are recommended to achieve compliance with the applicable noise goals. A summary of the receivers that would continue to have residual noise levels above the controlling criterion after in corridor measures are considered, are listed in **Table 5-4**.

Additional architectural treatment

For the 20 properties with exceedances up to 10 dB(A), fresh air ventilation, sealing of wall vents and upgraded window and door seals is generally considered appropriate (Architectural treatment type 1). Where exceedances are over 10 dB(A) *additional* upgrade of windows and doors may be considered (Architectural treatment type 2).

Table 5-4: Architectural treatment

Receiver	Treatment type
14a	Treatment Type 1
17a	Treatment Type 1
22a	Treatment Type 1
23	Treatment Type 1
25	Treatment Type 2
28	Treatment Type 1
29	Treatment Type 1
30	Treatment Type 1
33a	Treatment Type 1
73	Treatment Type 1
110	Treatment Type 1
299	Treatment Type 1
355	Treatment Type 1
374	Treatment Type 1
384	Treatment Type 1
386	Treatment Type 1
438	Treatment Type 1
439	Treatment Type 1
445	Treatment Type 1
451	Treatment Type 1

6 Conclusions

Attended and unattended ambient noise measurements have been undertaken to define the construction NMLs and calibrate the SoundPLAN noise model used for operational noise assessment. The attended noise measurements were undertaken to define the dominant noise source(s) at each location and confirm the suitability of the measurement location.

Existing acoustic environment

The unattended noise measurements were undertaken in six noise catchment areas throughout the project area. Simultaneous traffic counts were undertaken to measure the traffic volumes at the time of the noise measurements. The results of the unattended noise logging provided good correlation with the SoundPLAN model during the daytime and night-time periods with almost all results falling within the accuracy of CoRTN. A small number of results fell outside the accuracy of CoRTN, however these calibrations were not considered to influence the outcome of the report.

Noise criteria

The appropriate construction NMLs were derived from the unattended background noise logging results.

The predicted operational noise from the project has been assessed in accordance with the RNP and the ENMM. Appropriate criteria provided in these documents have been used as the basis for the noise impact assessment.

Impact assessment

Standard construction activities including site establishment, earthworks, piling, bridgeworks and paving activities were assessed in accordance with the ICNG. Both typical and worst case noise levels were predicted for the construction noise assessment. Predicted noise levels were found to exceed the noise management levels, but generally remain below the ‘highly affected’ noise level.

Works undertaken within the ancillary facilities were also found to exceed the noise management levels.

Extended working hours north of the Berry township have been proposed in this report. Considering the work practices would not differ from those during standard work hours, the predicted noise levels are the same. However the NMLs are typically 5 dB(A) to 10 d(A) more stringent during the evening and night-time periods, hence the potential exceedance of the NMLs would increase accordingly.

Some out of hours work (separate to the extended hours work) would be required for this project. This work is either typically not noise intensive or generally impractical to be undertaken during standard work hours due to safety and the need to maintain the operational integrity of the Princes Highway traffic.

Cumulative noise impacts from construction activities associated with other projects have also been considered. There are currently no proposed or current works that would be undertaken concurrently with the construction of this project. As such sensitive receivers are unlikely to be impacted from the cumulative impacts of construction noise.

Blasting criteria has been recommended to comply with the relevant guidelines. Higher limits have also been proposed with approval of the affected residents and the employment of safe work practices, to ensure that residents are not adversely affected as a result of blasting activities. A detailed Blast Management Plan would be prepared as part of the detailed design process.

The predicted noise from the project has been assessed in accordance with the RNP and the ENMM.

Reflection of noise from the proposed noise barrier has been considered in this assessment by adding a correction factor to residents located to the north of the proposed wall. The predicted noise levels indicate that the receivers would not be significantly impacted as a result of the additional wall. Appropriate mitigation has been recommended for these receivers (where appropriate) on the basis of the noise barrier correction factor.

Both temperature inversions and wind have been found to be a feature of the area. These weather effects have the potential to increase noise levels at affected receivers up to five dB(A).

A total of 164 receivers were found to exceed the applicable operational noise criteria of which 18 receivers are considered to be acutely affected as a result of the project.

Maximum noise levels currently exceed the recommended limits, and at most locations are predicted to in the future. The levels may reduce somewhat with the new road due to a reduction in gradients lessening the tendency for trucks to require engine braking and high engine revs. Receivers that would be exposed to a new road would be exposed to events similar to those currently experienced on existing sections of the Princes Highway.

Mitigation

Recommendations have been made to mitigate and manage the potential noise and vibration impacts from the construction works, wherever feasible and reasonable. The construction contractor would provide a detailed CNVMP to clarify the mitigation and management practices that will be utilised on this project.

Construction safe working distances have been recommended to ensure that receivers would not be adversely impacted by vibration as a result of the project. Vibration monitoring has been recommended within the prescribed safe working distances to ensure that the appropriate criteria are not exceeded. If a significant amount of vibration intensive activities are required within the safe working distances, the development of site laws for the decay of vibration are recommended to determine the project specific safe working distances, which are likely to be less stringent than those provided in this document.

Operational noise mitigation measures in the form of a low-noise pavement, a noise protection barrier of total height four metres to the north of North Street, a four metre noise barrier located on the Kangaroo Valley Road northbound off-ramp and consideration of 20 architectural property treatments have been recommended. These mitigation measures will ensure that the levels of road traffic noise experienced by residents would be reduced as low as reasonable and feasible once the bypass is operational. These requirements would be confirmed when assessed against the detailed design.

Appendix A

Glossary

Glossary of terms and definitions

The following is a brief description of acoustic terminology used in this report.

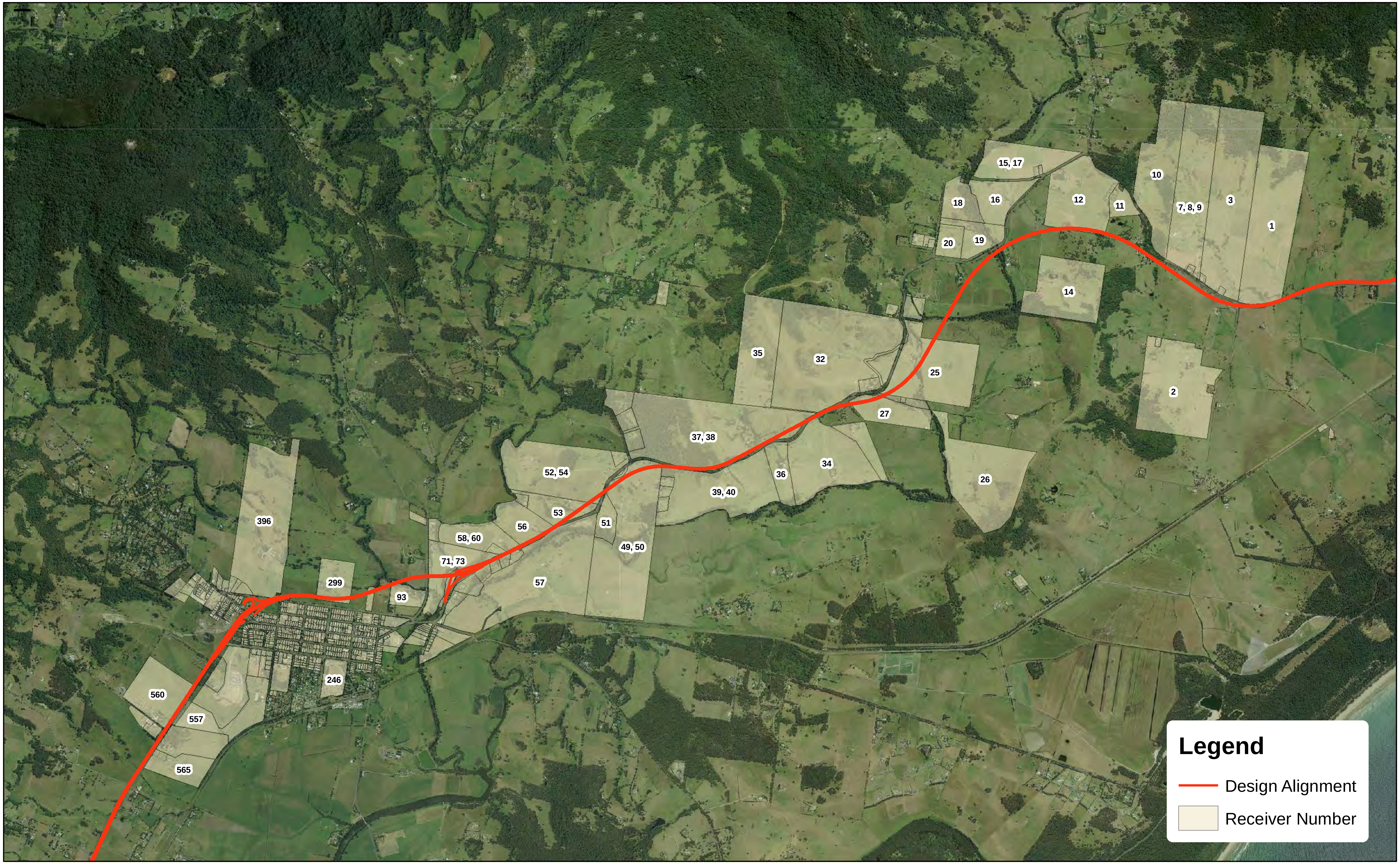
Term	Definition
Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: 0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Insertion loss	Reduction in noise by inserting a barrier between the source and receiver
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.

Term	Definition
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L90 sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the entire length of noise monitoring.

**Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 "Acoustics – Glossary of terms and related symbols", the OEH's INP and the OEH's Road Noise Policy.*

Appendix B

Sensitive receiver locations



Foxground and Berry Bypass

Reciever Numbers

Source:

JUL 2012

60021933

Fig. **1**

AECOM

Foxground and Berry Bypass
Reciever Numbers
Source:

JUL 2012
60021933

Fig. **2**

Foxground and Berry Bypass
Reciever Numbers
Source:

JUL 2012
60021933

Fig. **3**

AECOM

Foxground and Berry Bypass

Reciever Numbers

Source:

JUL 2012

60021933

Fig. **4**

0 50 100 200 300 400 m

AECOM

Foxground and Berry Bypass

Reciever Numbers

Source:

JUL 2012

60021933

Fig. **5**

Foxground and Berry Bypass

Reciever Numbers

Source:

0 50 100 200 300 400 m

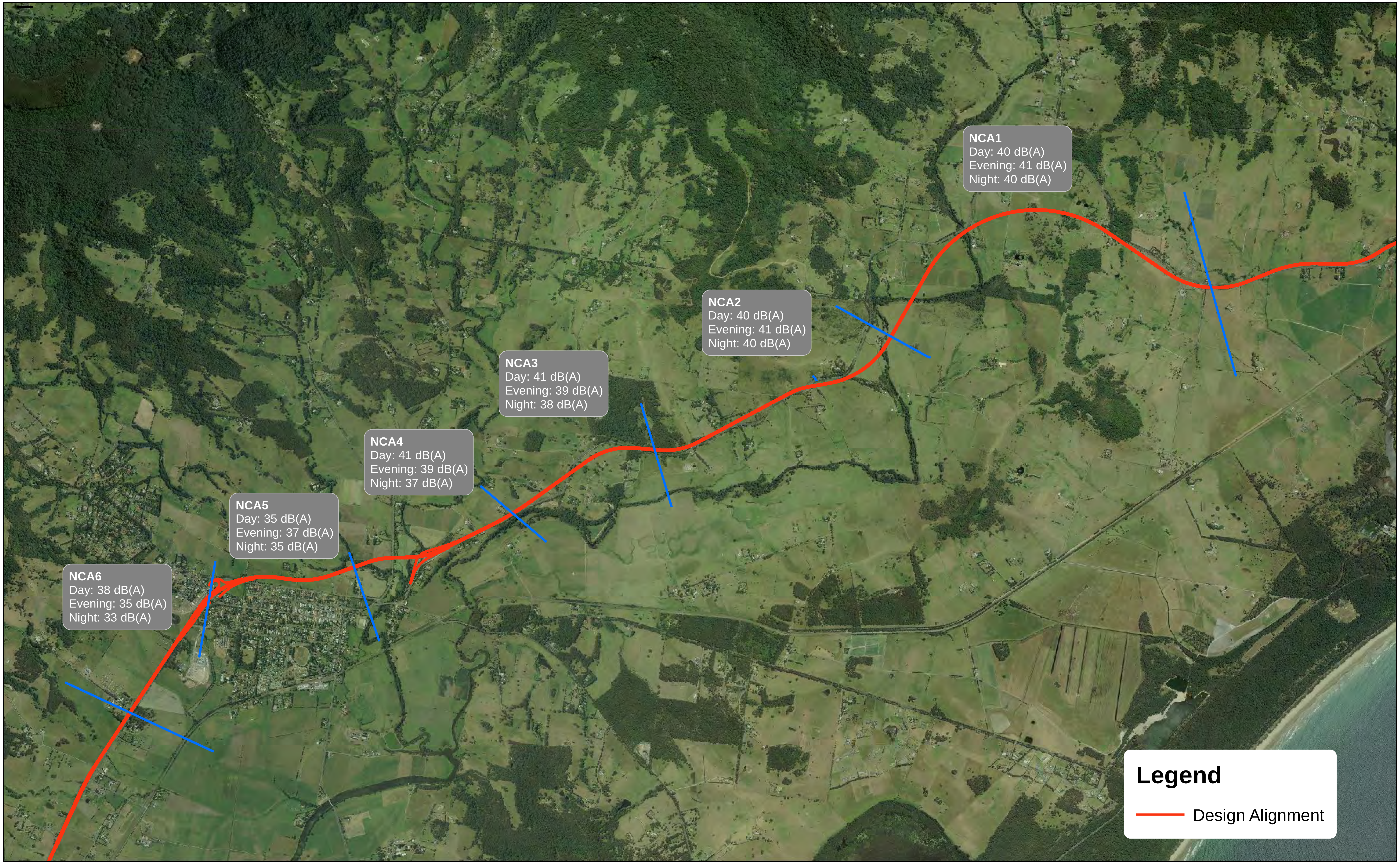
JUL 2012

60021933

Fig. **6**

Appendix C

Noise catchment areas



Foxground and Berry Bypass

Noise Catchment Areas

Source:

0 500 1,000 2,000 3,000 4,000 m

JAN 2012

60021933

Fig. **1**

Appendix D

Logger locations and site compounds

Foxground and Berry Bypass

Noise Logger Locations

Source:

AUG 2012

60021933

0 100 200 400 600 800 m

Fig. **1**

AECOM

Foxground and Berry Bypass

Noise Logger Locations

Source:

AUG 2012

60021933

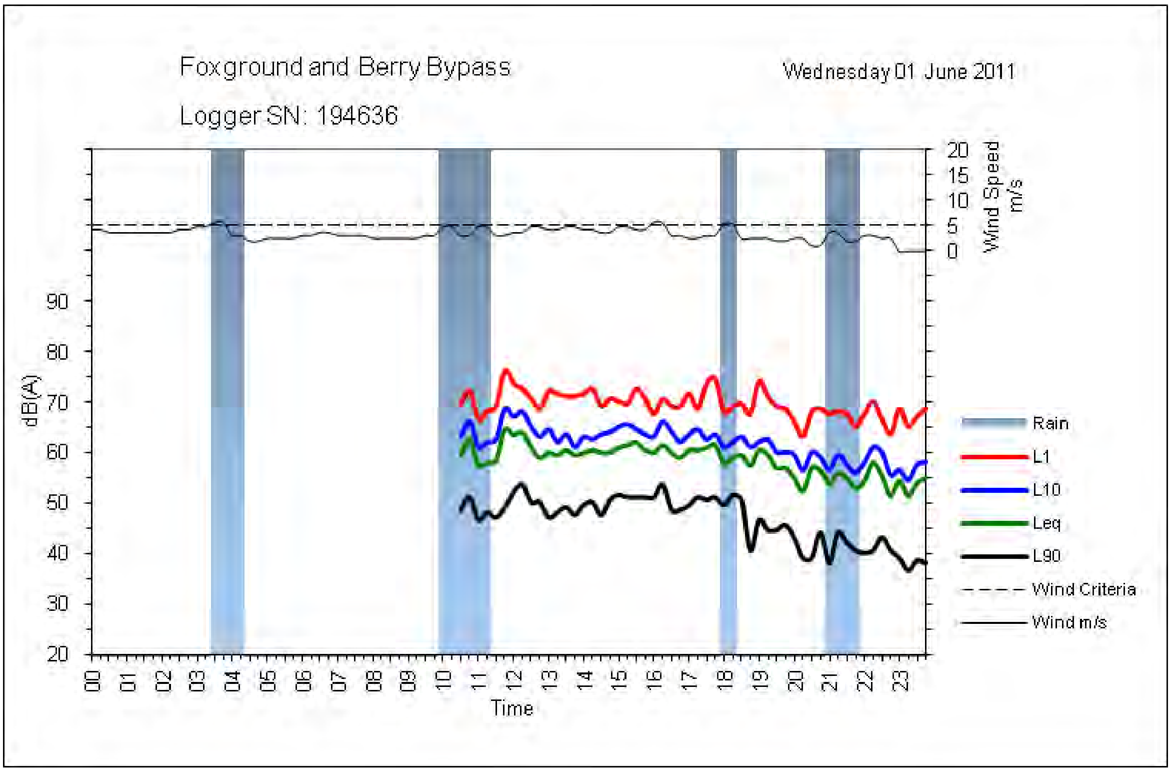
Fig. **2**

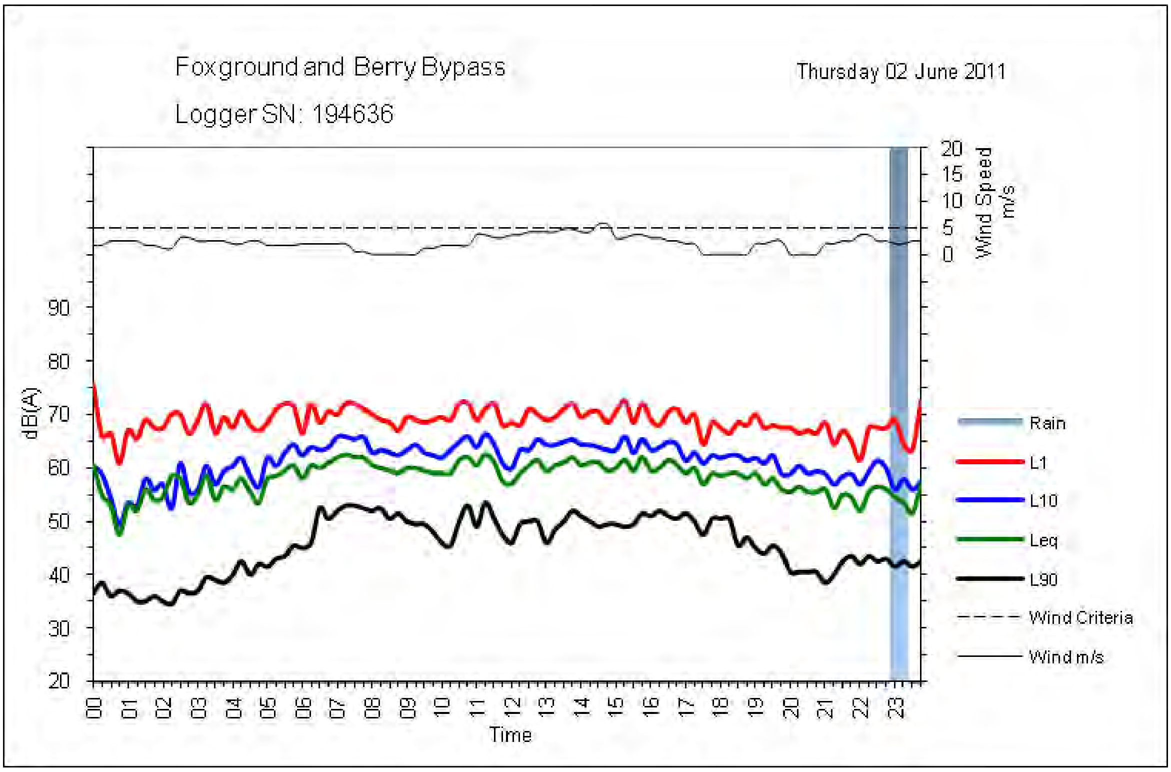
Appendix E

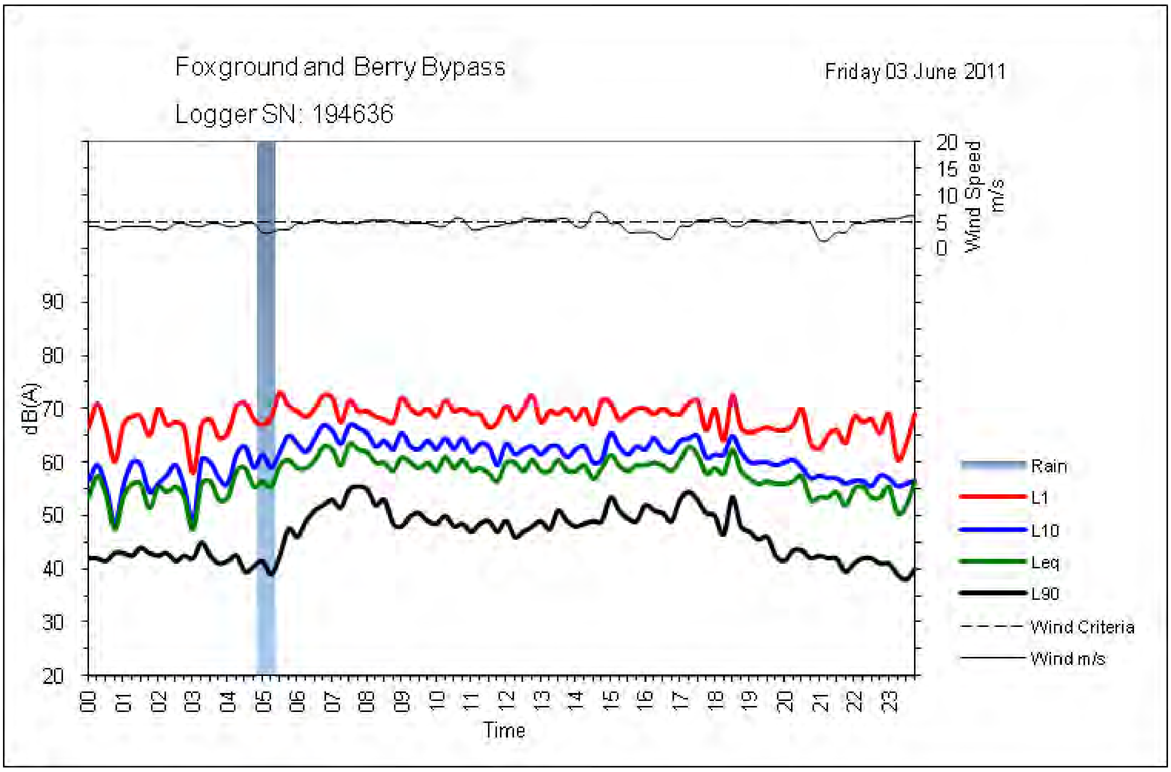
Ambient noise graphs

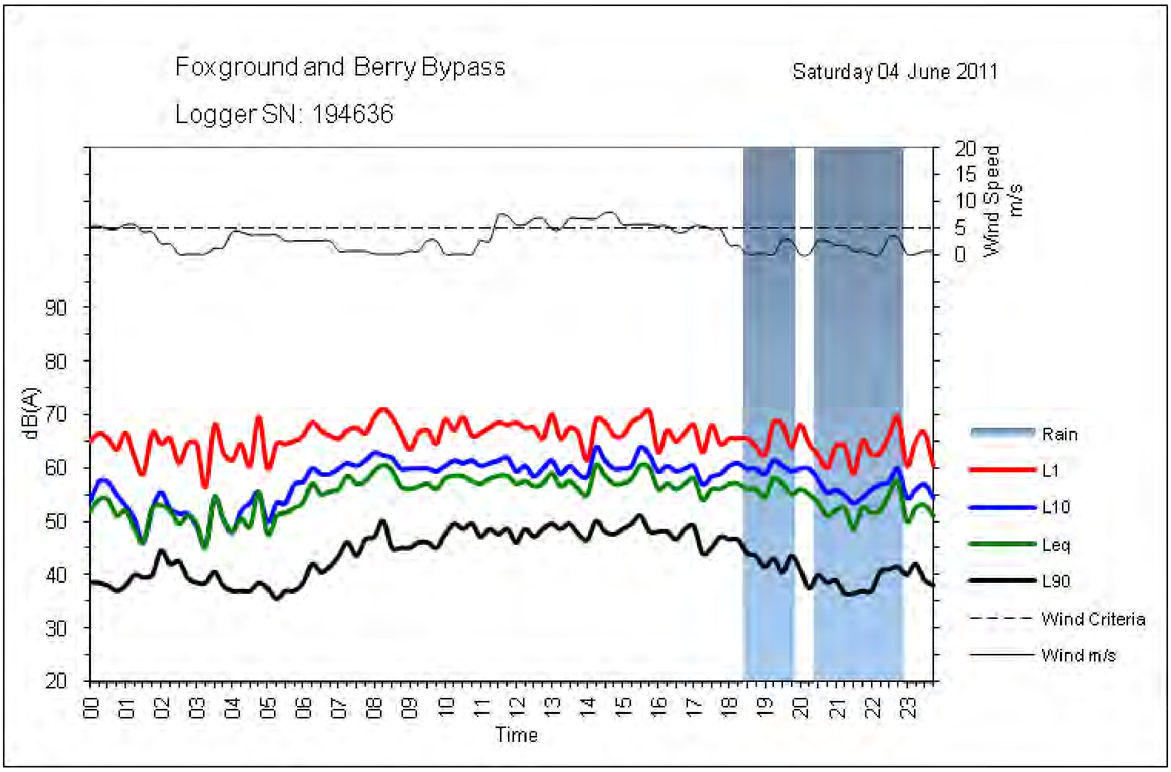
Ambient noise graphs

BG1






Foxground and Berry Bypass
Logger SN: 194636
Friday 03 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194636
Saturday 04 June 2011
dB(A)
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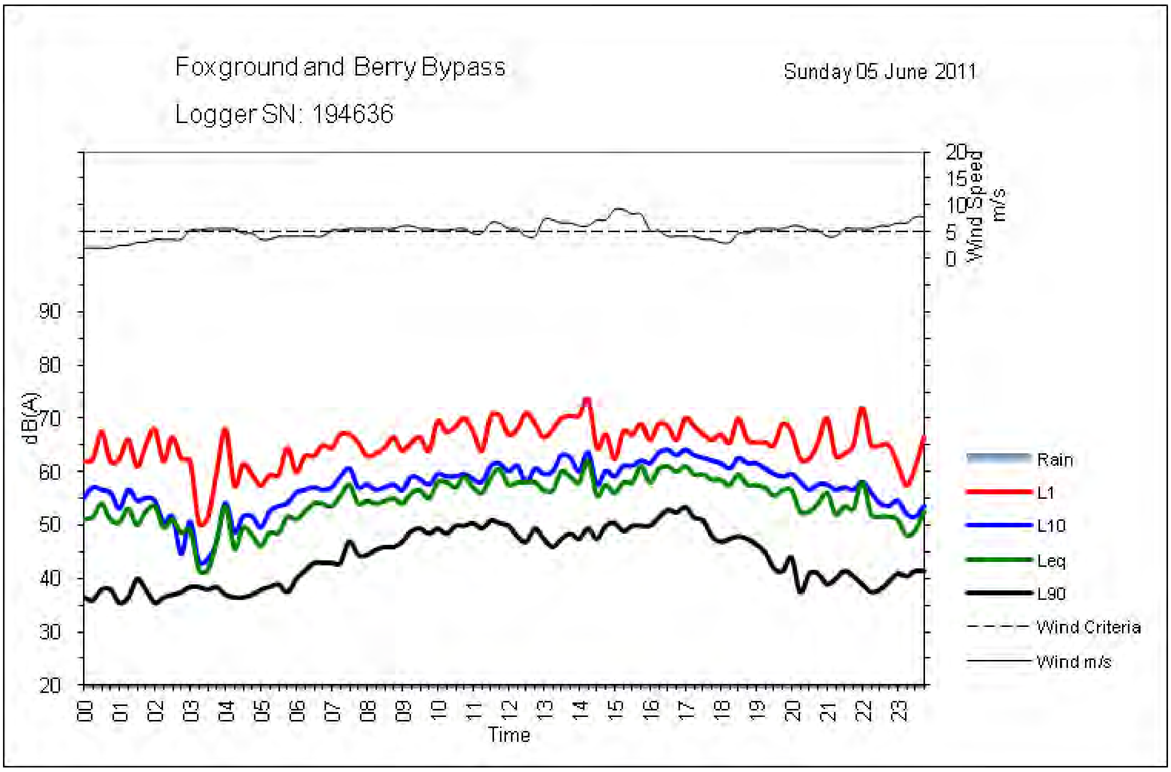
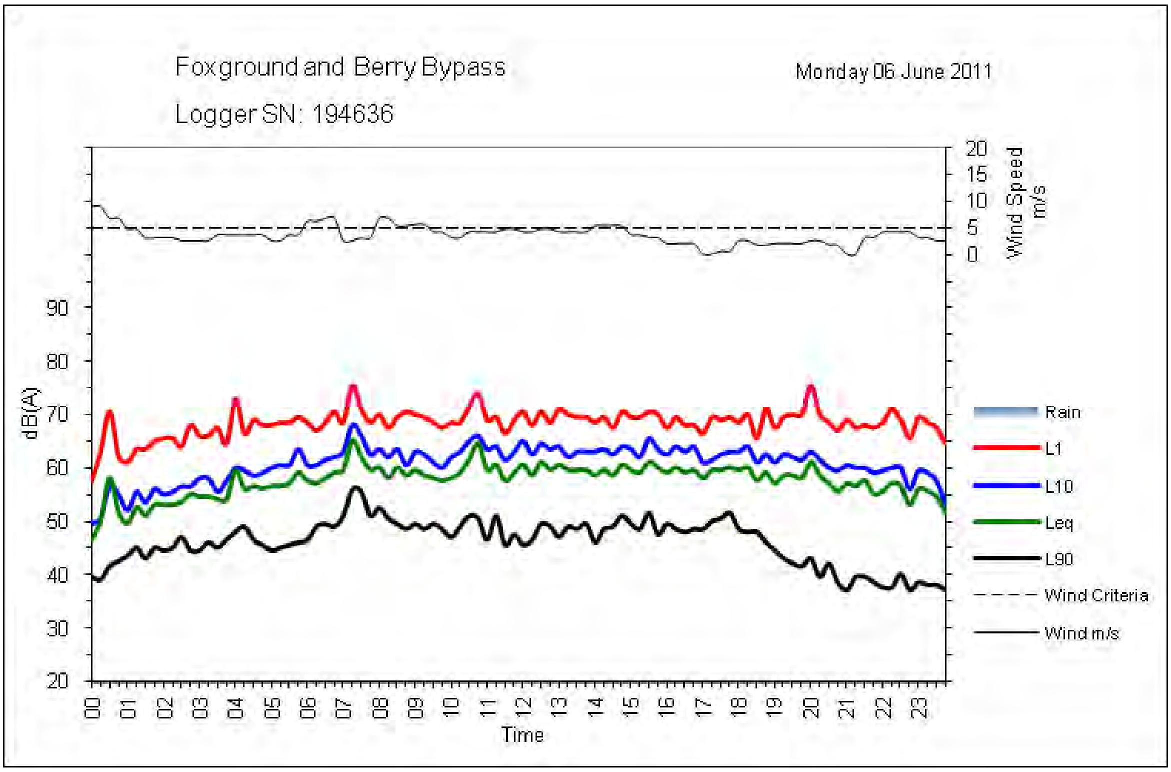
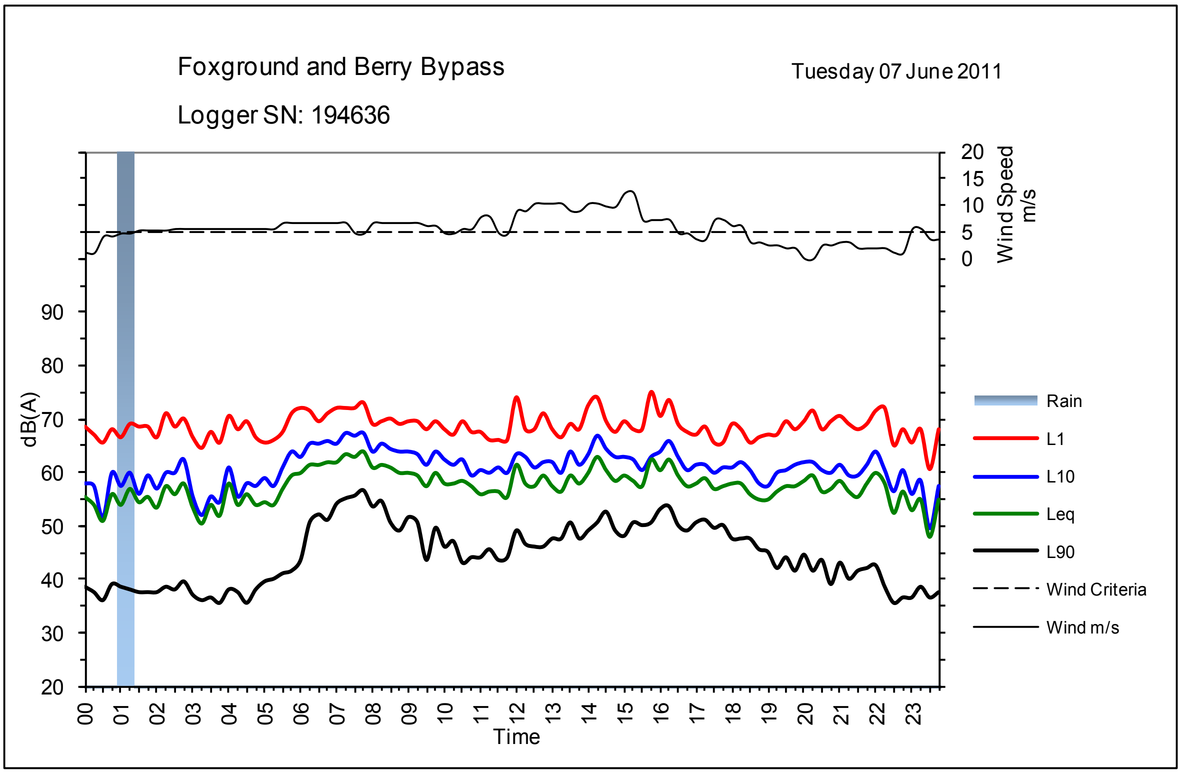
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s



Foxground and Berry Bypass
Logger SN: 194636
Sunday 05 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s



Foxground and Berry Bypass
Logger SN: 194636
Monday 06 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Tuesday 07 June 2011
Logger SN: 194636
dB(A)
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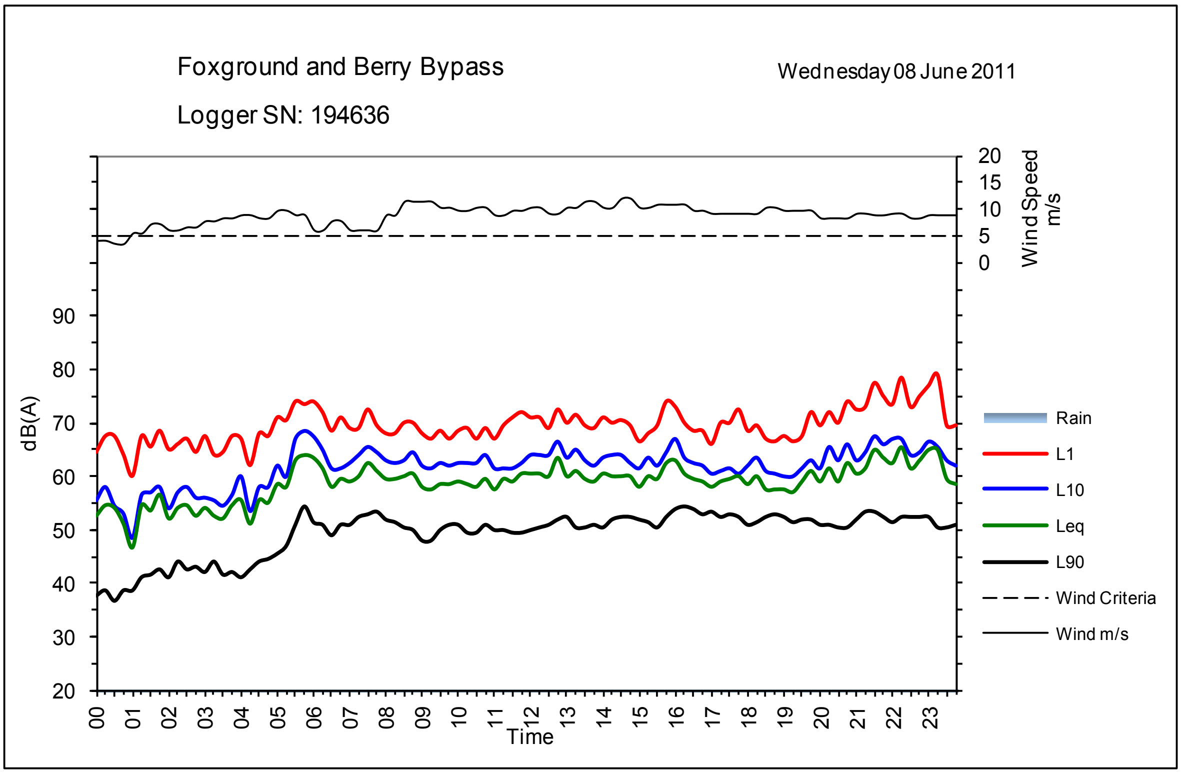
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Wednesday 08 June 2011
Logger SN: 194636
dB(A)
90
80
70
60
50
40
30
20
20
15
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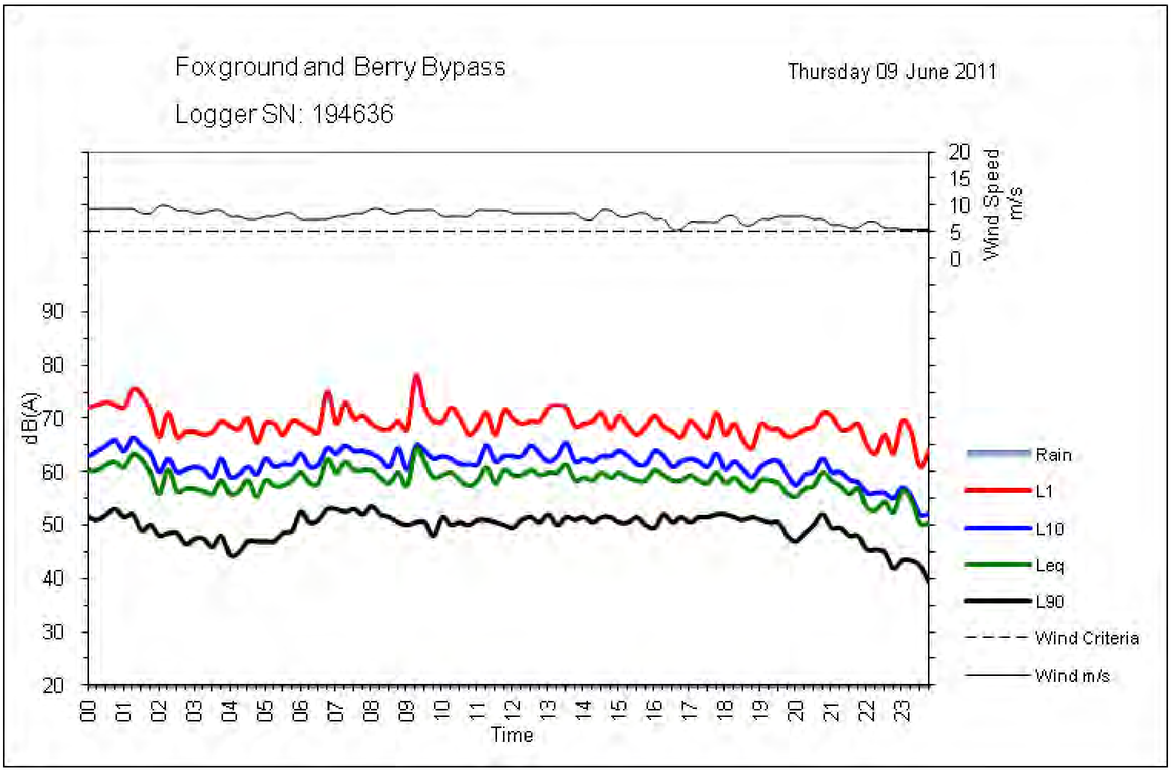
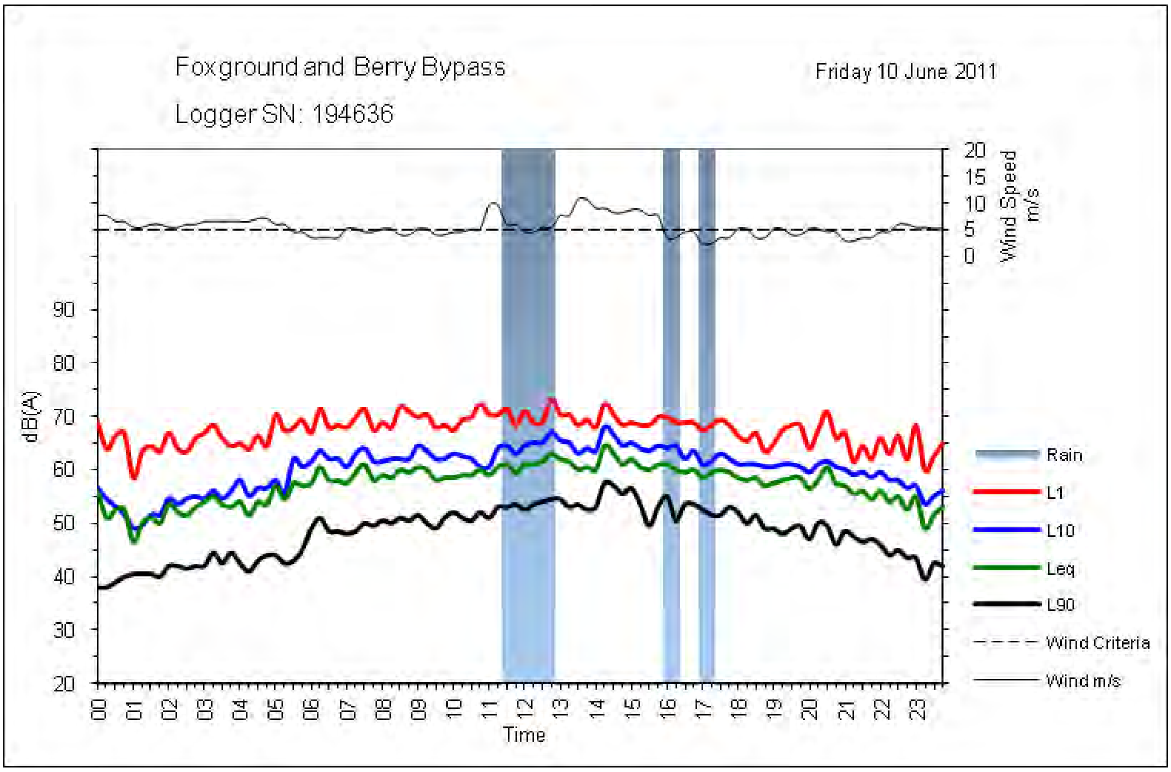
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194636
Thursday 09 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194636
Friday 10 June 2011
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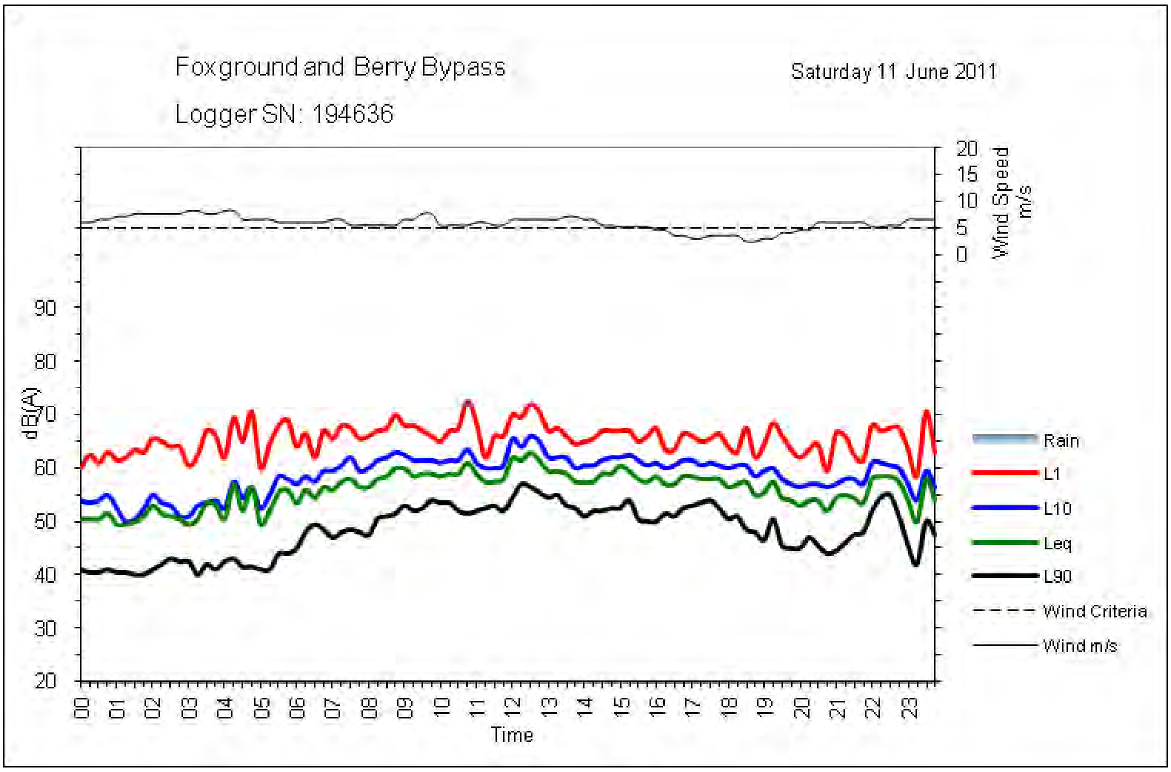
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194636
Saturday 11 June 2011
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15
10
5
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Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
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09
10
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12
13
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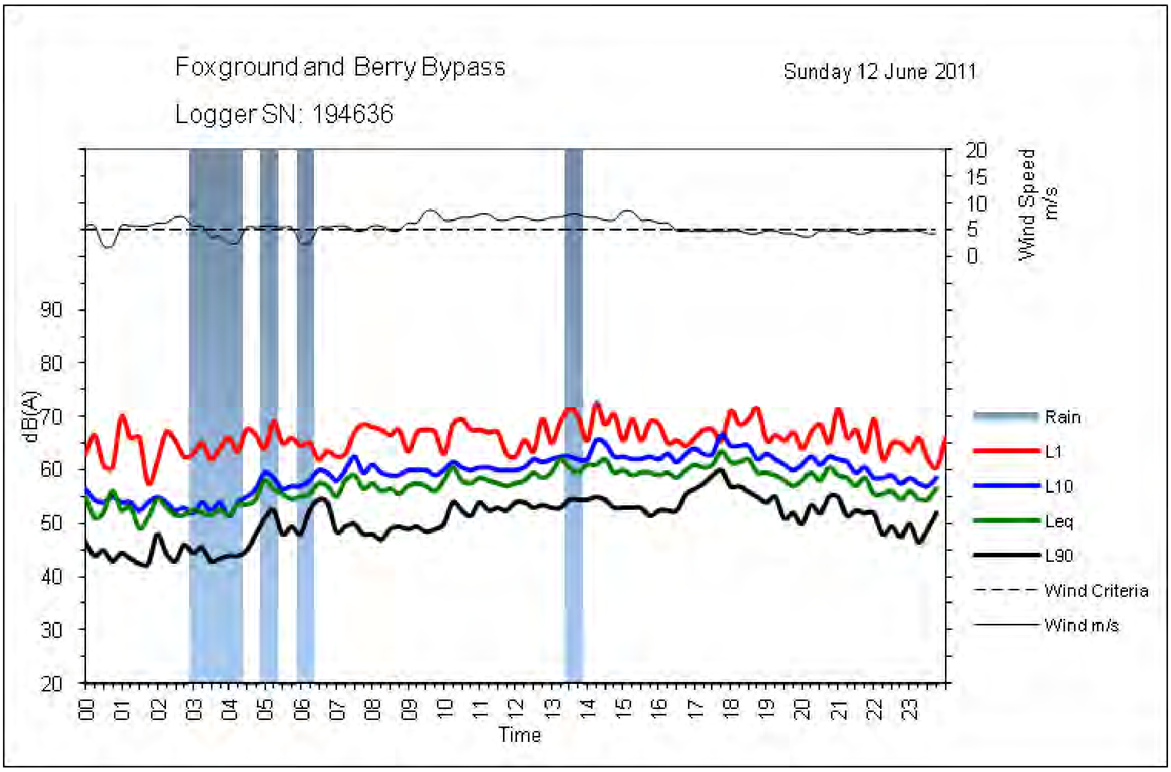
16
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194636
Sunday 12 June 2011
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15
10
5
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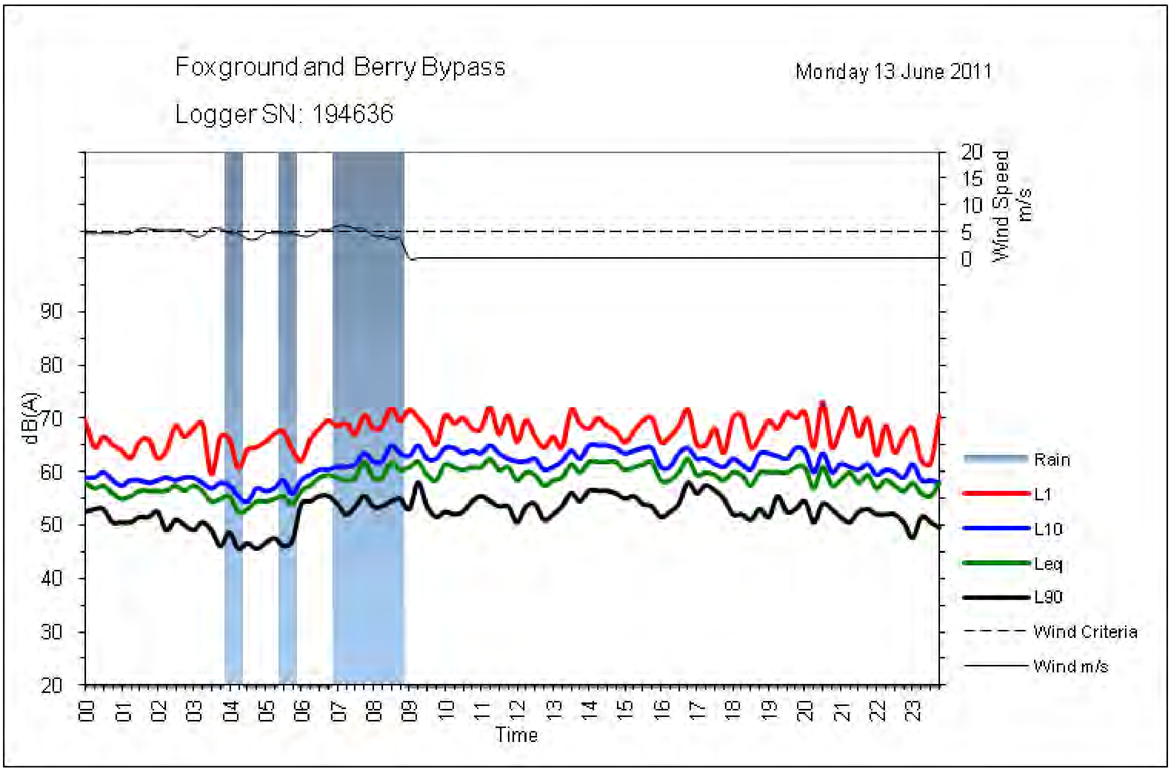
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194636
Monday 13 June 2011
dB(A)
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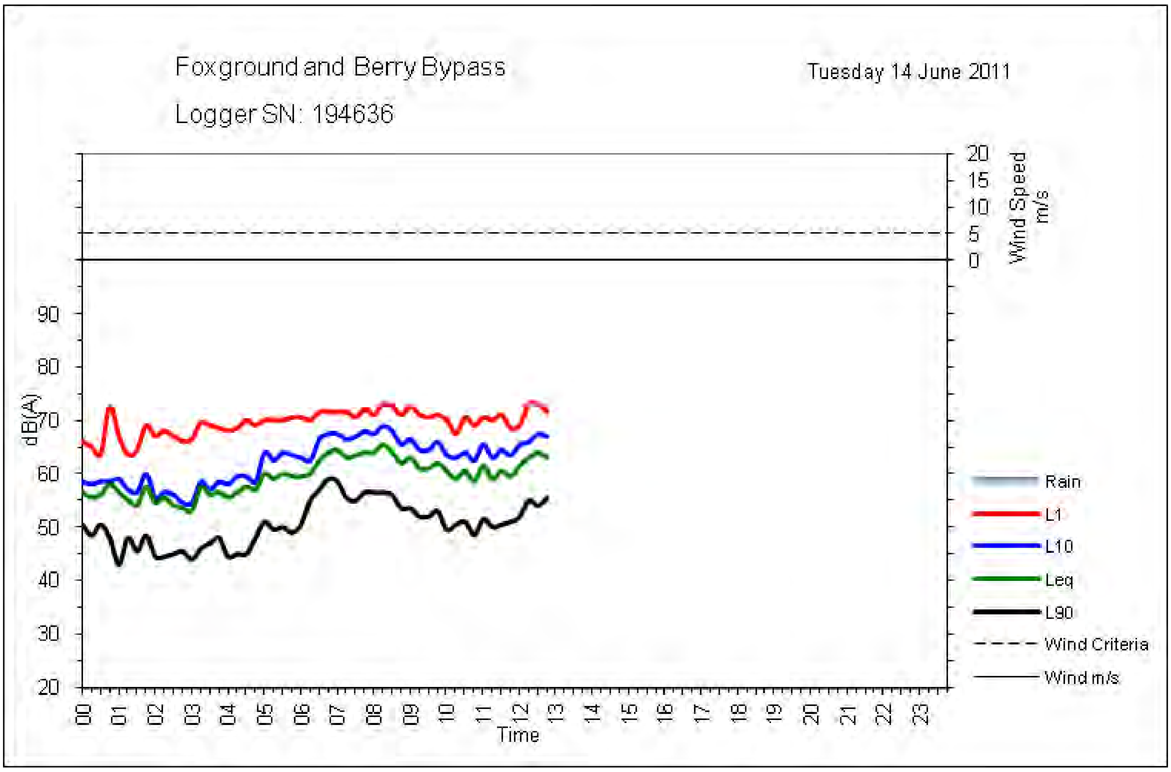
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194636
Tuesday 14 June 2011
dB(A)
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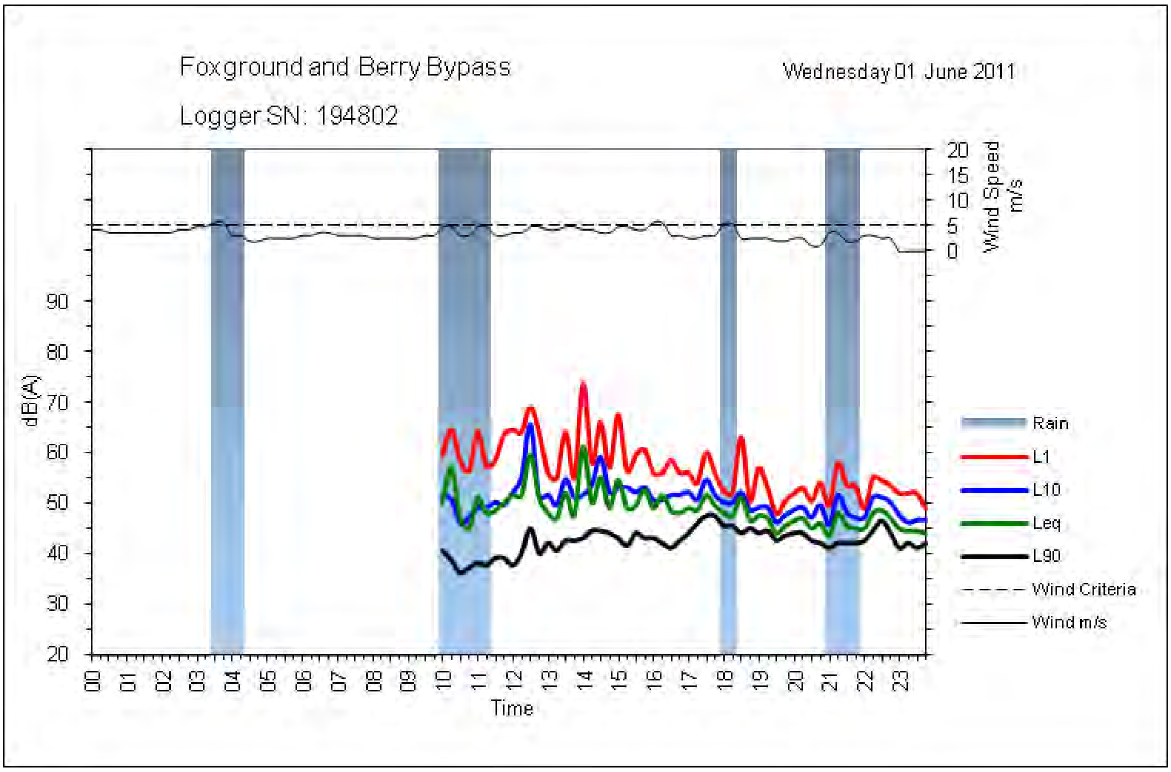
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

BG2


Foxground and Berry Bypass
Wednesday 01 June 2011
Logger SN: 194802
dB(A)
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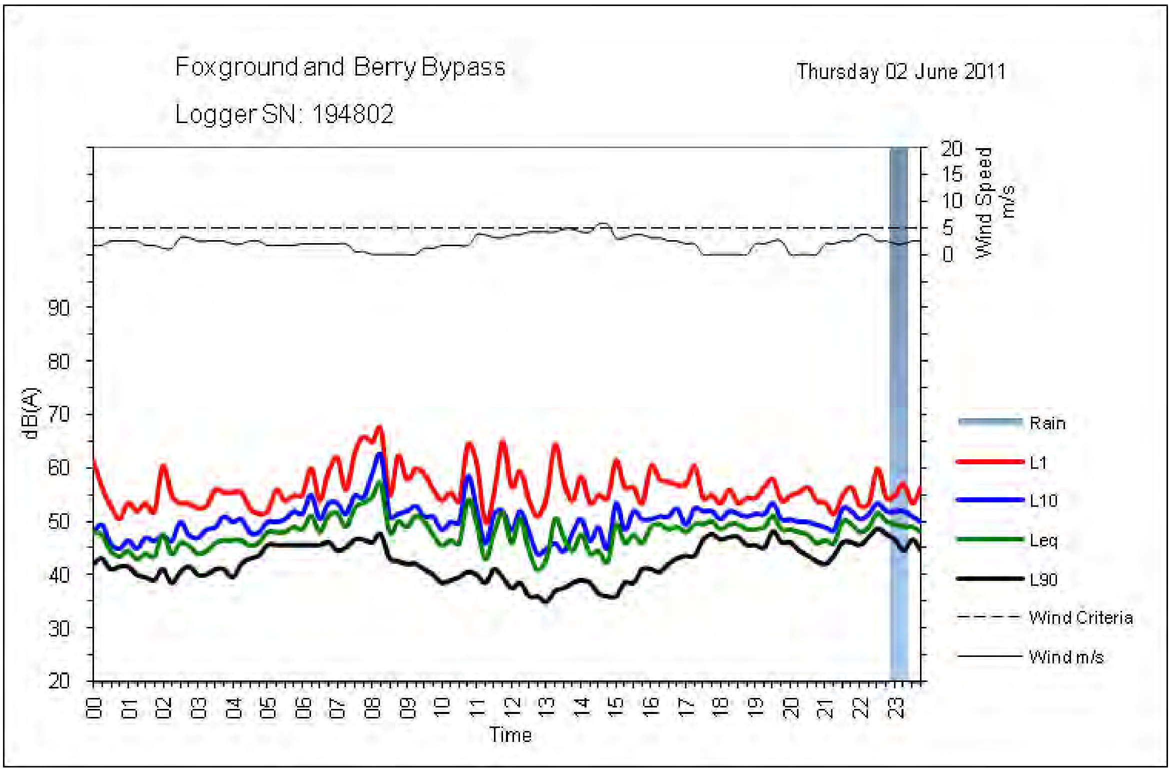
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Thursday 02 June 2011
Logger SN: 194802
dB(A)
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30
40
50
60
70
80
90
Wind Speed m/s
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5
10
15
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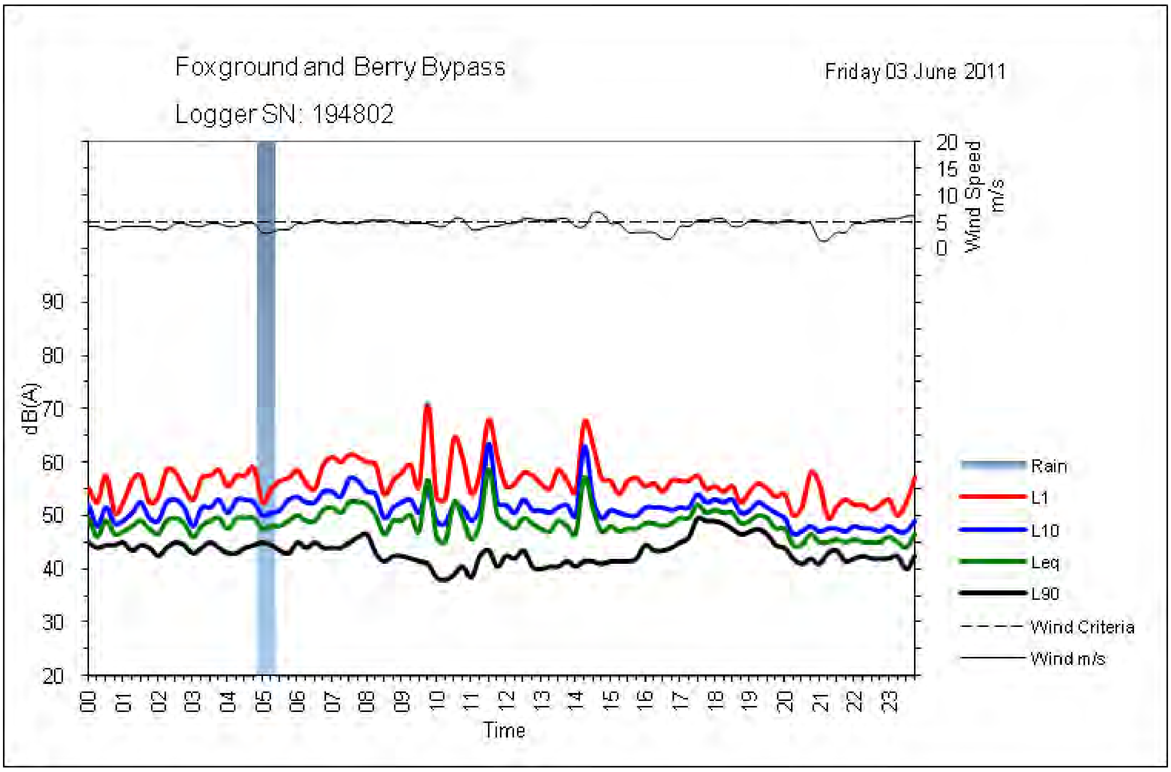
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Friday 03 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
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5
10
15
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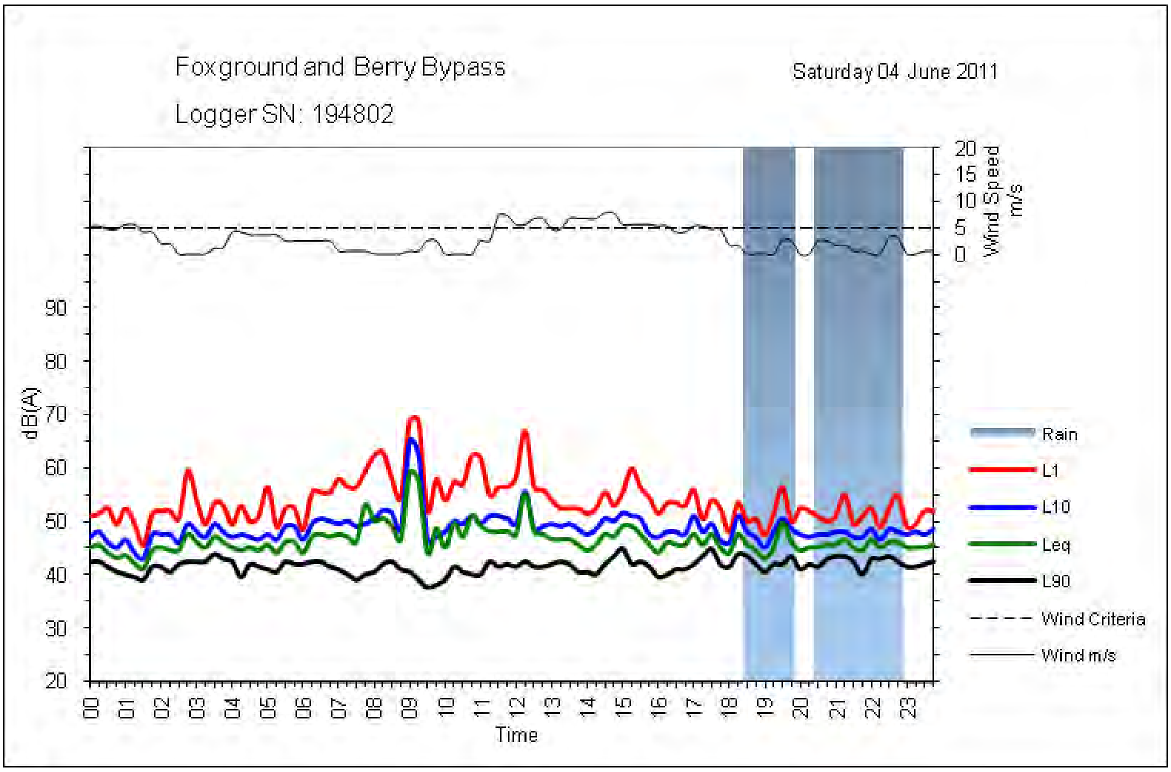
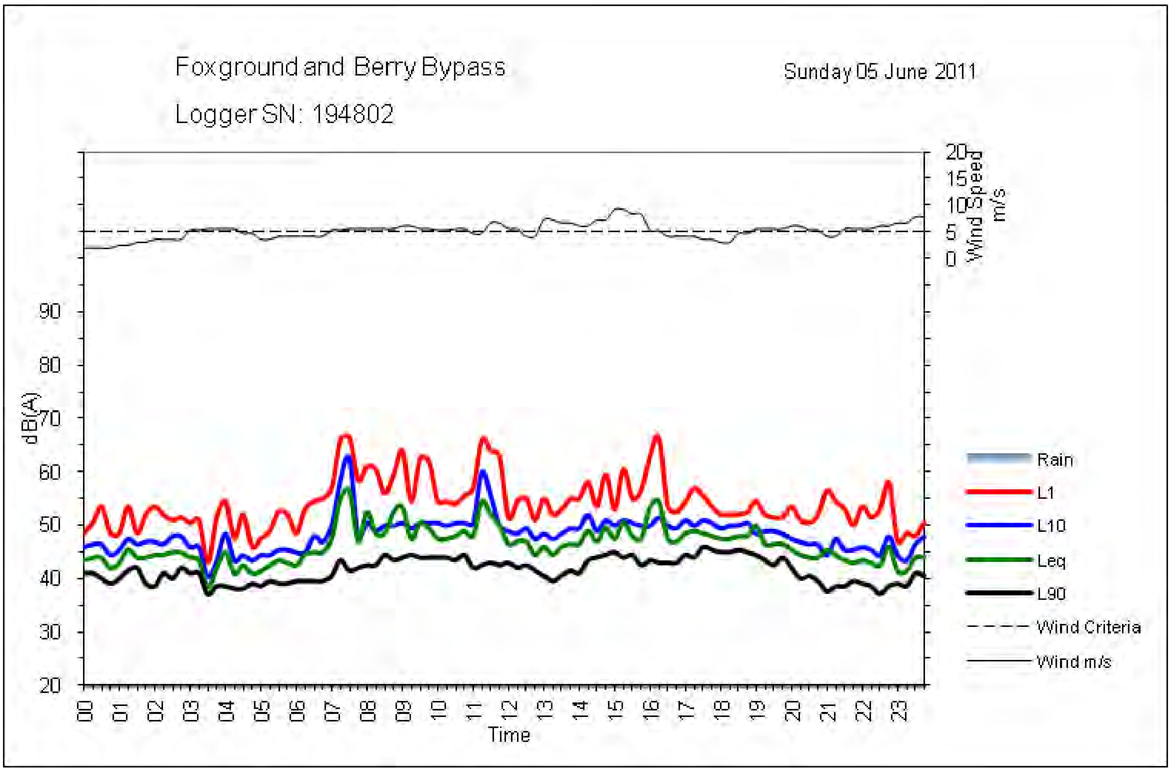
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Saturday 04 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Sunday 05 June 2011
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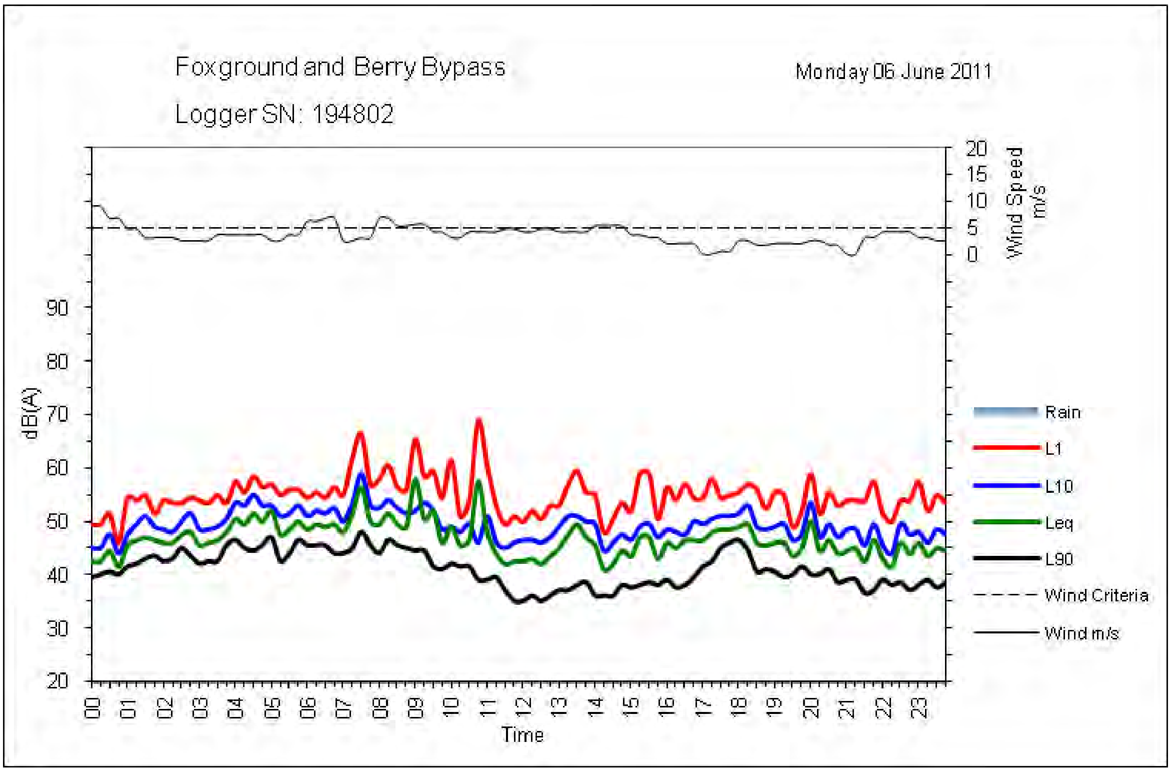
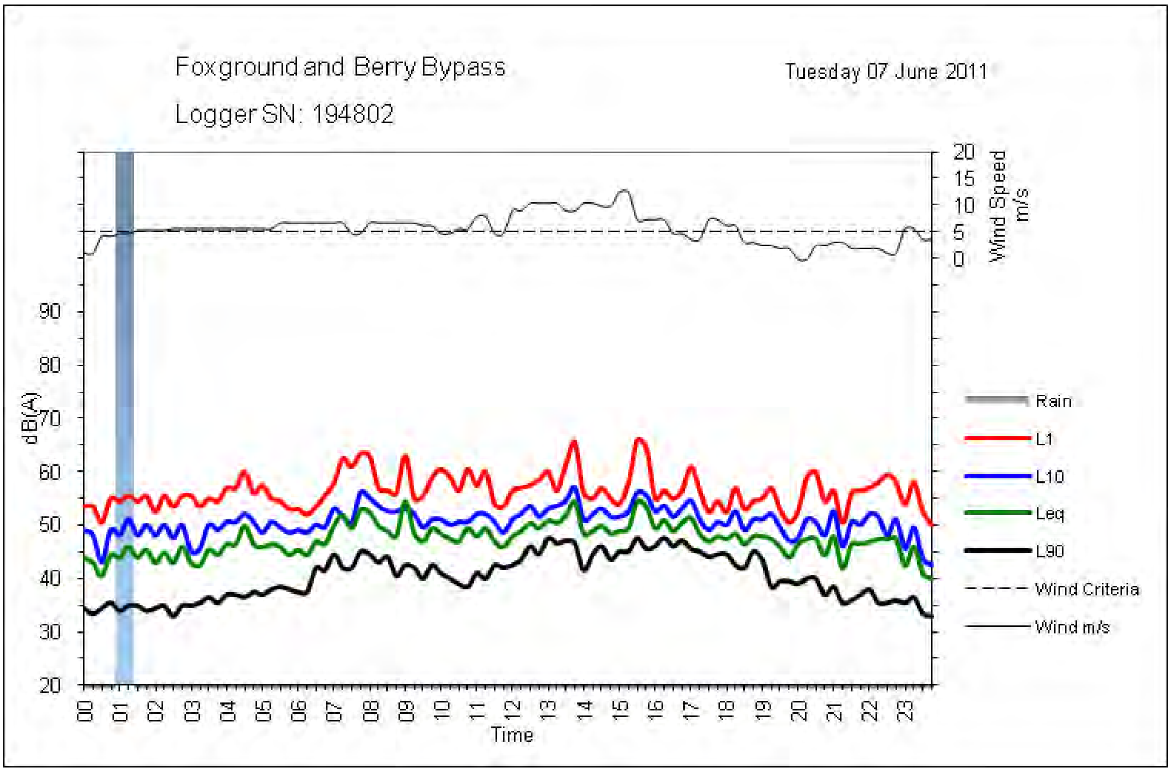
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Monday 06 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Tuesday 07 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
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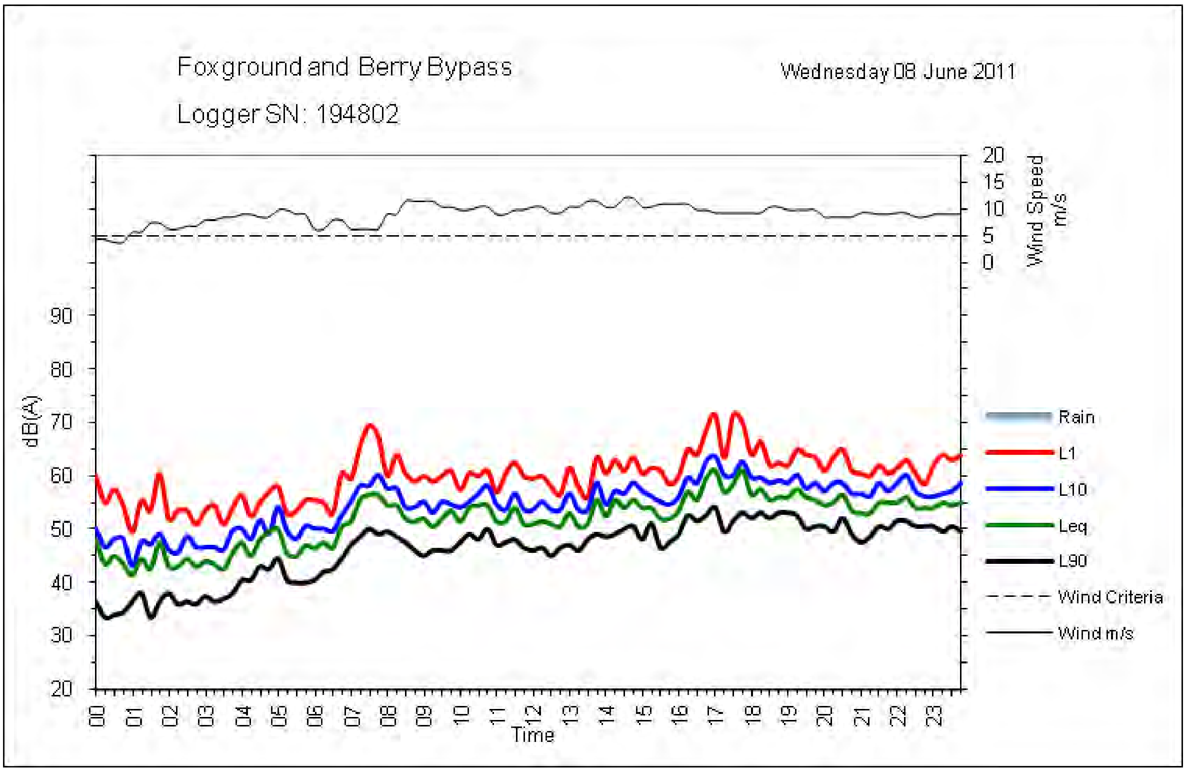
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194802
Wednesday 08 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
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06
07
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09
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13
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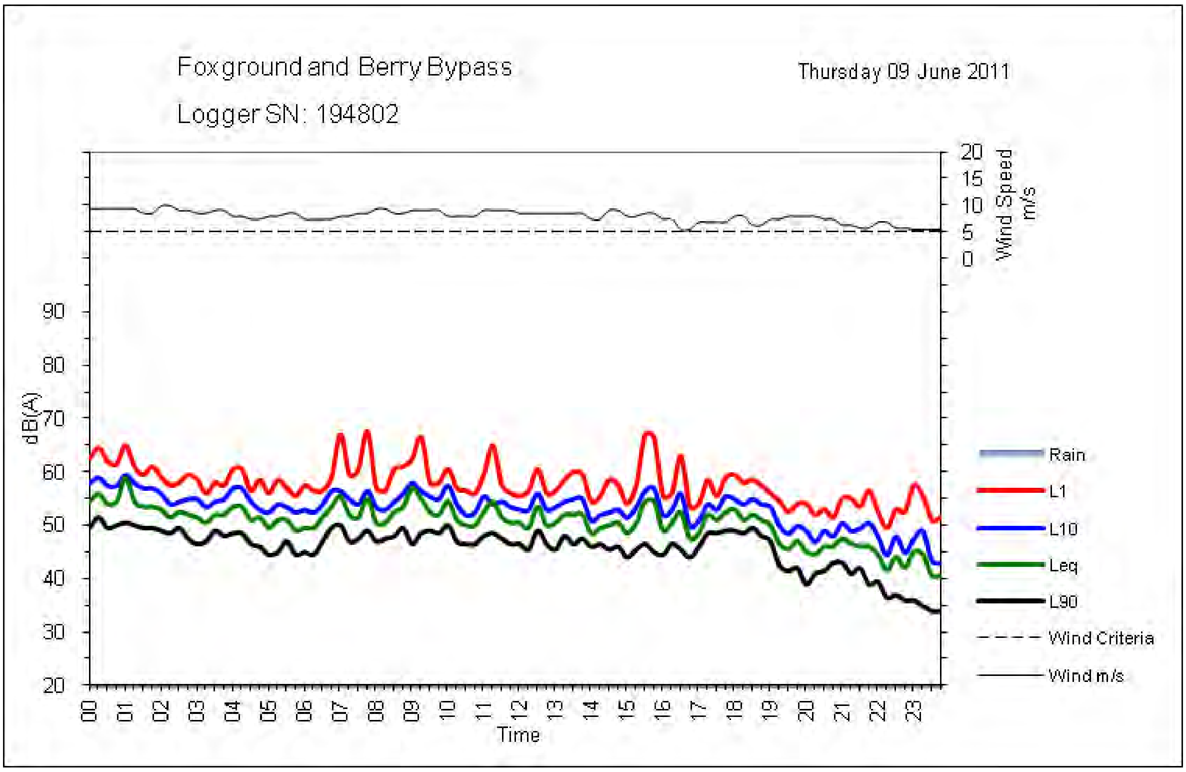
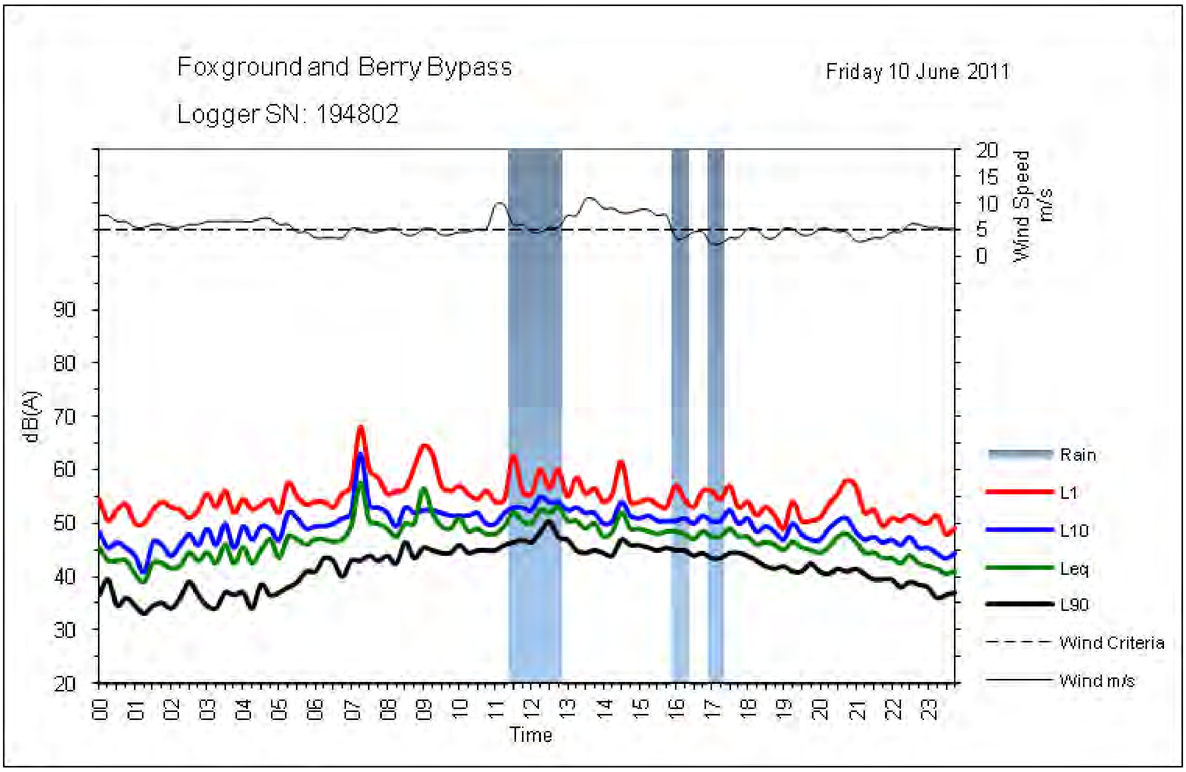
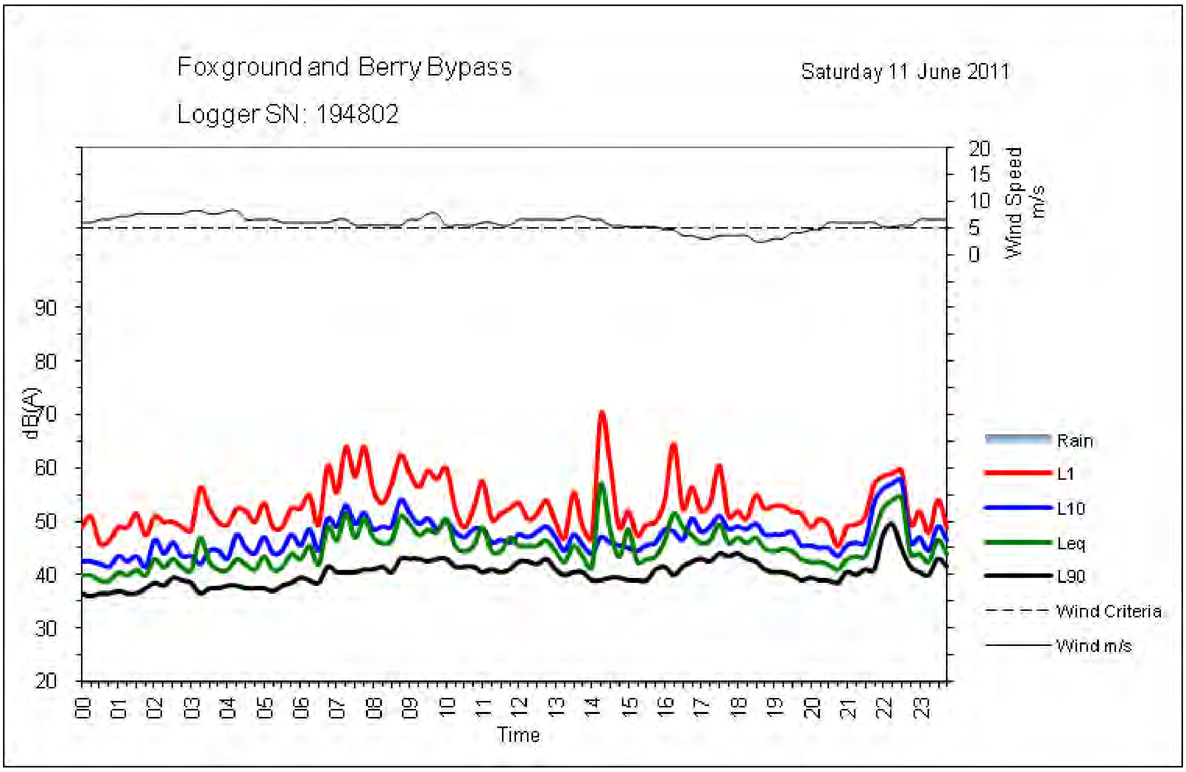
15
16
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194802
Thursday 09 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Friday 10 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194802
Saturday 11 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
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05
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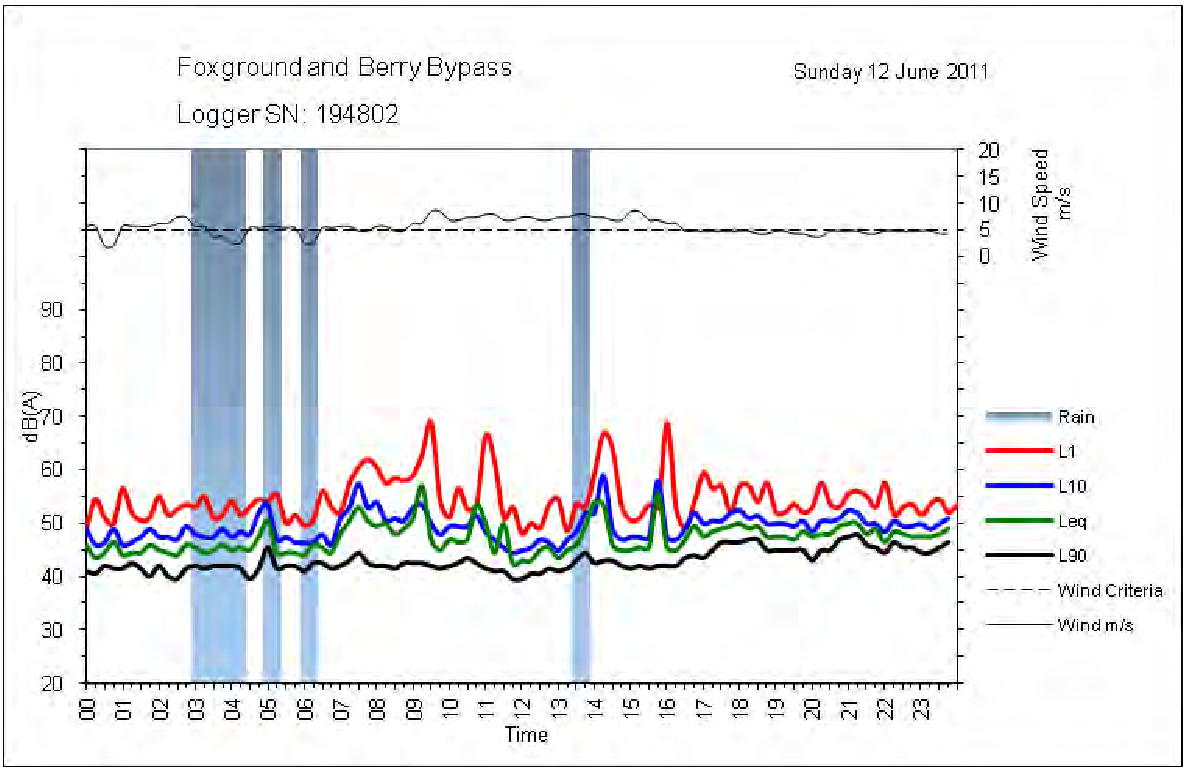
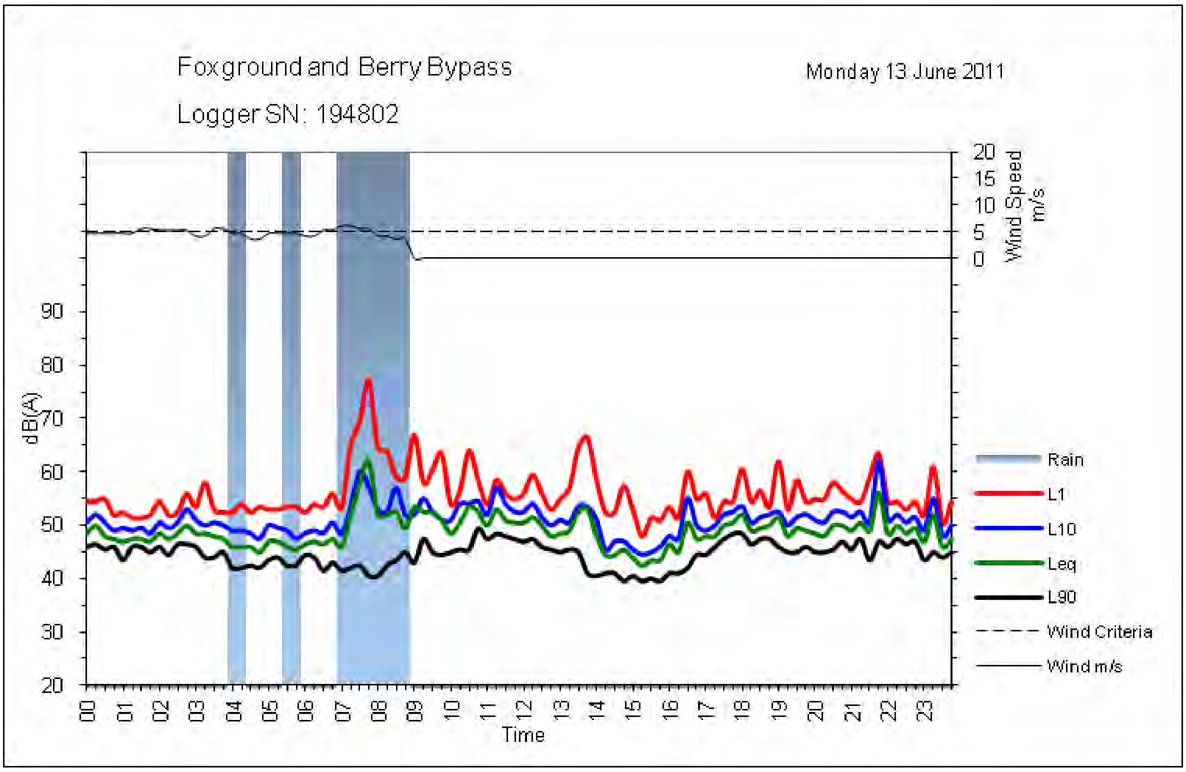
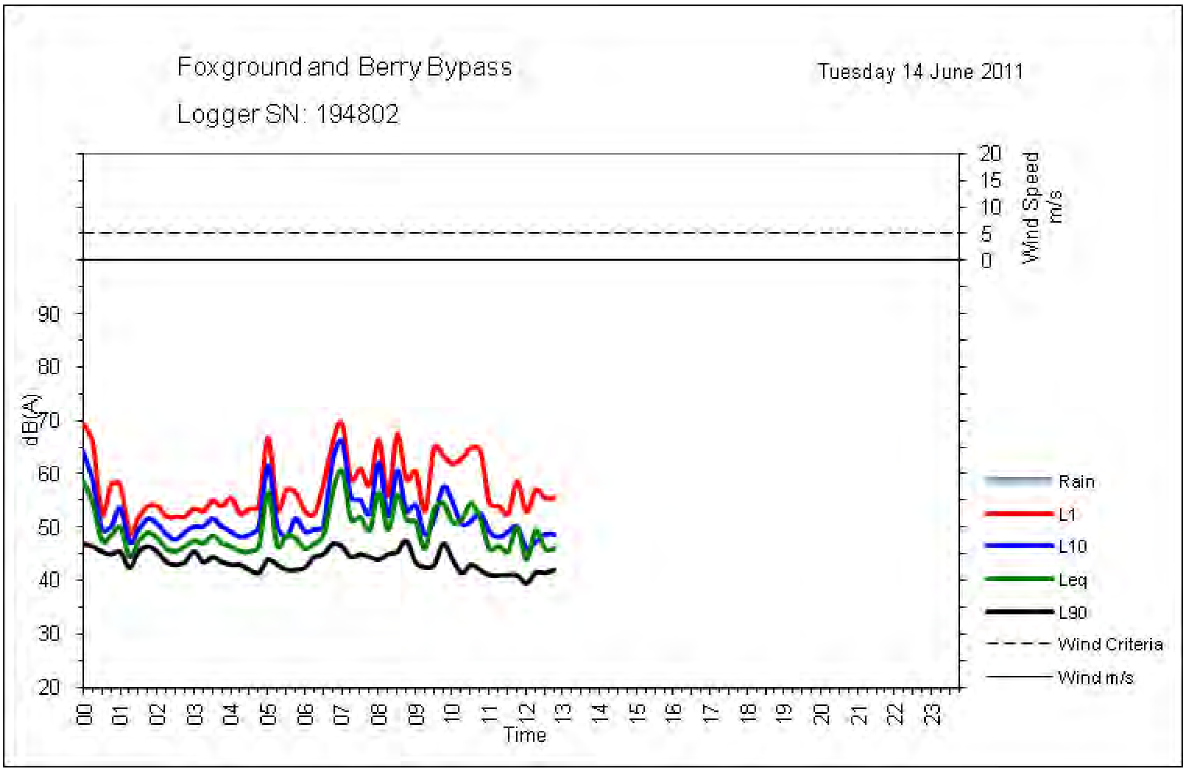
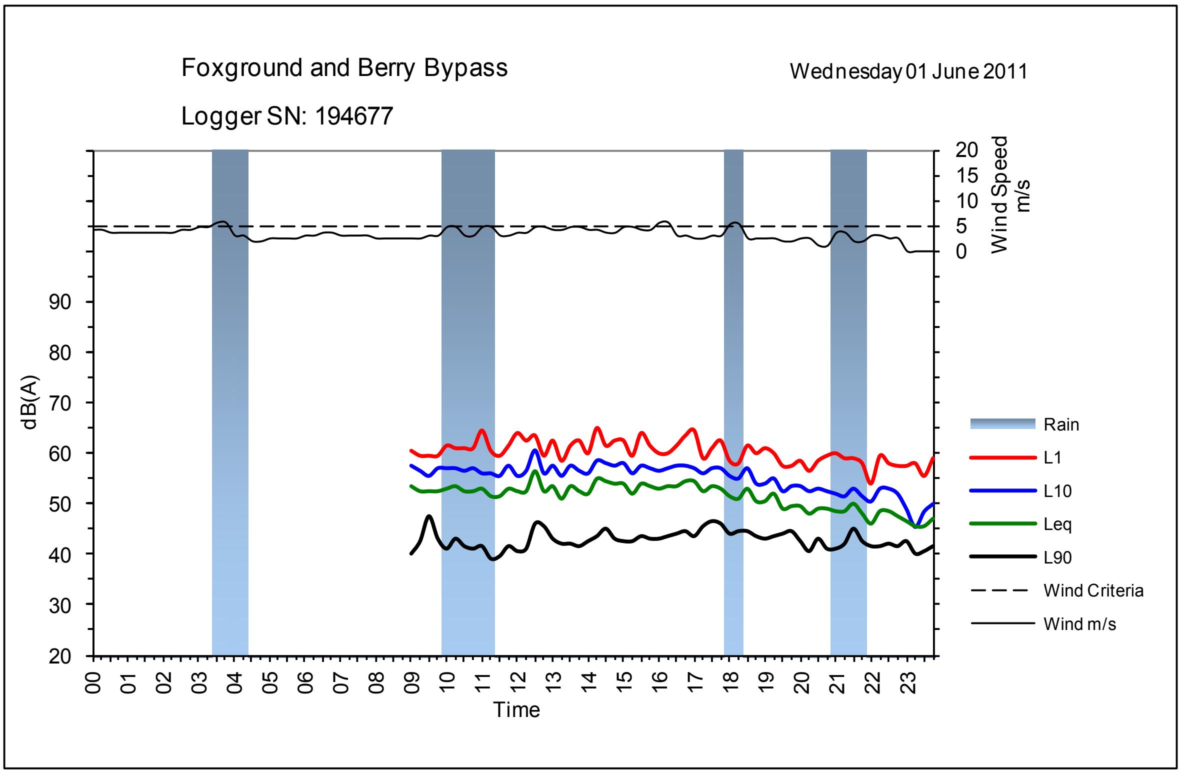
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

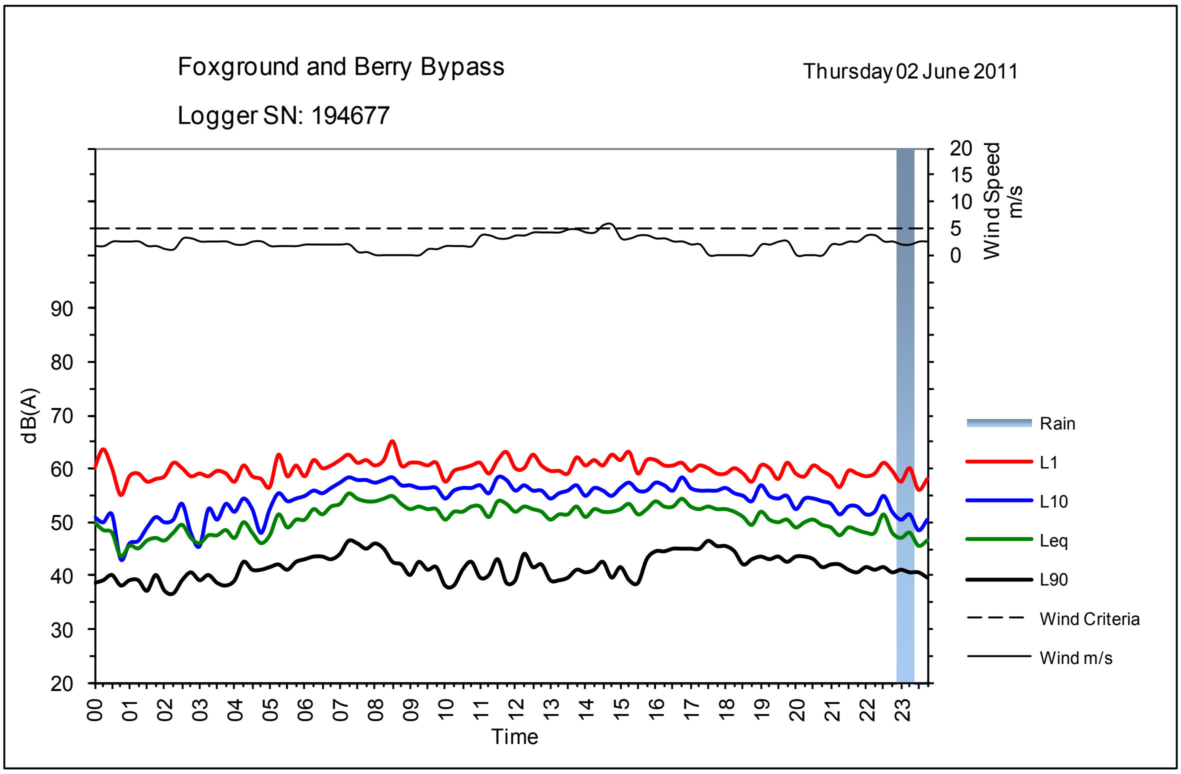

Foxground and Berry Bypass
Logger SN: 194802
Sunday 12 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

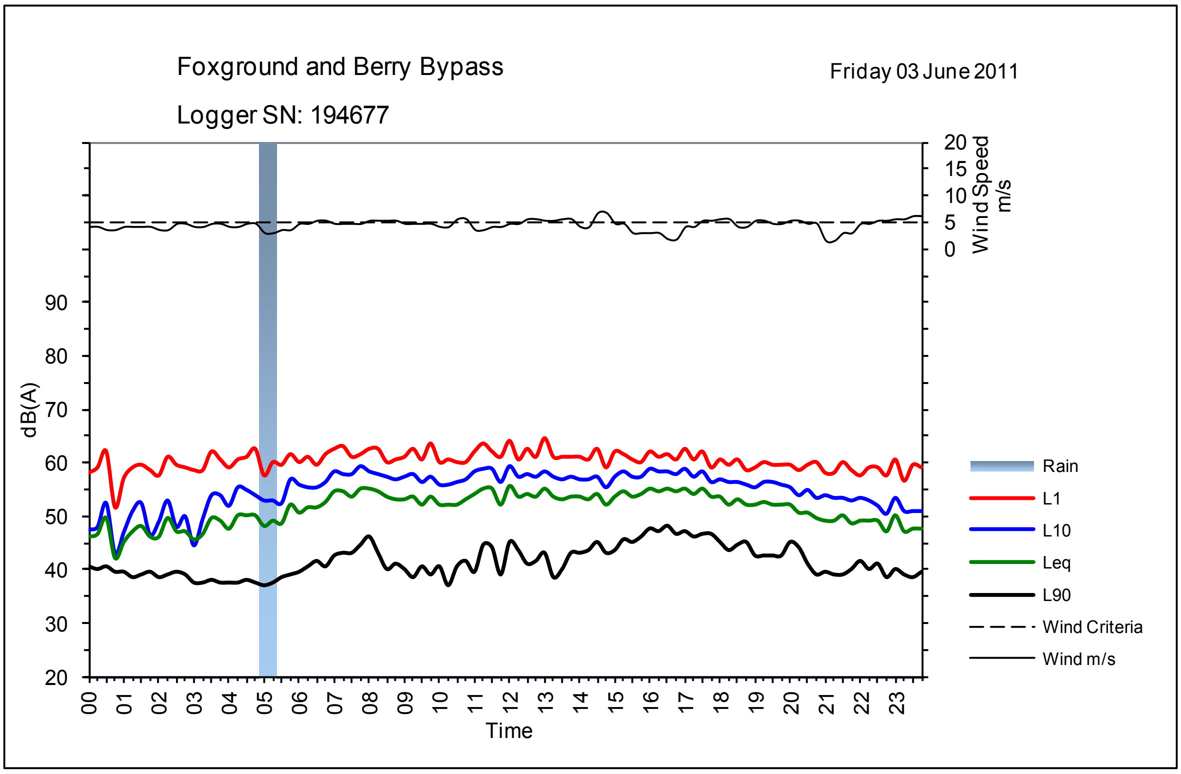

Foxground and Berry Bypass
Logger SN: 194802
Monday 13 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

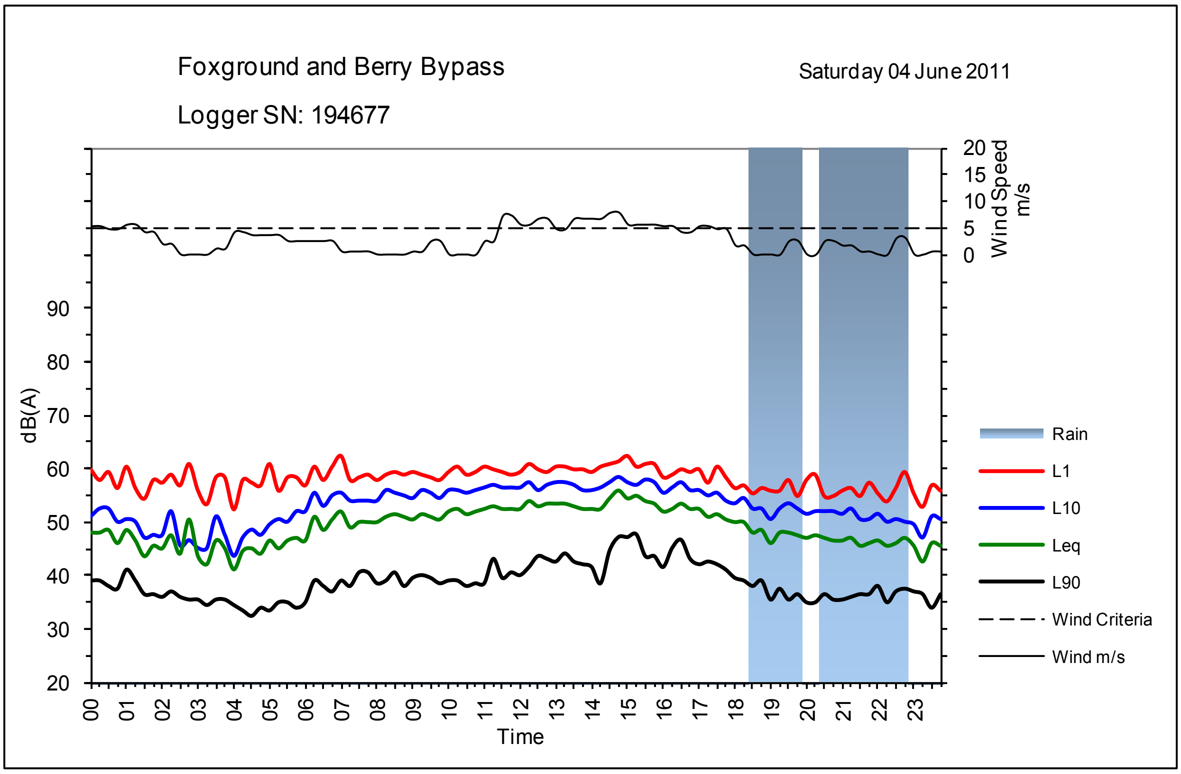

Foxground and Berry Bypass
Logger SN: 194802
Tuesday 14 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

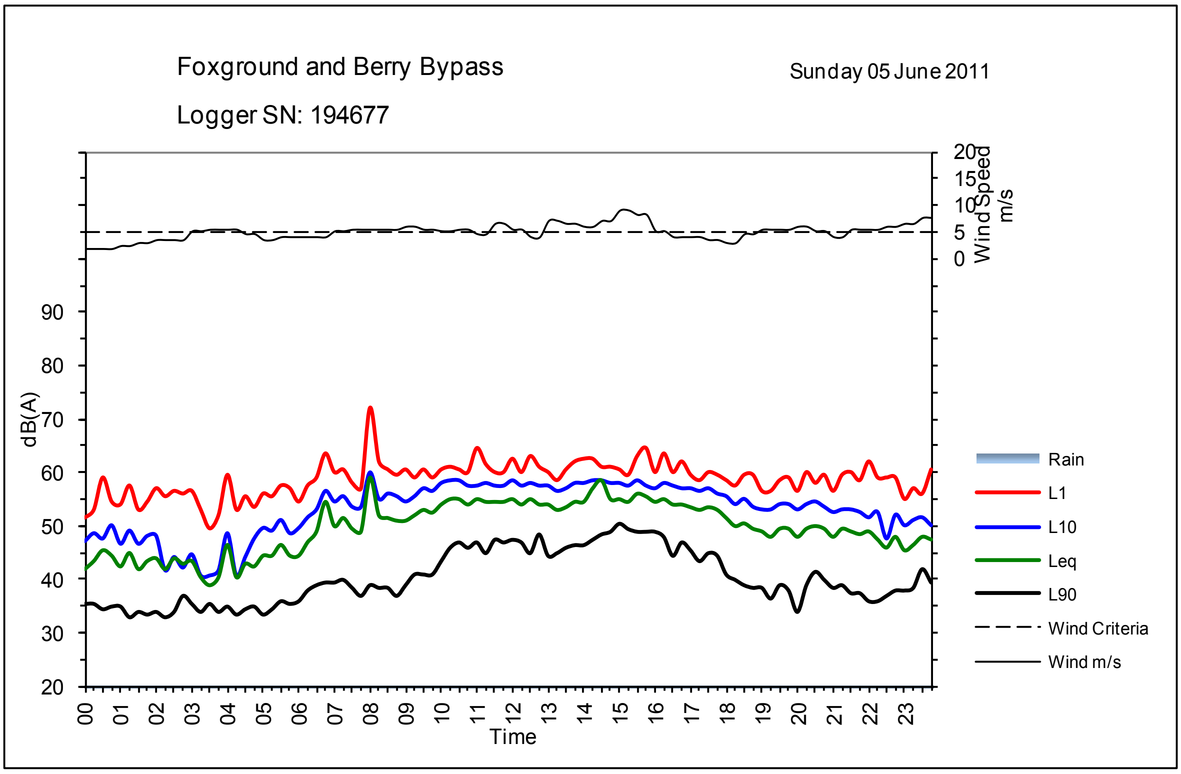
BG3

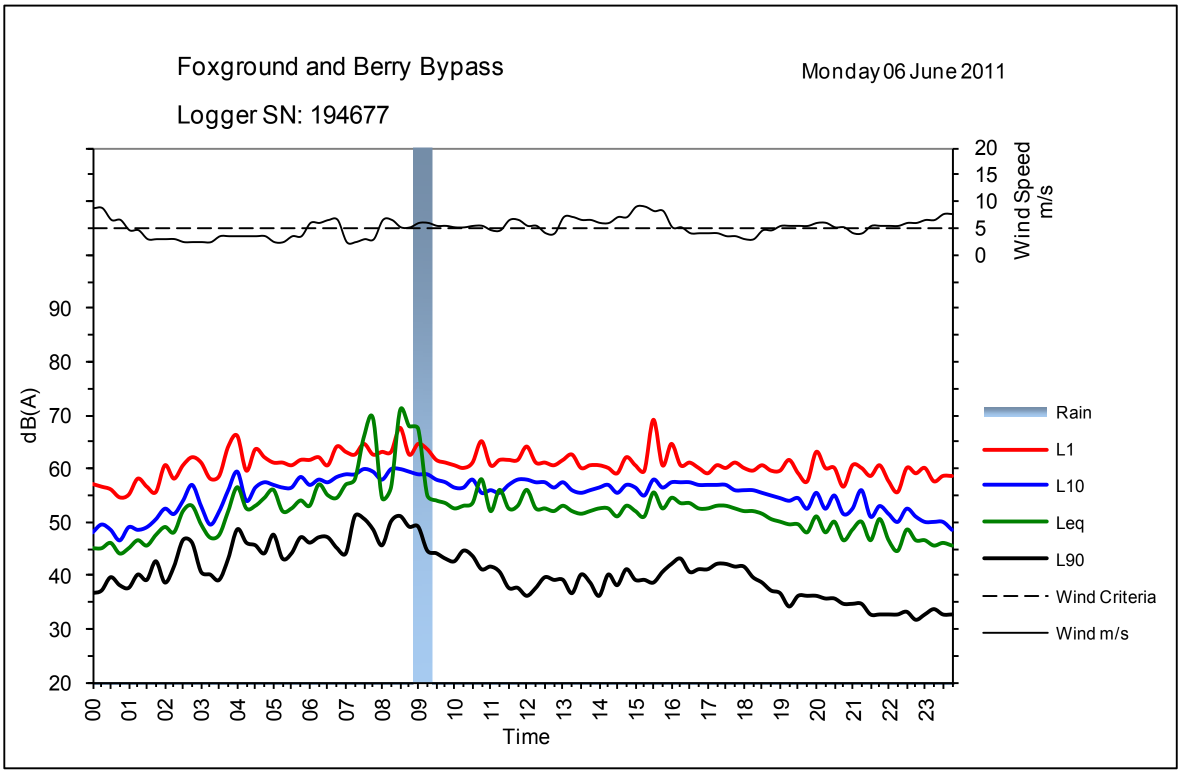

Foxground and Berry Bypass
Wednesday 01 June 2011
Logger SN: 194677
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

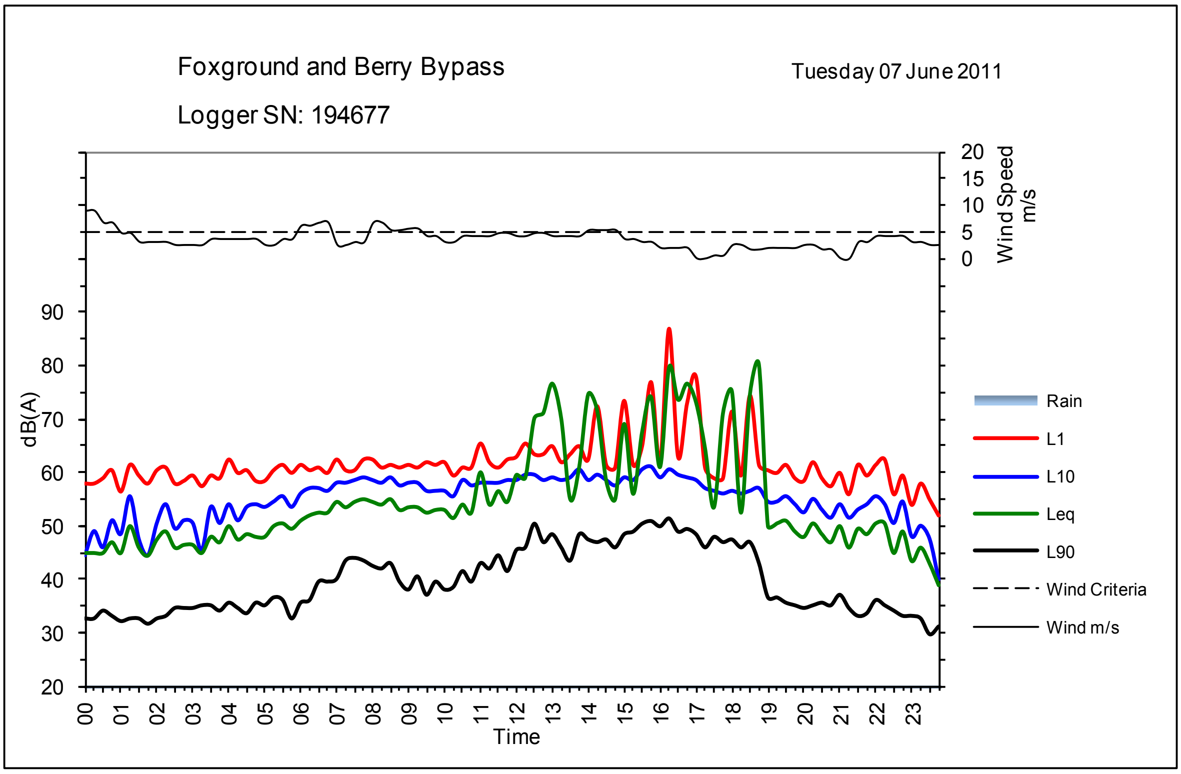

Foxground and Berry Bypass
Thursday 02 June 2011
Logger SN: 194677
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Friday 03 June 2011
Logger SN: 194677
dB(A)
20
30
40
50
60
70
80
90
20
15
10
5
0
Wind Speed m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Saturday 04 June 2011
Logger SN: 194677
dB(A)
20
30
40
50
60
70
80
90
20
15
10
5
0
Wind Speed m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

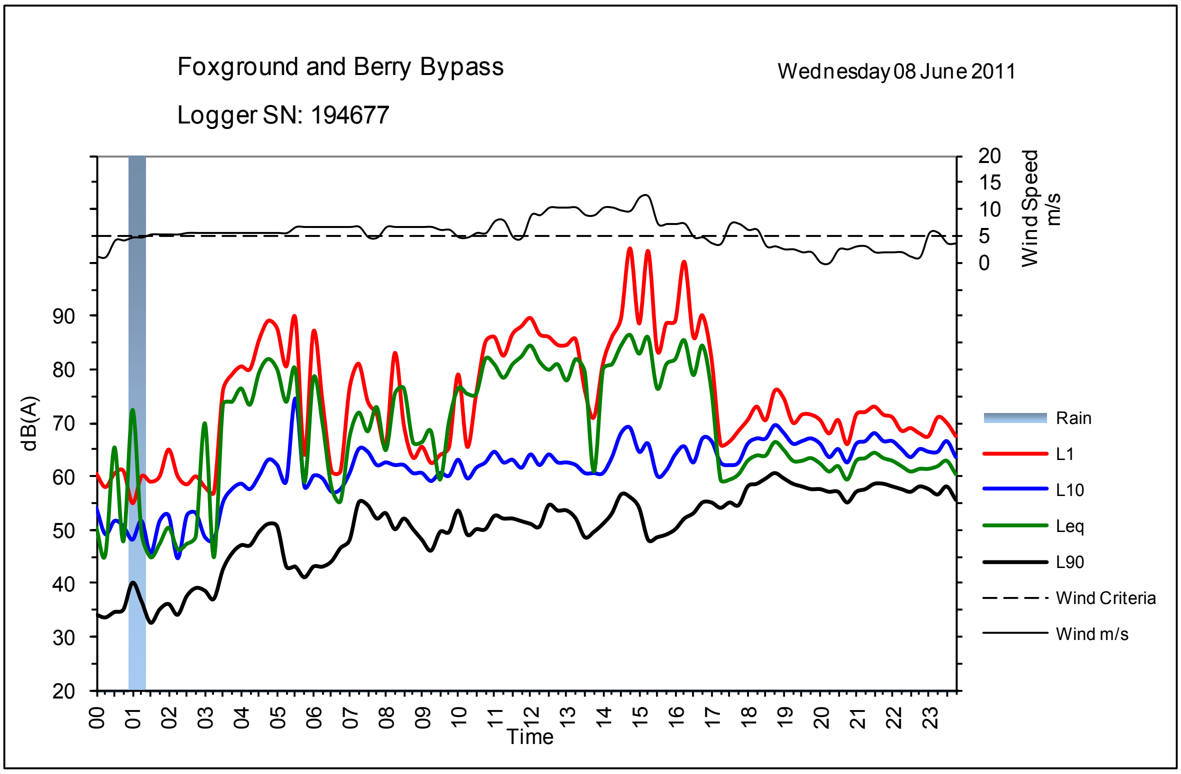

Foxground and Berry Bypass
Sunday 05 June 2011
Logger SN: 194677
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Monday 06 June 2011
Logger SN: 194677
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass

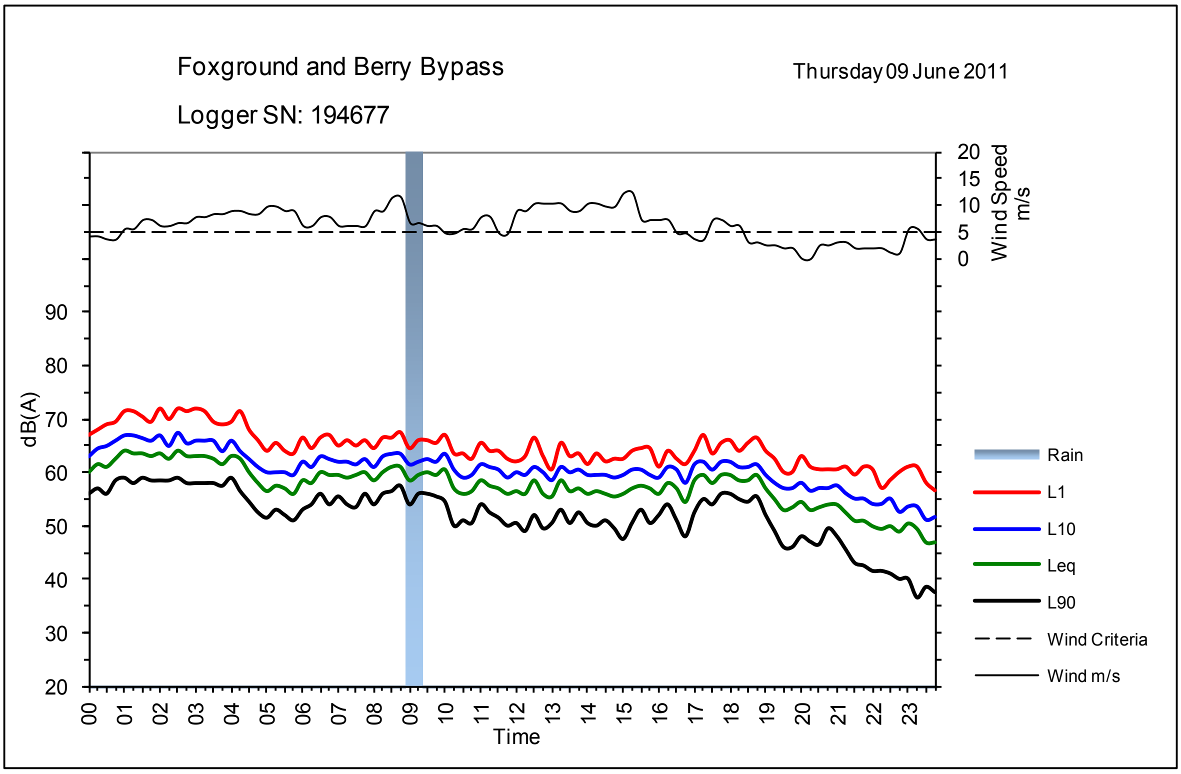
Logger SN: 194677

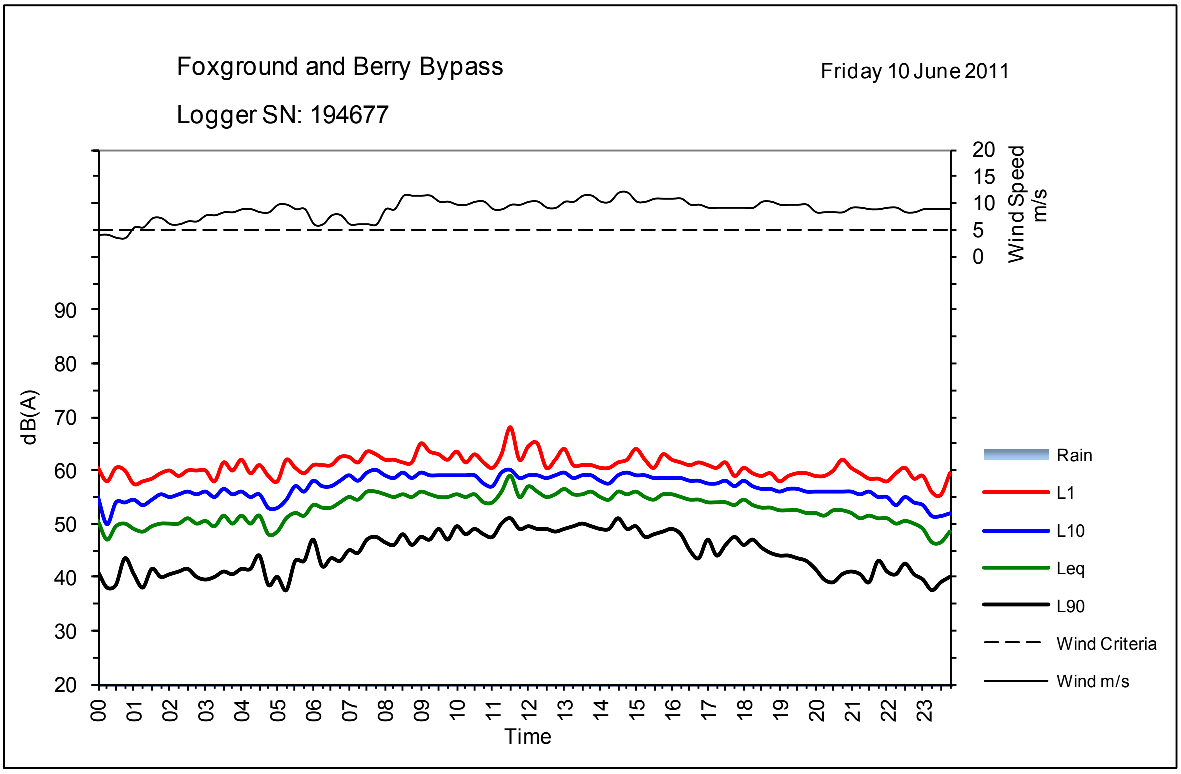
Tuesday 07 June 2011

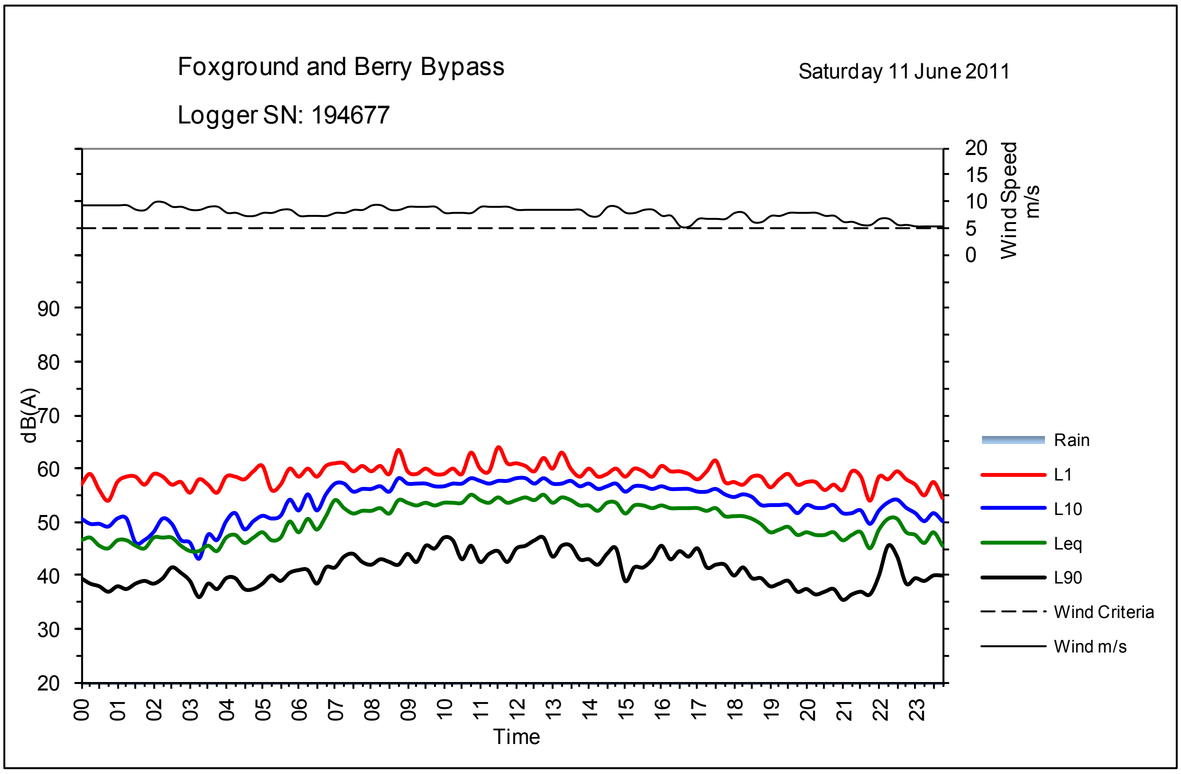

Foxground and Berry Bypass

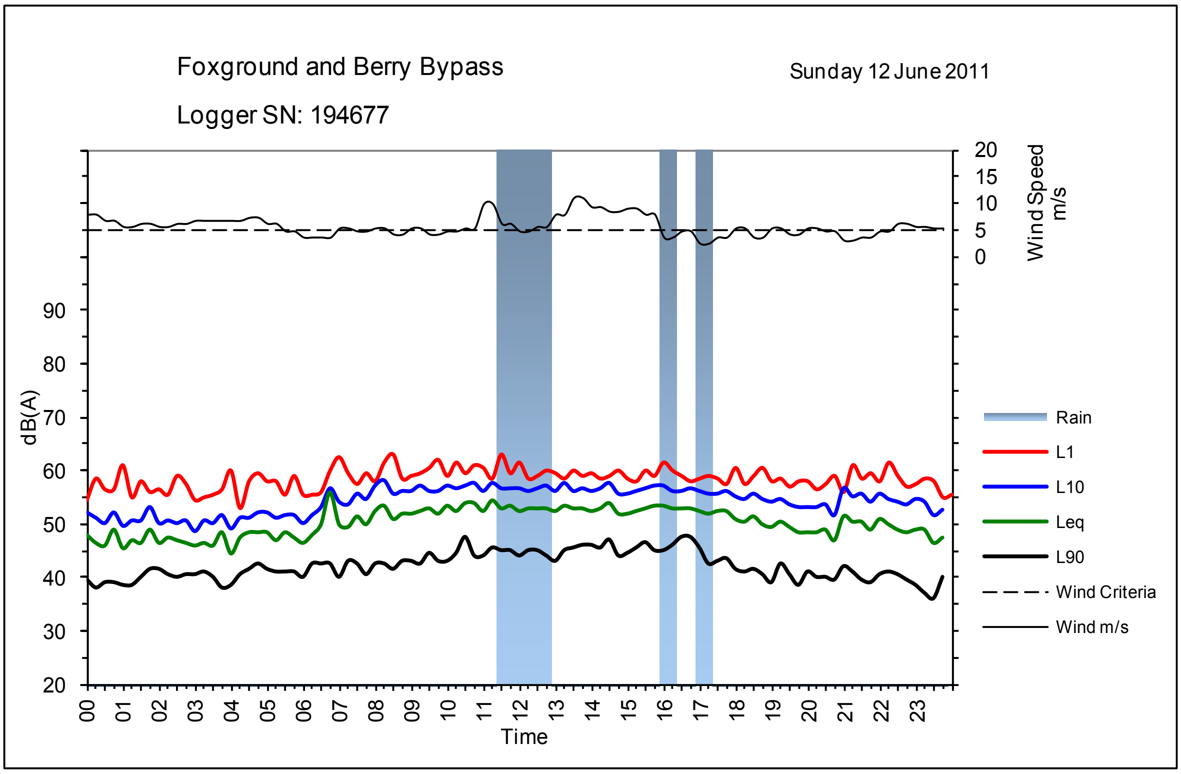
Logger SN: 194677

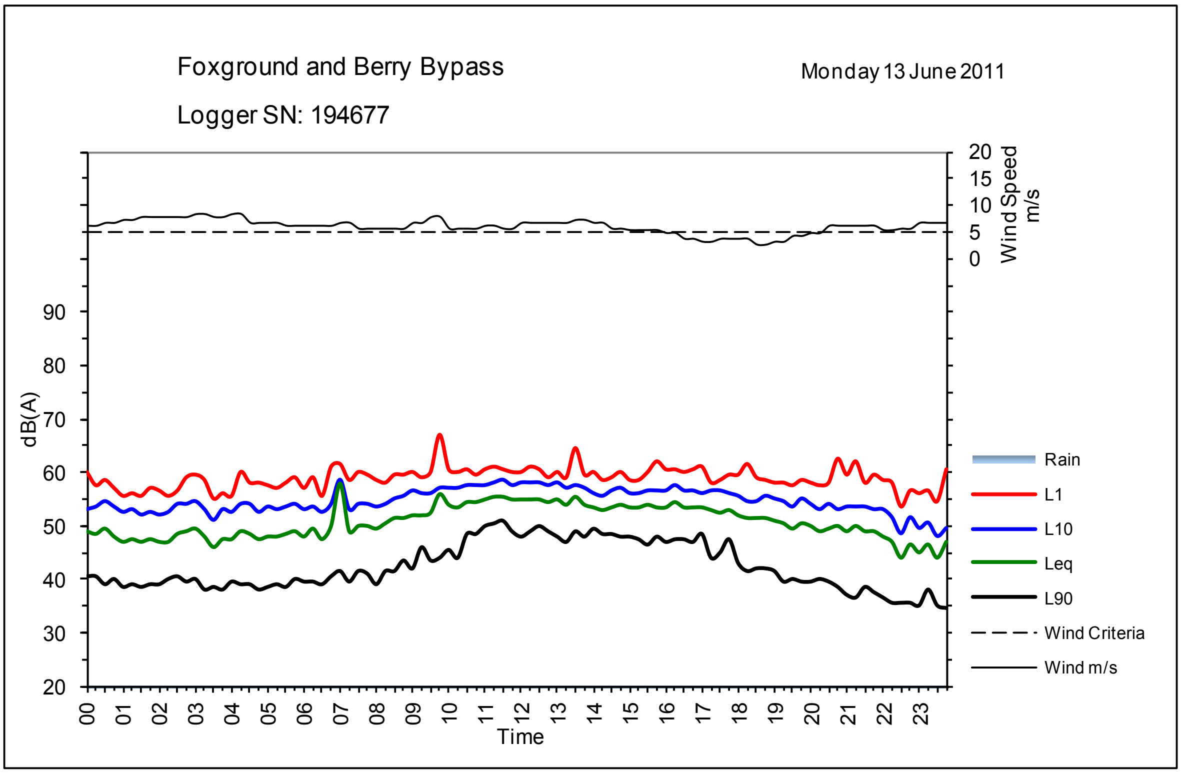
Wednesday 08 June 2011

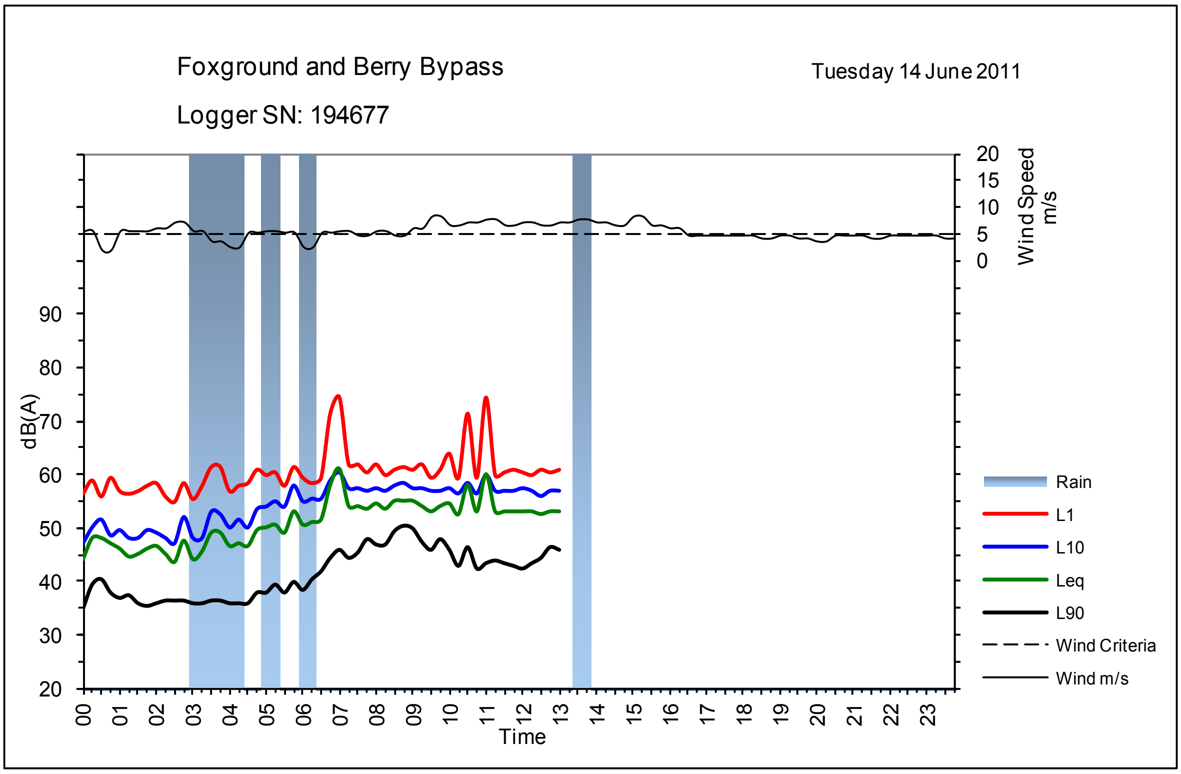

Foxground and Berry Bypass
Thursday 09 June 2011
Logger SN: 194677
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Friday 10 June 2011
Logger SN: 194677
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

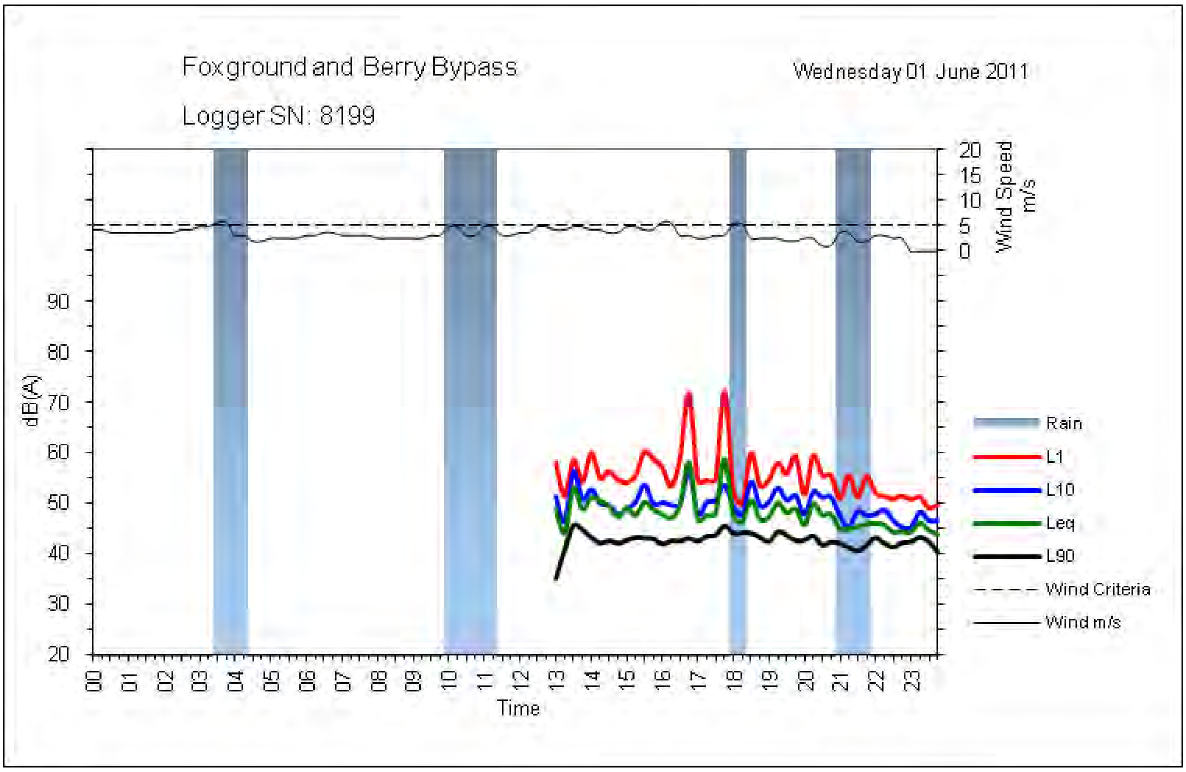

Foxground and Berry Bypass
Saturday 11 June 2011
Logger SN: 194677
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time

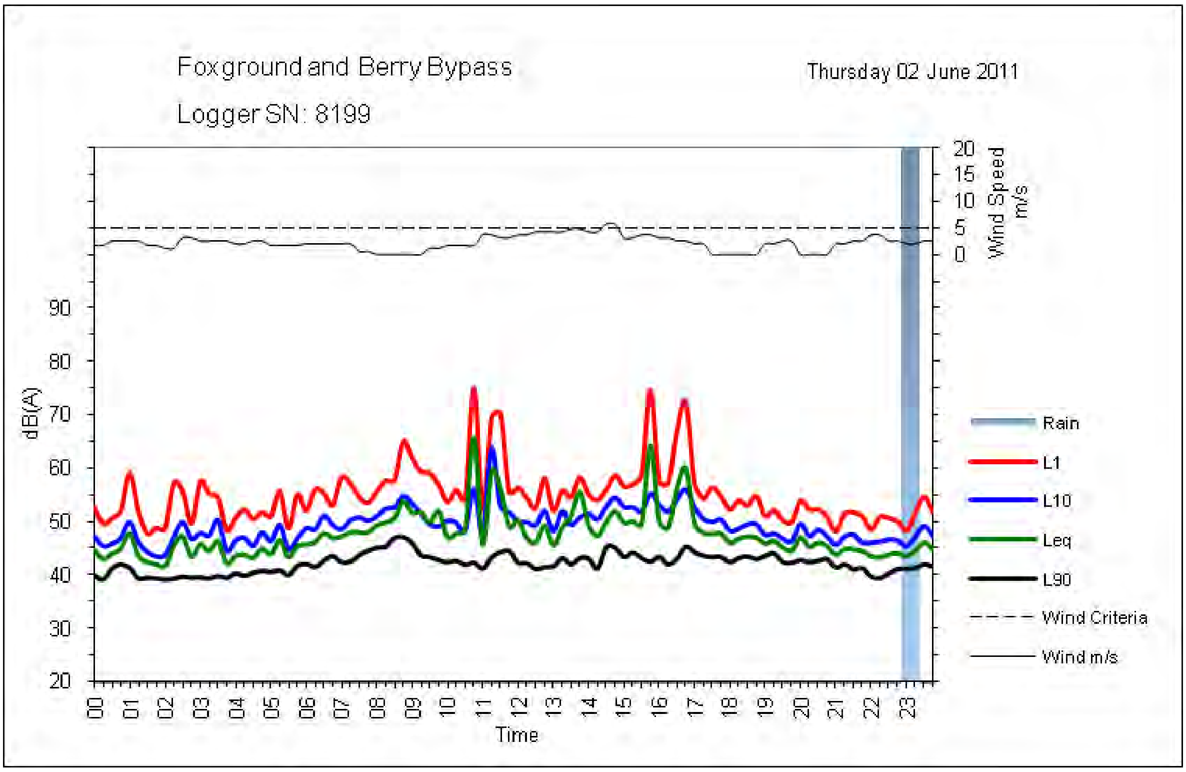

Foxground and Berry Bypass
Sunday 12 June 2011
Logger SN: 194677
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time

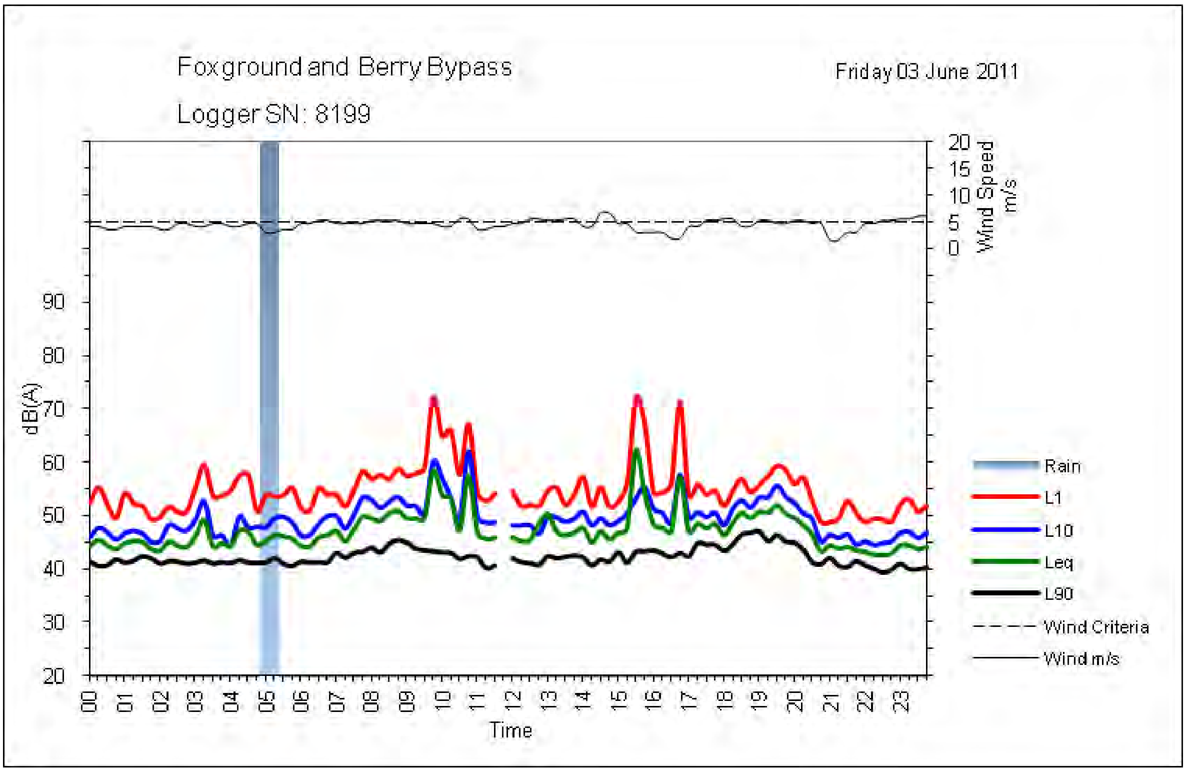

Foxground and Berry Bypass
Monday 13 June 2011
Logger SN: 194677
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Tuesday 14 June 2011
Logger SN: 194677
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

BG4


Foxground and Berry Bypass
Logger SN: 8199
Wednesday 01 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 8199
Thursday 02 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 8199
Friday 03 June 2011
dB(A)
Wind Speed m/s
20
15
10
5
0
90
80
70
60
50
40
30
20
00
01
02
03
04
05
06
07
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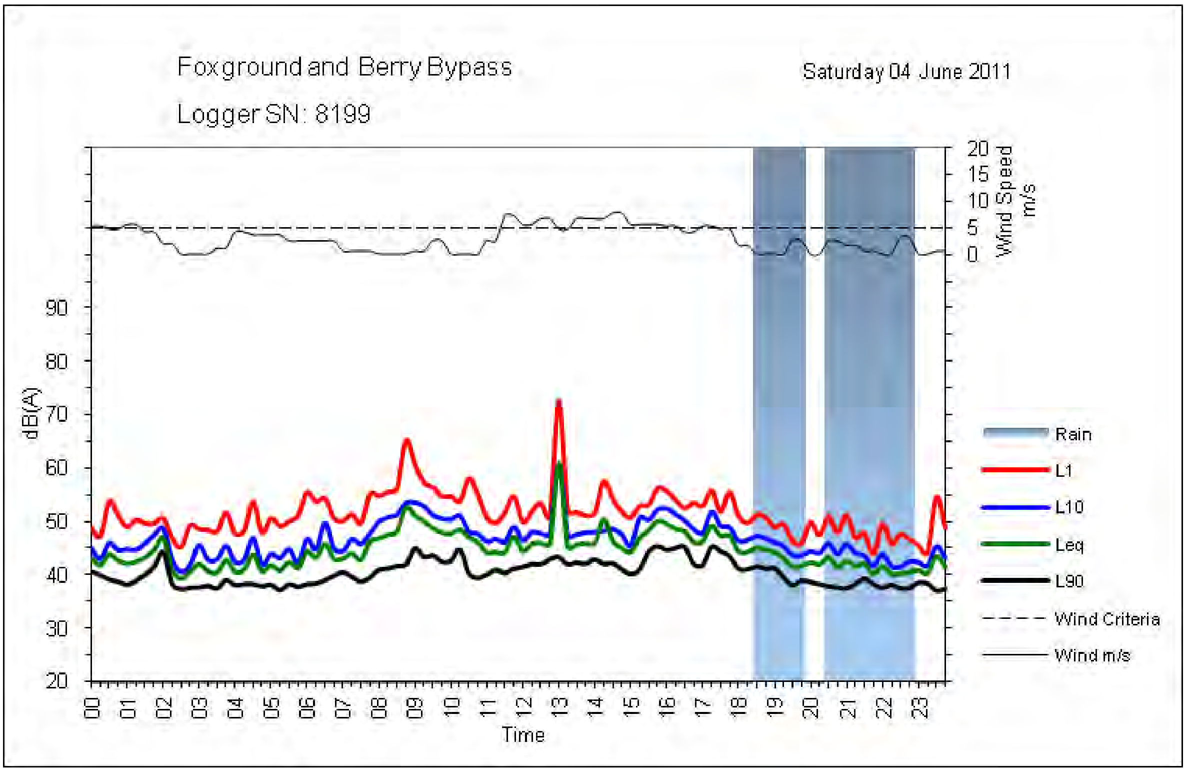
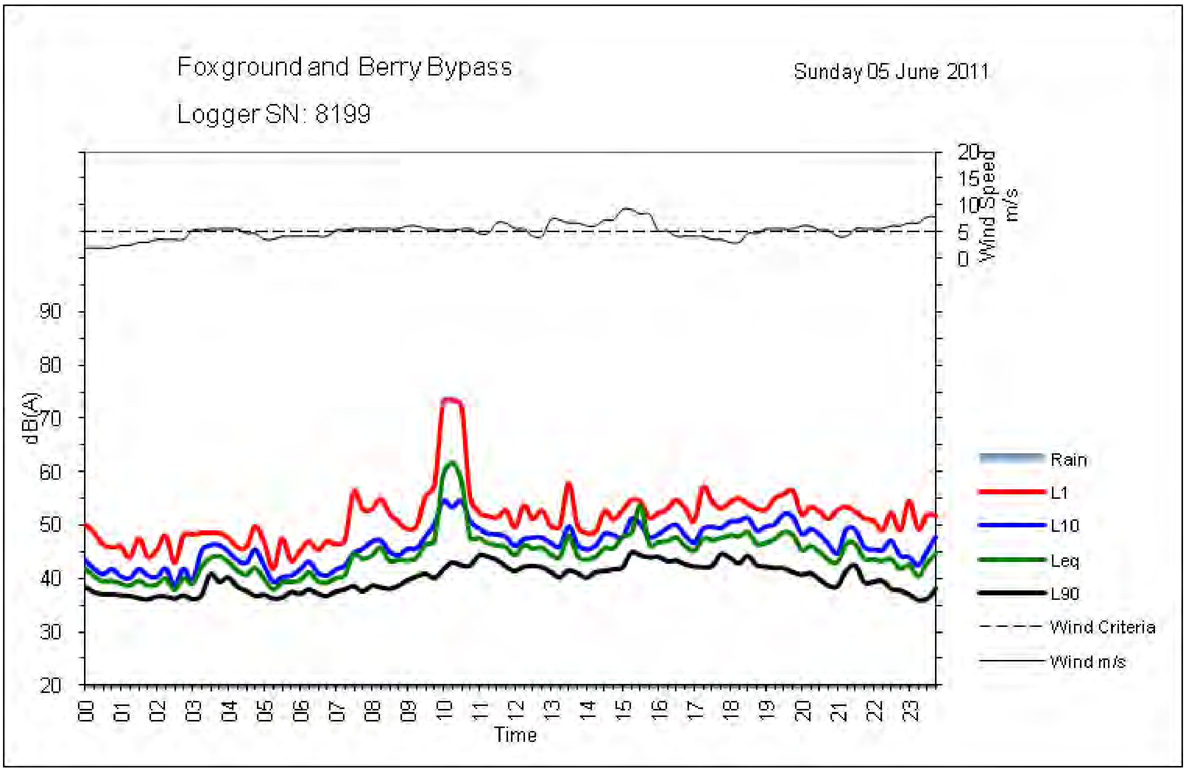
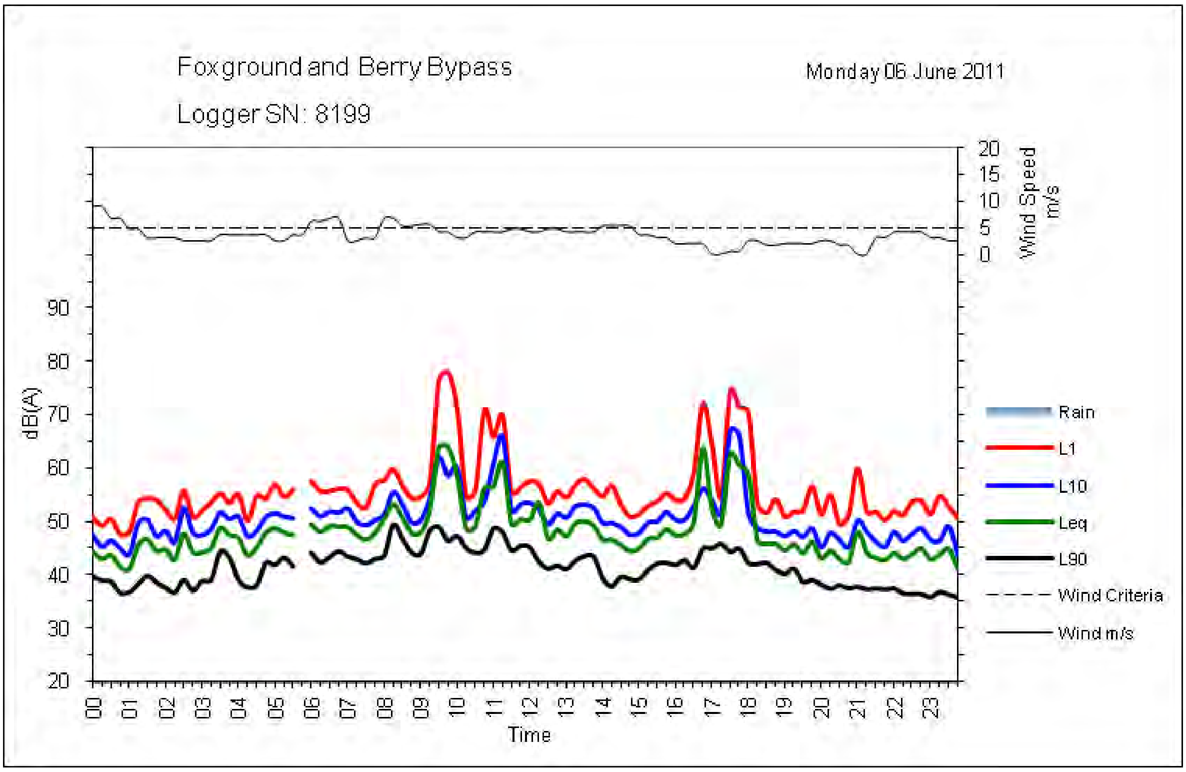
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 8199
Saturday 04 June 2011
dB(A)
Wind Speed m/s
20
15
10
5
0
90
80
70
60
50
40
30
20
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 8199
Sunday 05 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 8199
Monday 06 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00
01
02
03
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05
06
07
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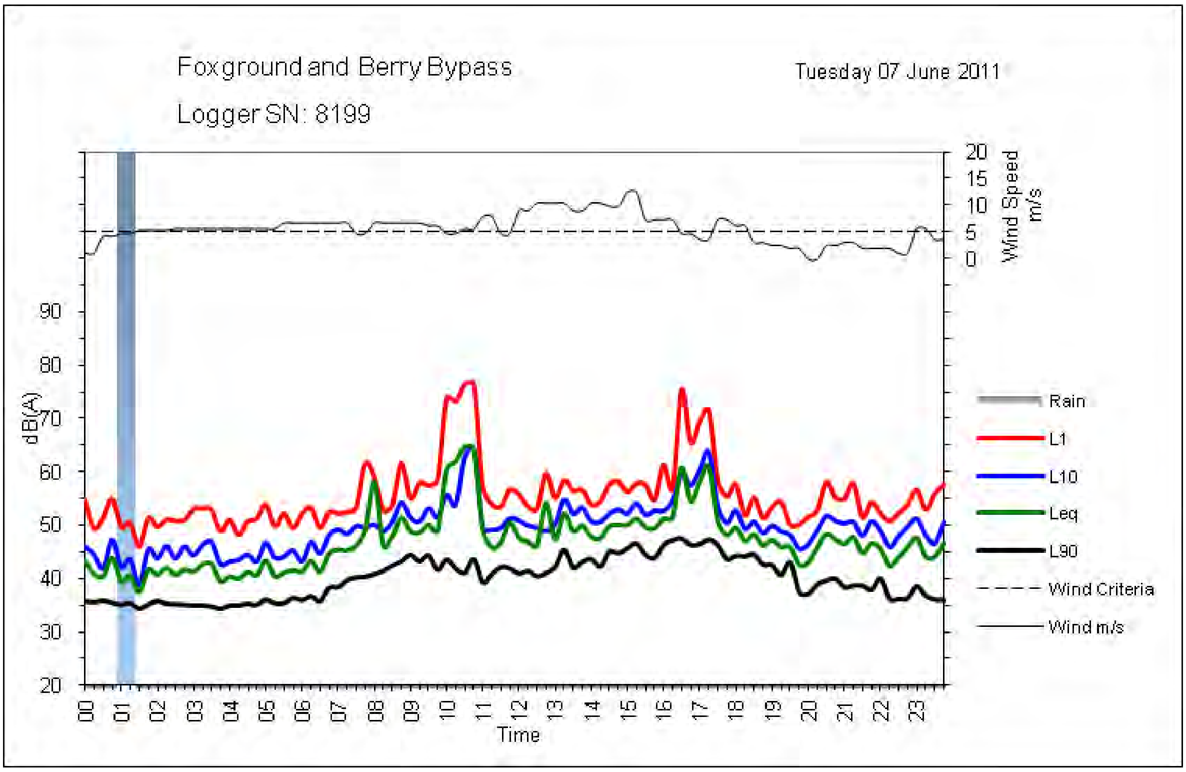
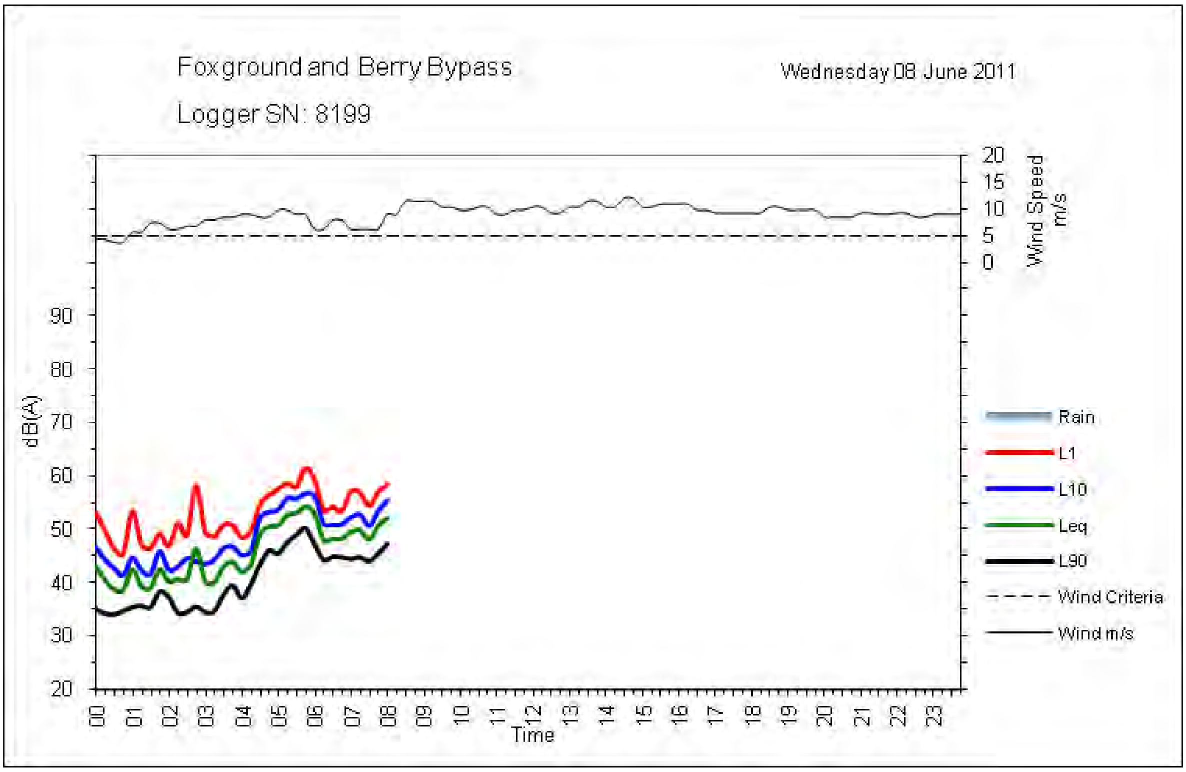
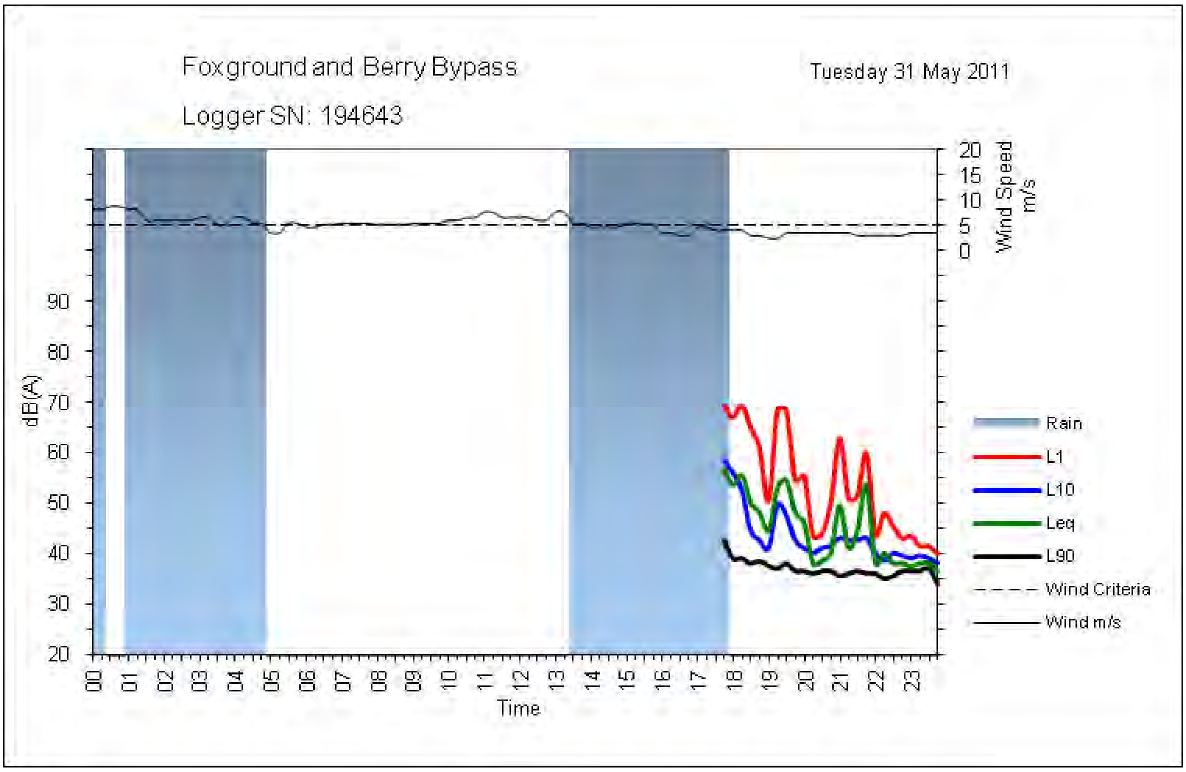
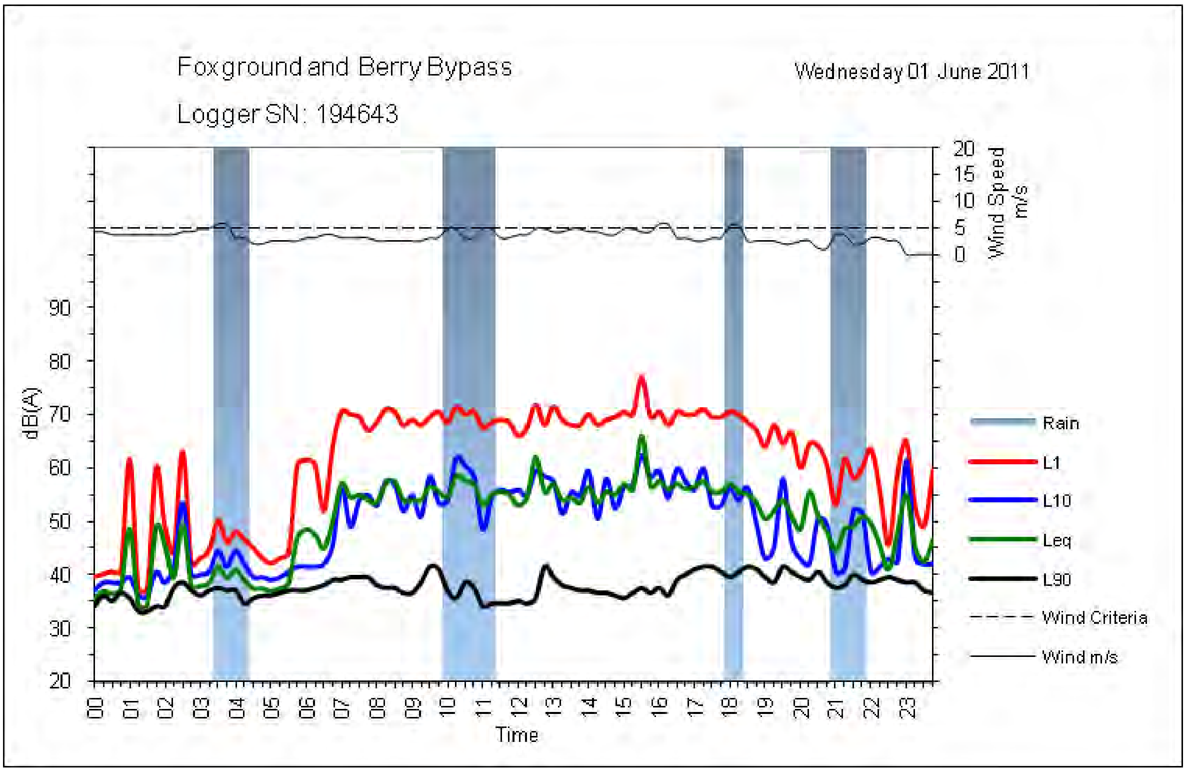
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

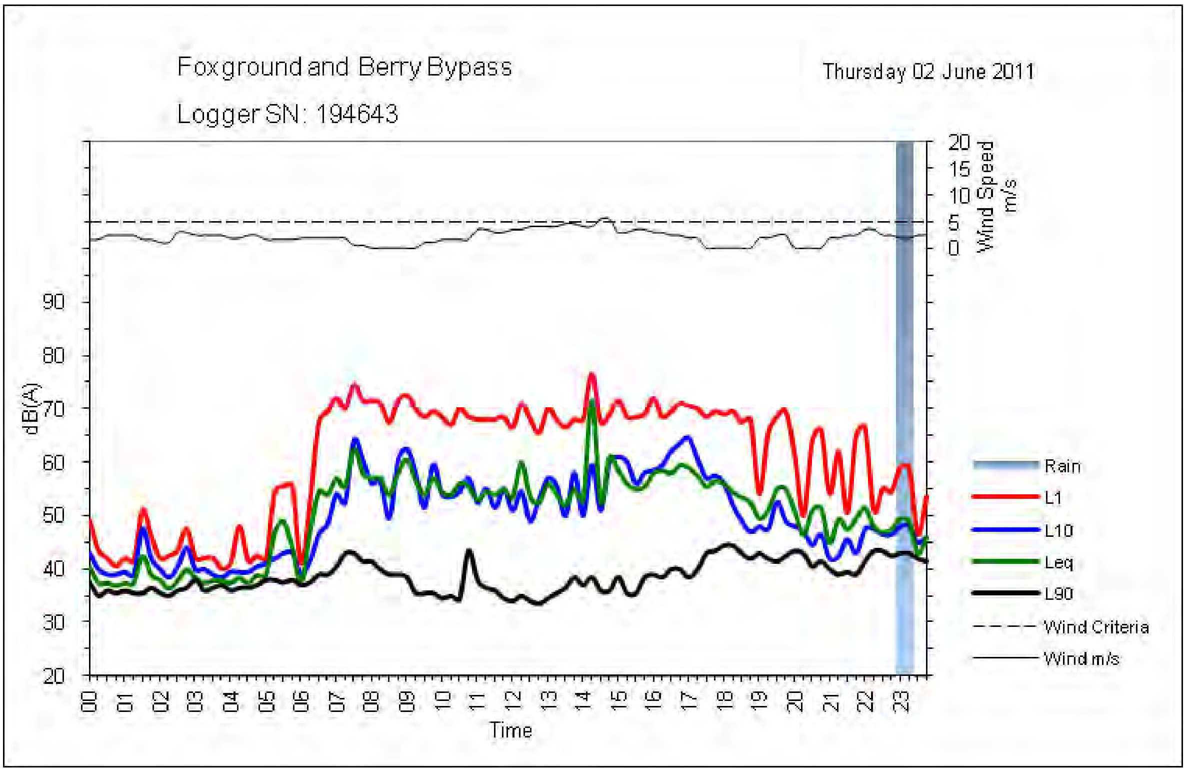

Foxground and Berry Bypass
Logger SN: 8199
Tuesday 07 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 8199
Wednesday 08 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

BG5


Foxground and Berry Bypass
Logger SN: 194643
Tuesday 31 May 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Wednesday 01 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Thursday 02 June 2011
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00
01
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03
04
05
06
07
08
09
10
11
12
13
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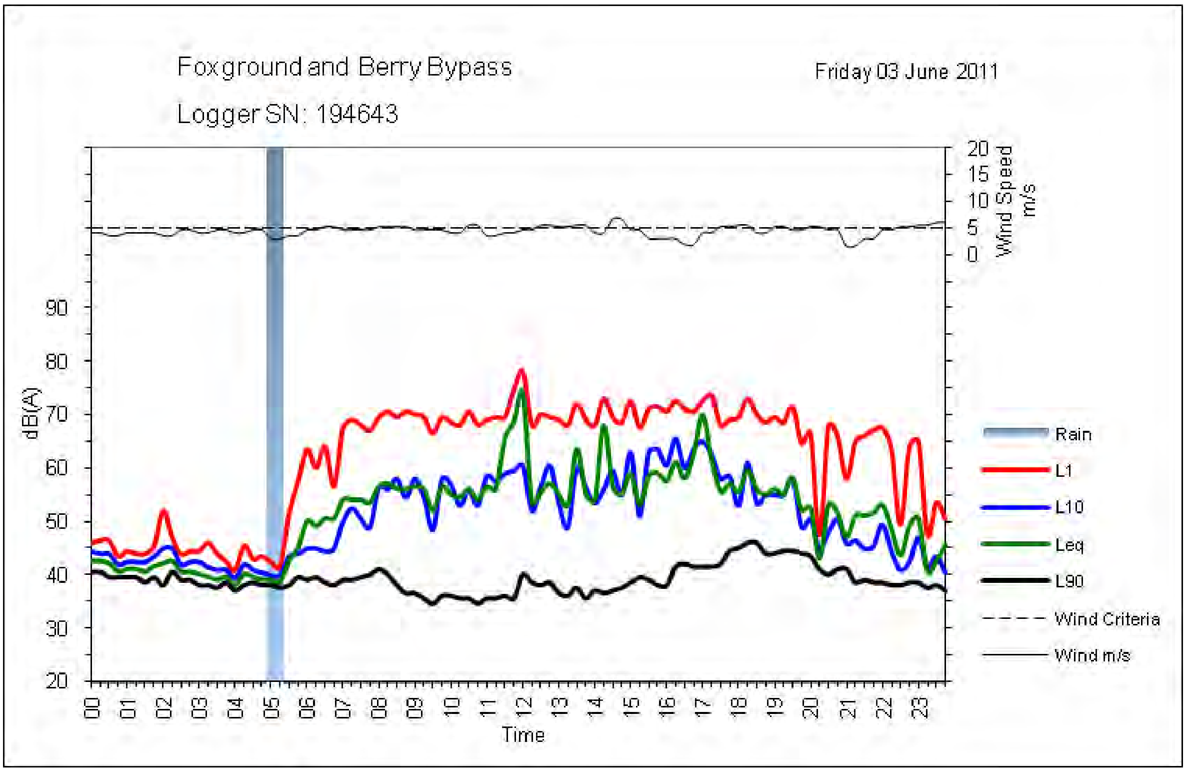
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Friday 03 June 2011
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00
01
02
03
04
05
06
07
08
09
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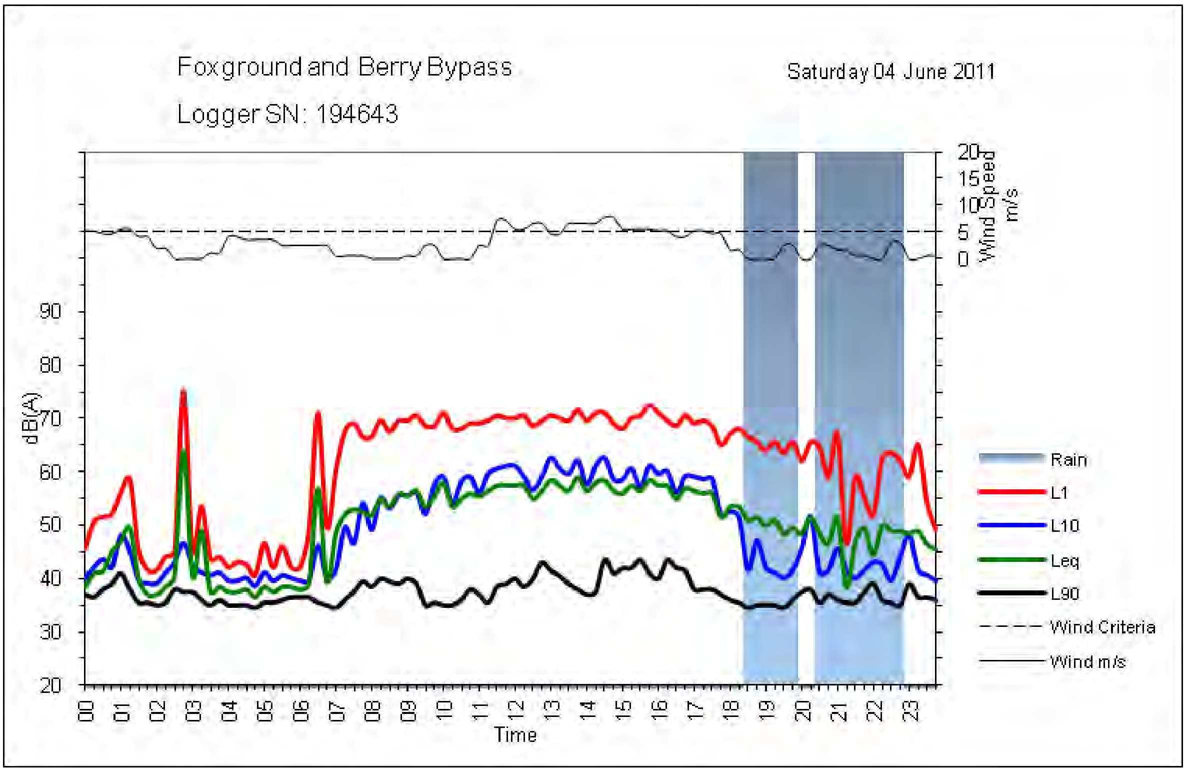
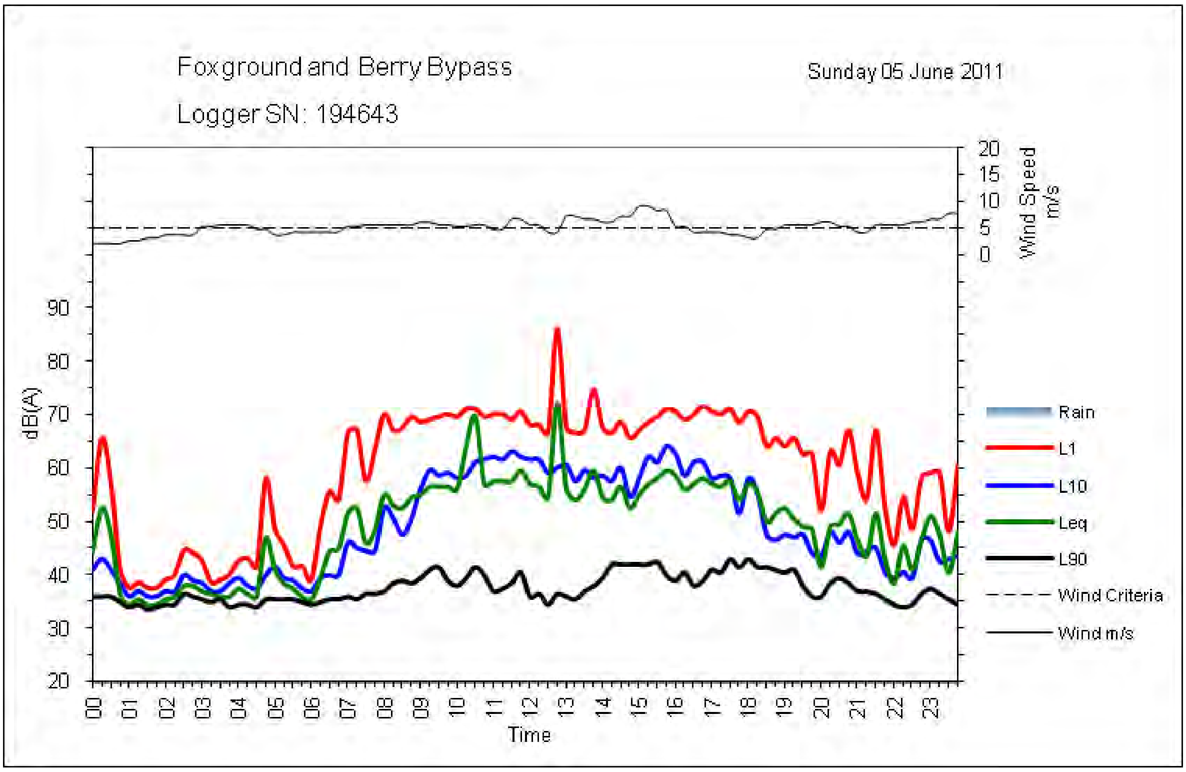
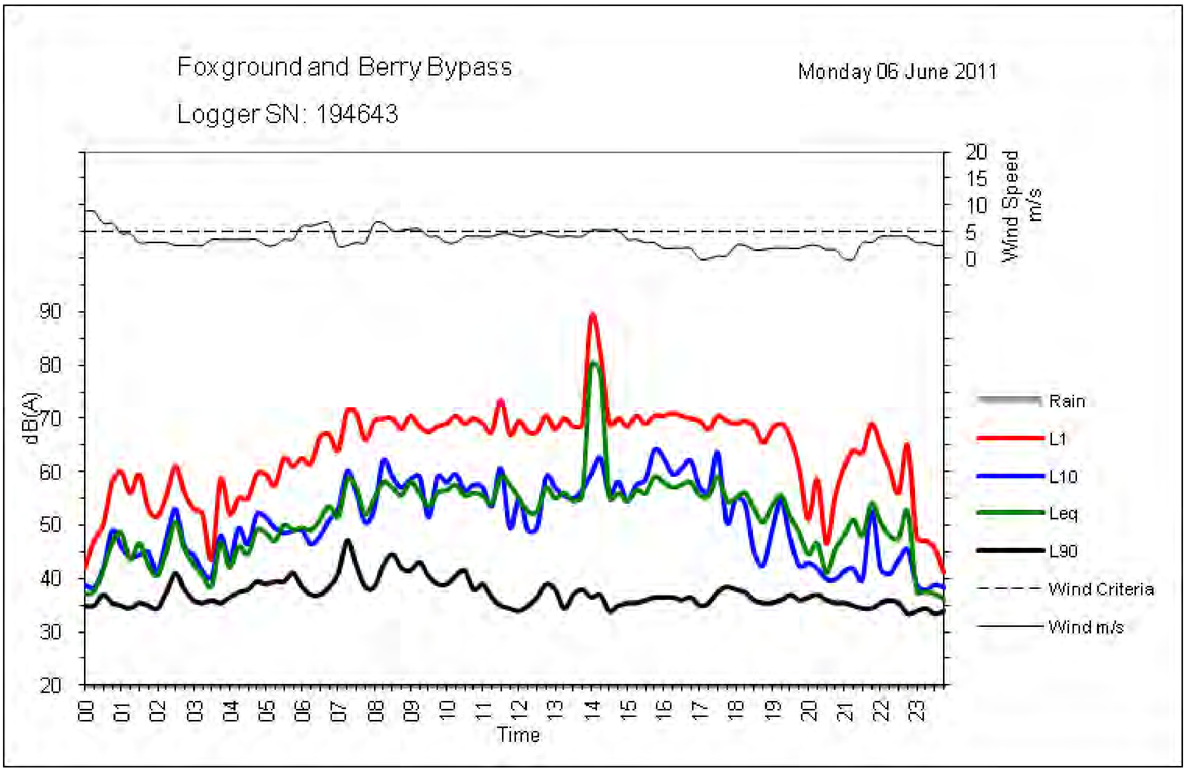
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Saturday 04 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Sunday 05 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Monday 06 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
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09
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11
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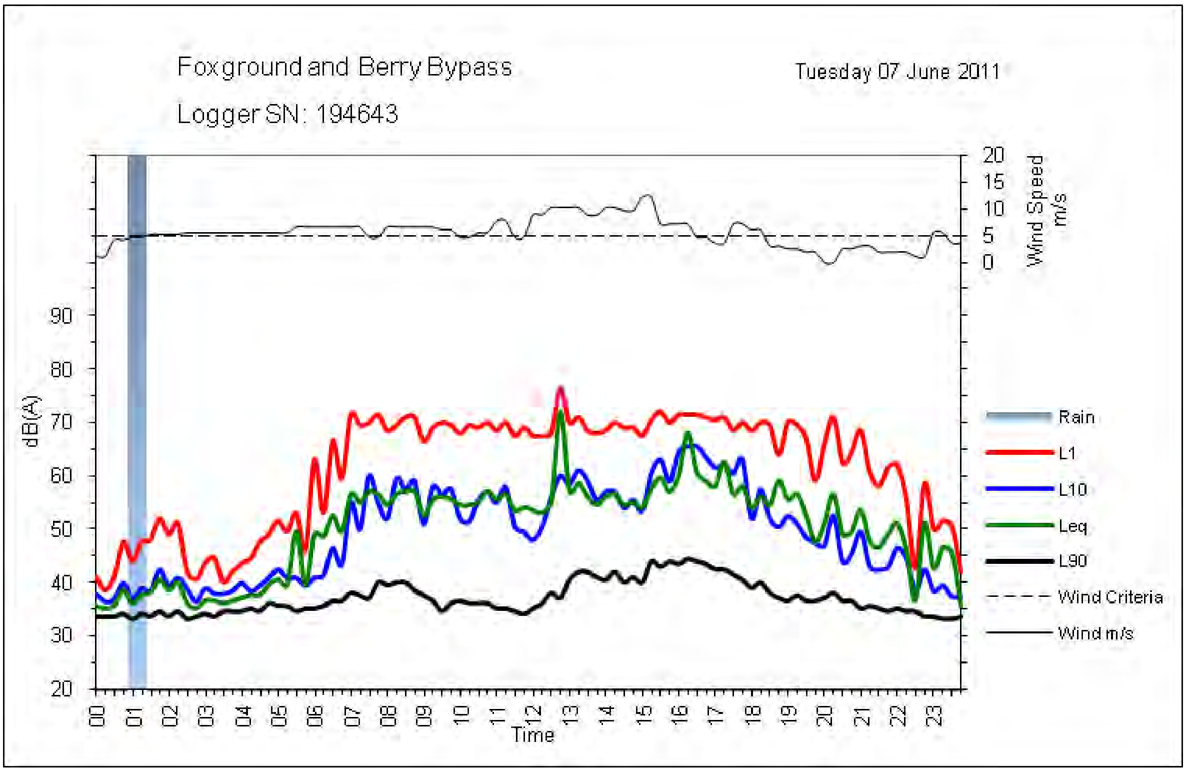
14
15
16
17
18
19
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194643
Tuesday 07 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
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07
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09
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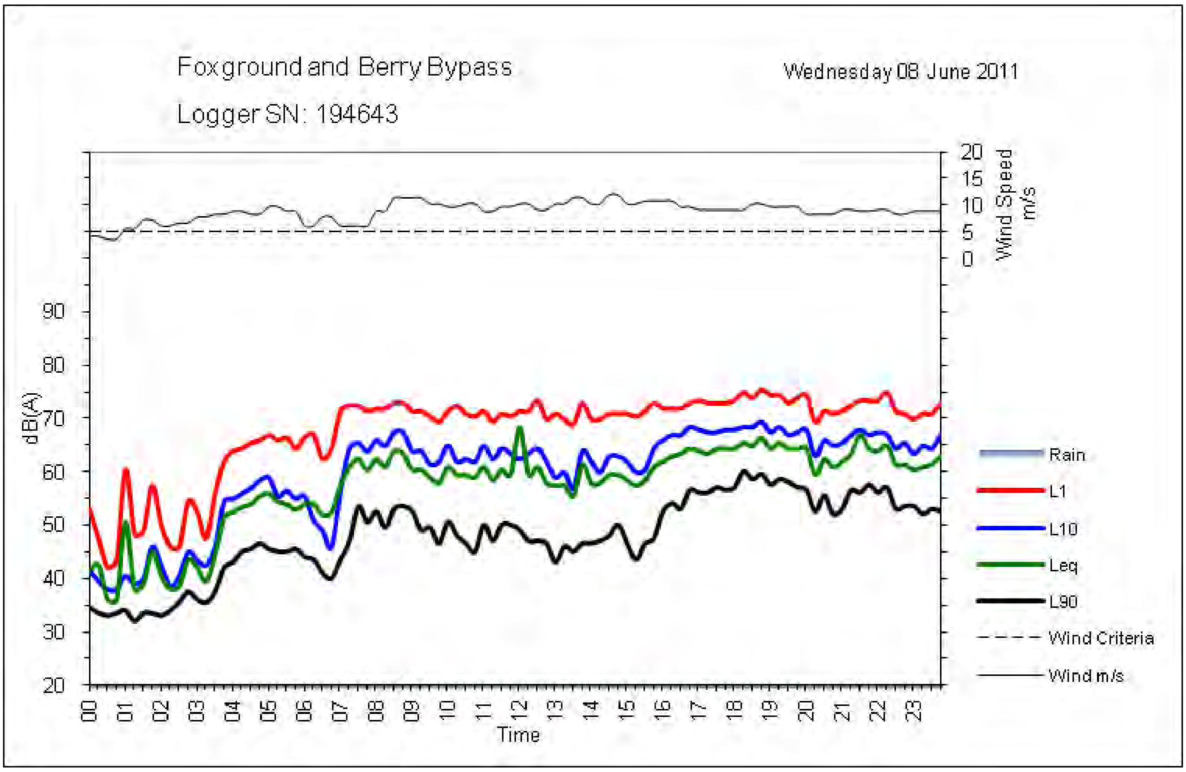
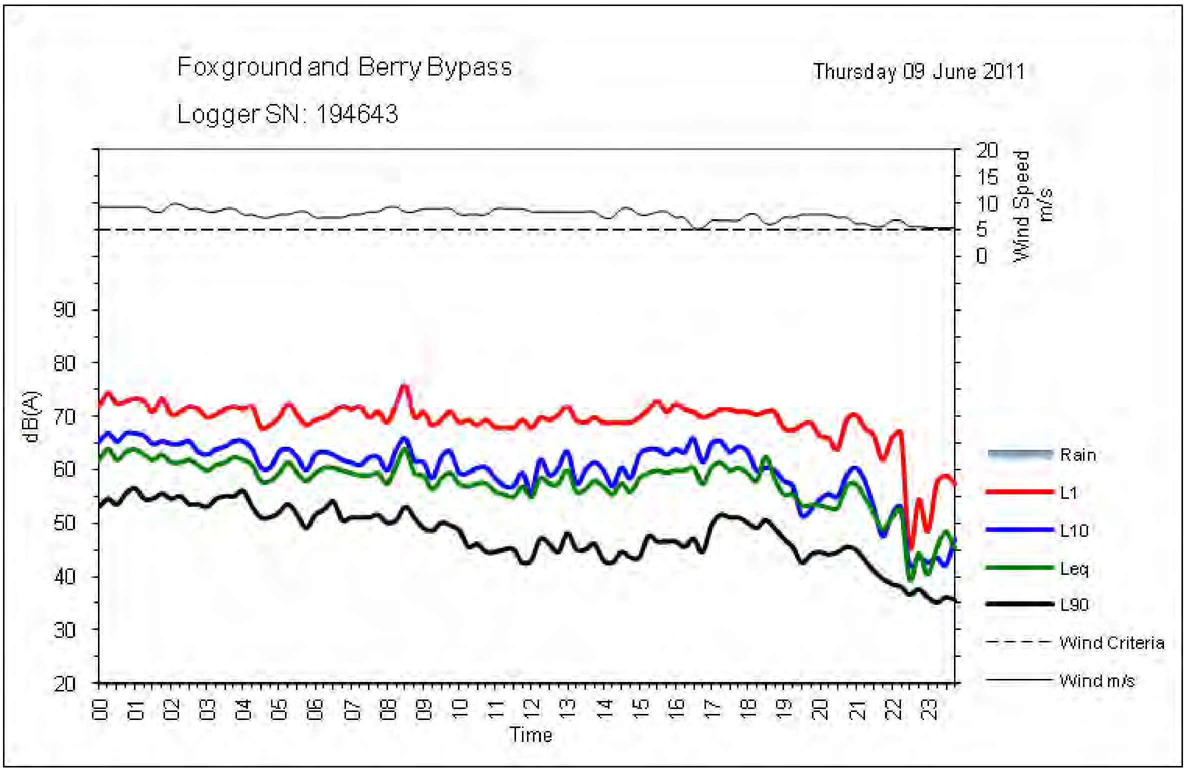
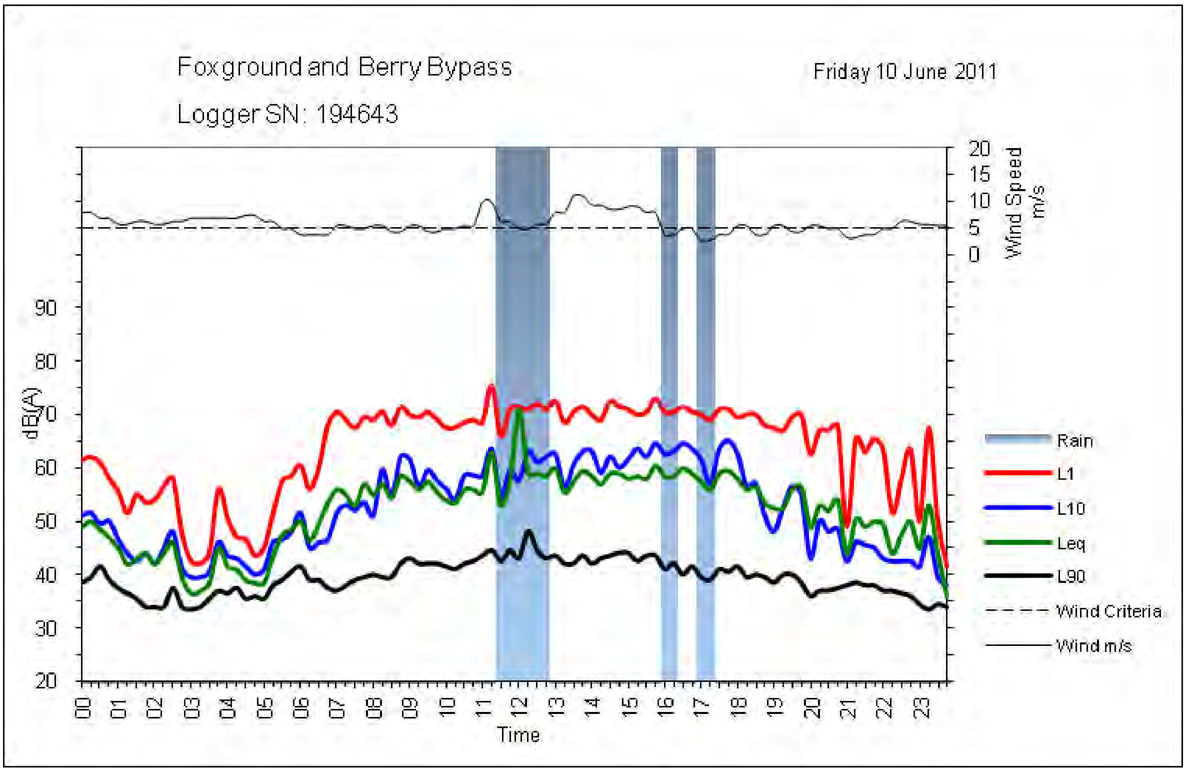
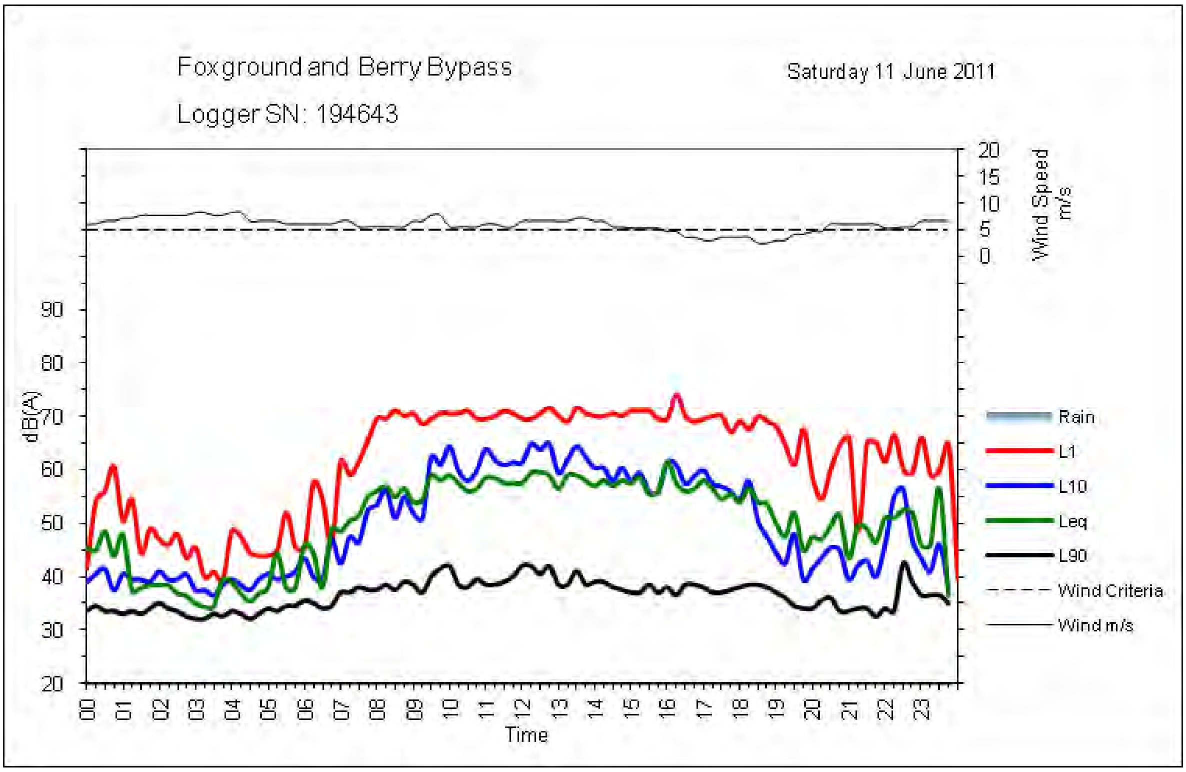
20
21
22
23
Time


Foxground and Berry Bypass
Logger SN: 194643
Wednesday 08 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Thursday 09 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Friday 10 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Time
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Saturday 11 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Time
00
01
02
03
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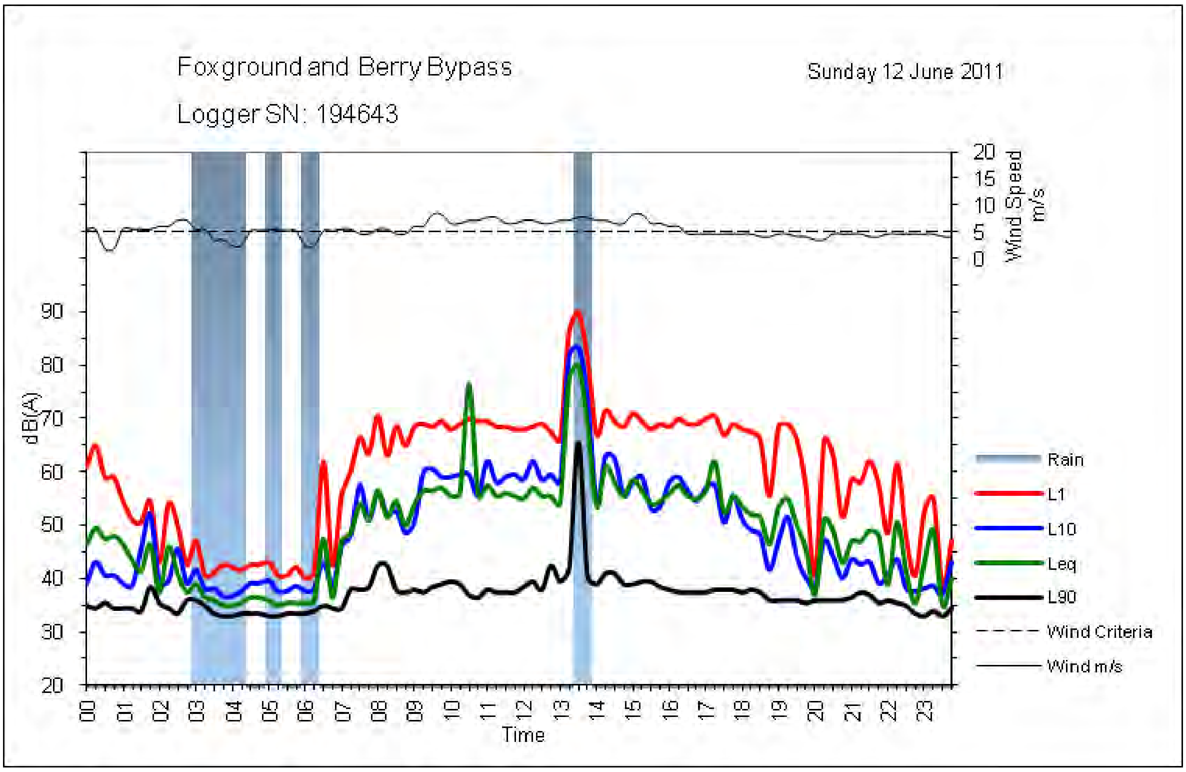
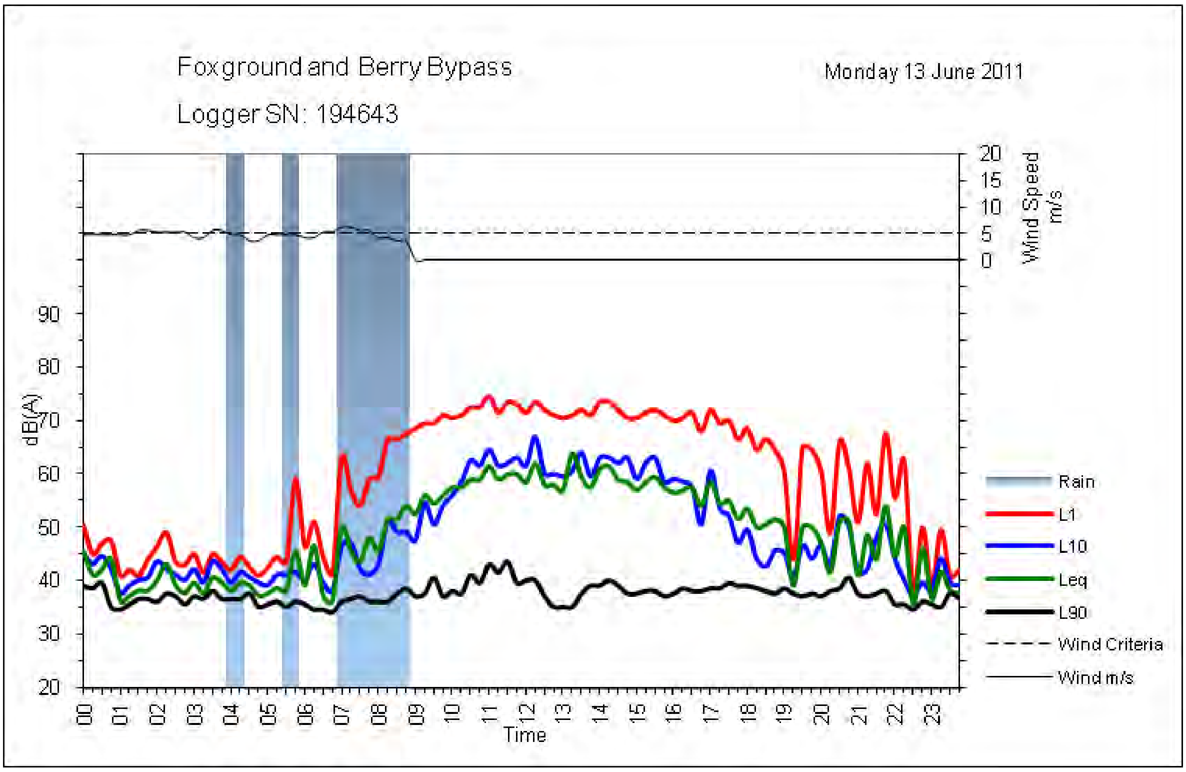
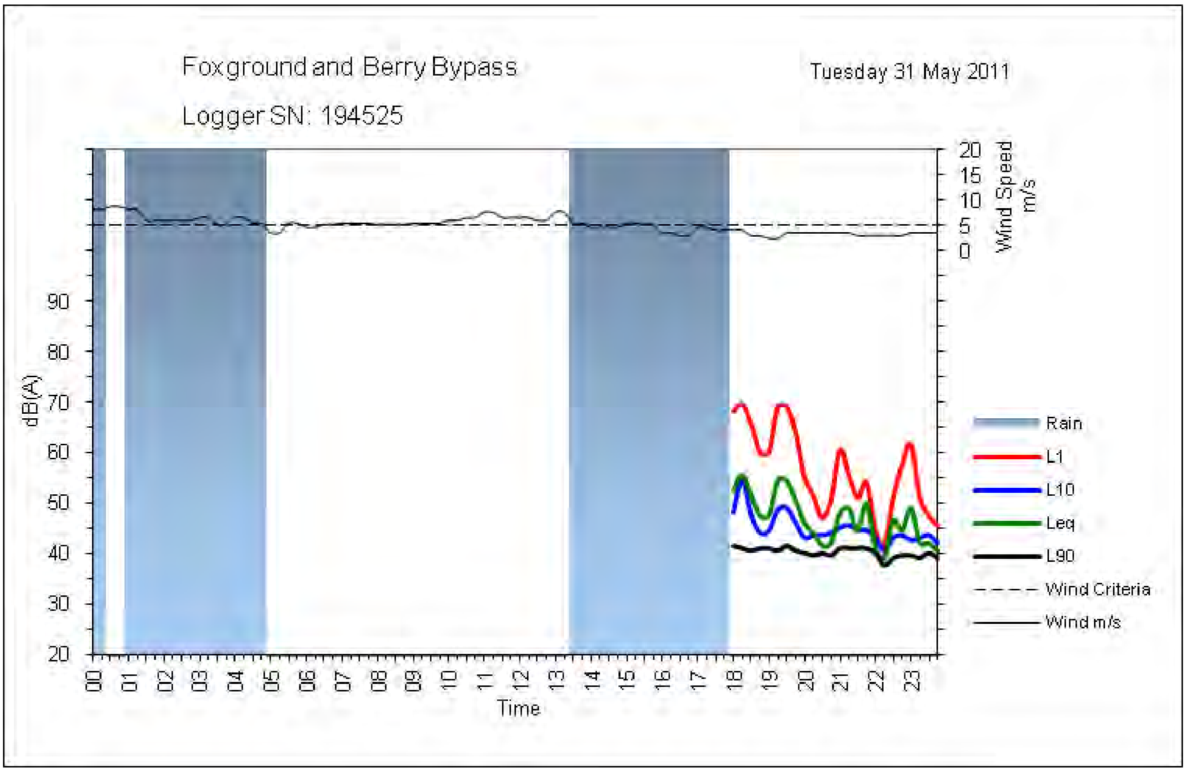
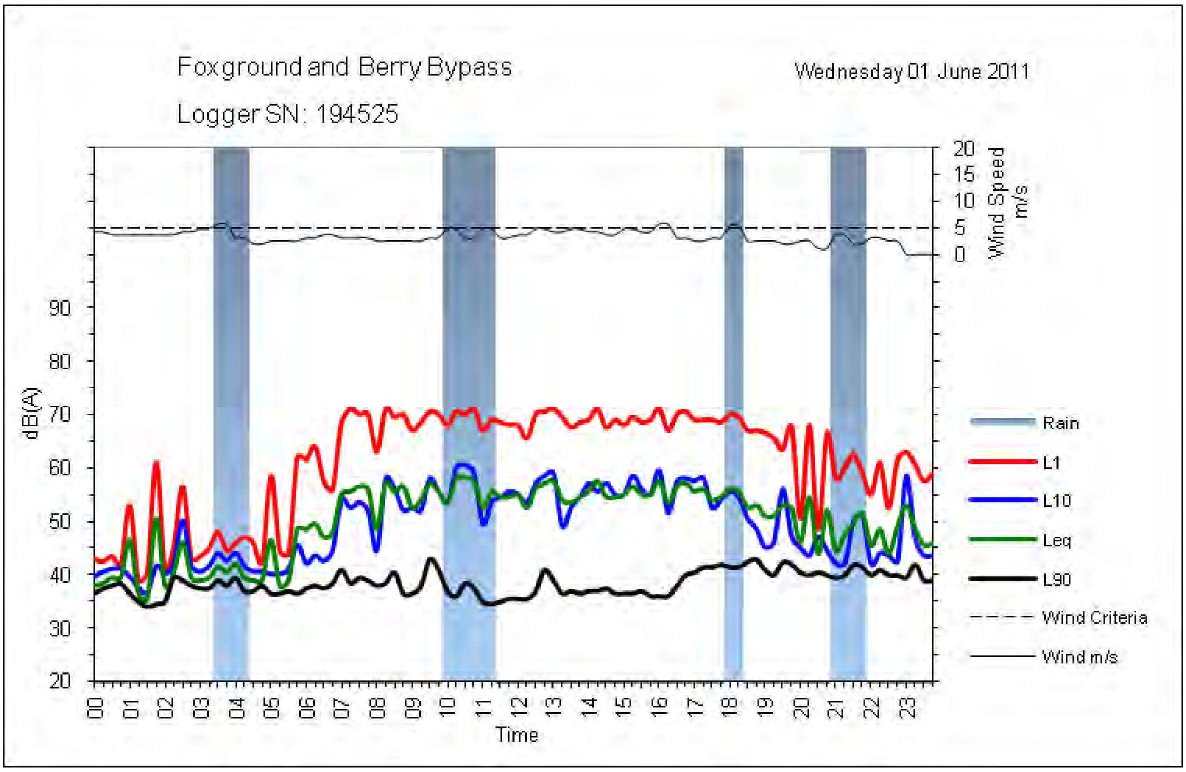
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

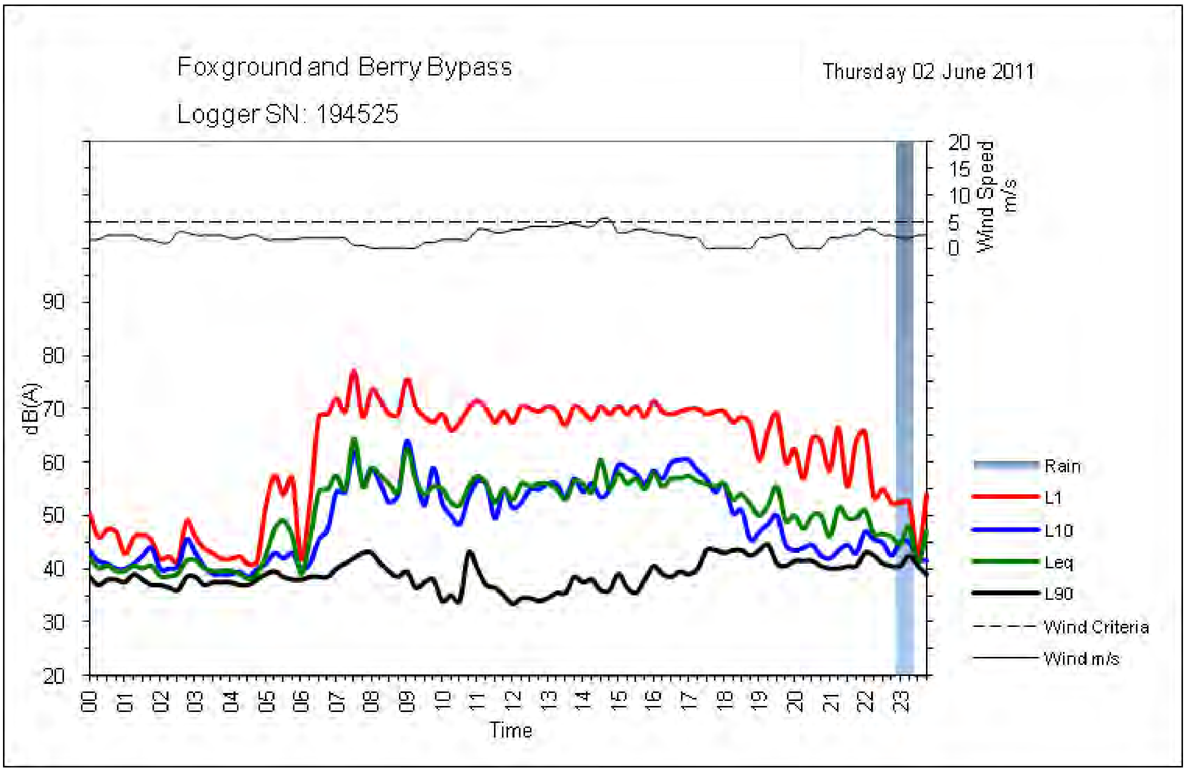

Foxground and Berry Bypass
Logger SN: 194643
Sunday 12 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194643
Monday 13 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

BG6


Foxground and Berry Bypass
Logger SN: 194525
Tuesday 31 May 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Wednesday 01 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Thursday 02 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
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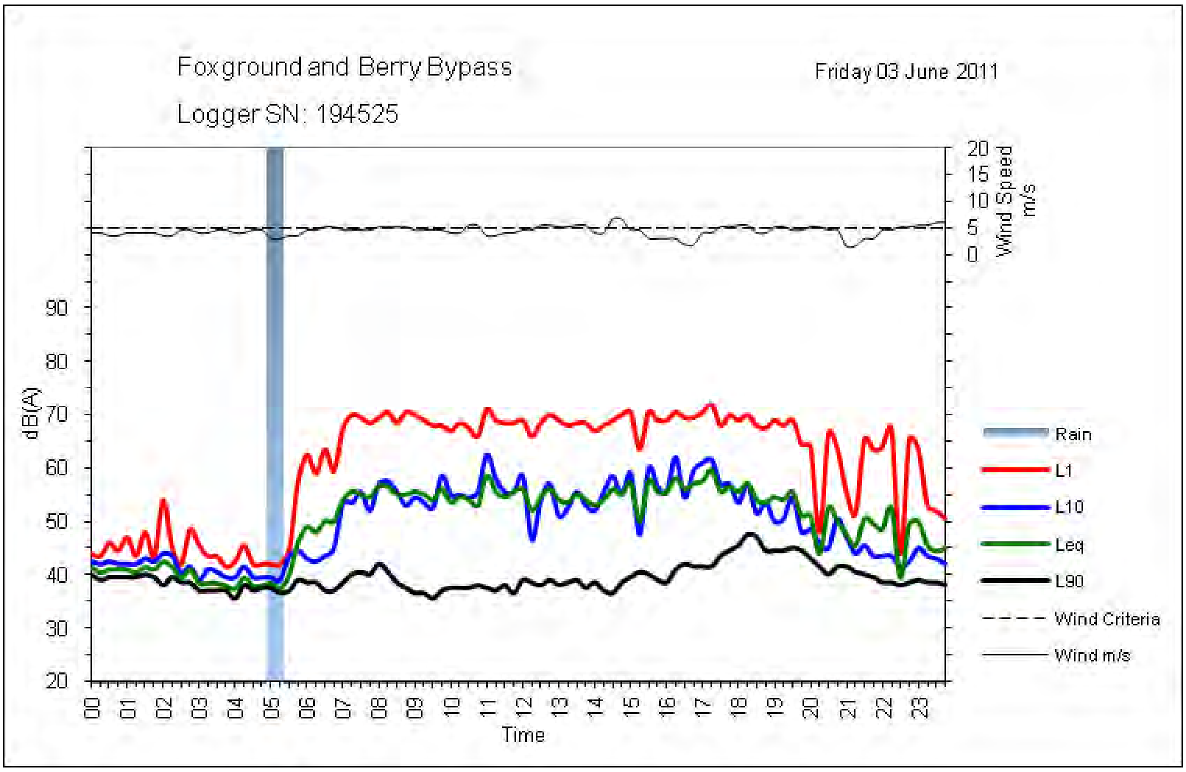
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Friday 03 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
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12
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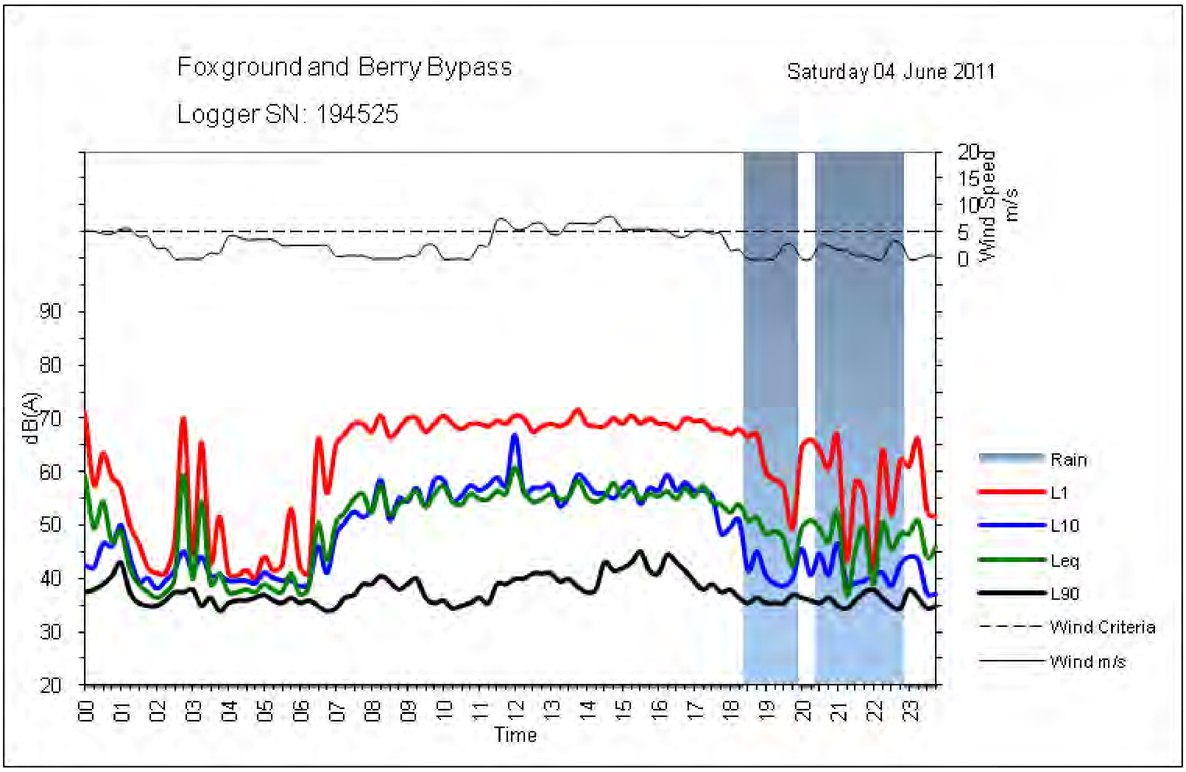
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Saturday 04 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
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09
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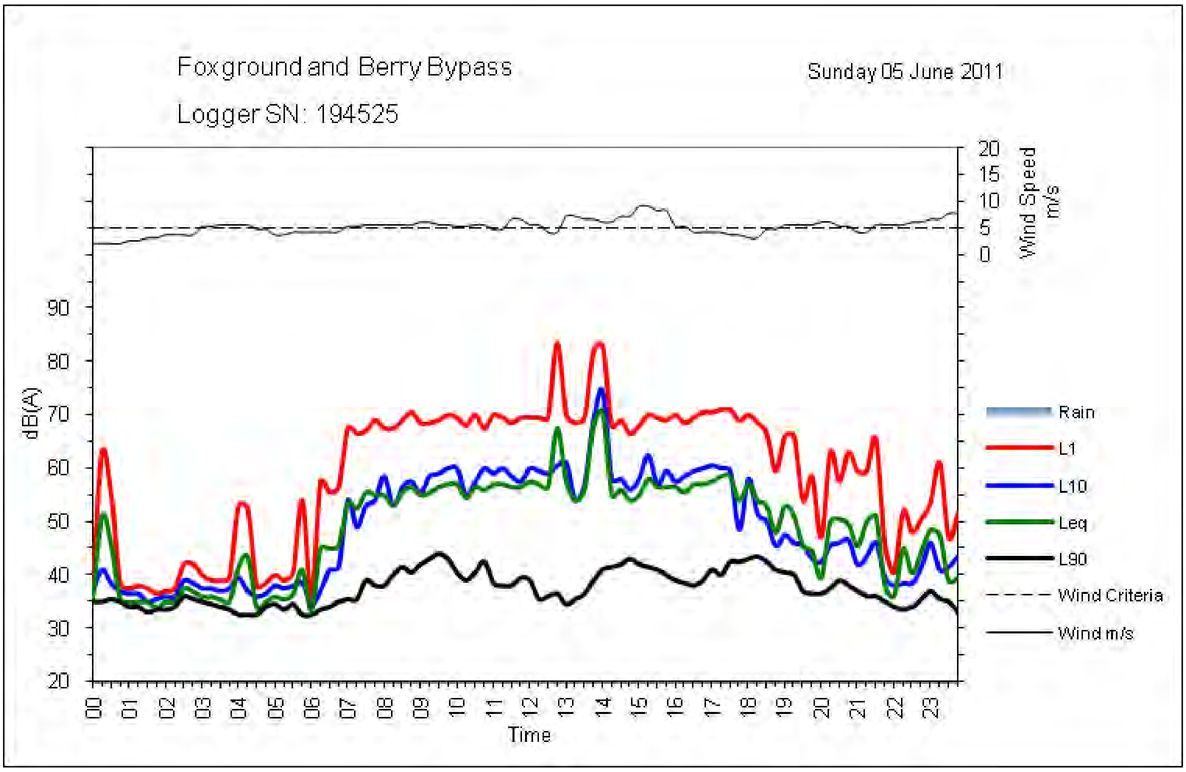
11
12
13
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Sunday 05 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
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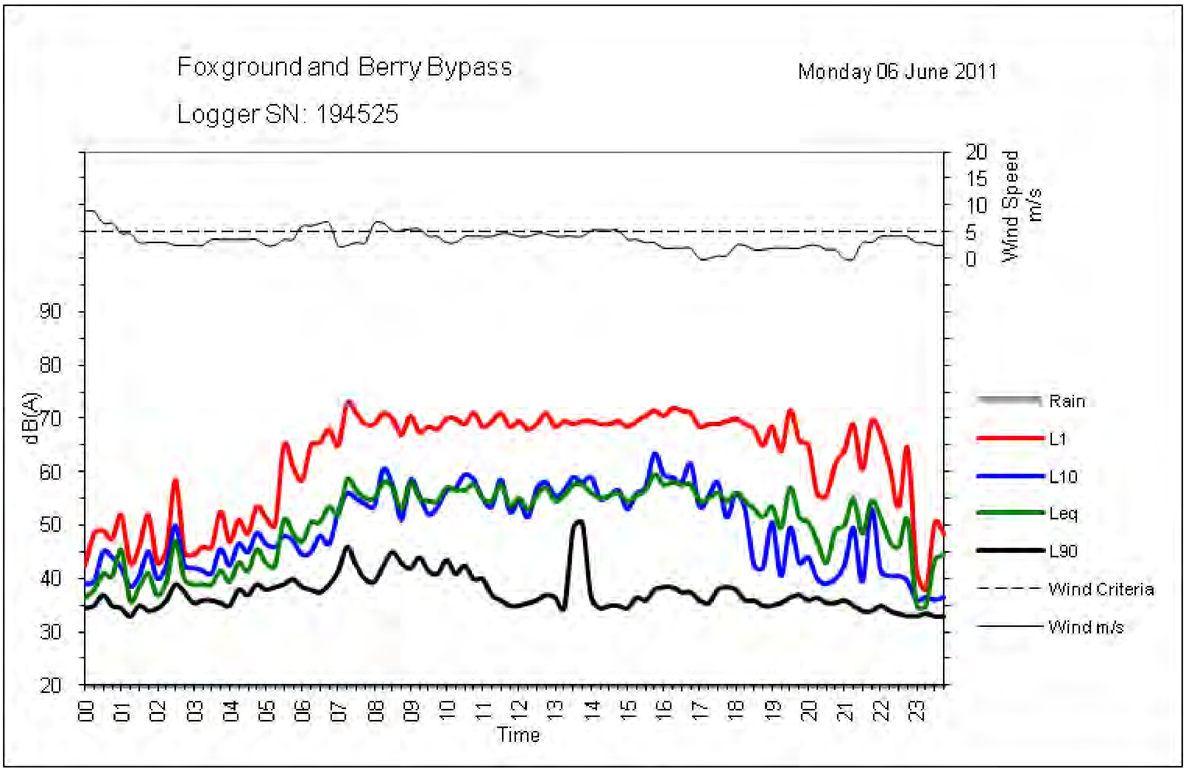
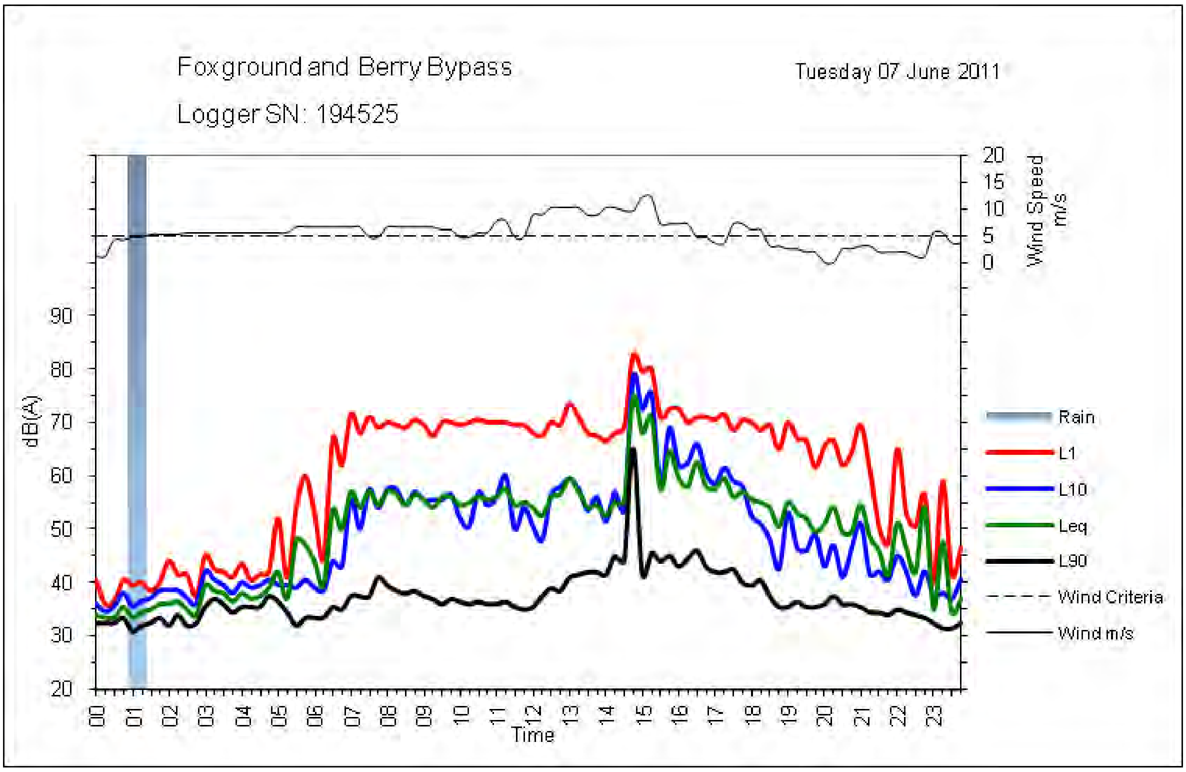
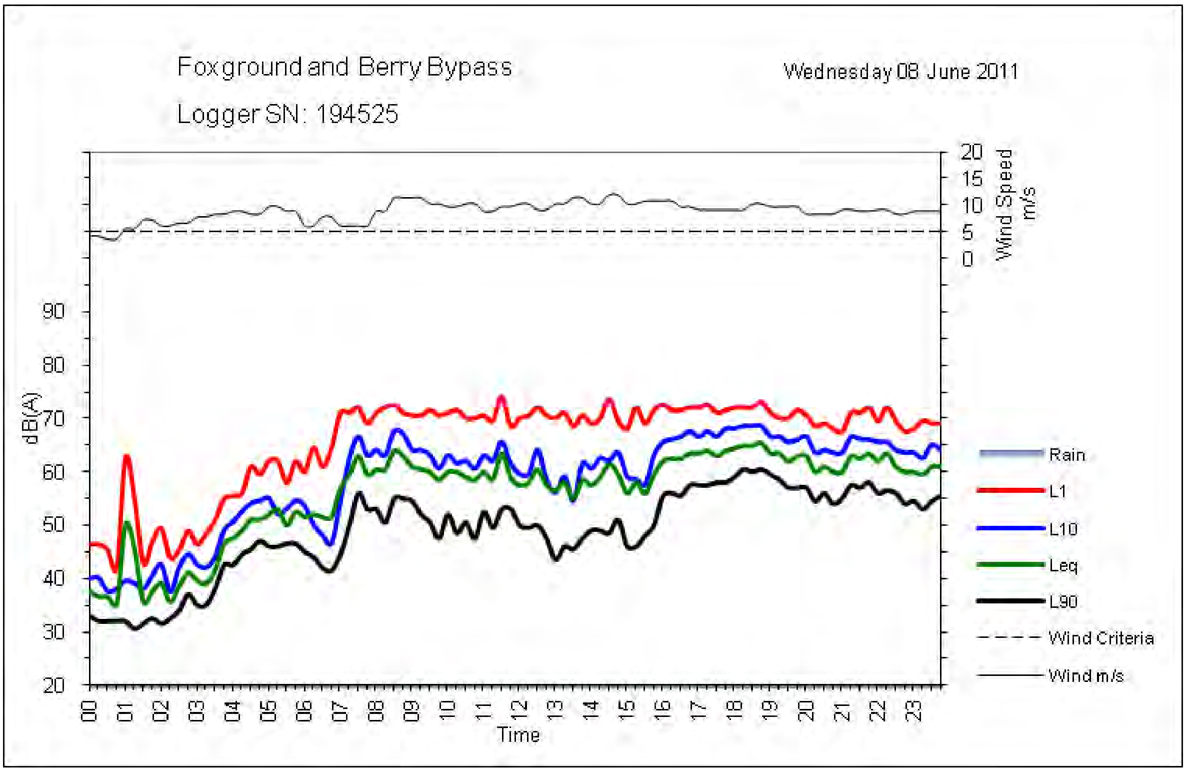
14
15
16
17
18
19
20
21
22
23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Monday 06 June 2011
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Tuesday 07 June 2011
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Wednesday 08 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
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01
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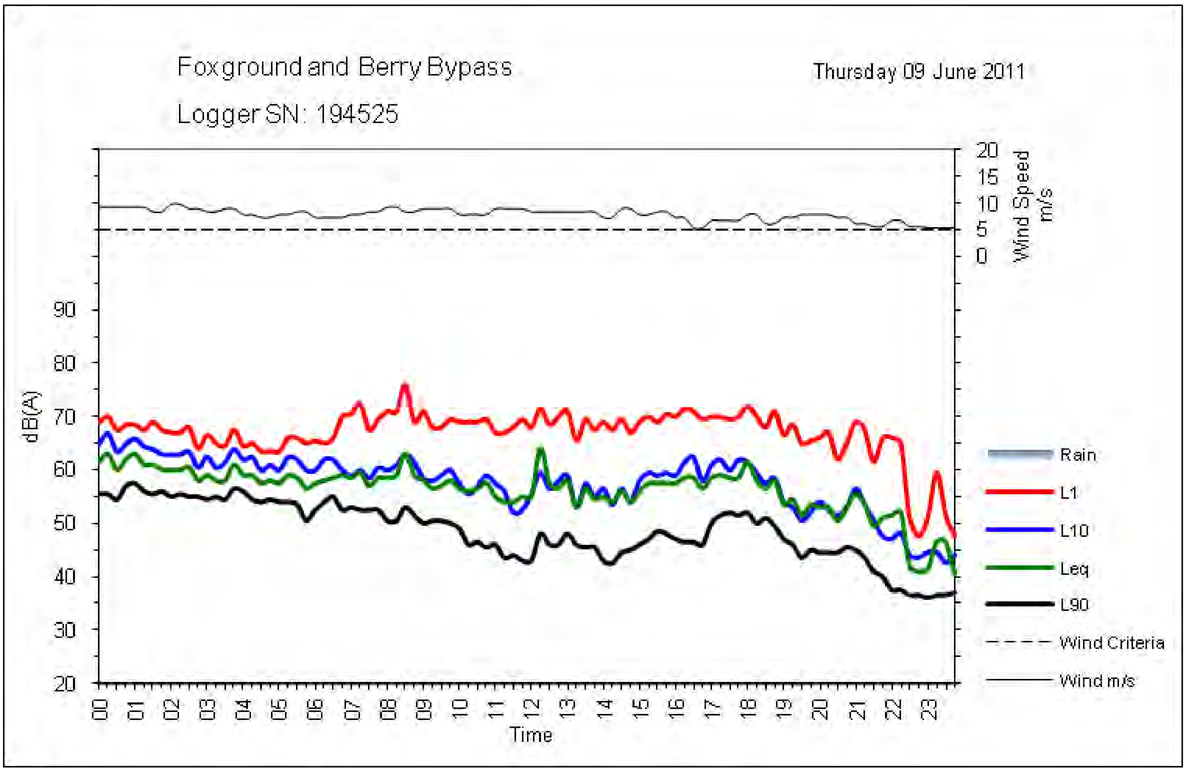
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Thursday 09 June 2011
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15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
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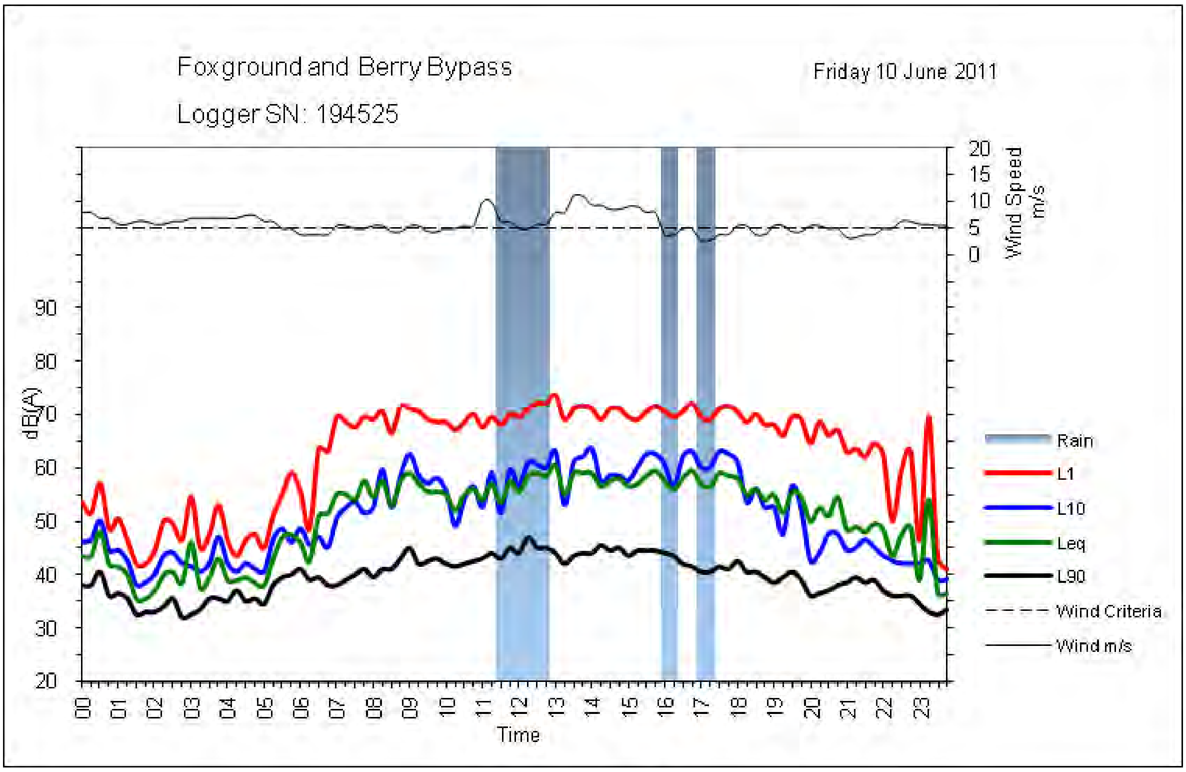
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Friday 10 June 2011
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15
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5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
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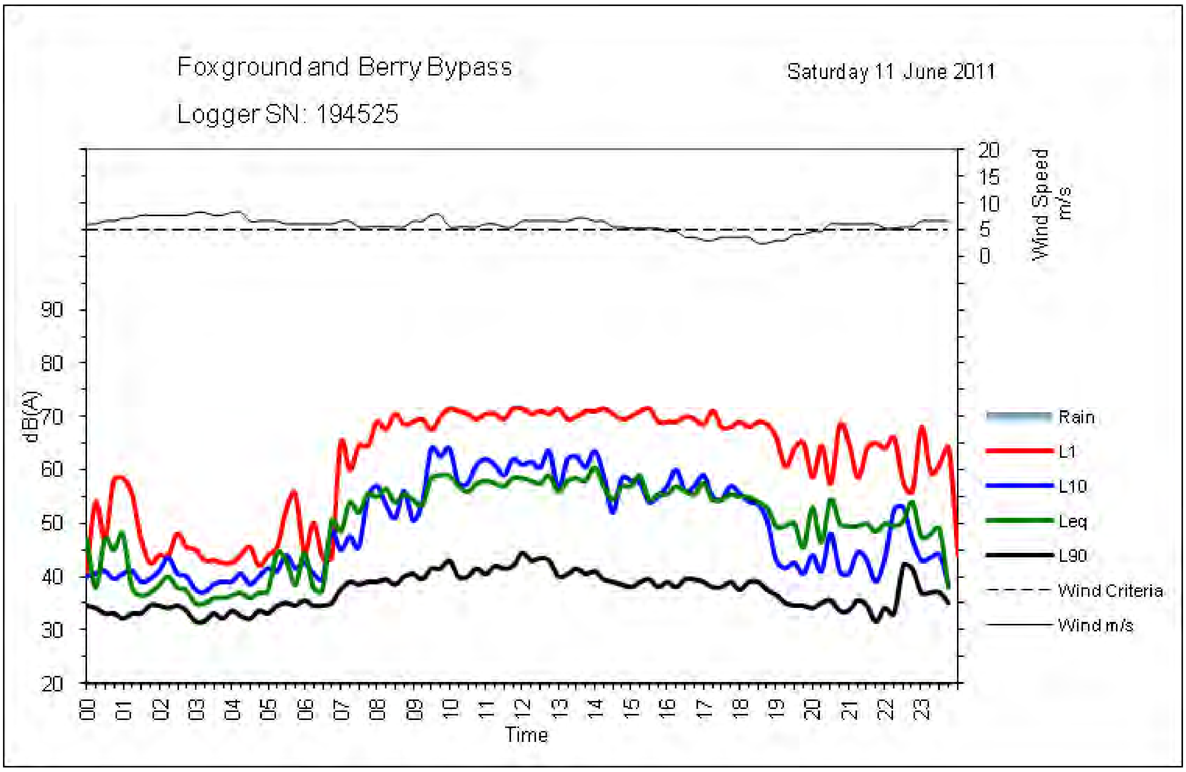
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Saturday 11 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
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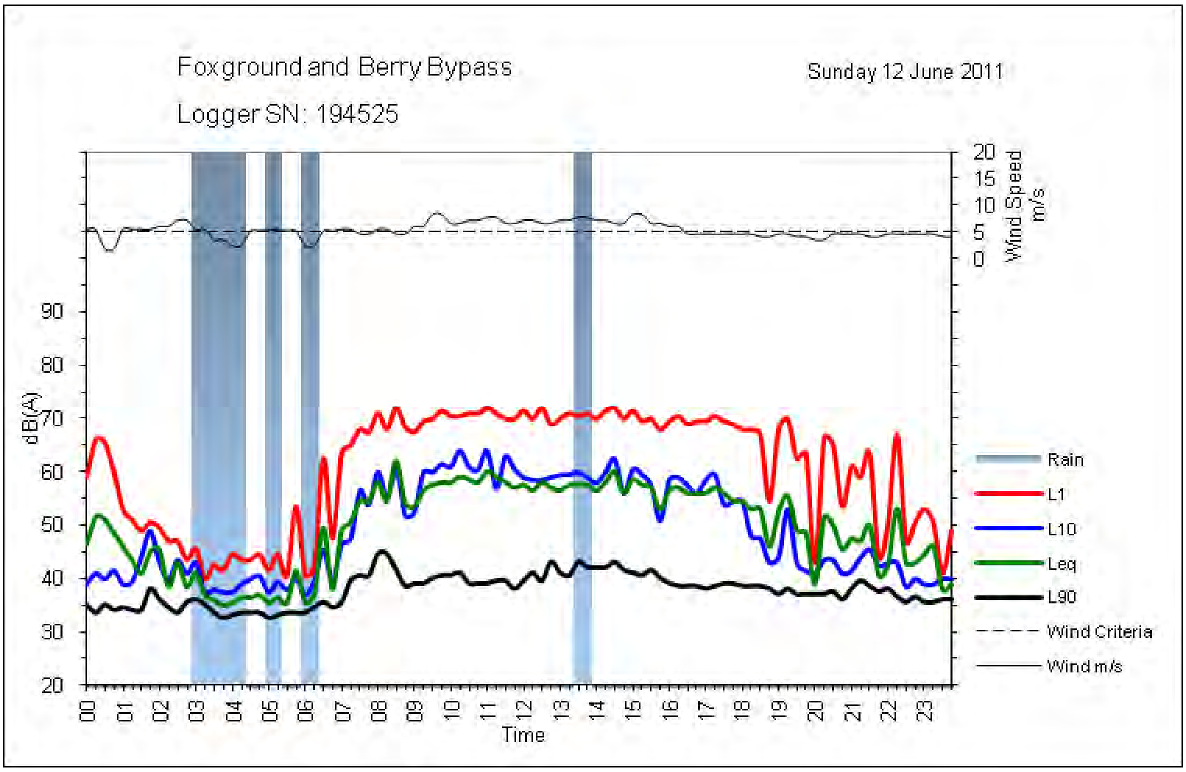
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Sunday 12 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
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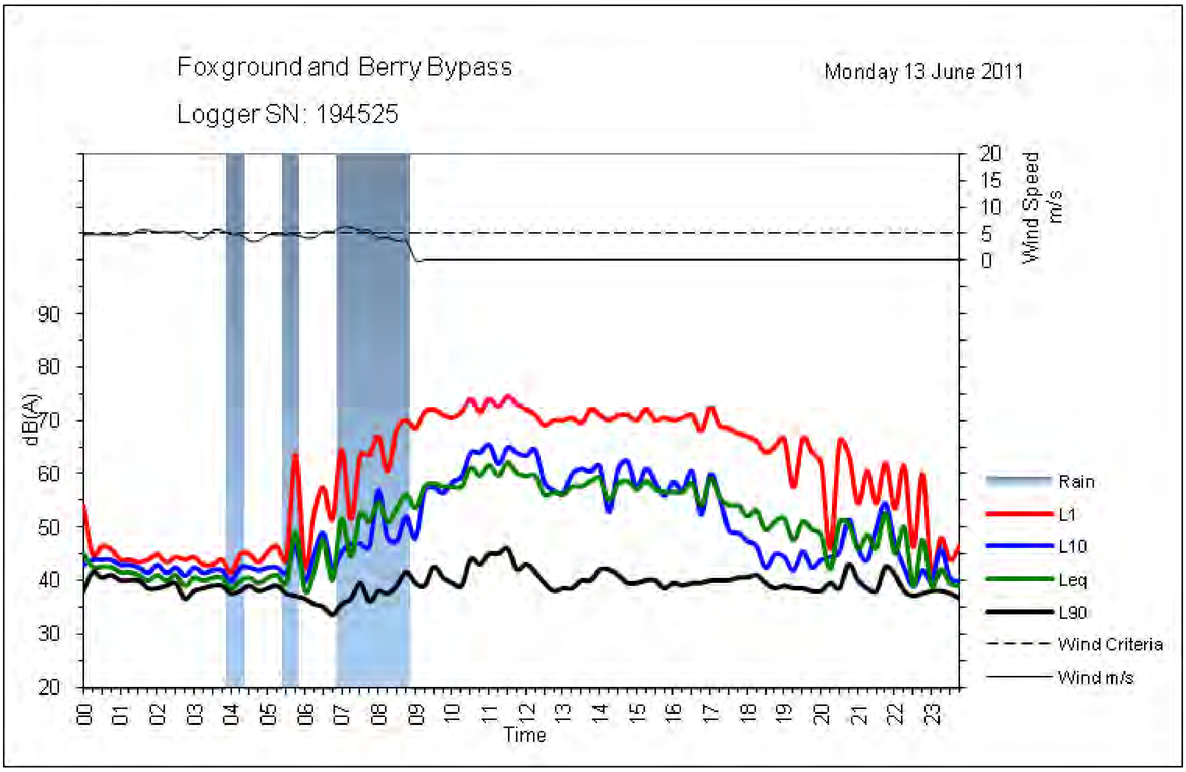
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194525
Monday 13 June 2011
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15
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5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
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01
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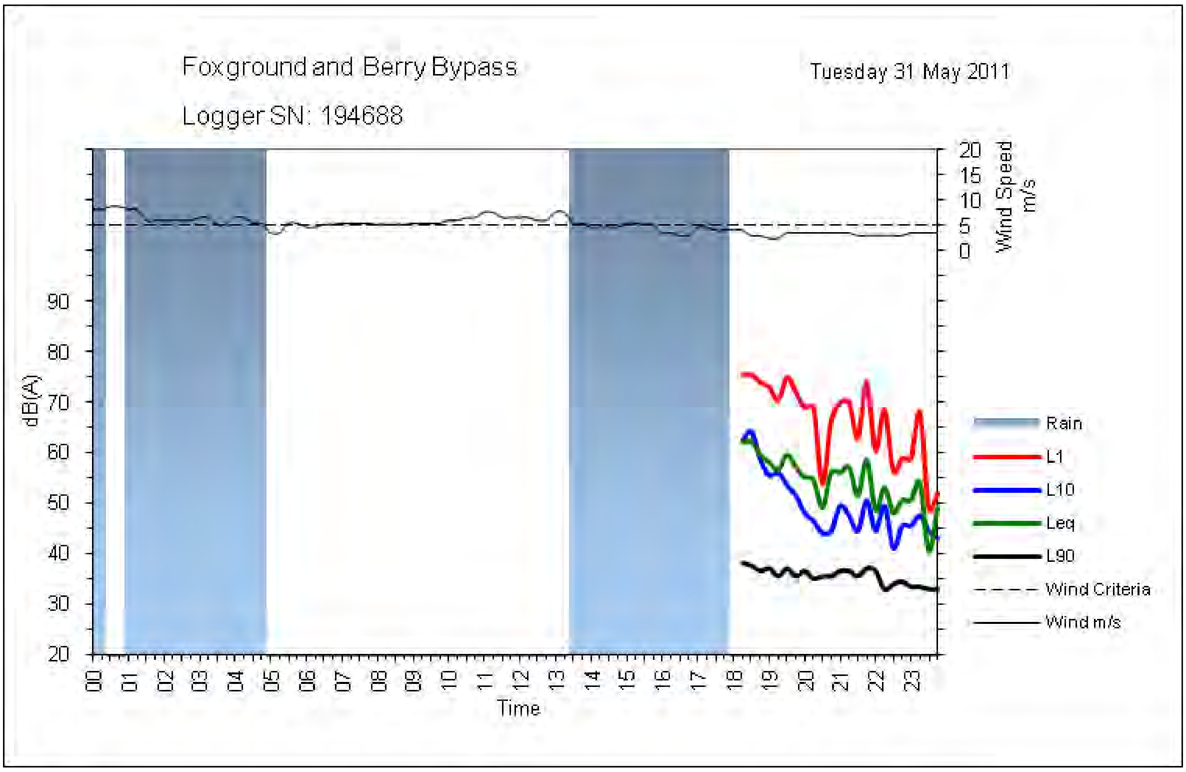
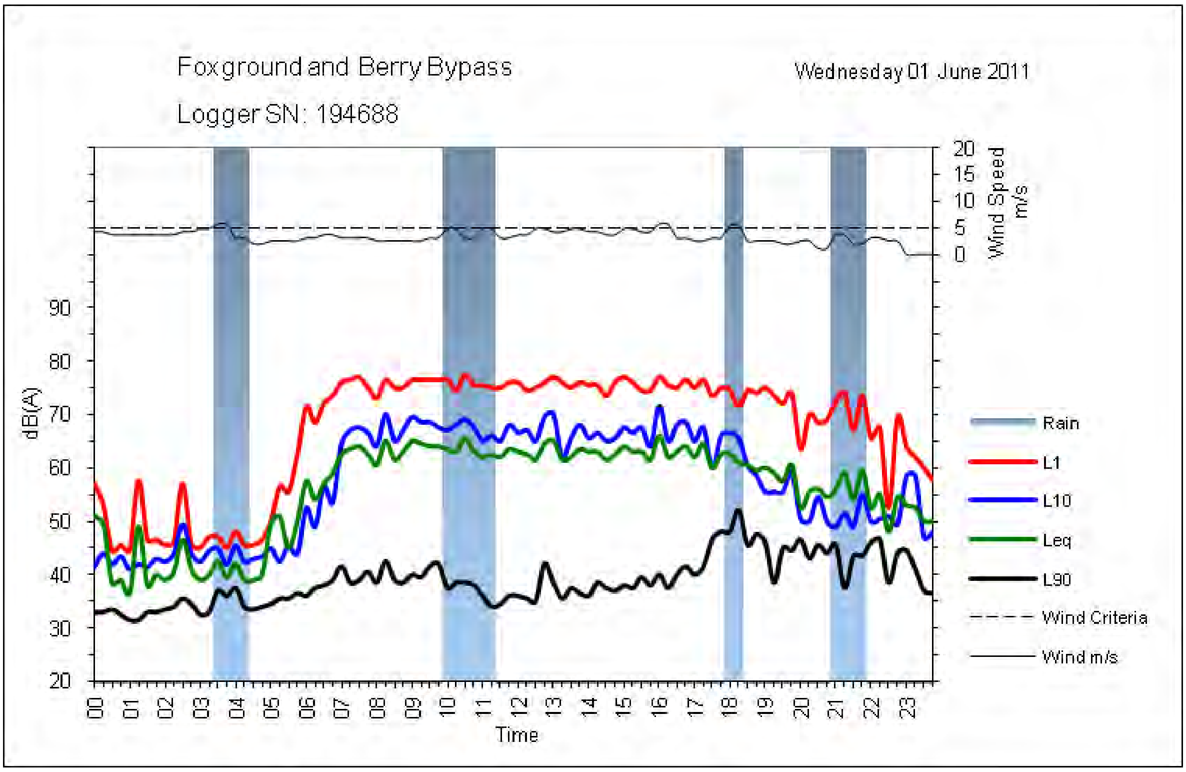
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

BG7


Foxground and Berry Bypass
Logger SN: 194688
Tuesday 31 May 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194688
Wednesday 01 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
00
01
02
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09
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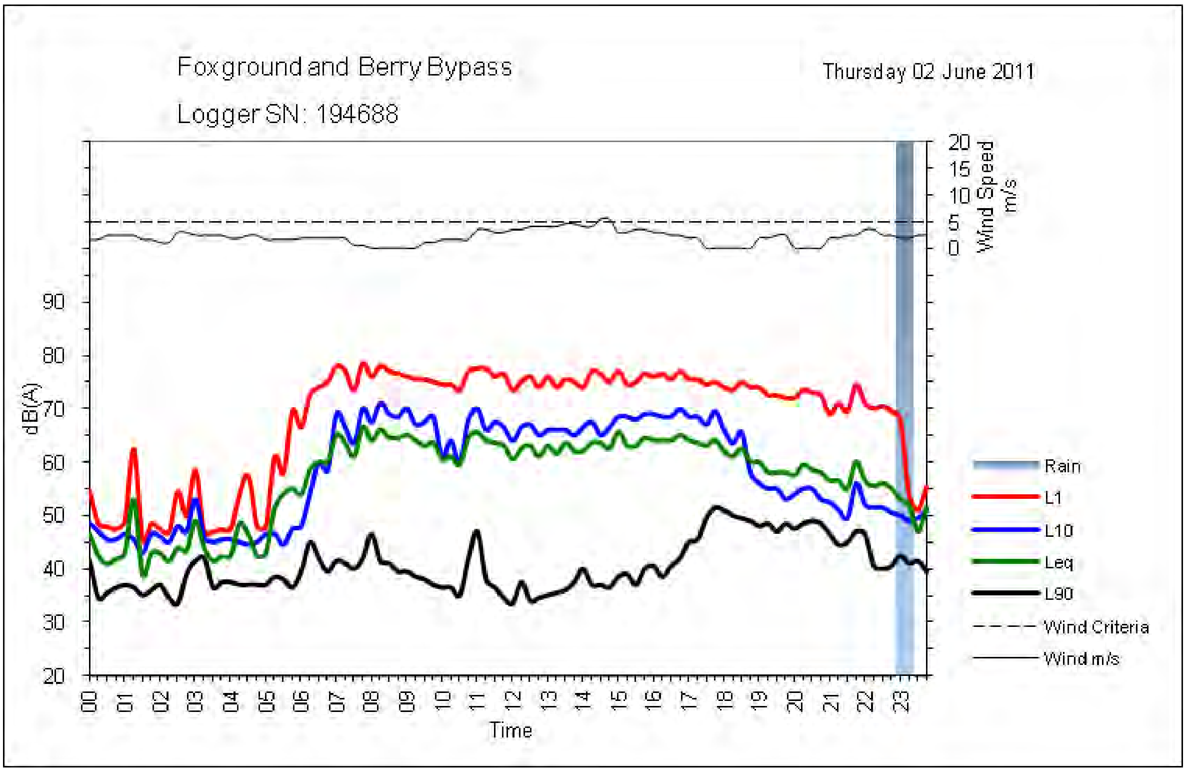
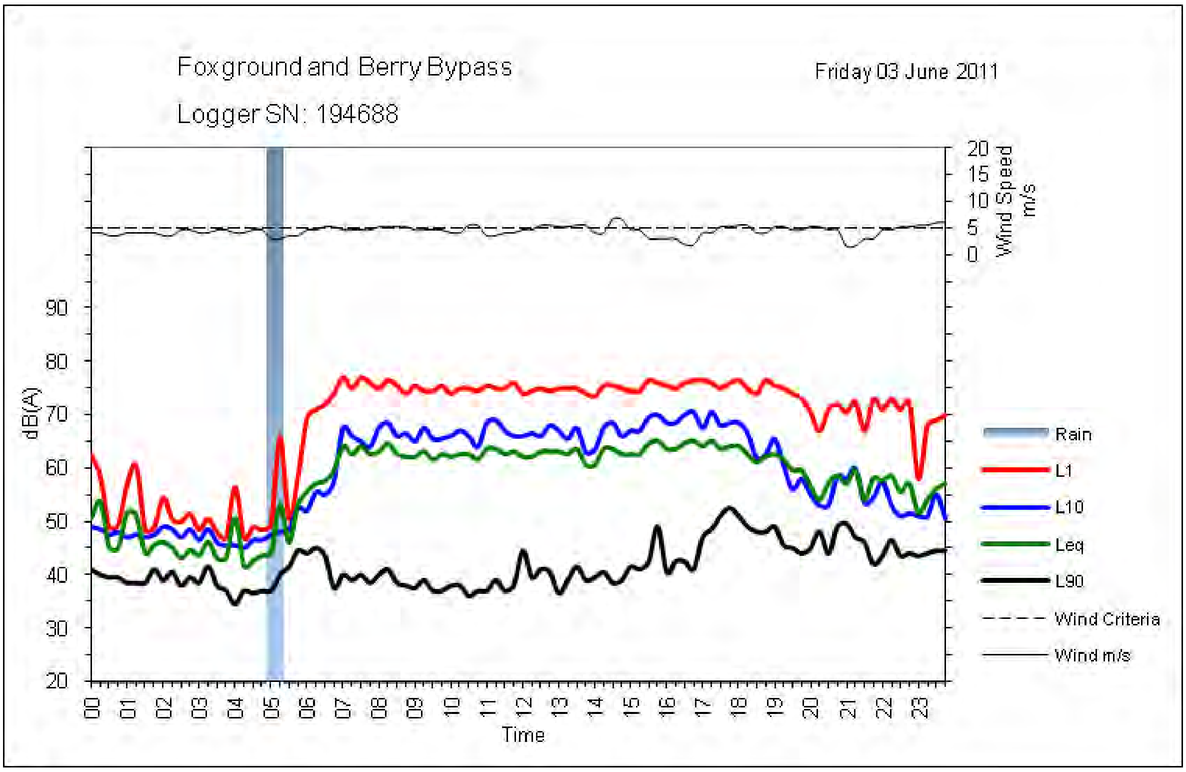
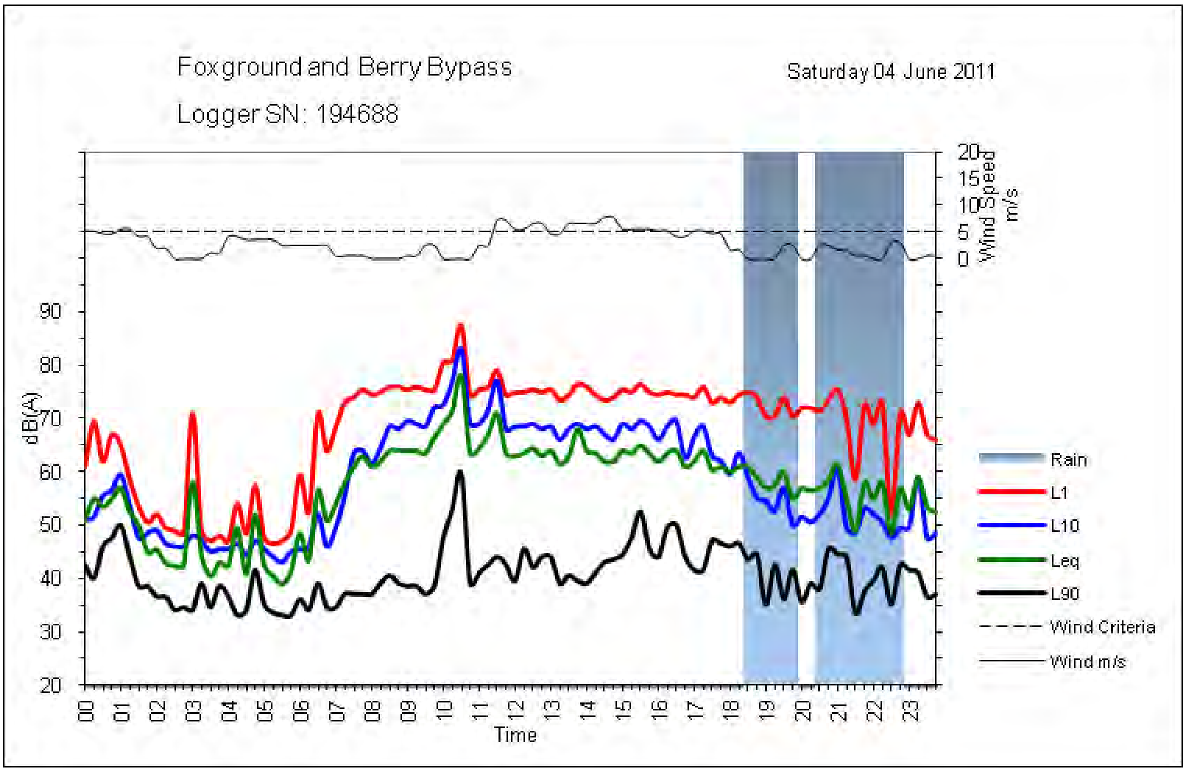
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194688
Thursday 02 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194688
Friday 03 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194688
Saturday 04 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
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01
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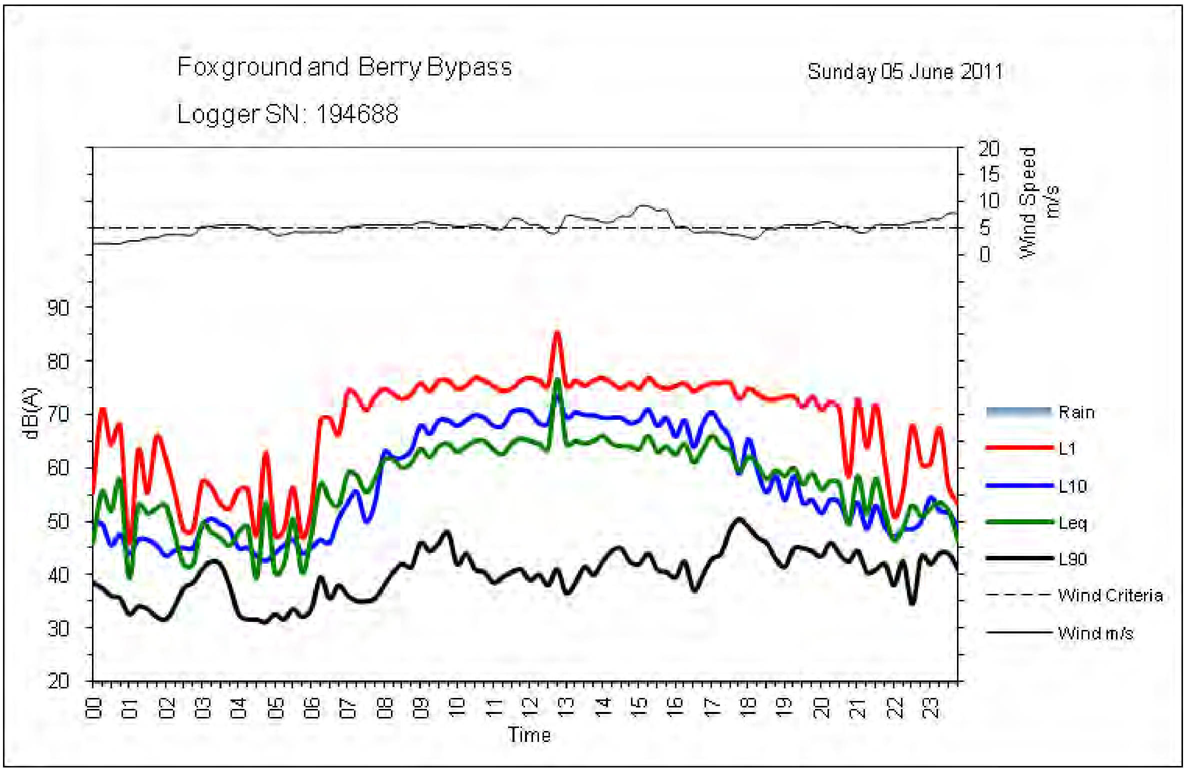
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194688
Sunday 05 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
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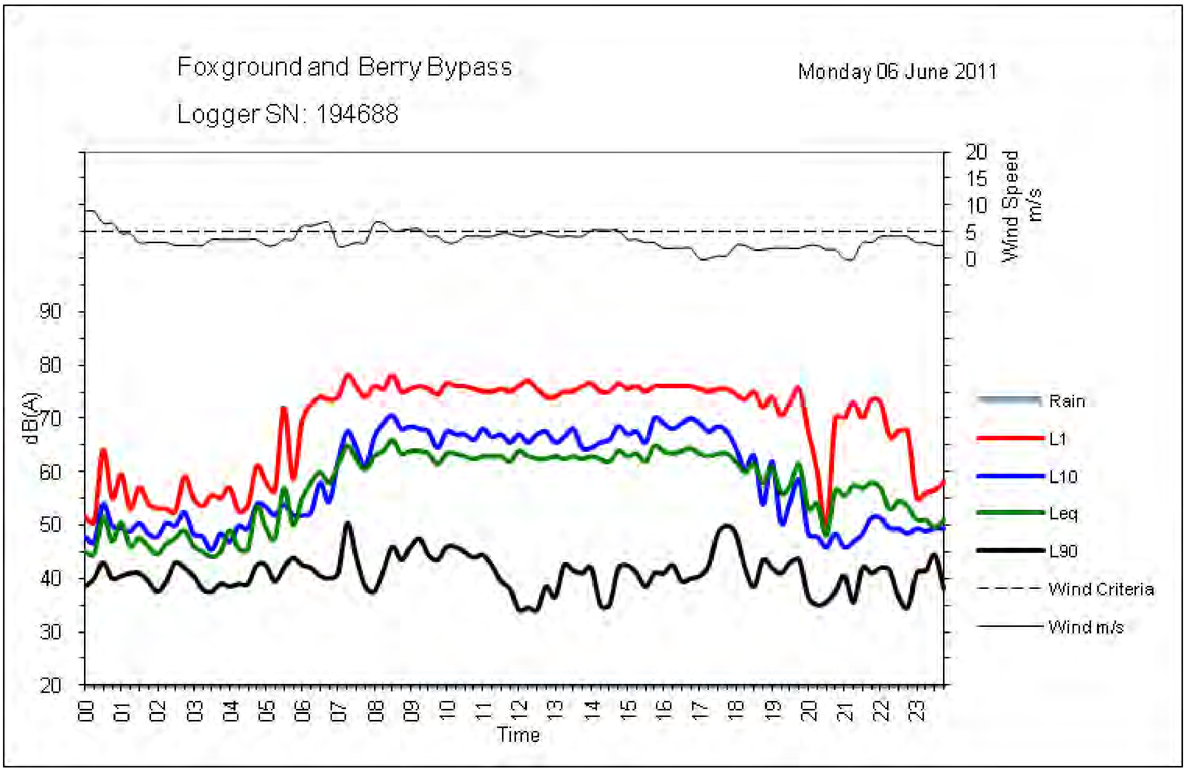
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s



Foxground and Berry Bypass
Logger SN: 194688
Monday 06 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
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01
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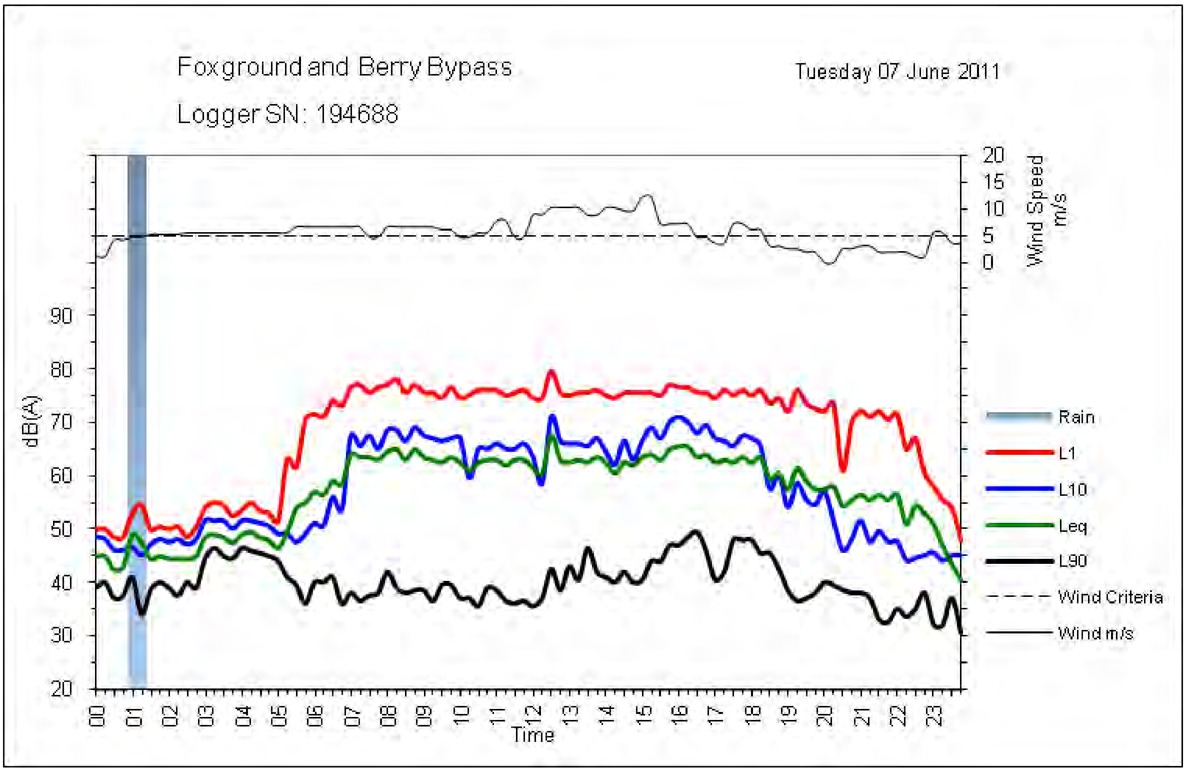
23
Time



Foxground and Berry Bypass
Logger SN: 194688
Tuesday 07 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
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05
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17
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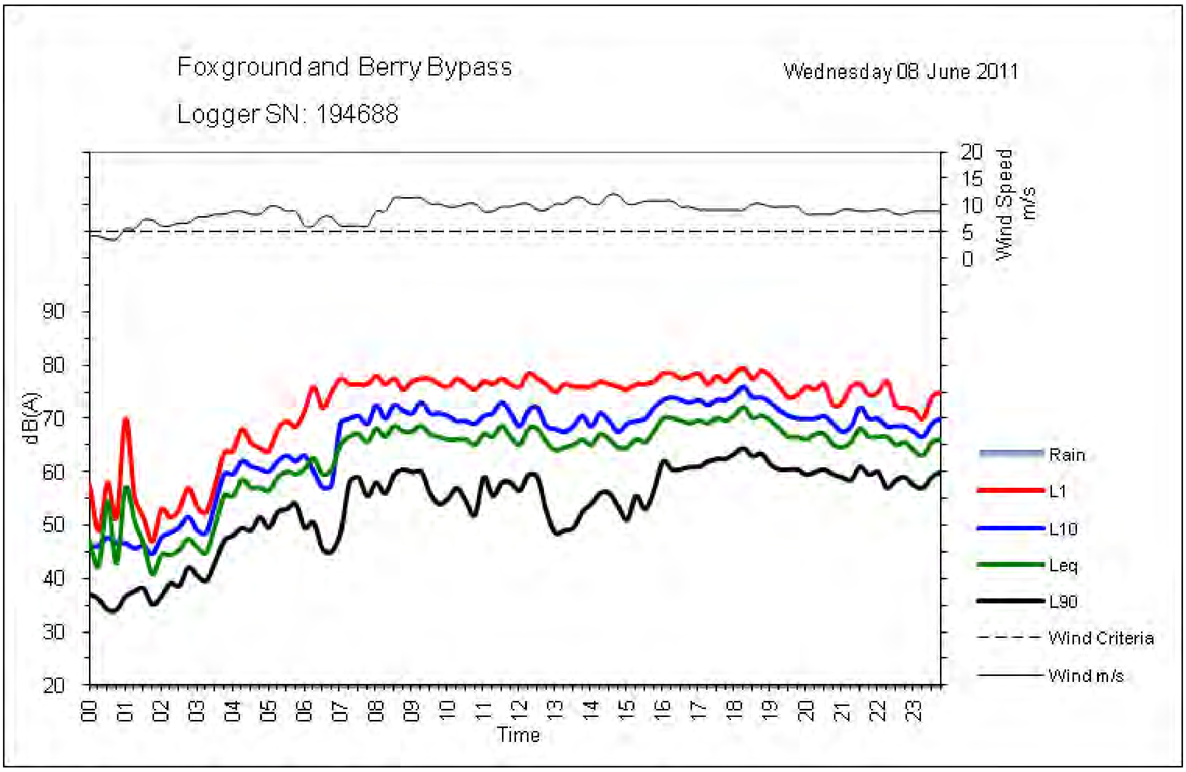
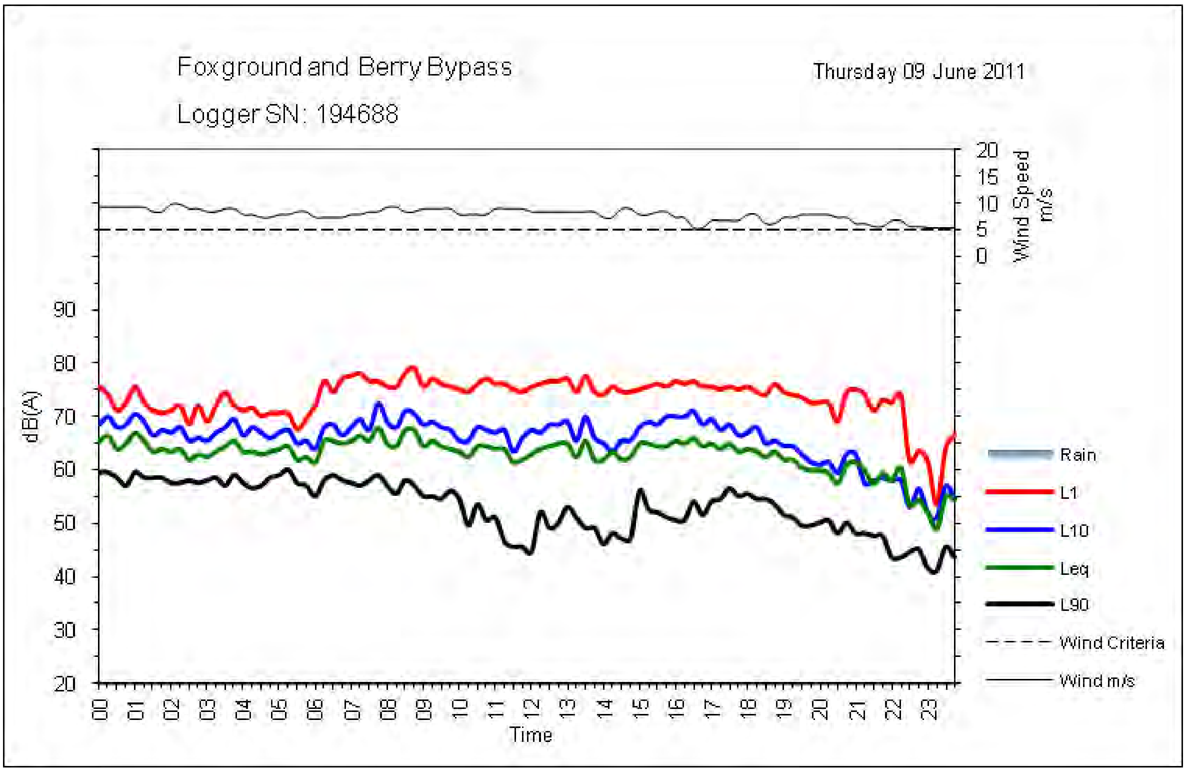
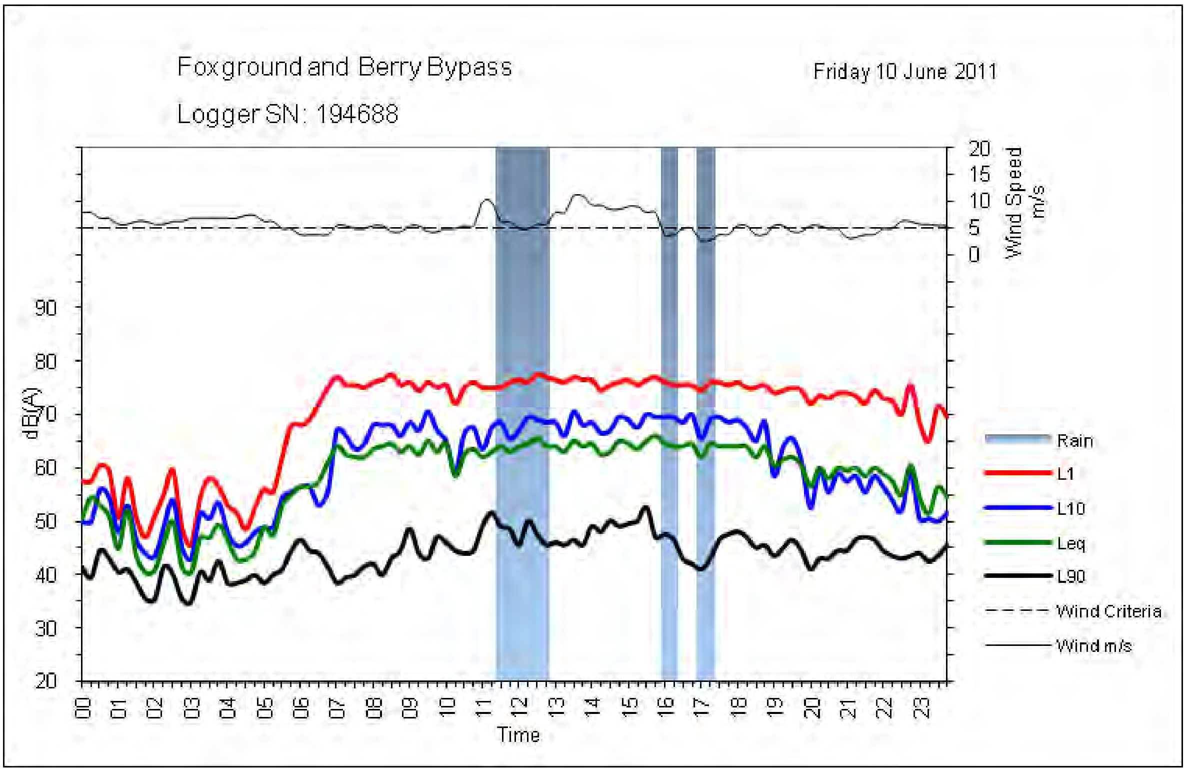
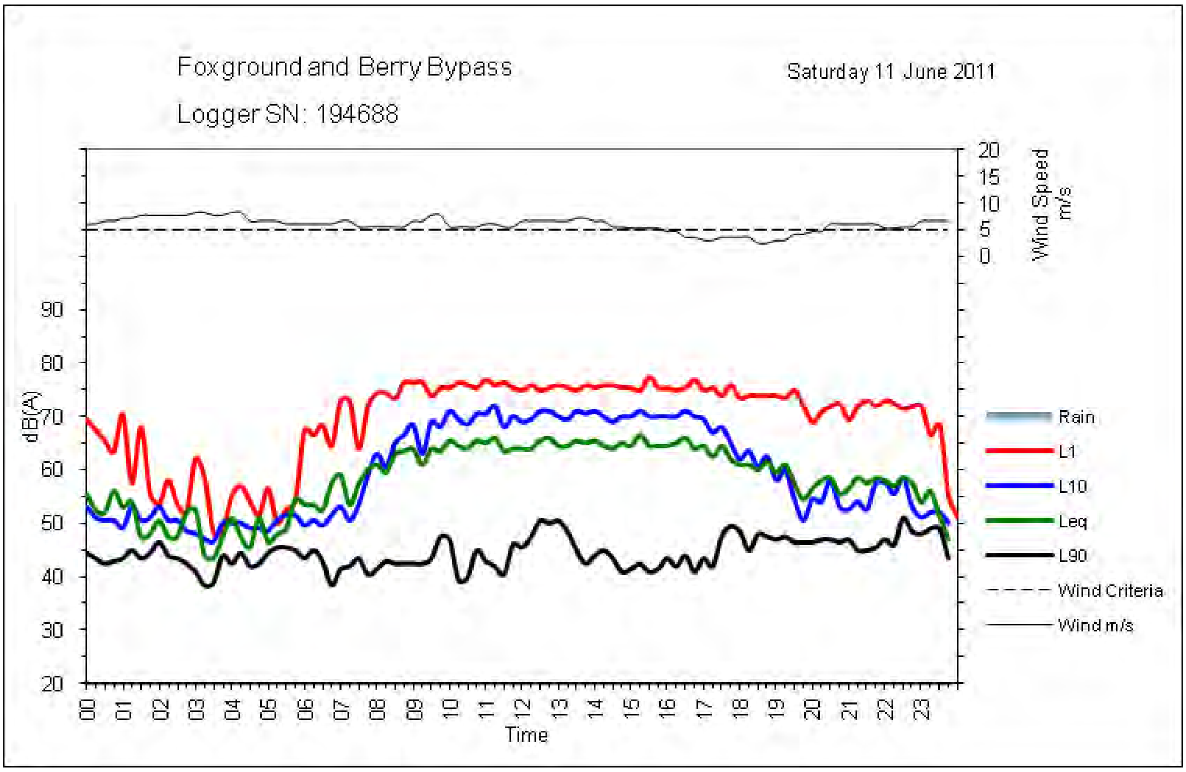
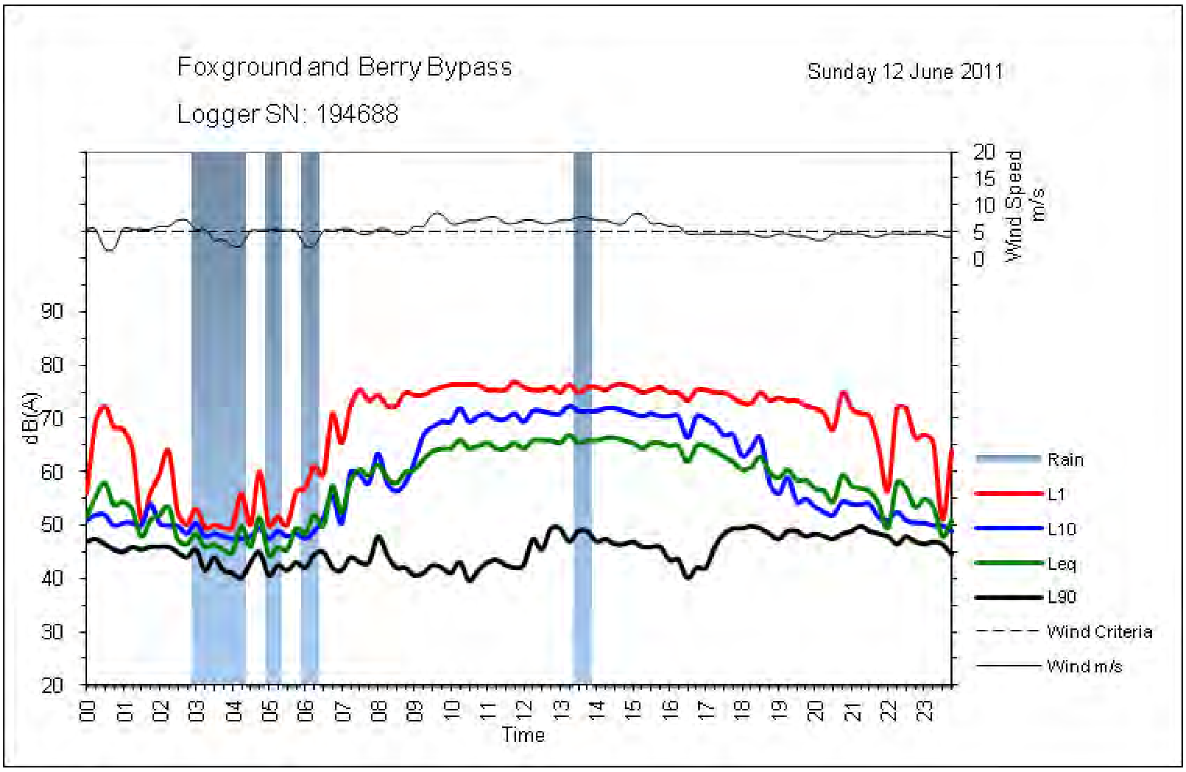
20
21
22
23
Time

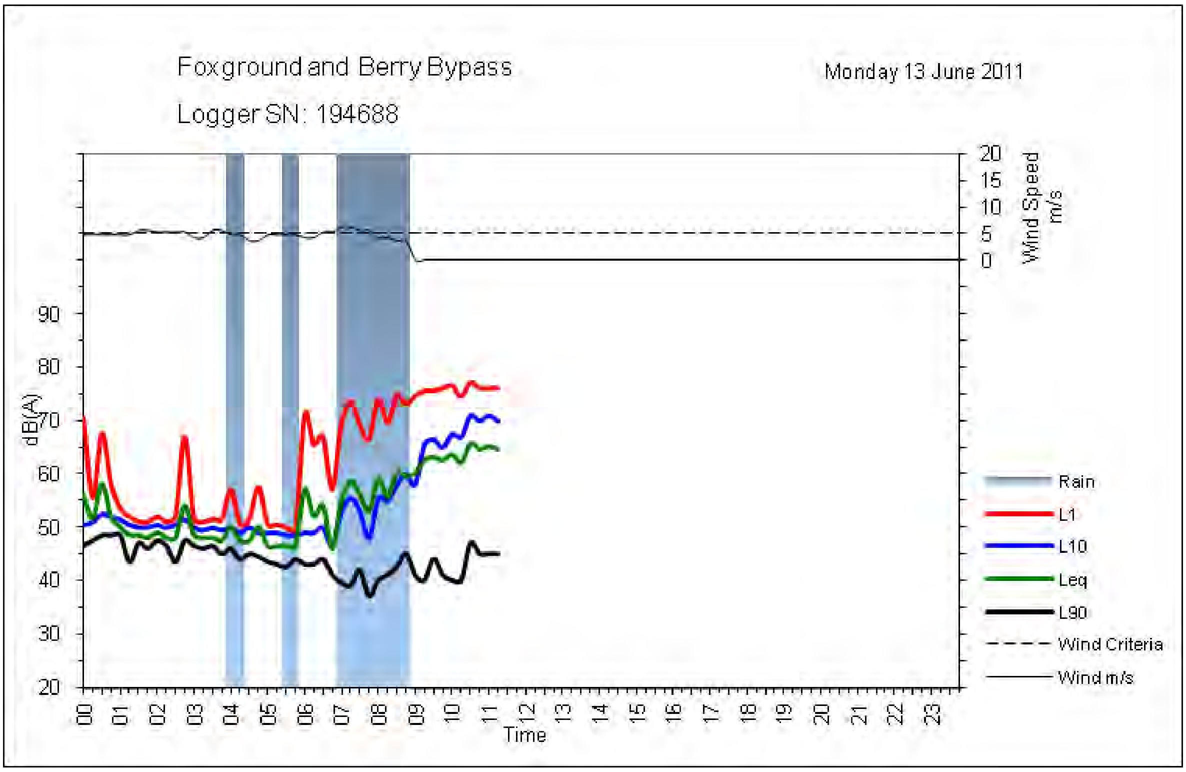

Foxground and Berry Bypass
Logger SN: 194688
Wednesday 08 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194688
Thursday 09 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

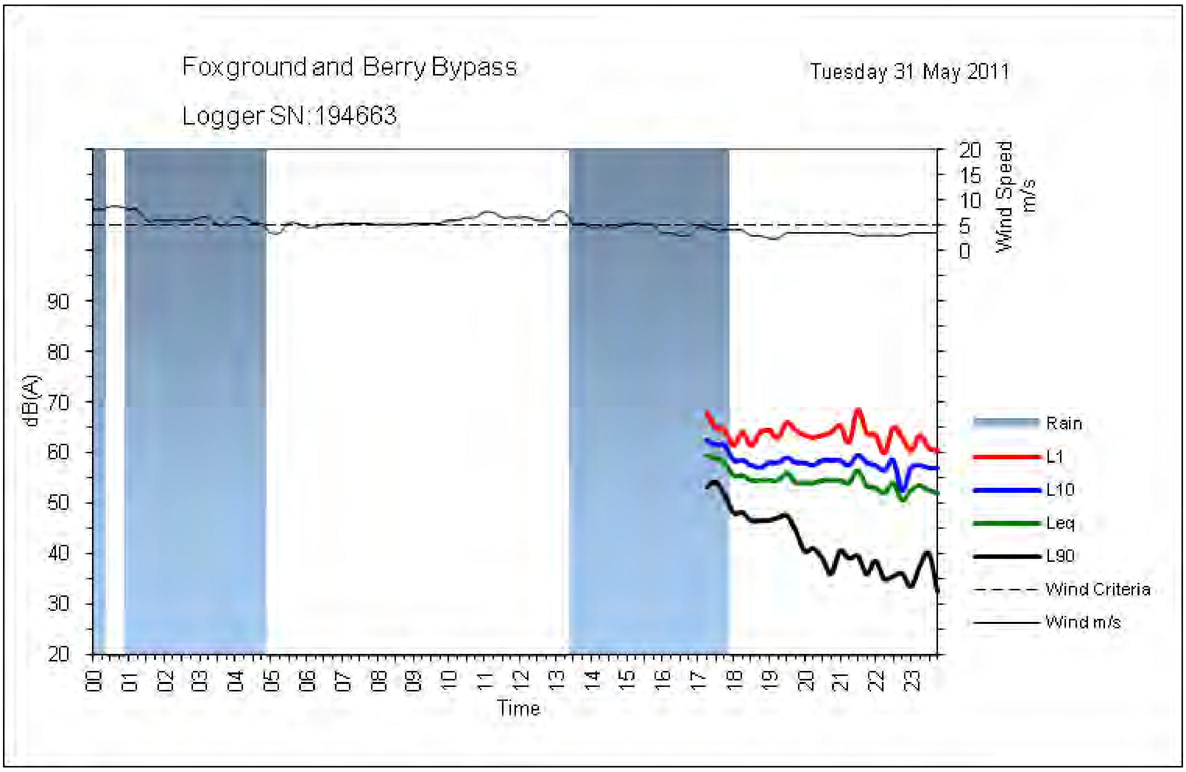

Foxground and Berry Bypass
Logger SN: 194688
Friday 10 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

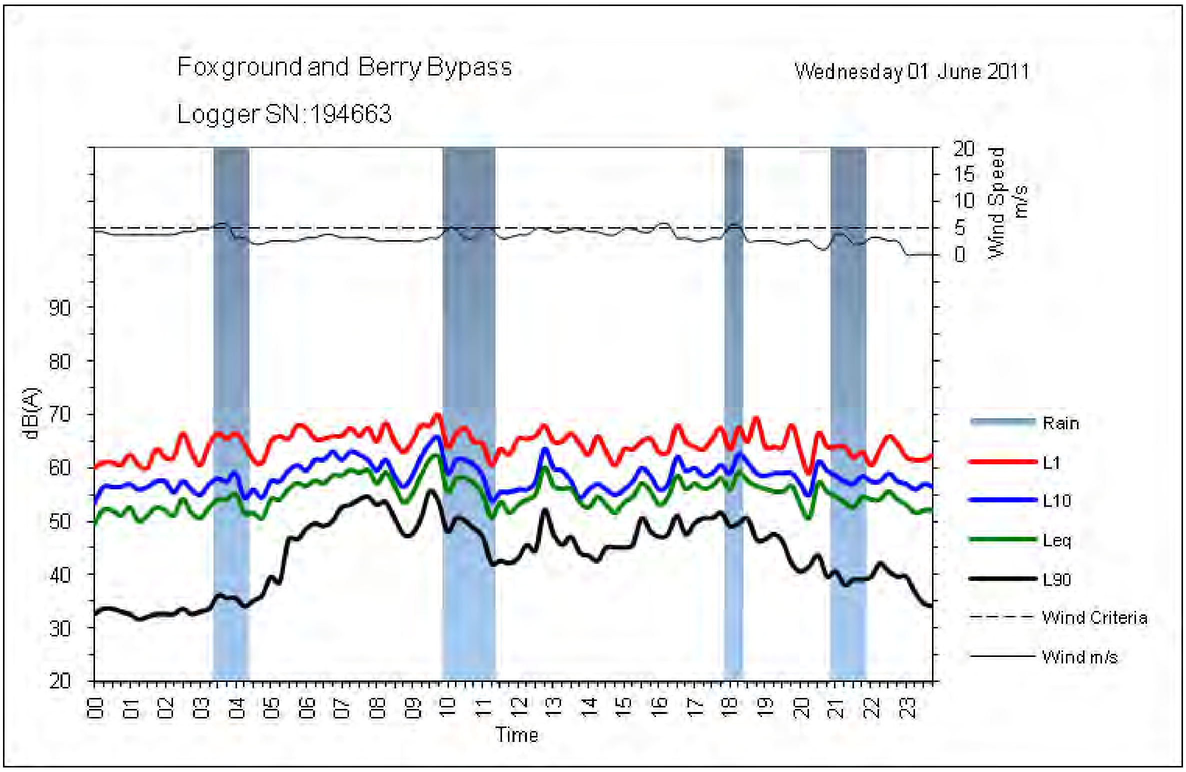

Foxground and Berry Bypass
Logger SN: 194688
Saturday 11 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

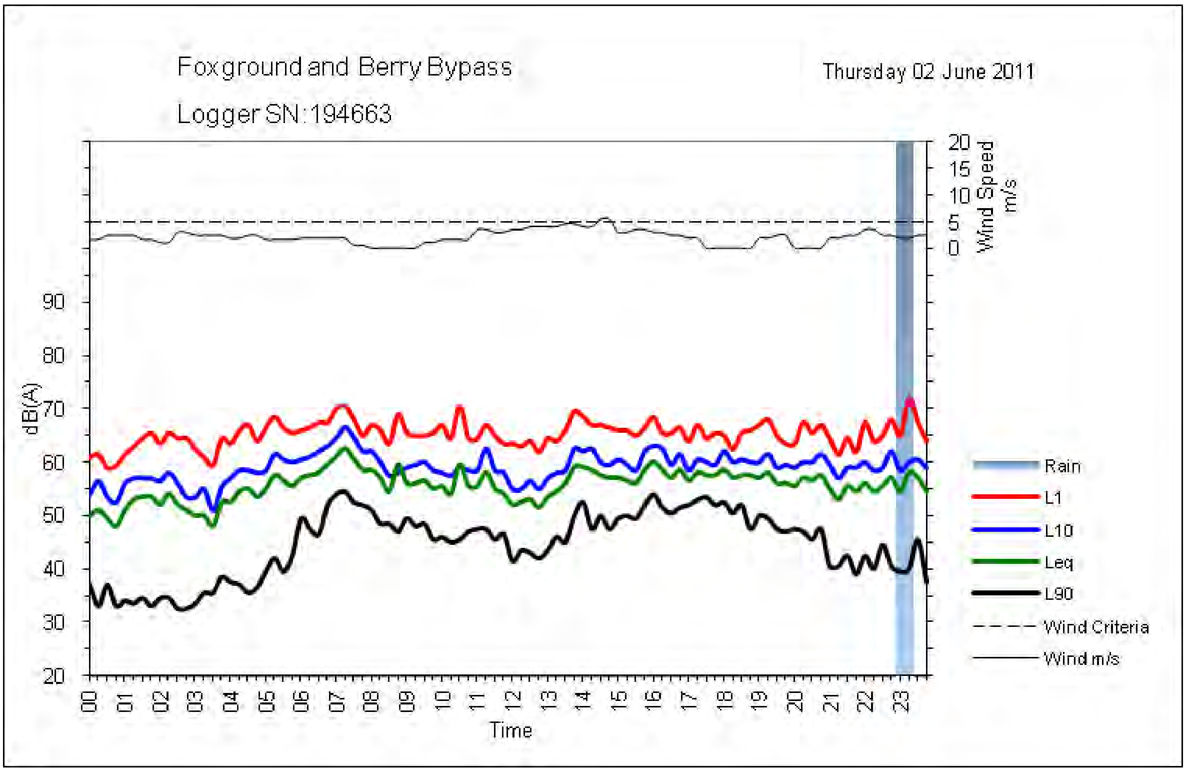

Foxground and Berry Bypass
Logger SN: 194688
Sunday 12 June 2011
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

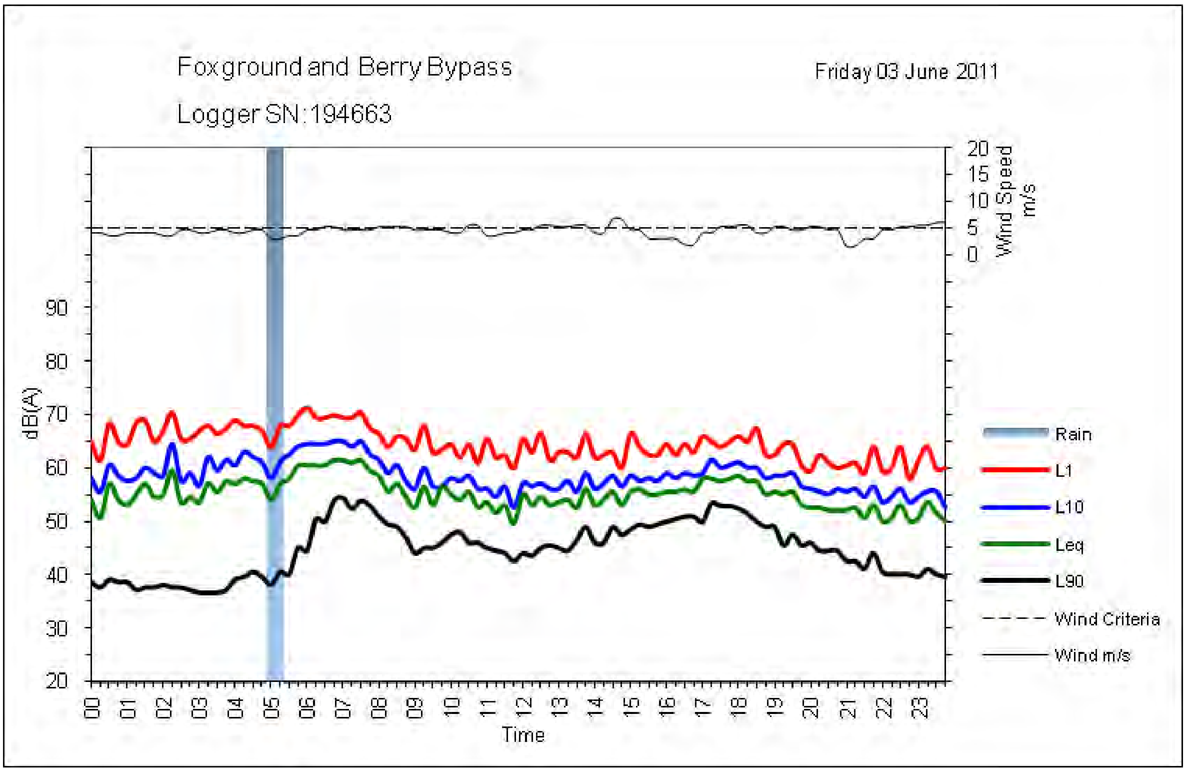

Foxground and Berry Bypass
Logger SN: 194688
Monday 13 June 2011
Wind Speed m/s
20
15
10
5
0
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

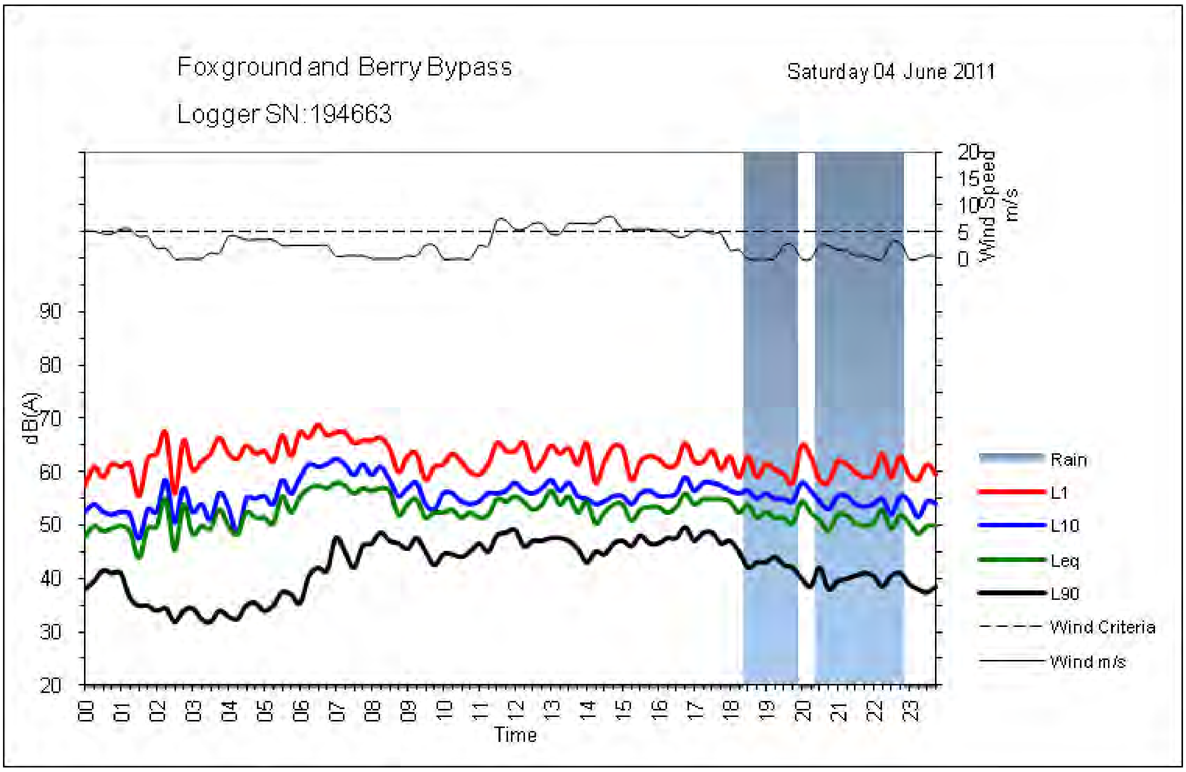
BG8

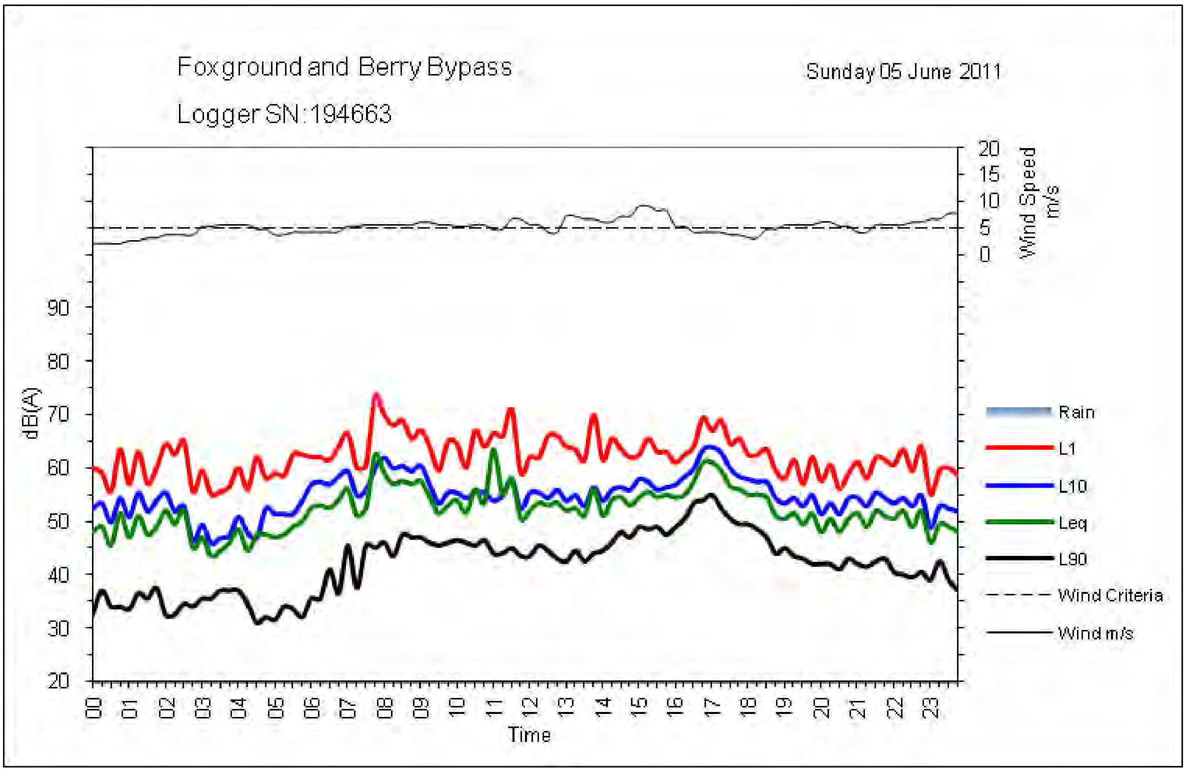

Foxground and Berry Bypass
Logger SN:194663
Tuesday 31 May 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
20
15
10
5
0
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

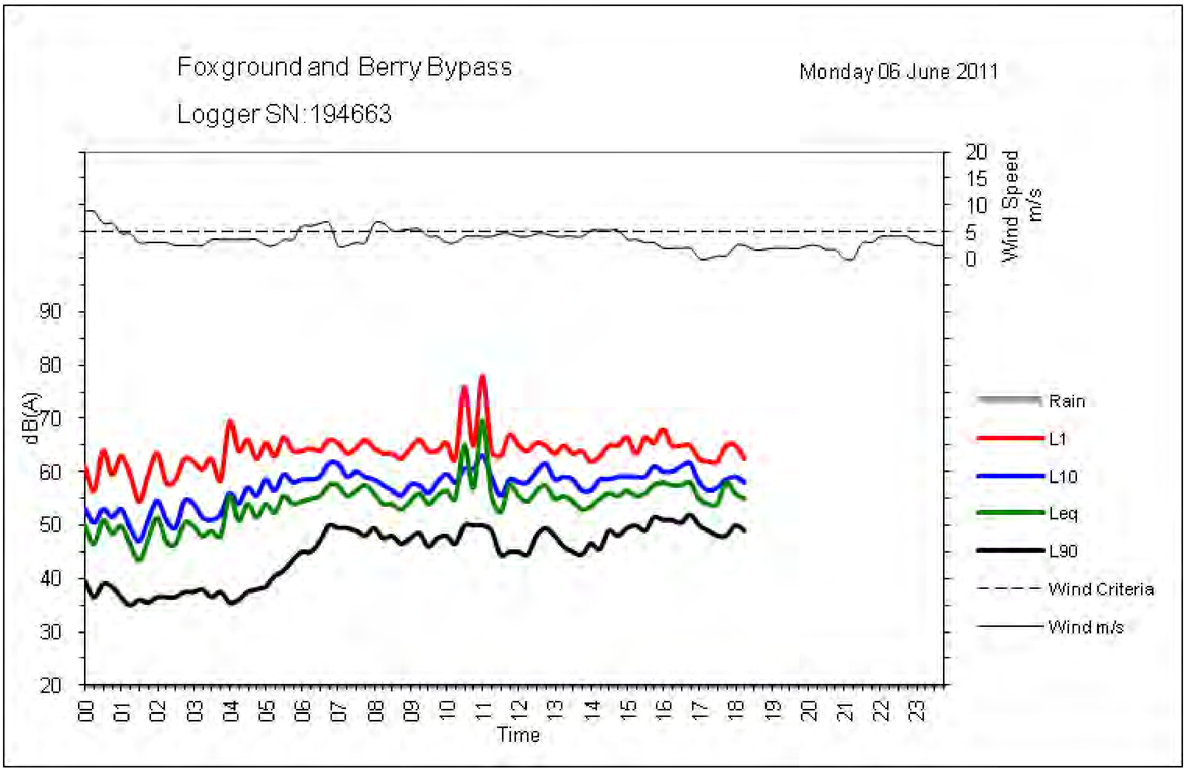

Foxground and Berry Bypass
Logger SN:194663
Wednesday 01 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
20
15
10
5
0
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194663
Thursday 02 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

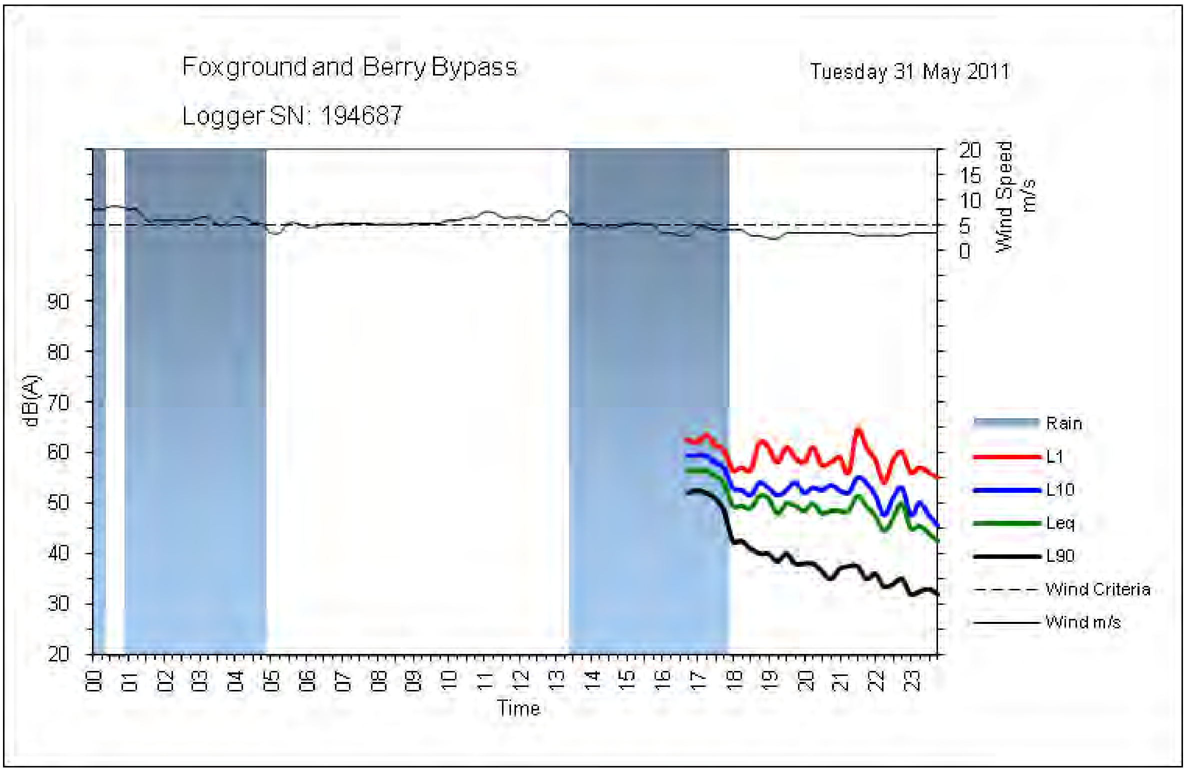

Foxground and Berry Bypass
Logger SN: 194663
Friday 03 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194663
Saturday 04 June 2011
dB(A)
90
80
70
60
50
40
30
20
Wind Speed m/s
20
15
10
5
0
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

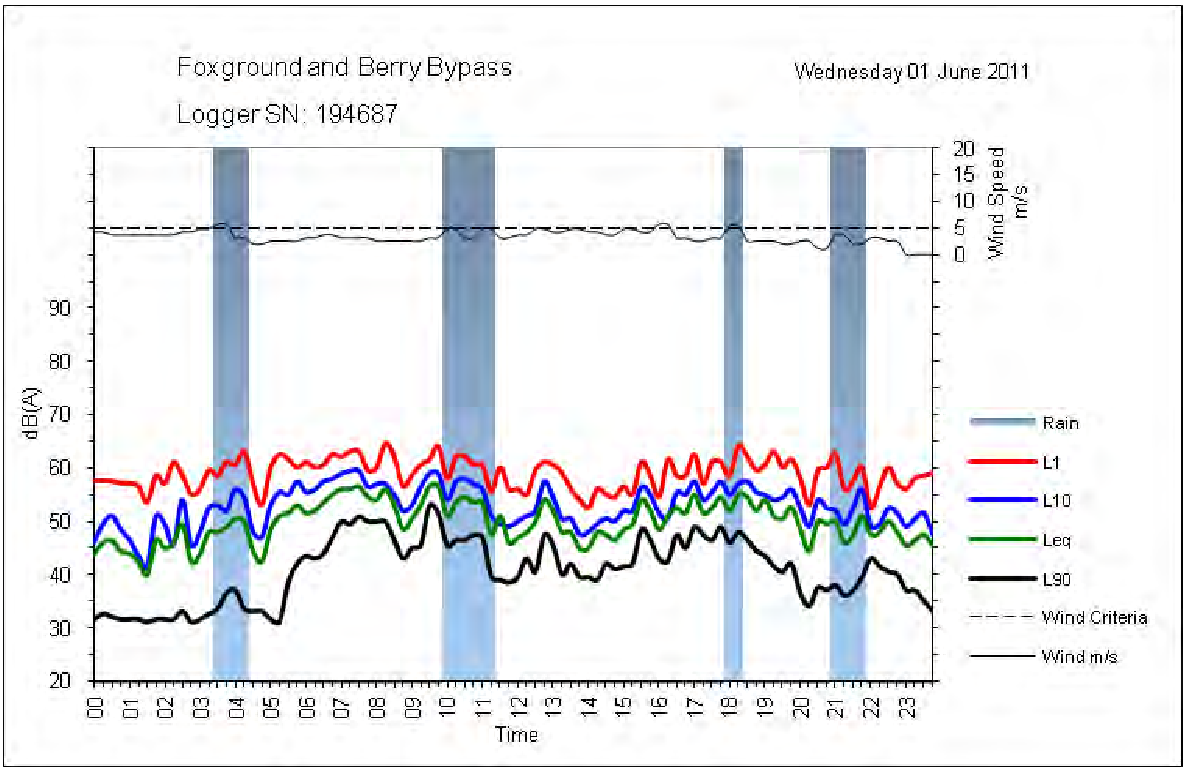

Foxground and Berry Bypass
Logger SN: 194663
Sunday 05 June 2011
dB(A)
90
80
70
60
50
40
30
20
Wind Speed m/s
20
15
10
5
0
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN:194663
Monday 06 June 2011
dB(A)
90
80
70
60
50
40
30
20
Wind Speed m/s
20
15
10
5
0
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

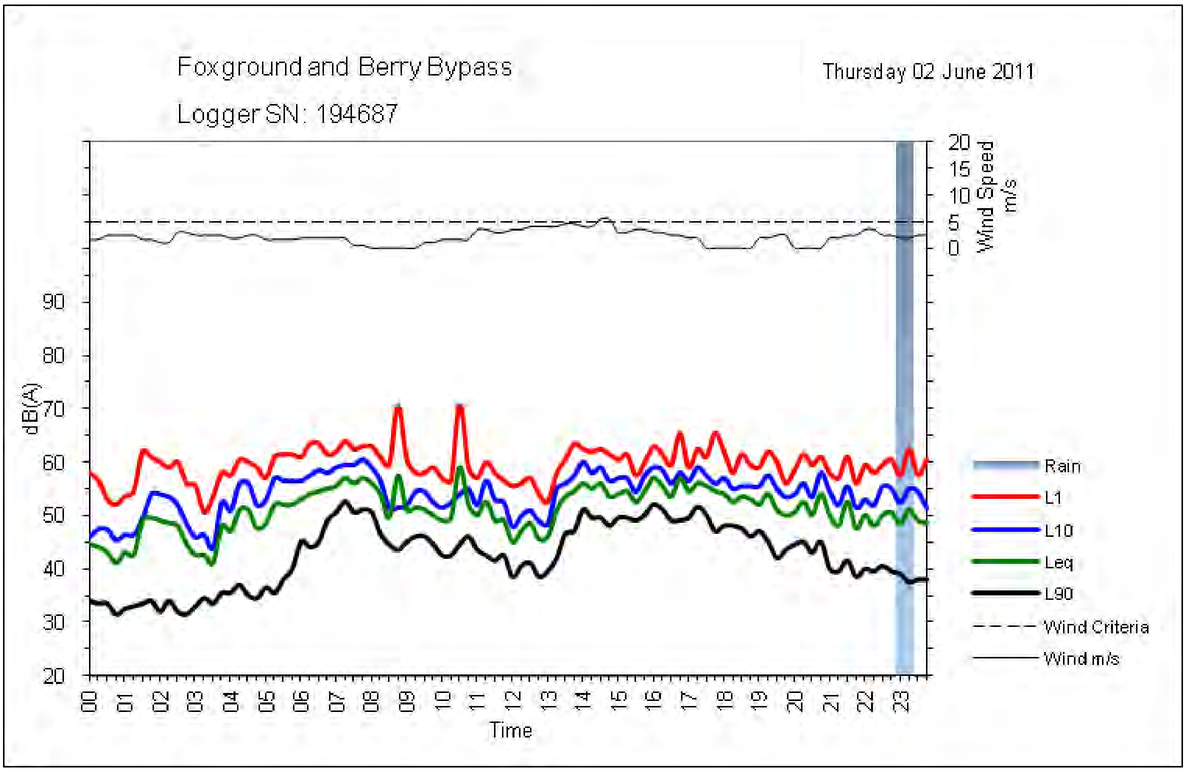
BG9

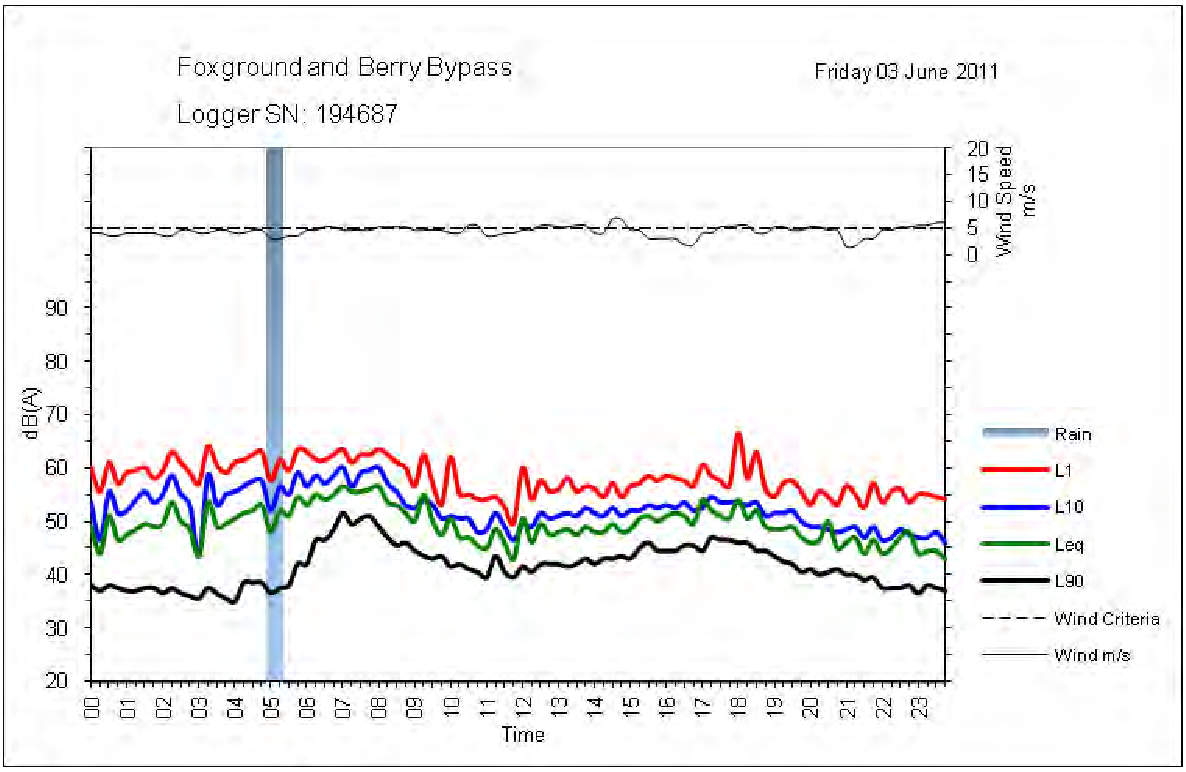


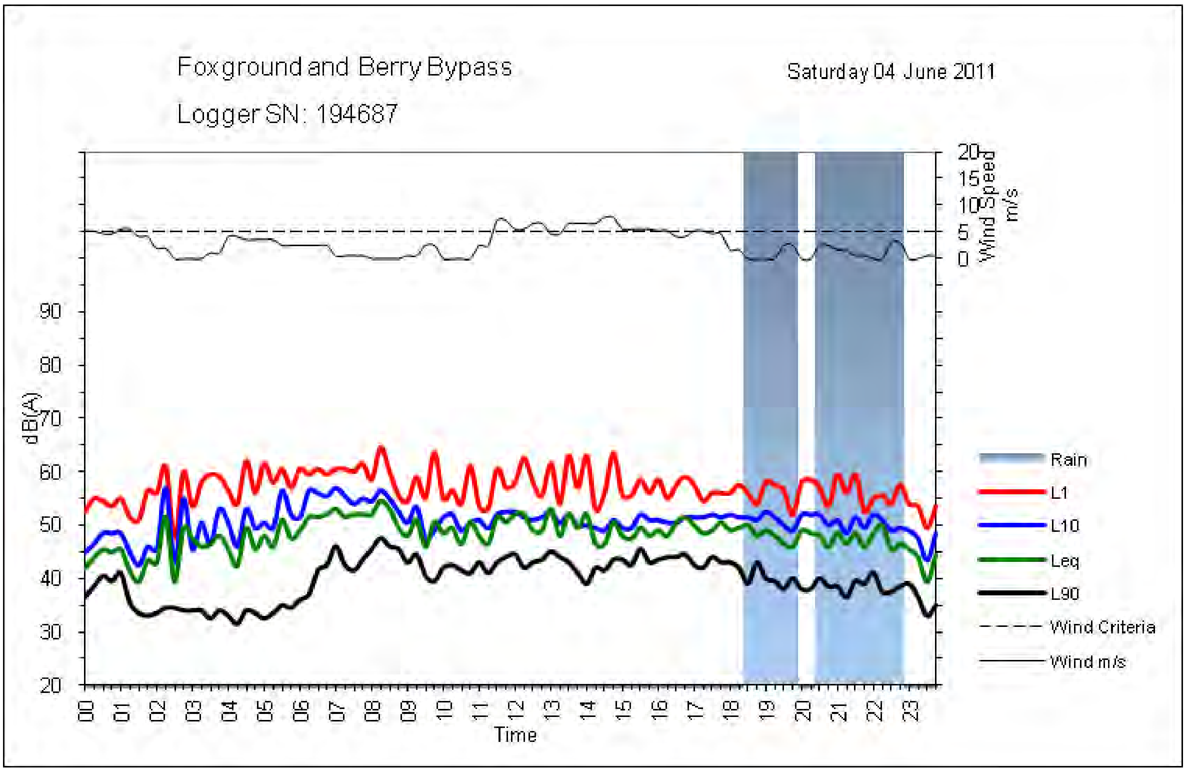
Foxground and Berry Bypass
Logger SN: 194687
Tuesday 31 May 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

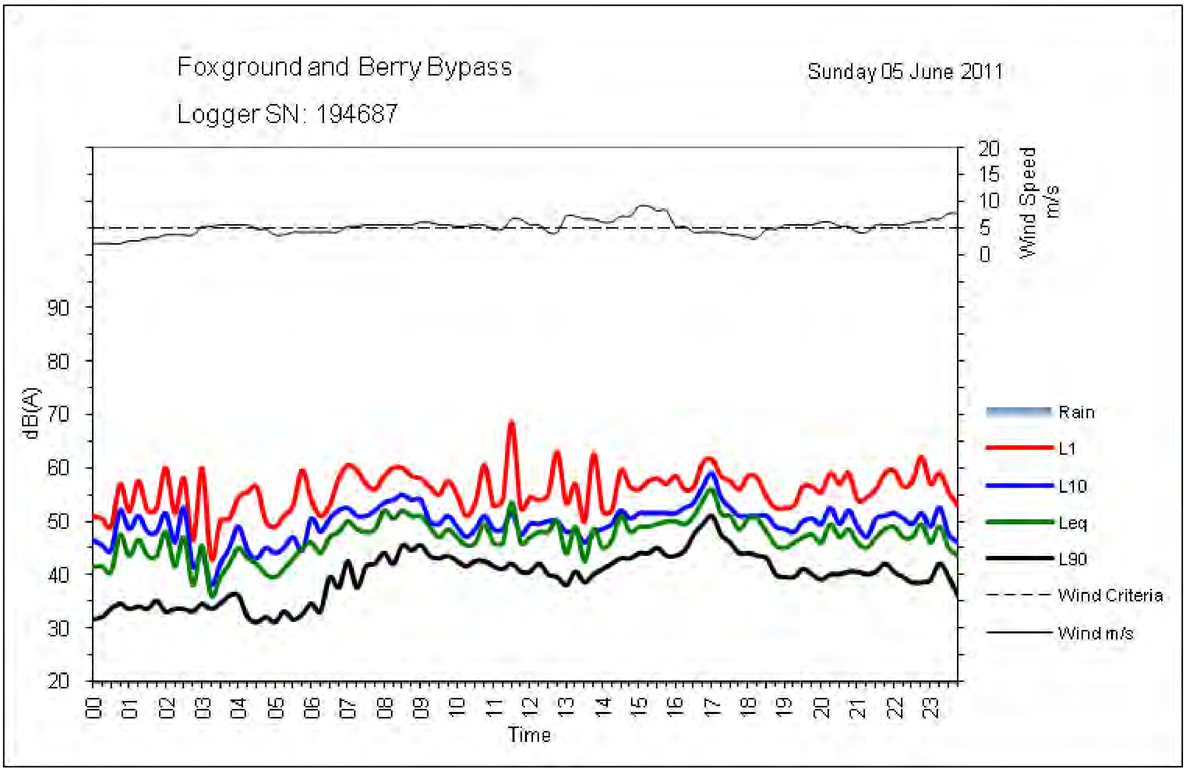


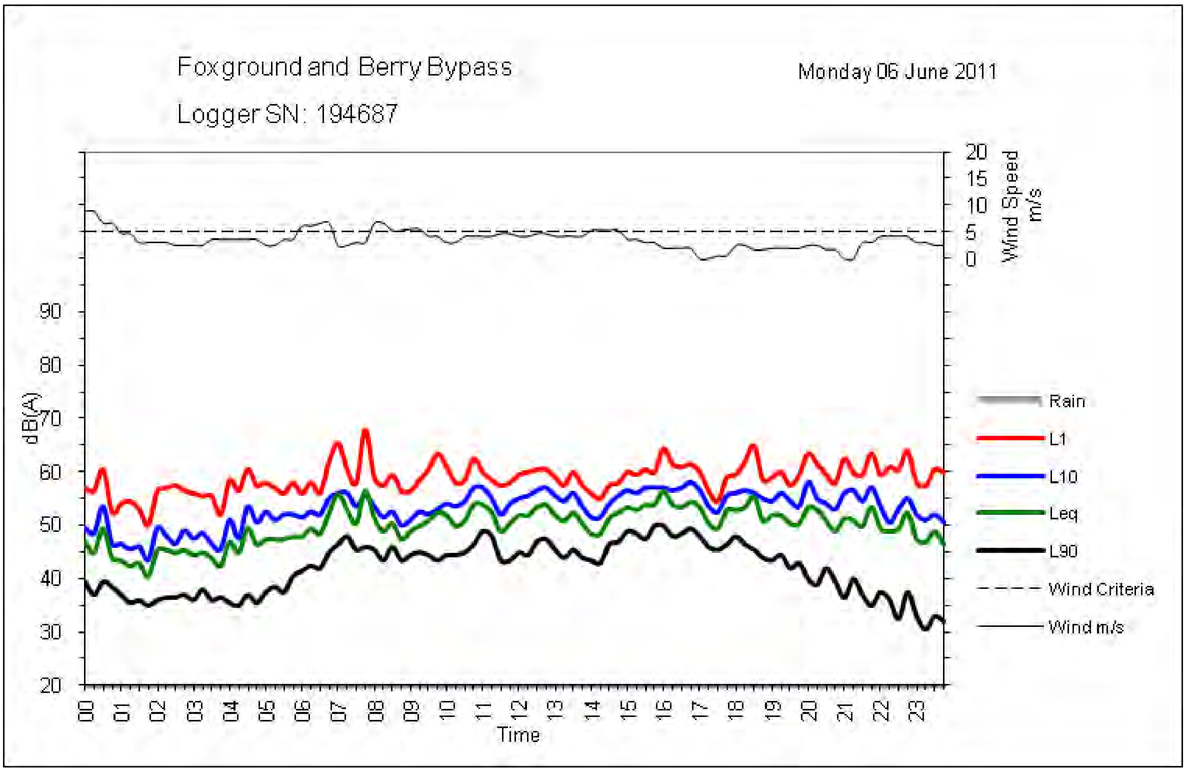
Foxground and Berry Bypass
Logger SN: 194687
Wednesday 01 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

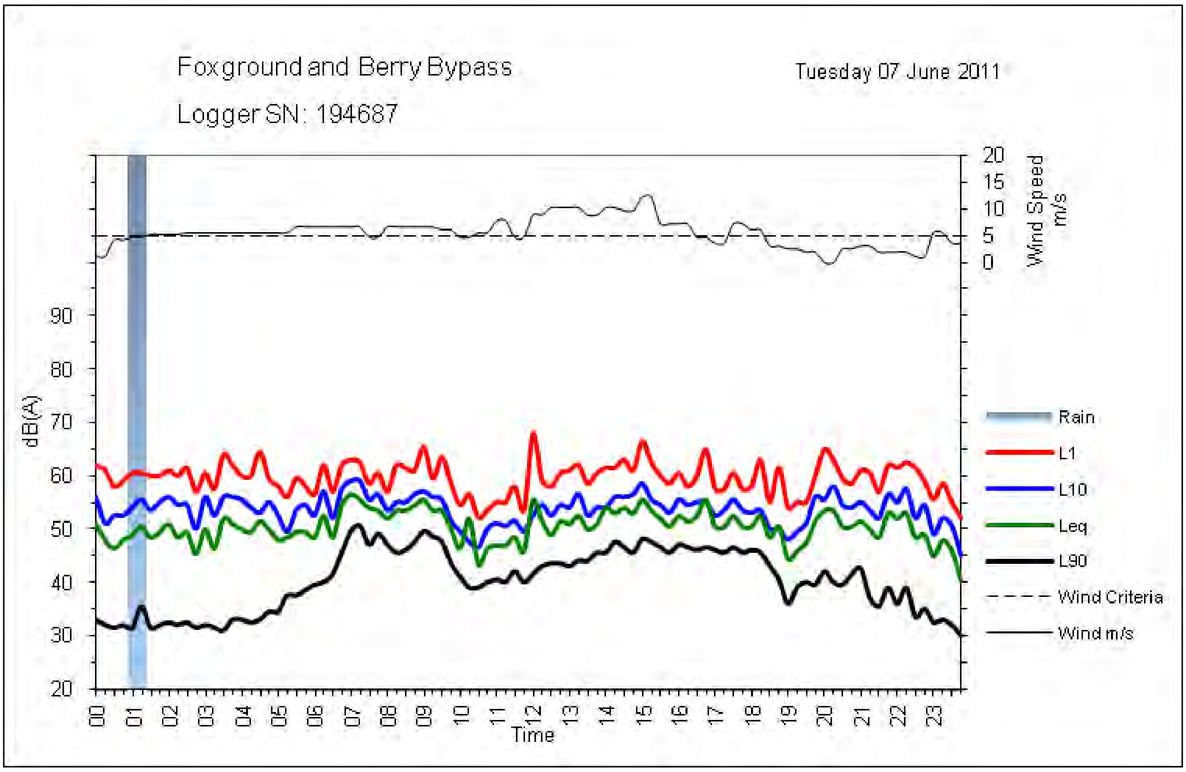

Foxground and Berry Bypass
Logger SN: 194687
Thursday 02 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

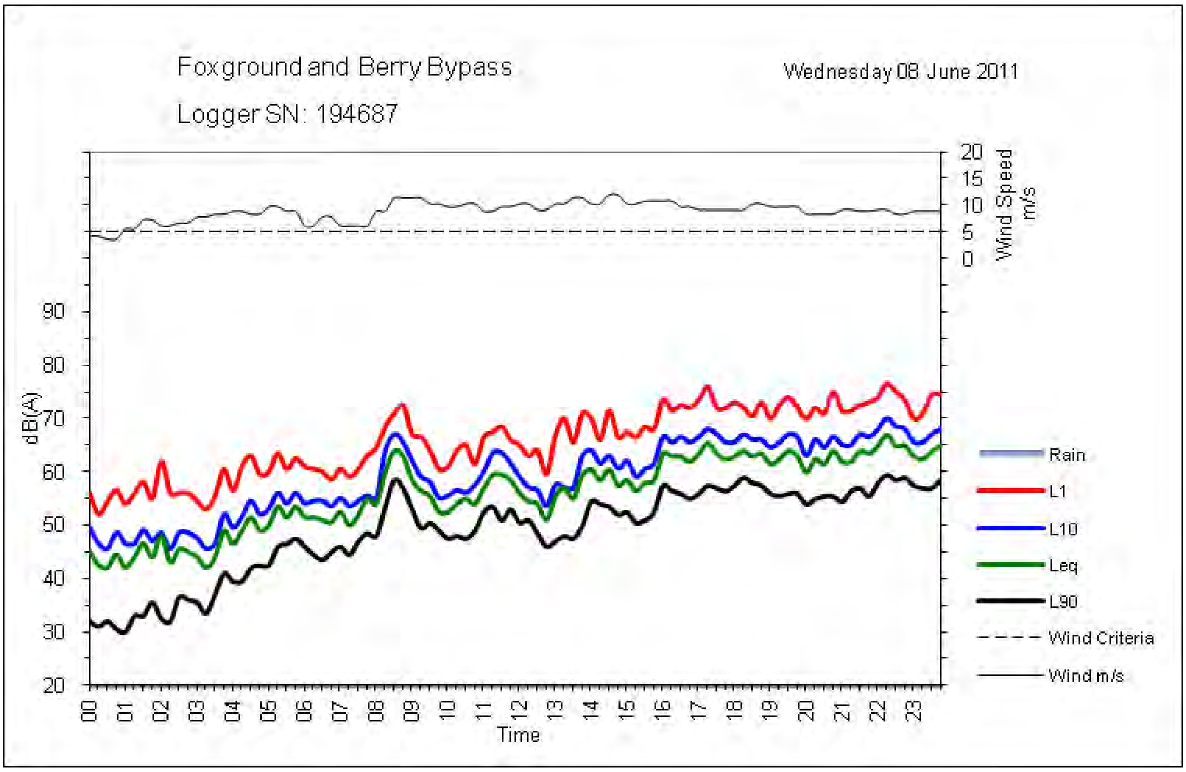

Foxground and Berry Bypass
Logger SN: 194687
Friday 03 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

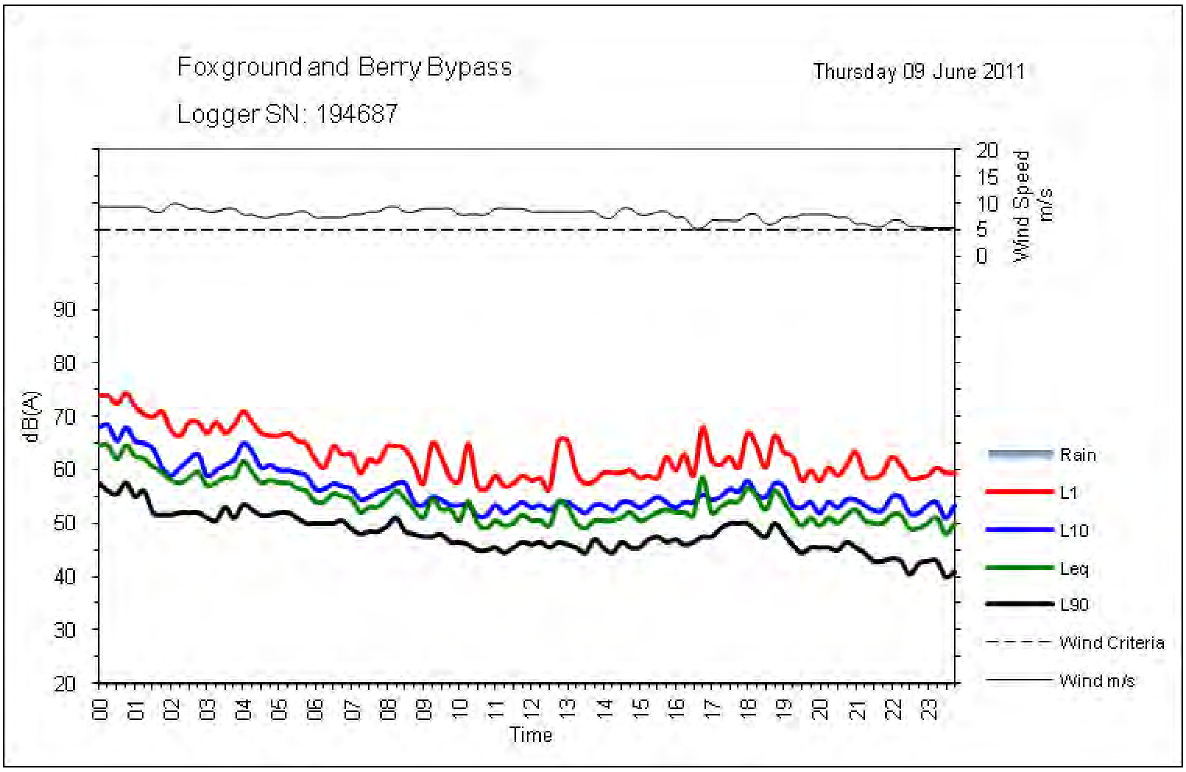

Foxground and Berry Bypass
Logger SN: 194687
Saturday 04 June 2011
20
15
10
5
0
Wind Speed m/s
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

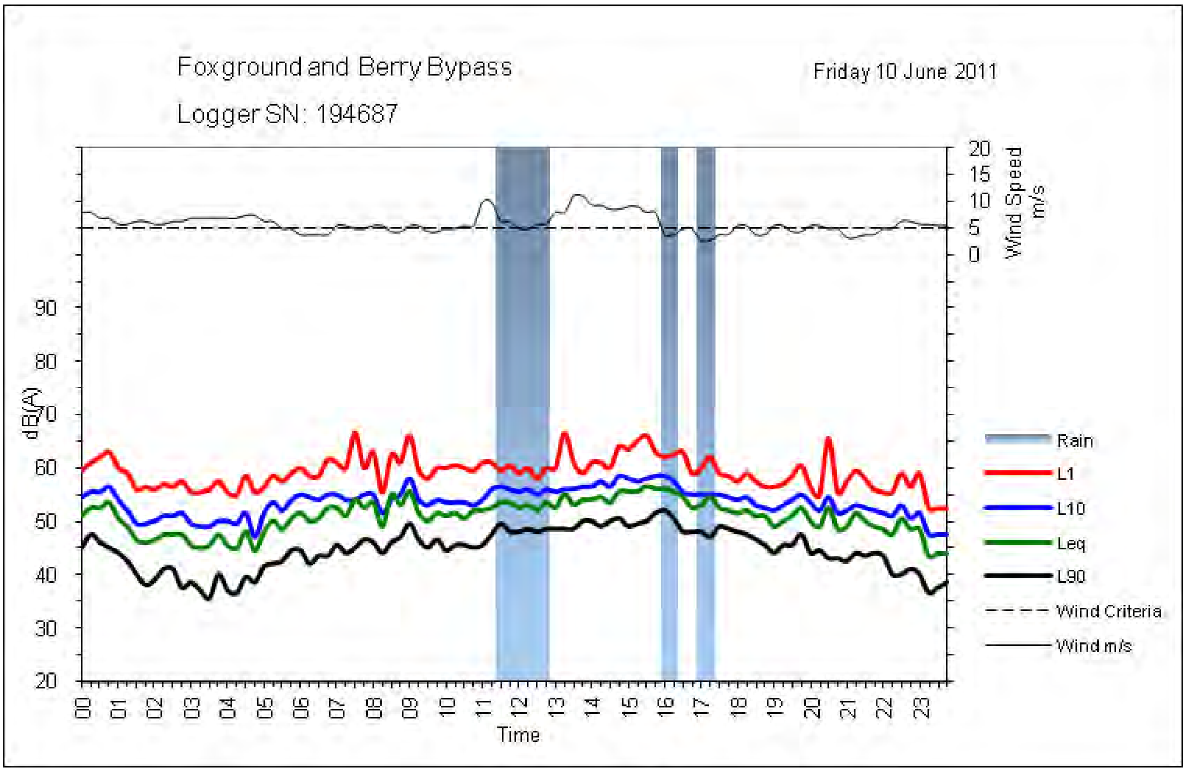

Foxground and Berry Bypass
Logger SN: 194687
Sunday 05 June 2011
20
15
10
5
0
Wind Speed m/s
dB(A)
90
80
70
60
50
40
30
20
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194687
Monday 06 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time

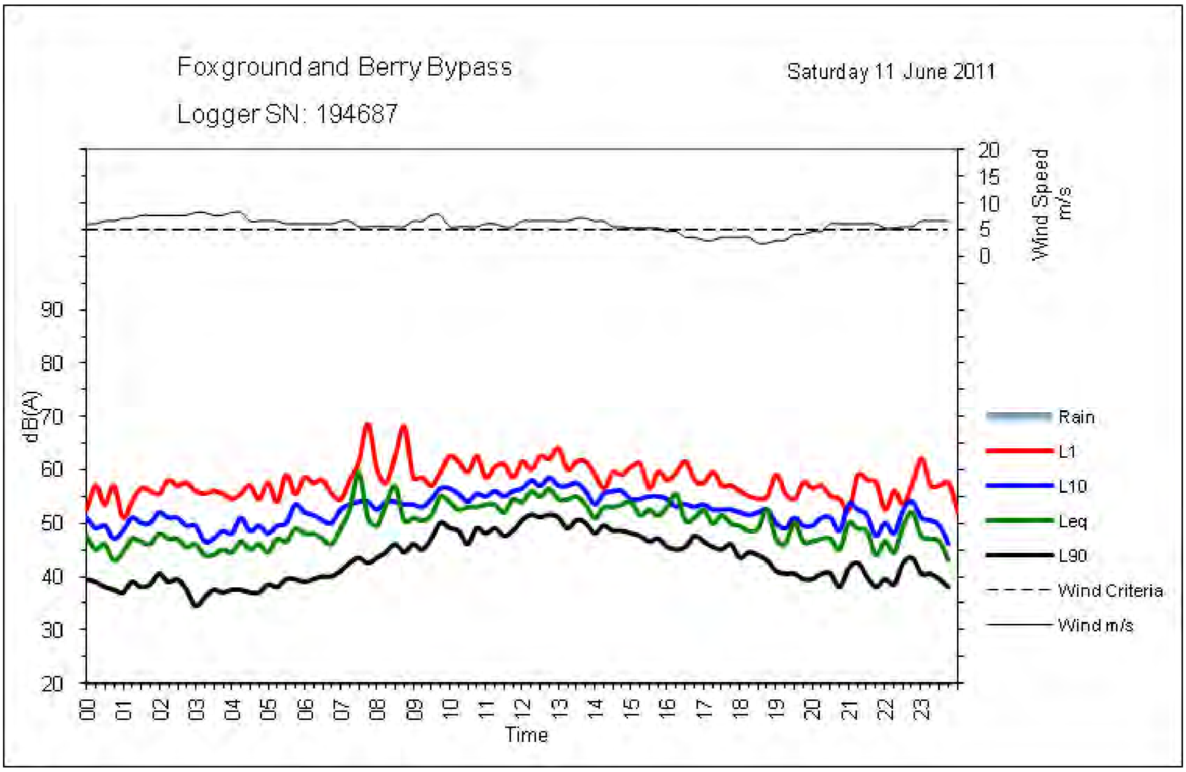

Foxground and Berry Bypass
Logger SN: 194687
Tuesday 07 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time


Foxground and Berry Bypass
Logger SN: 194687
Wednesday 08 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

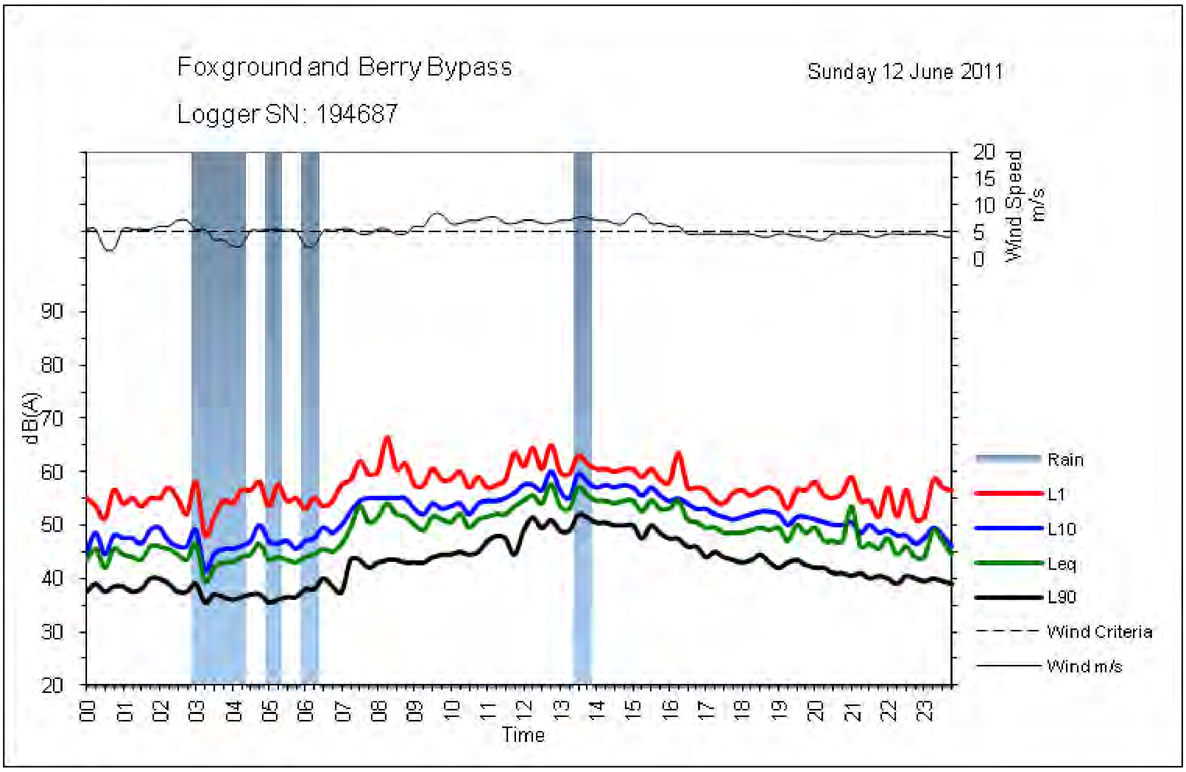

Foxground and Berry Bypass
Logger SN: 194687
Thursday 09 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

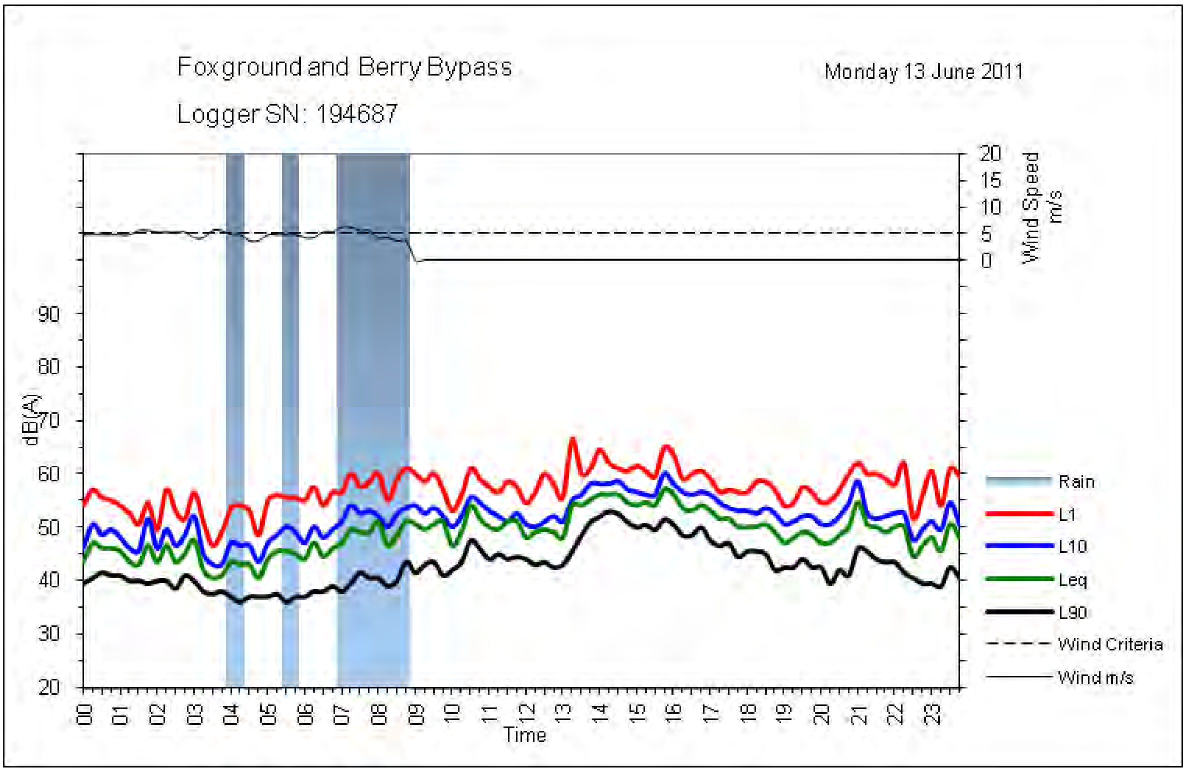


Foxground and Berry Bypass
Friday 10 June 2011
Logger SN: 194687
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time

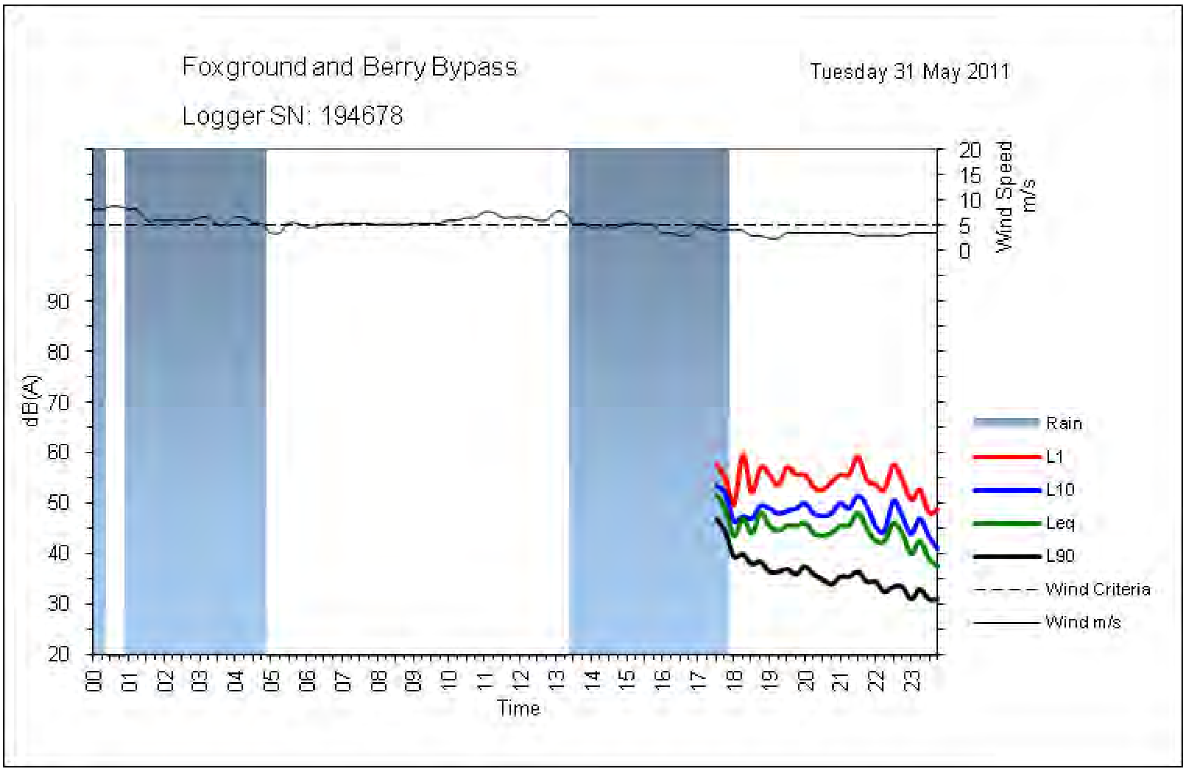


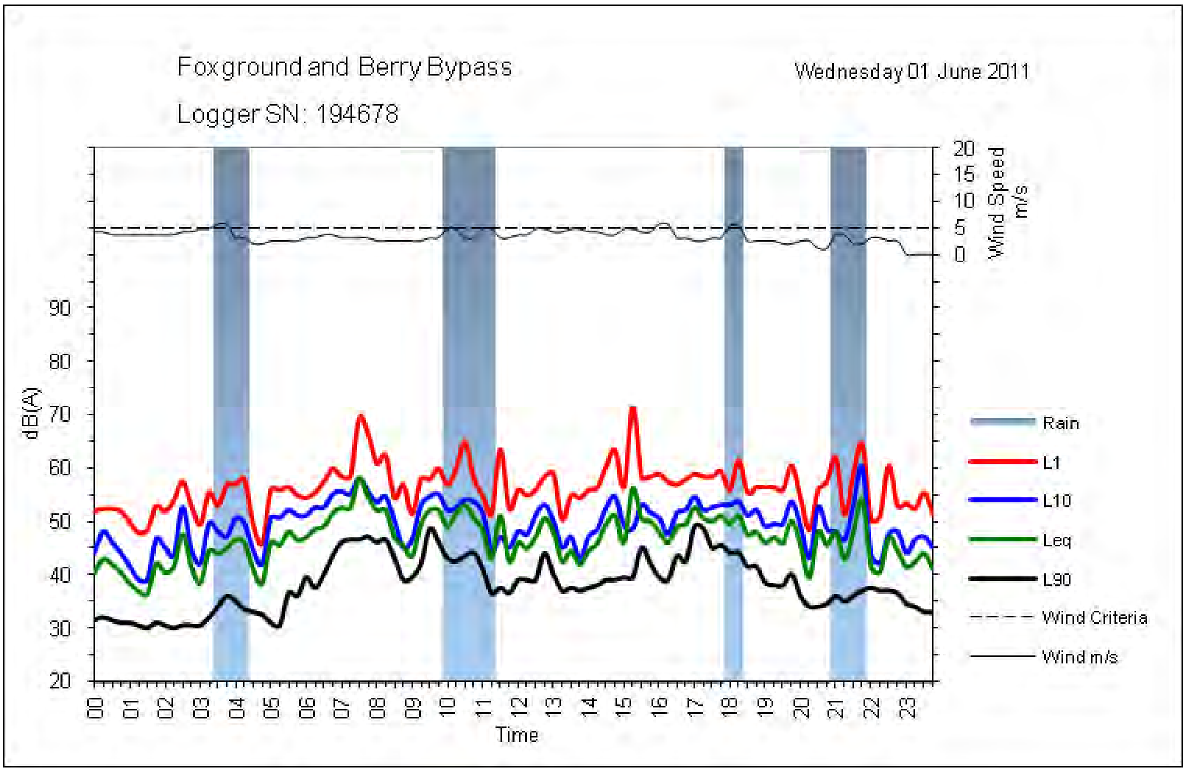
Foxground and Berry Bypass
Saturday 11 June 2011
Logger SN: 194687
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time

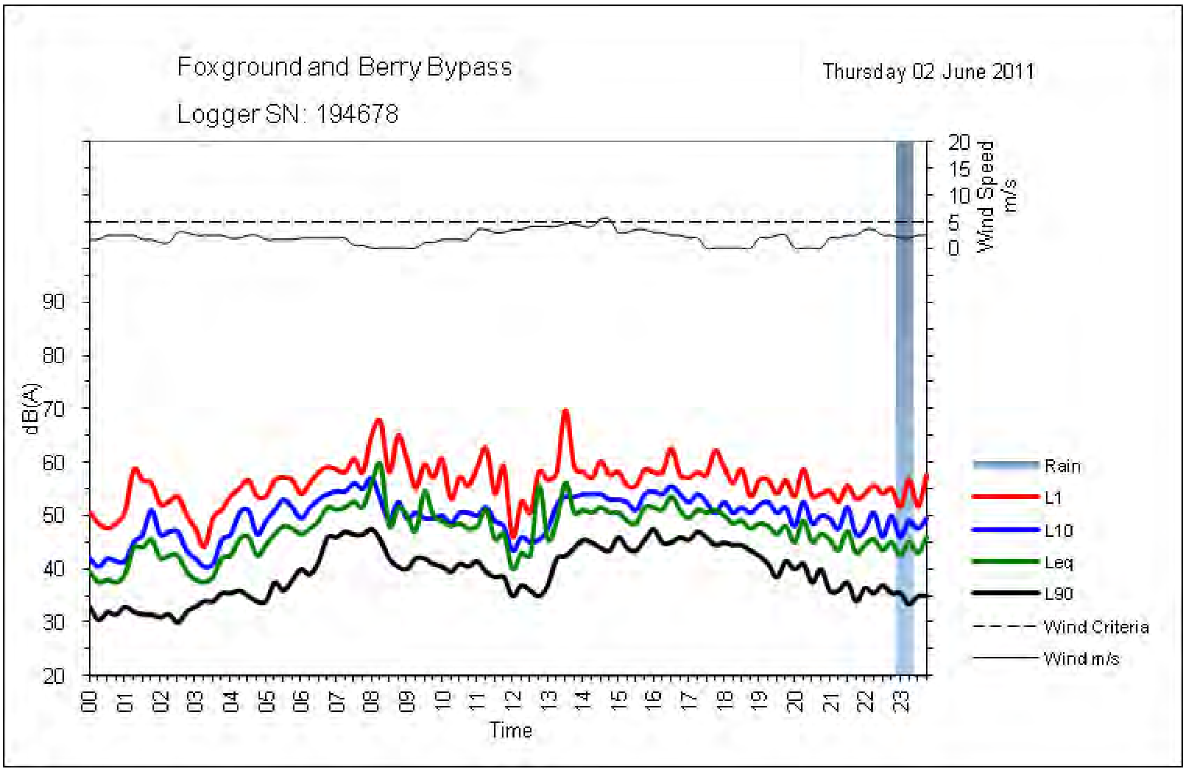

Foxground and Berry Bypass
Logger SN: 194687
Sunday 12 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

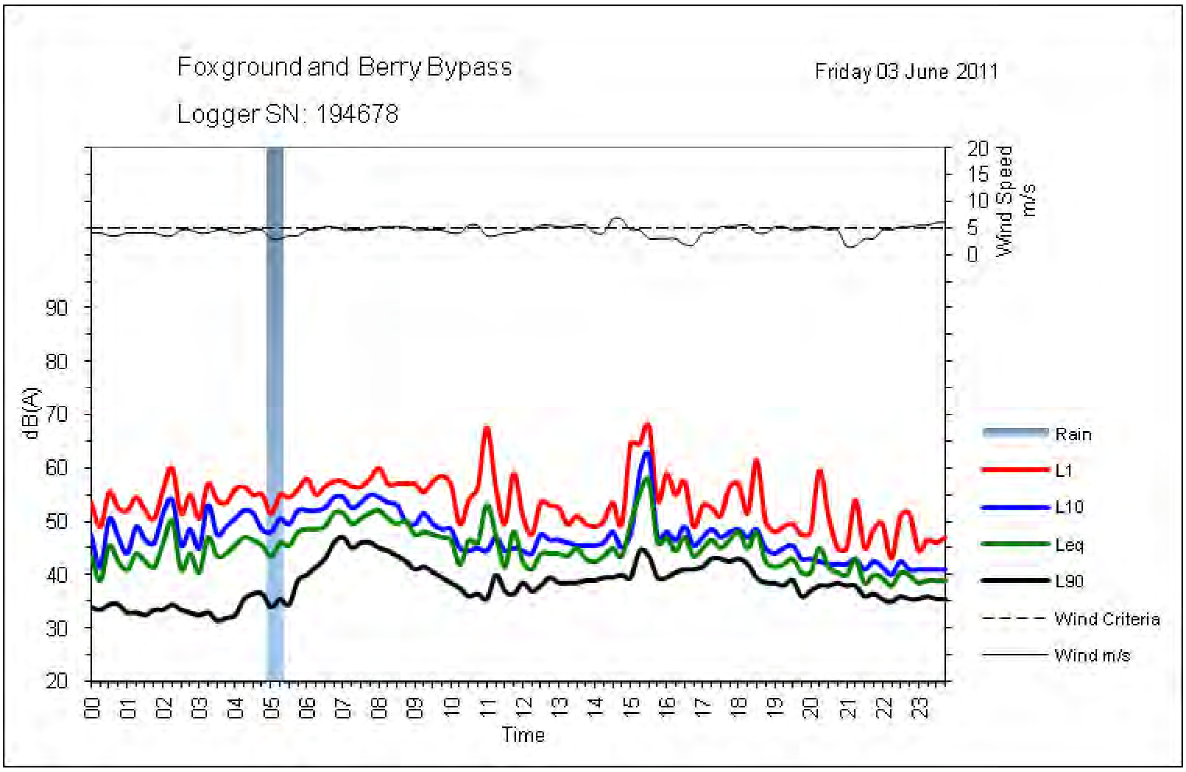

Foxground and Berry Bypass
Logger SN: 194687
Monday 13 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

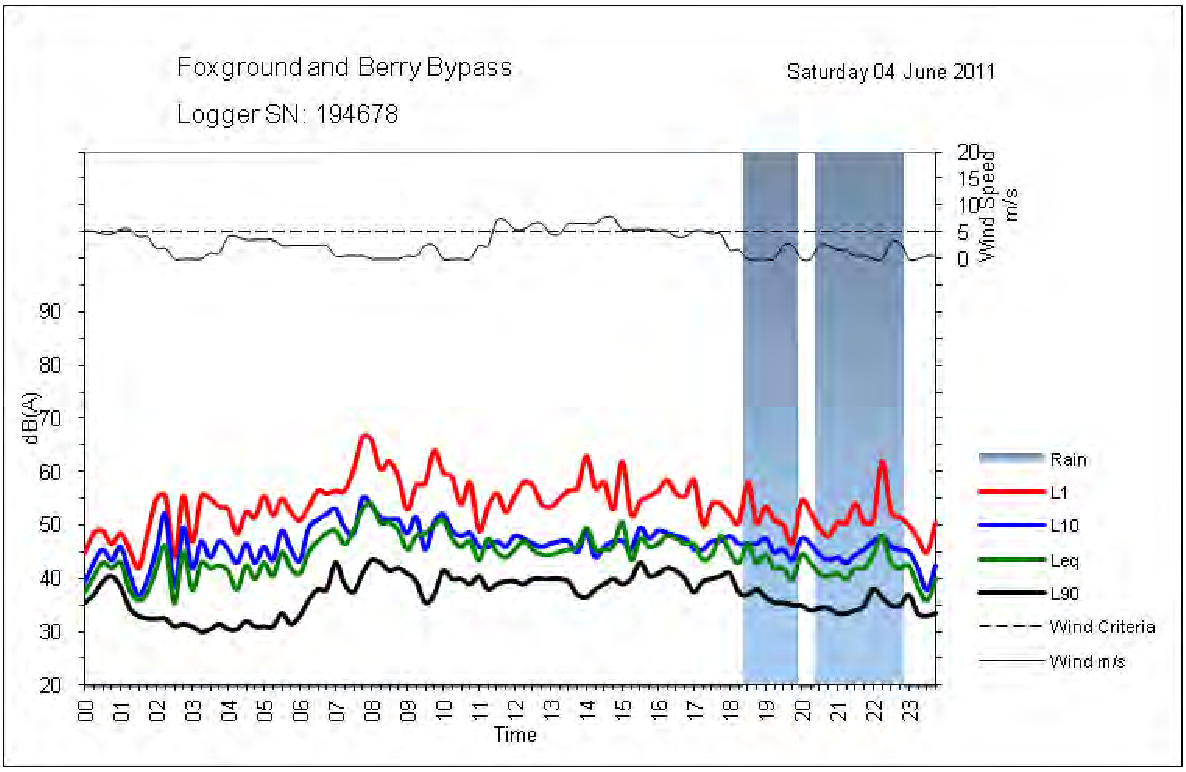
BG10

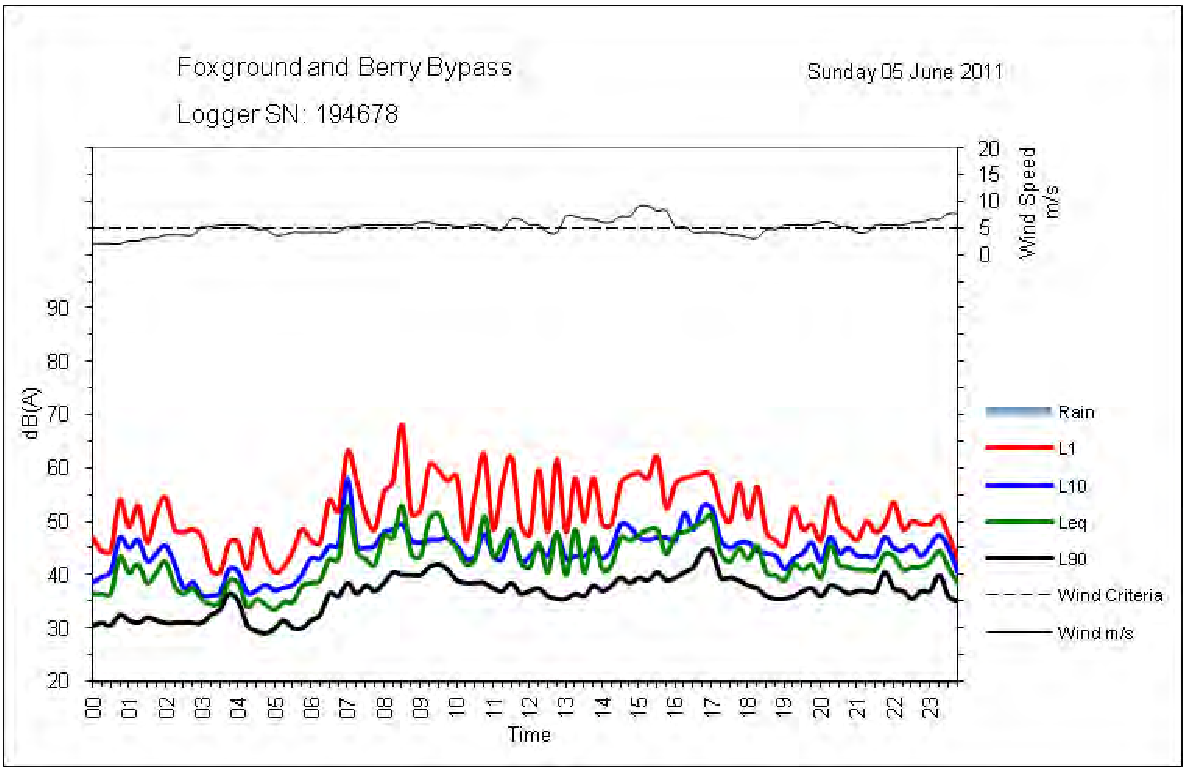

Foxground and Berry Bypass
Logger SN: 194678
Tuesday 31 May 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

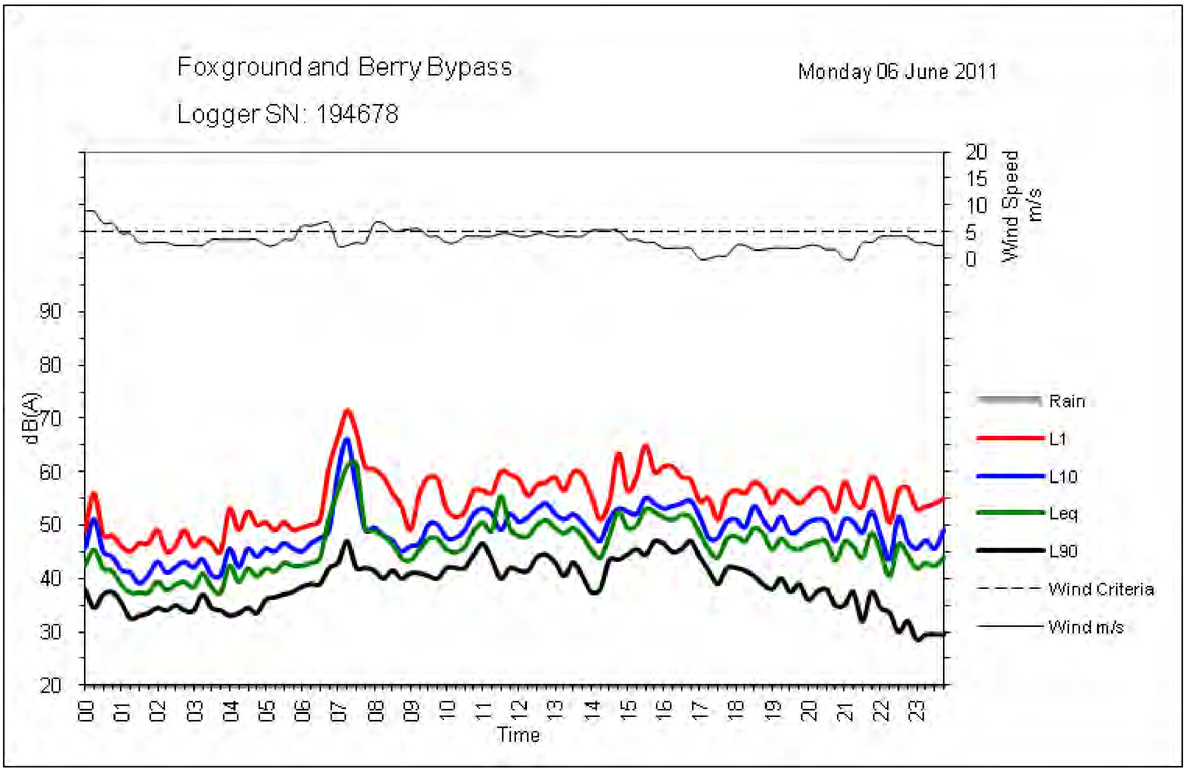

Foxground and Berry Bypass
Logger SN: 194678
Wednesday 01 June 2011
dB(A)
90
80
70
60
50
40
30
20
20
15
10
5
0
Wind Speed m/s
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time

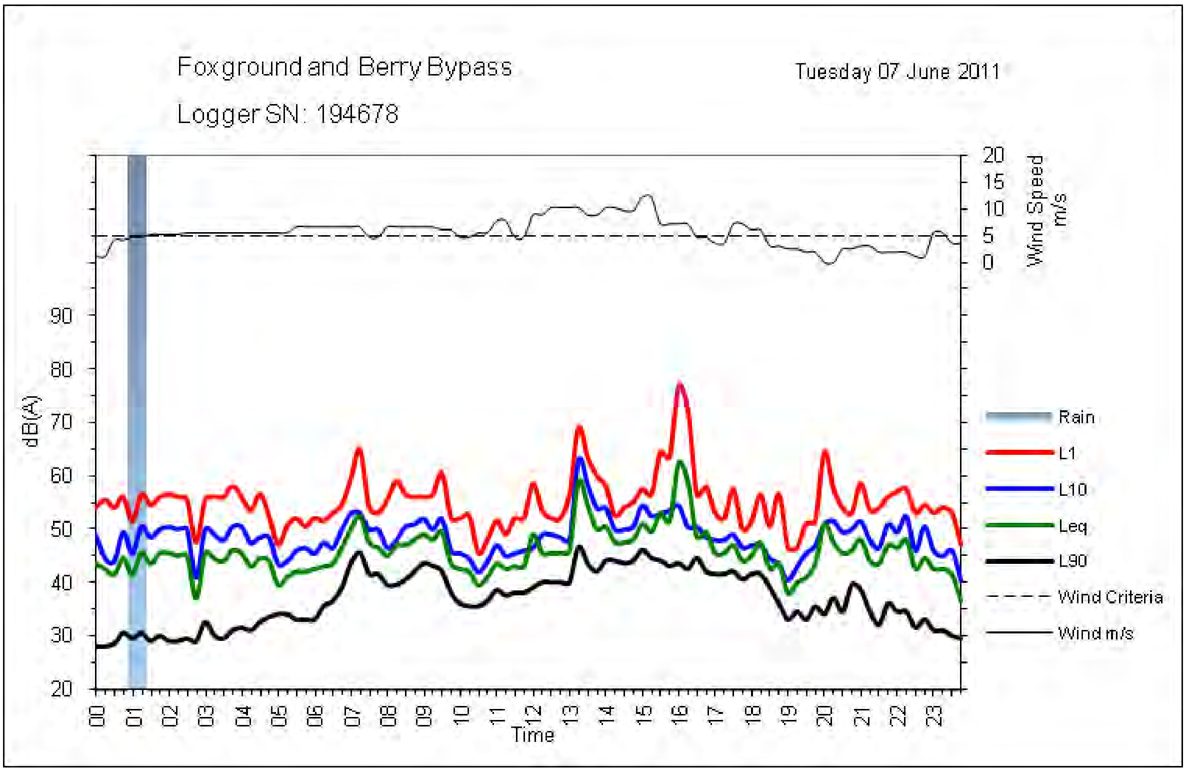

Foxground and Berry Bypass
Thursday 02 June 2011
Logger SN: 194678
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

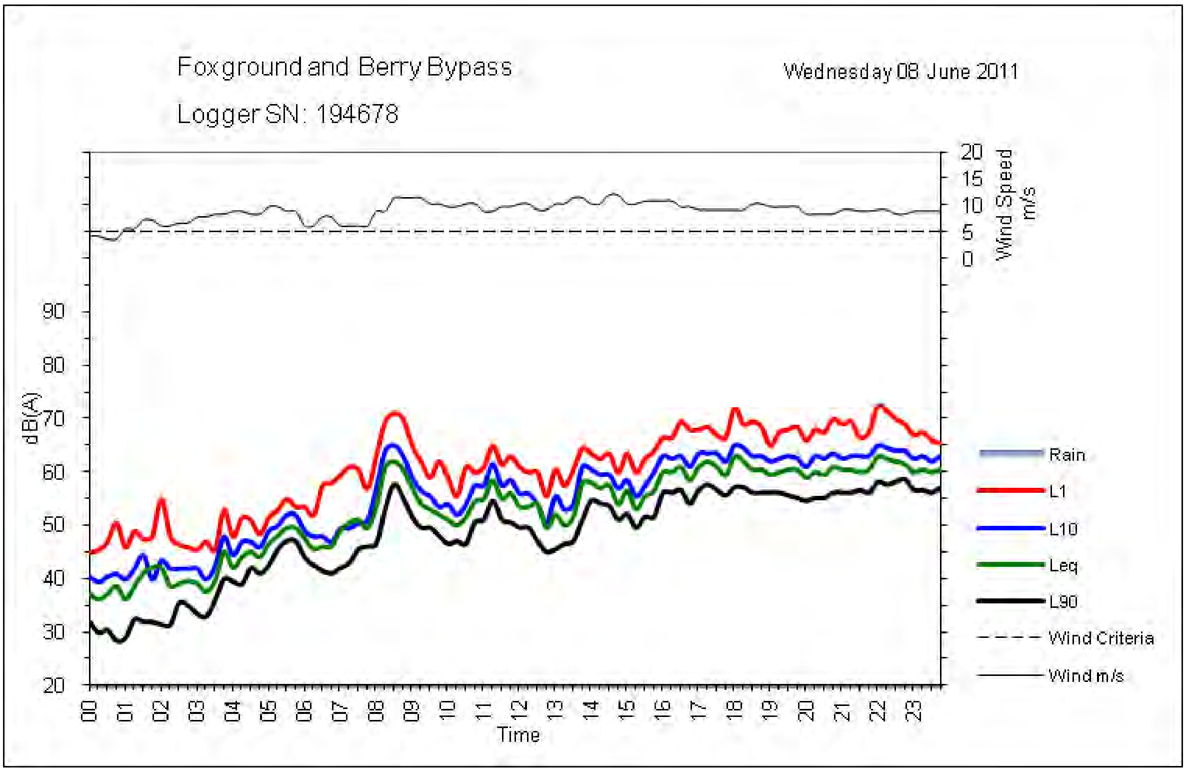

Foxground and Berry Bypass
Friday 03 June 2011
Logger SN: 194678
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

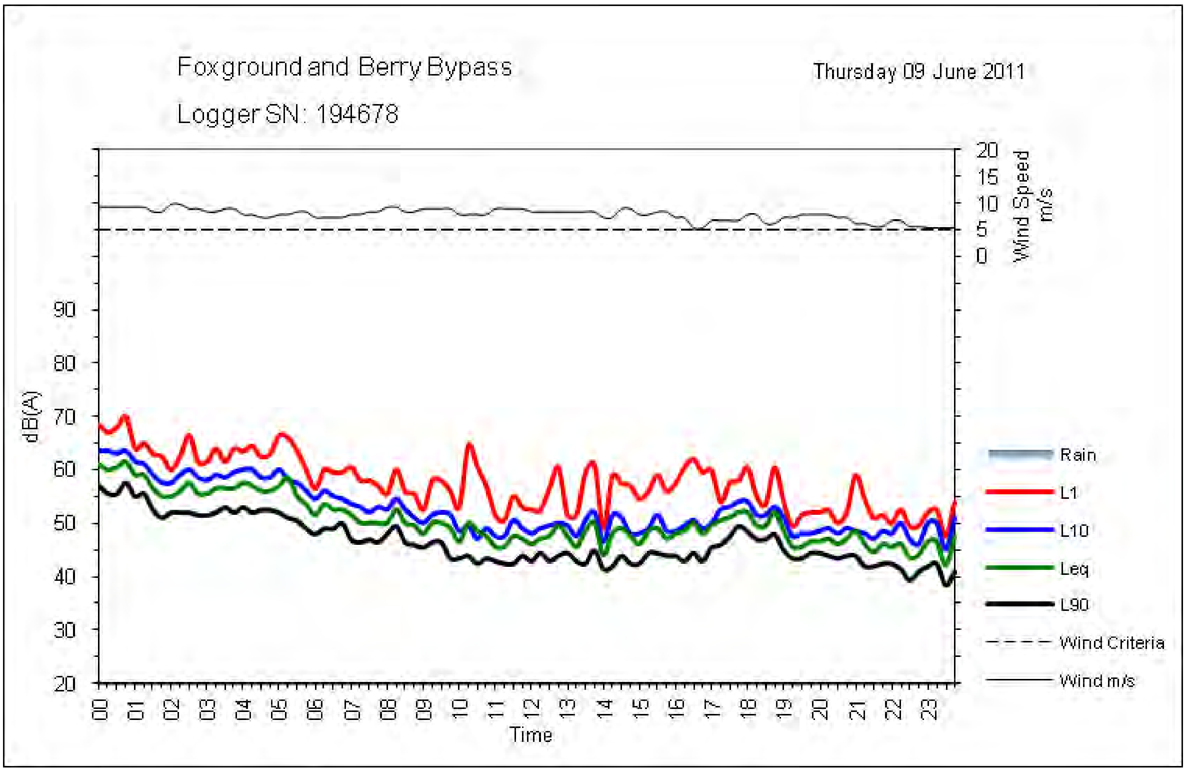

Foxground and Berry Bypass
Logger SN: 194678
Saturday 04 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

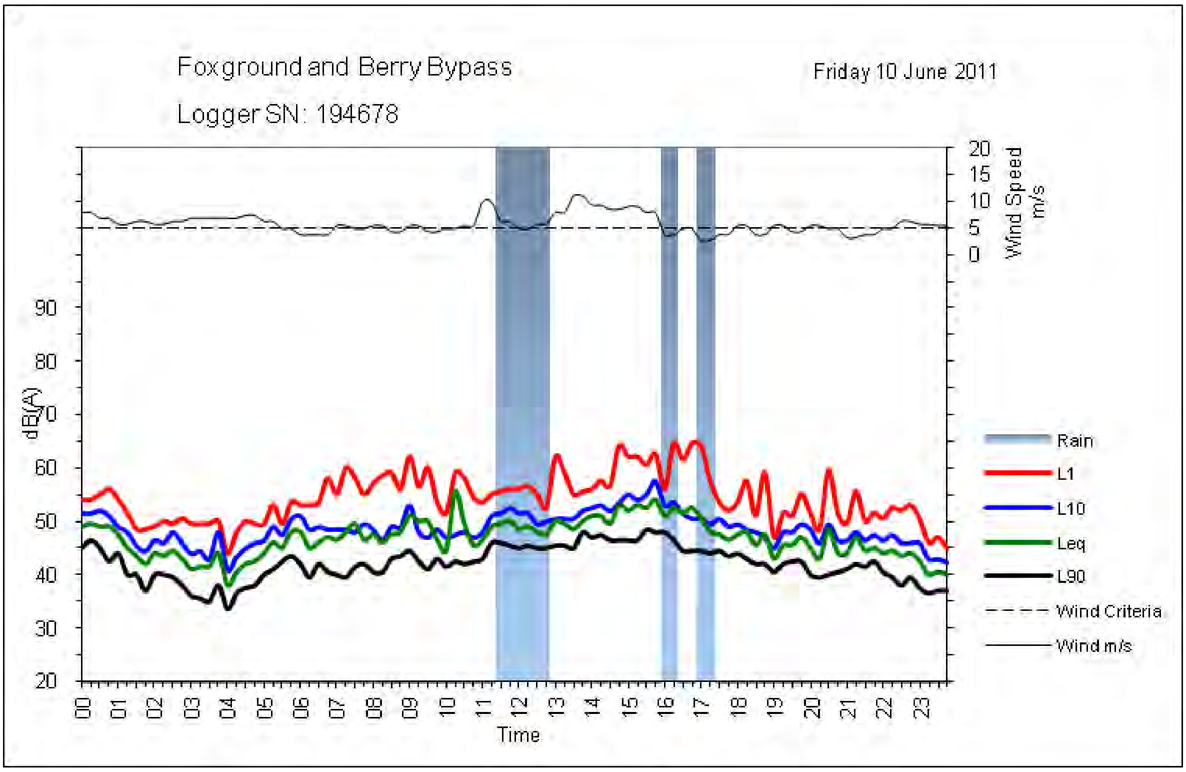

Foxground and Berry Bypass
Logger SN: 194678
Sunday 05 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

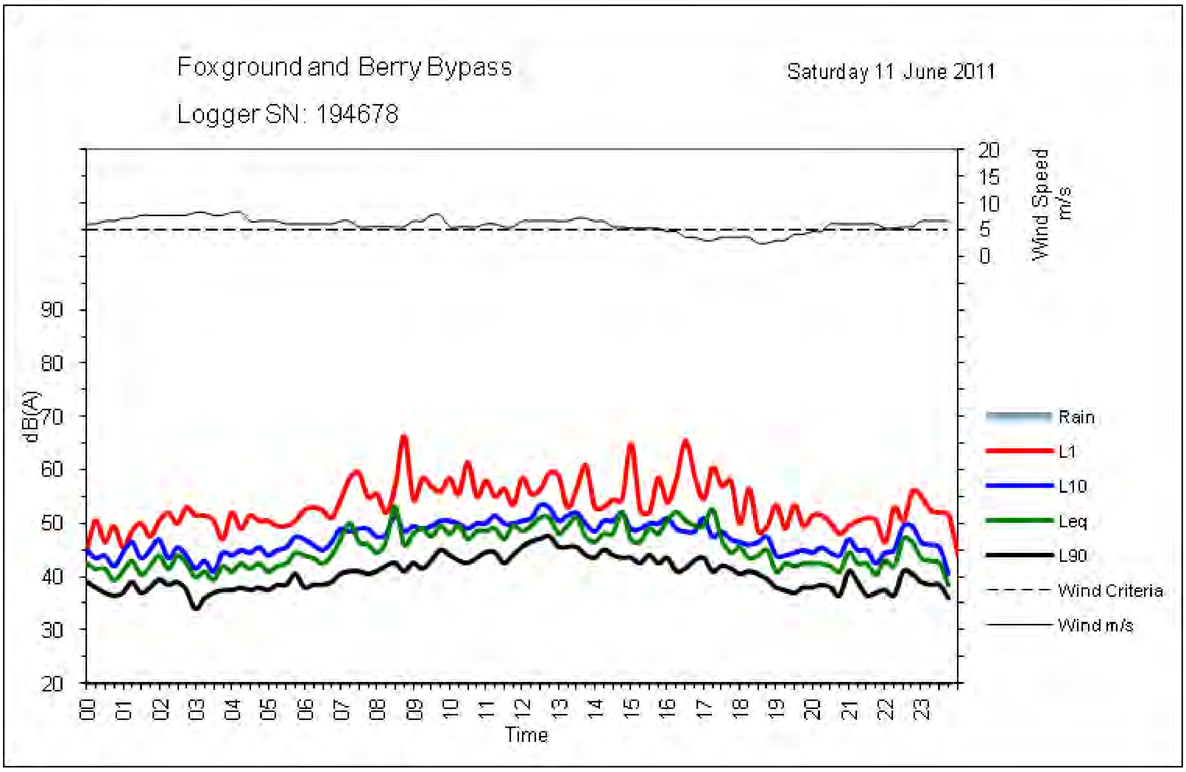

Foxground and Berry Bypass
Logger SN: 194678
Monday 06 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

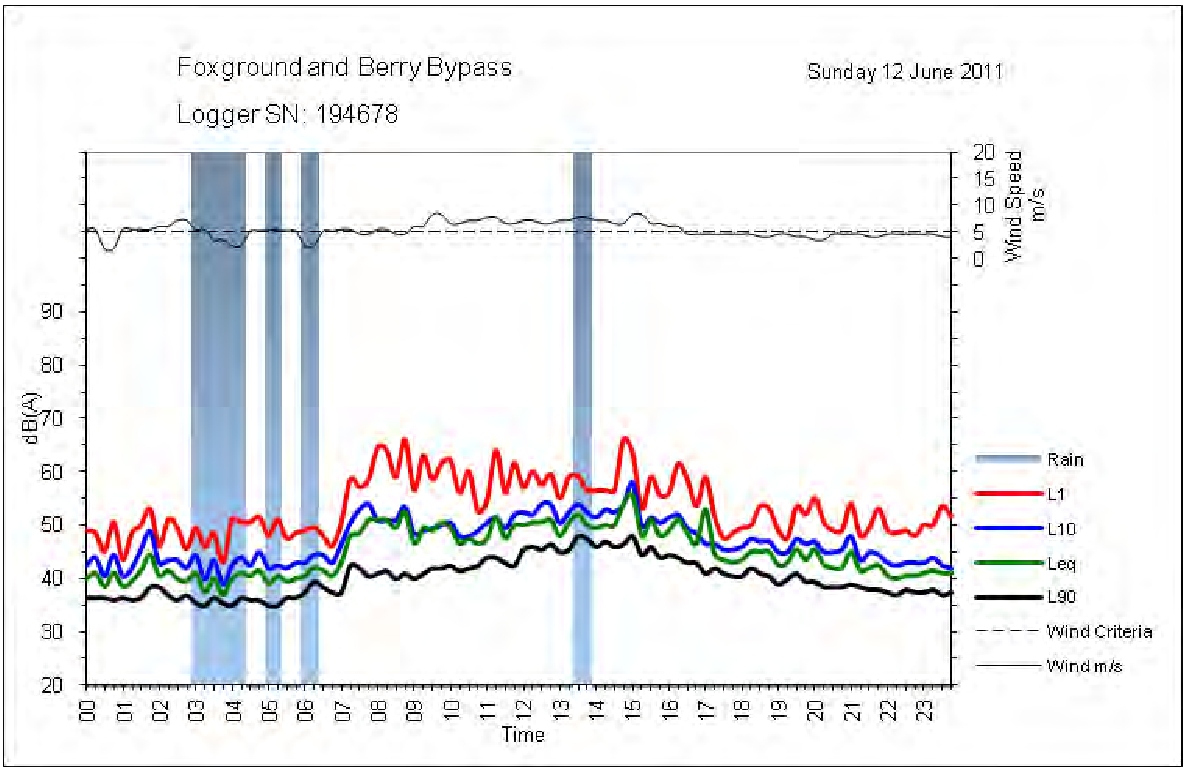

Foxground and Berry Bypass
Logger SN: 194678
Tuesday 07 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

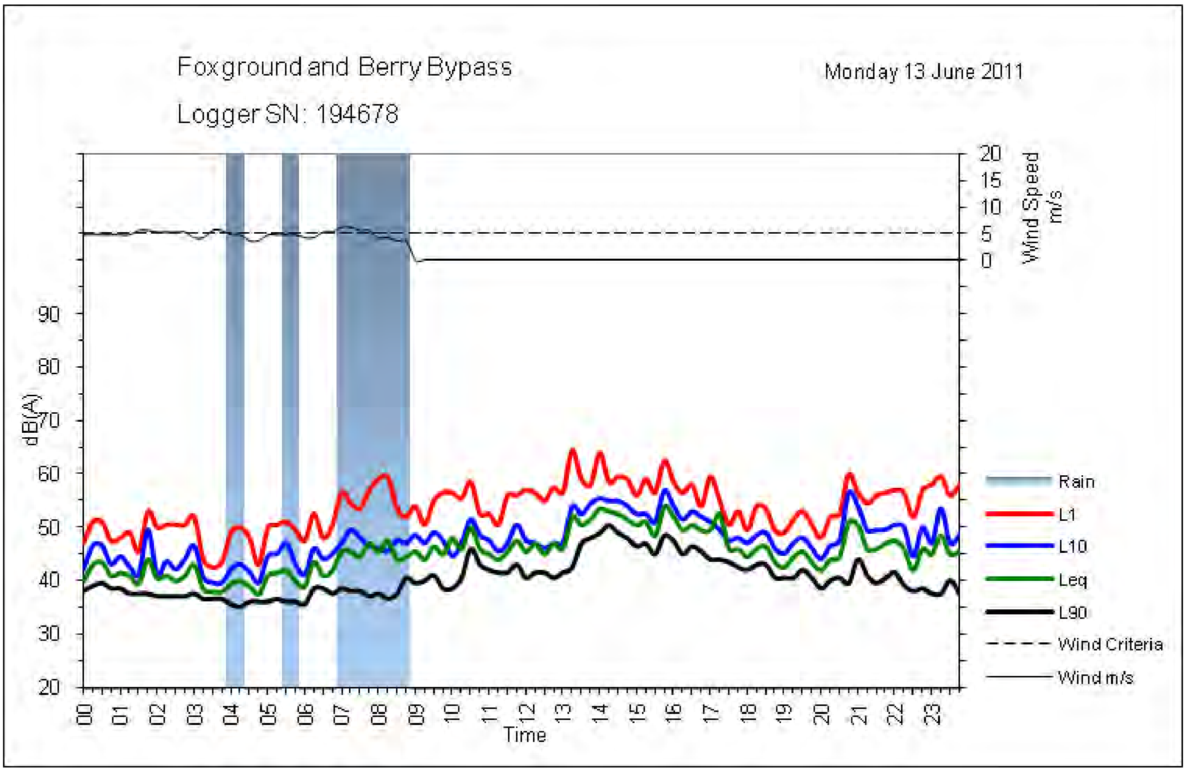

Foxground and Berry Bypass
Logger SN: 194678
Wednesday 08 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194678
Thursday 09 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194678
Friday 10 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194678
Saturday 11 June 2011
20
15
10
5
0
Wind Speed m/s
90
80
70
60
50
40
30
20
dB(A)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

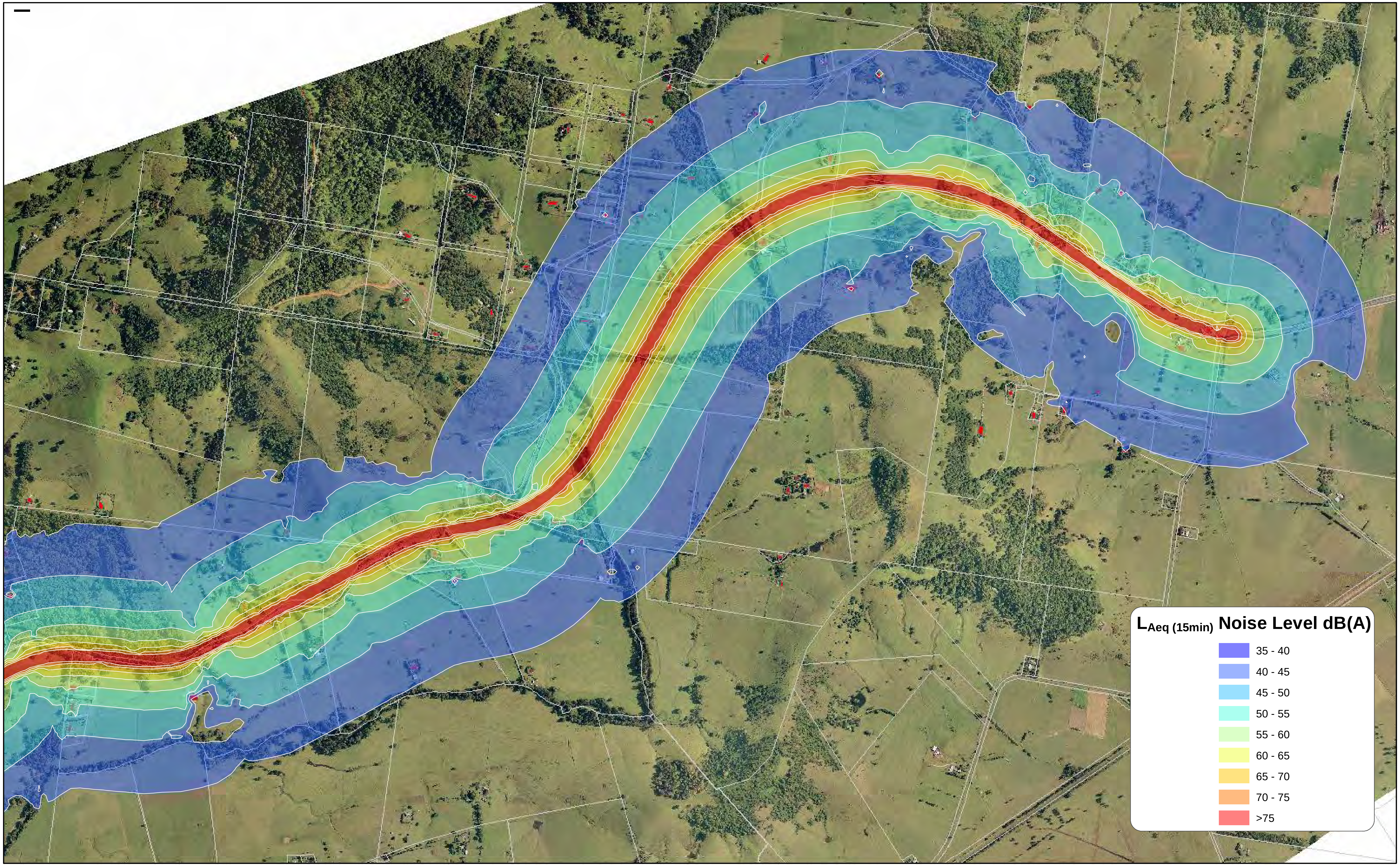

Foxground and Berry Bypass
Logger SN: 194678
Sunday 12 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Foxground and Berry Bypass
Logger SN: 194678
Monday 13 June 2011
dB(A)
20
30
40
50
60
70
80
90
Wind Speed m/s
0
5
10
15
20
Time
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

Appendix F

Construction noise contours (standard scenario)

AECOM



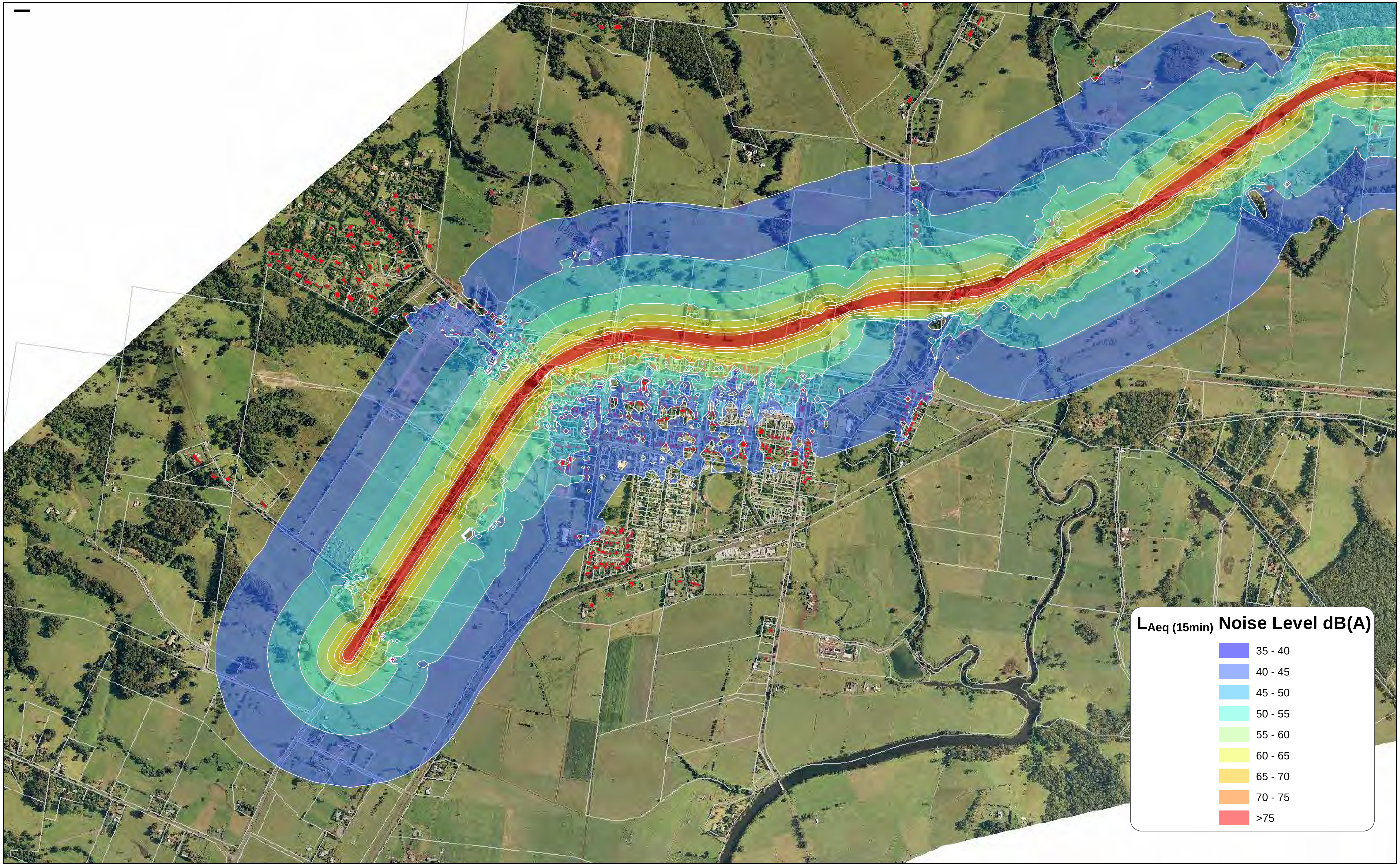
FOXGROUND AND BERRY BYPASS

Bored Piling Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



FOXGROUND AND BERRY BYPASS

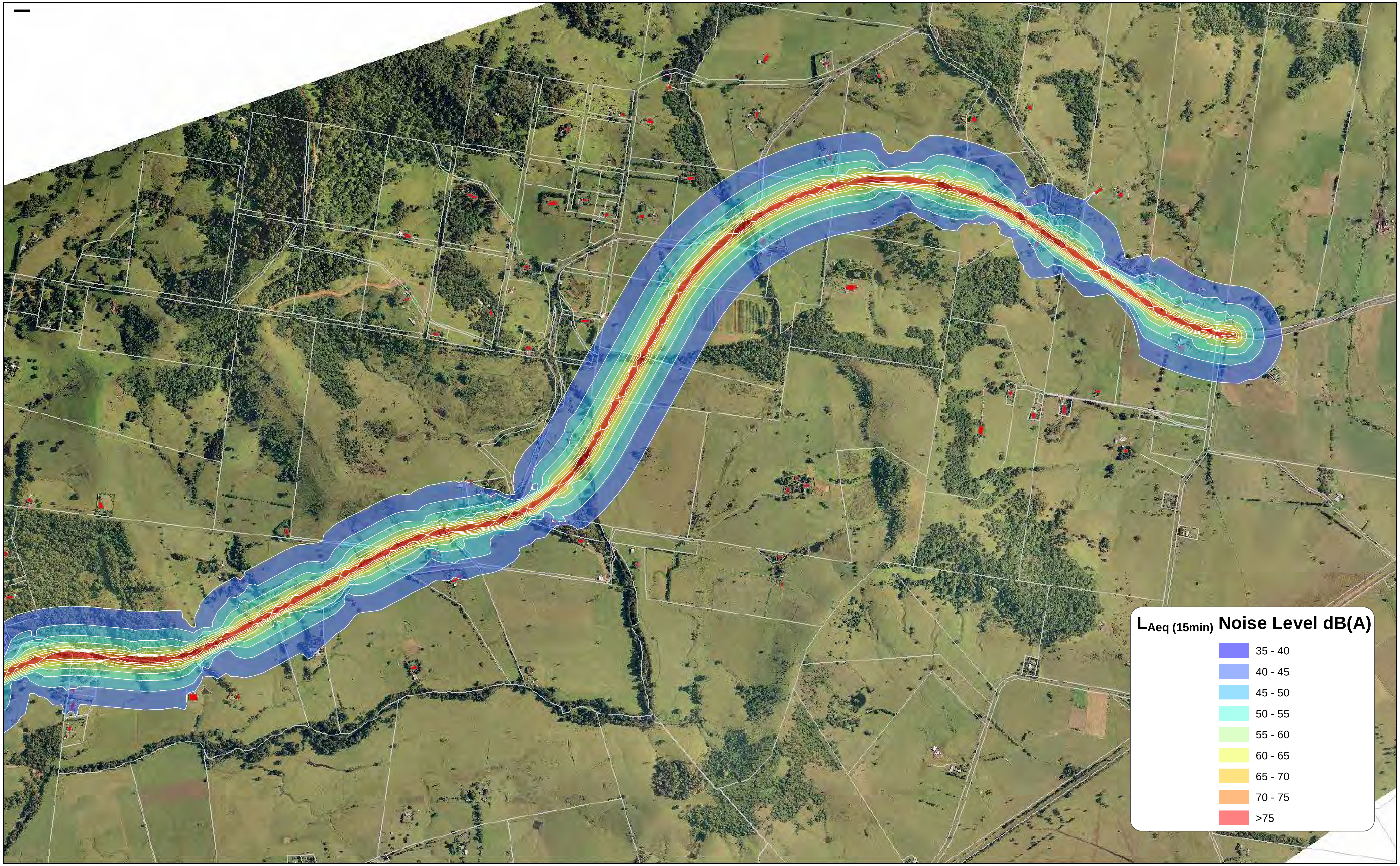
Bored Piling Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



FOXGROUND AND BERRY BYPASS

Bored Piling Works - Maximum Noise Levels

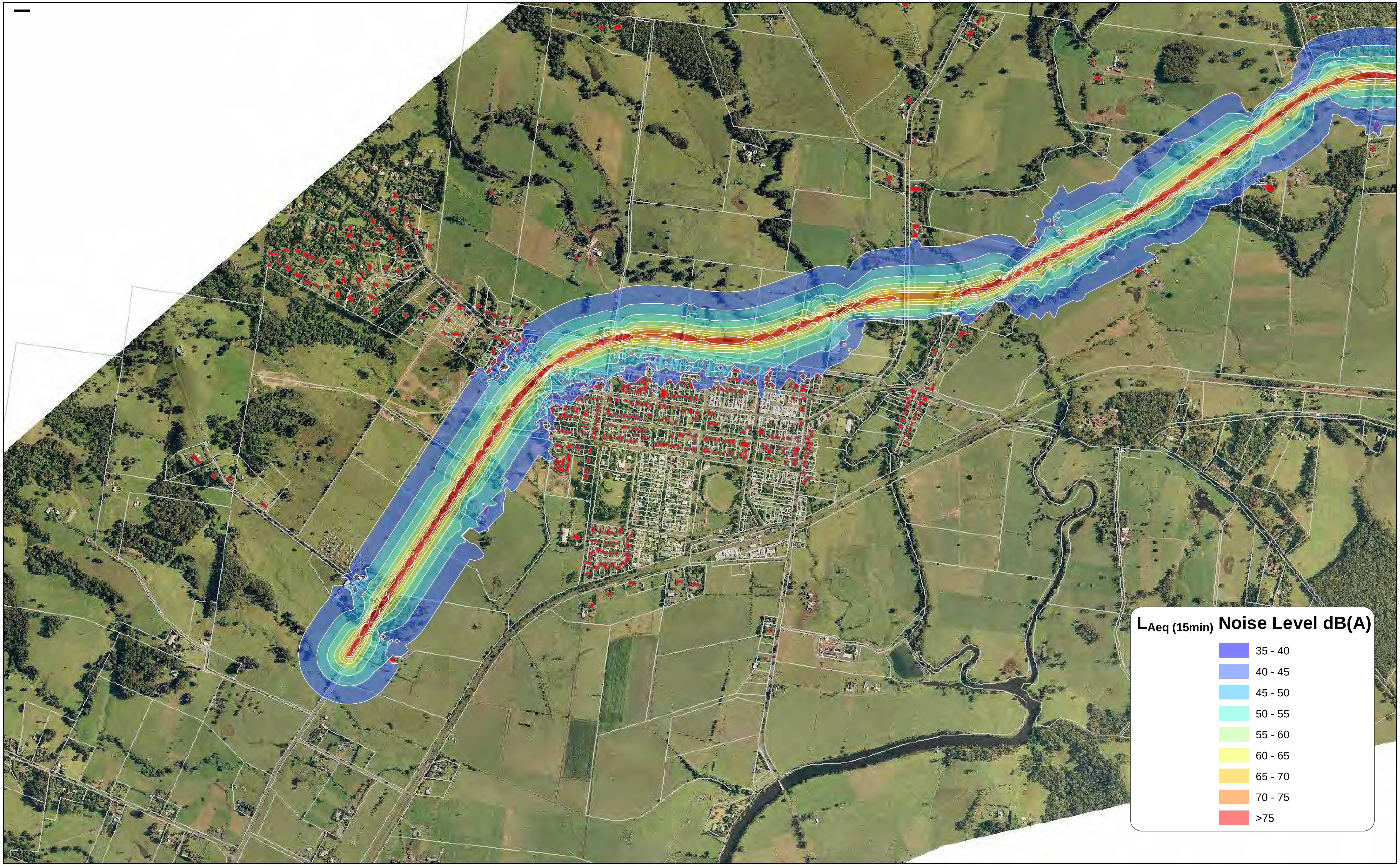
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



FOXGROUND AND BERRY BYPASS

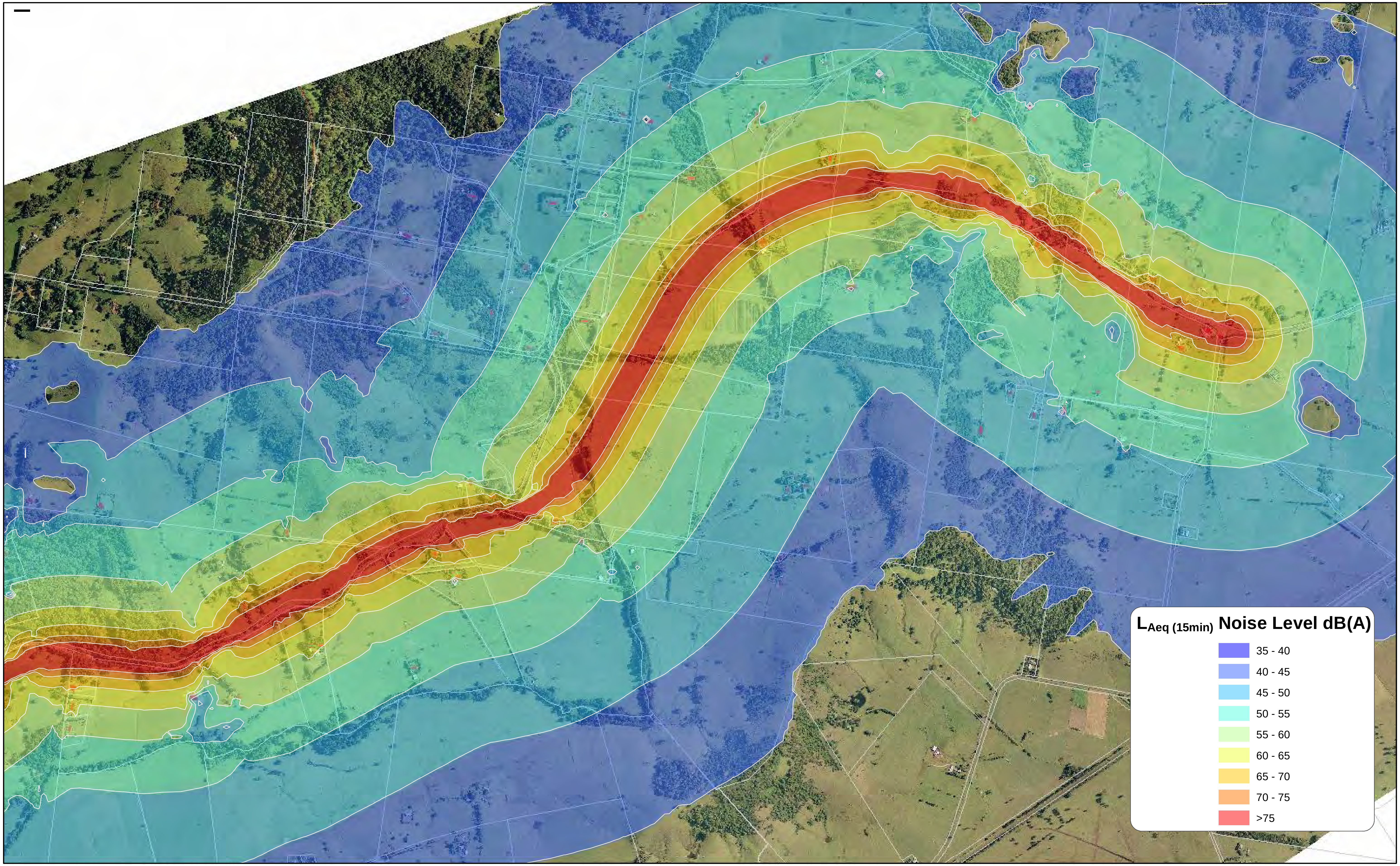
Bored Piling Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



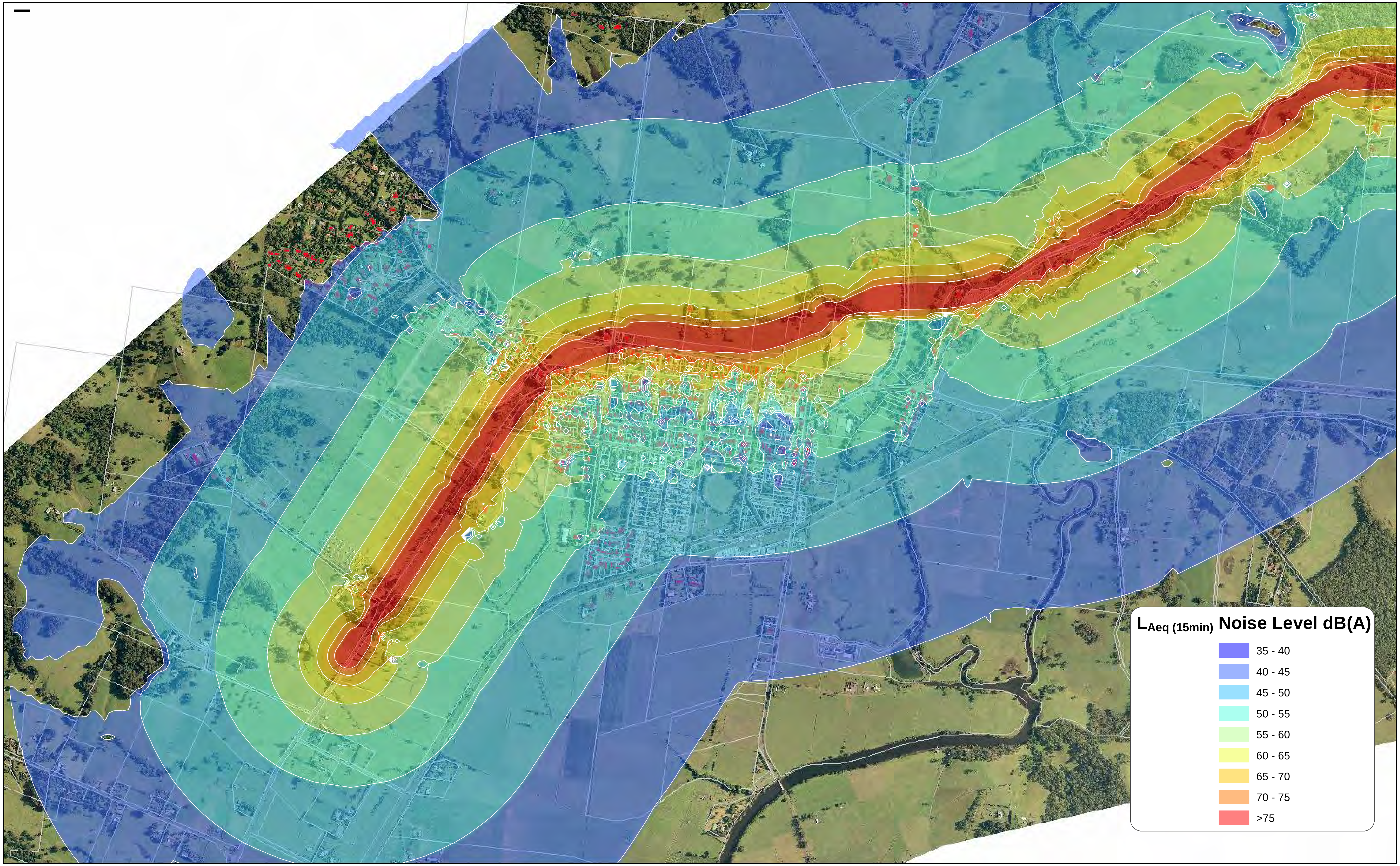
FOXGROUND AND BERRY BYPASS

Bridge Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



FOXGROUND AND BERRY BYPASS

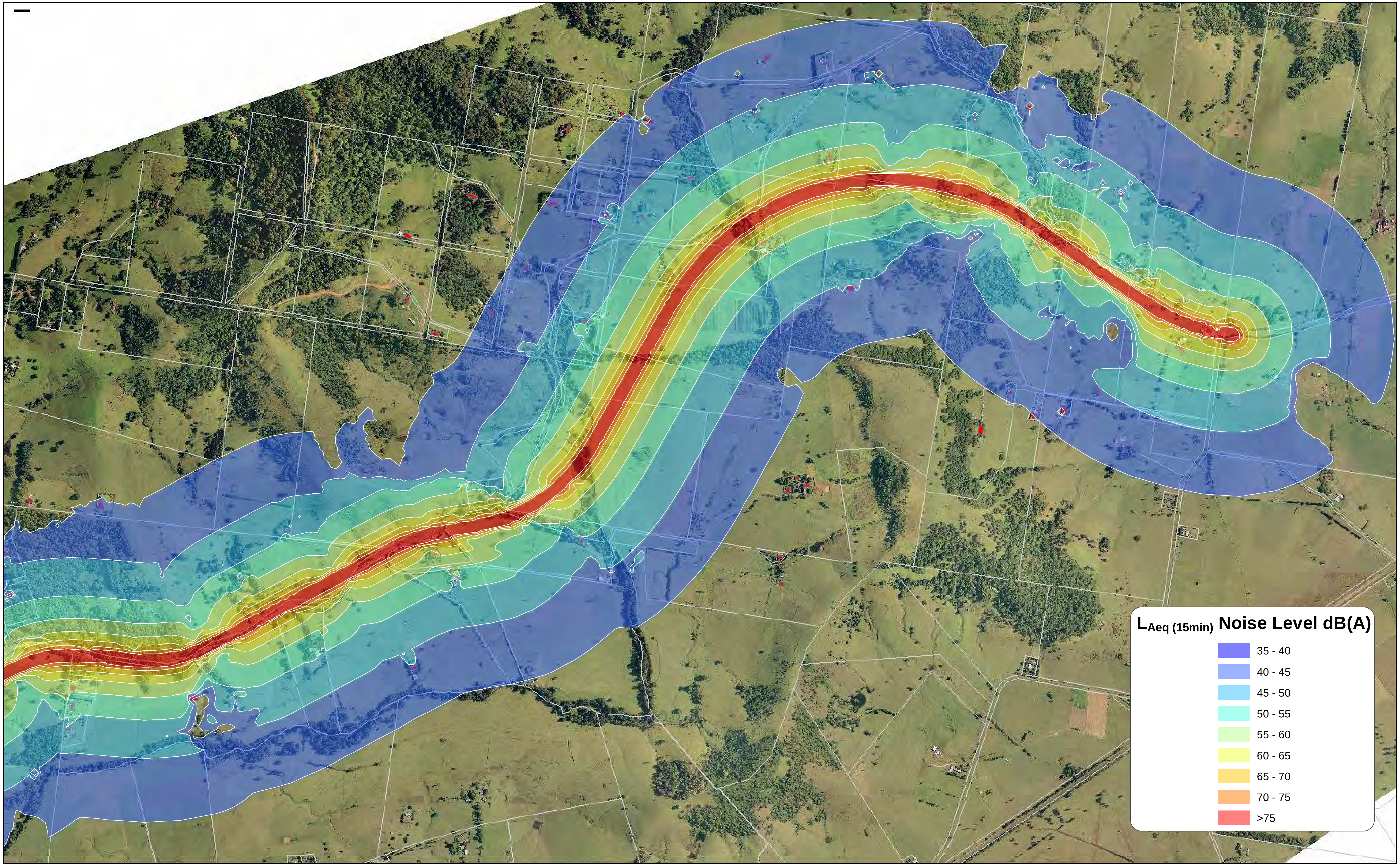
Bridge Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000
m



FOXGROUND AND BERRY BYPASS

Bridge Works - Typical Noise Levels

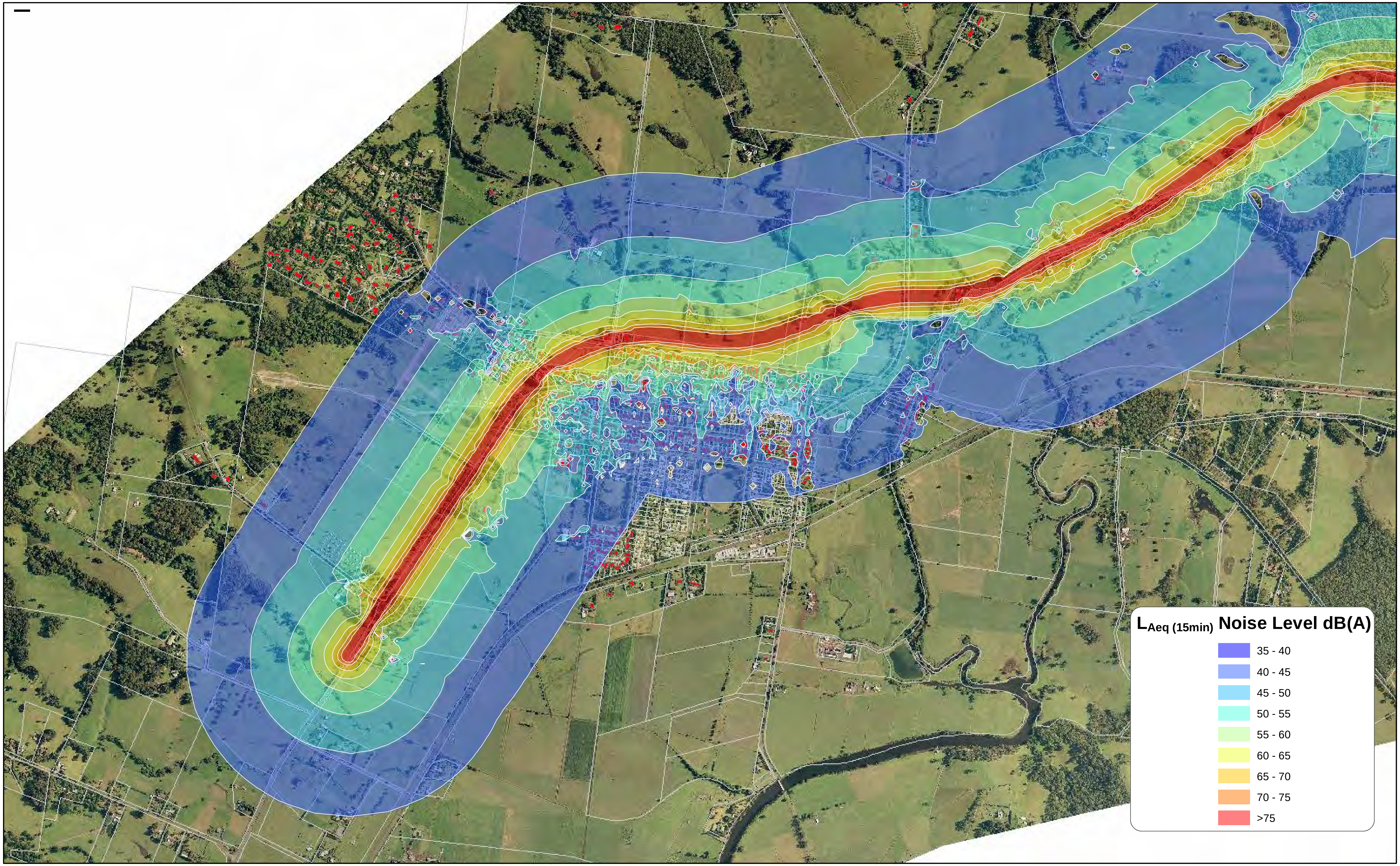
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



FOXGROUND AND BERRY BYPASS

Bridge Works - Typical Noise Levels

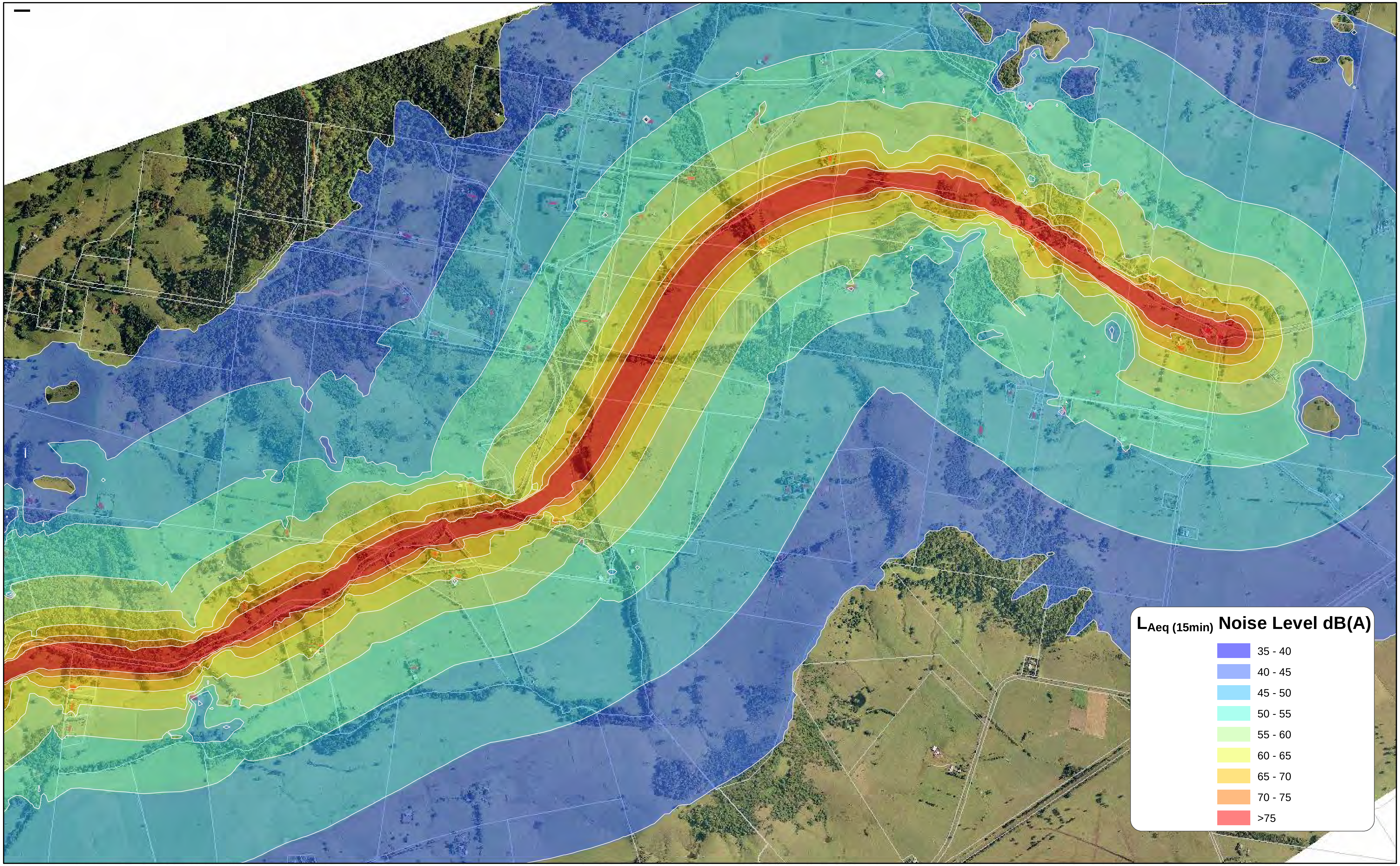
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



FOXGROUND AND BERRY BYPASS

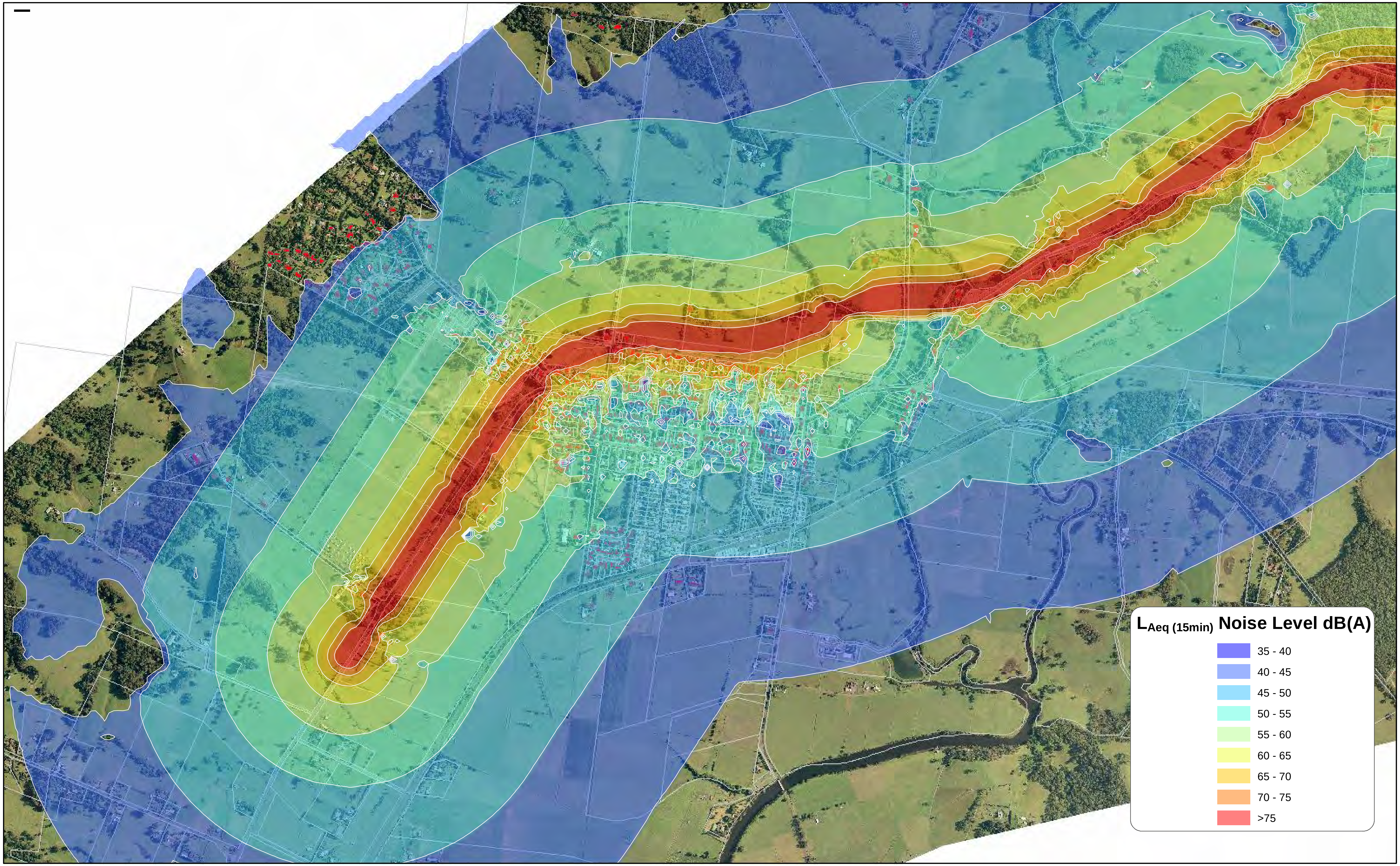
Earthworks - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



FOXGROUND AND BERRY BYPASS

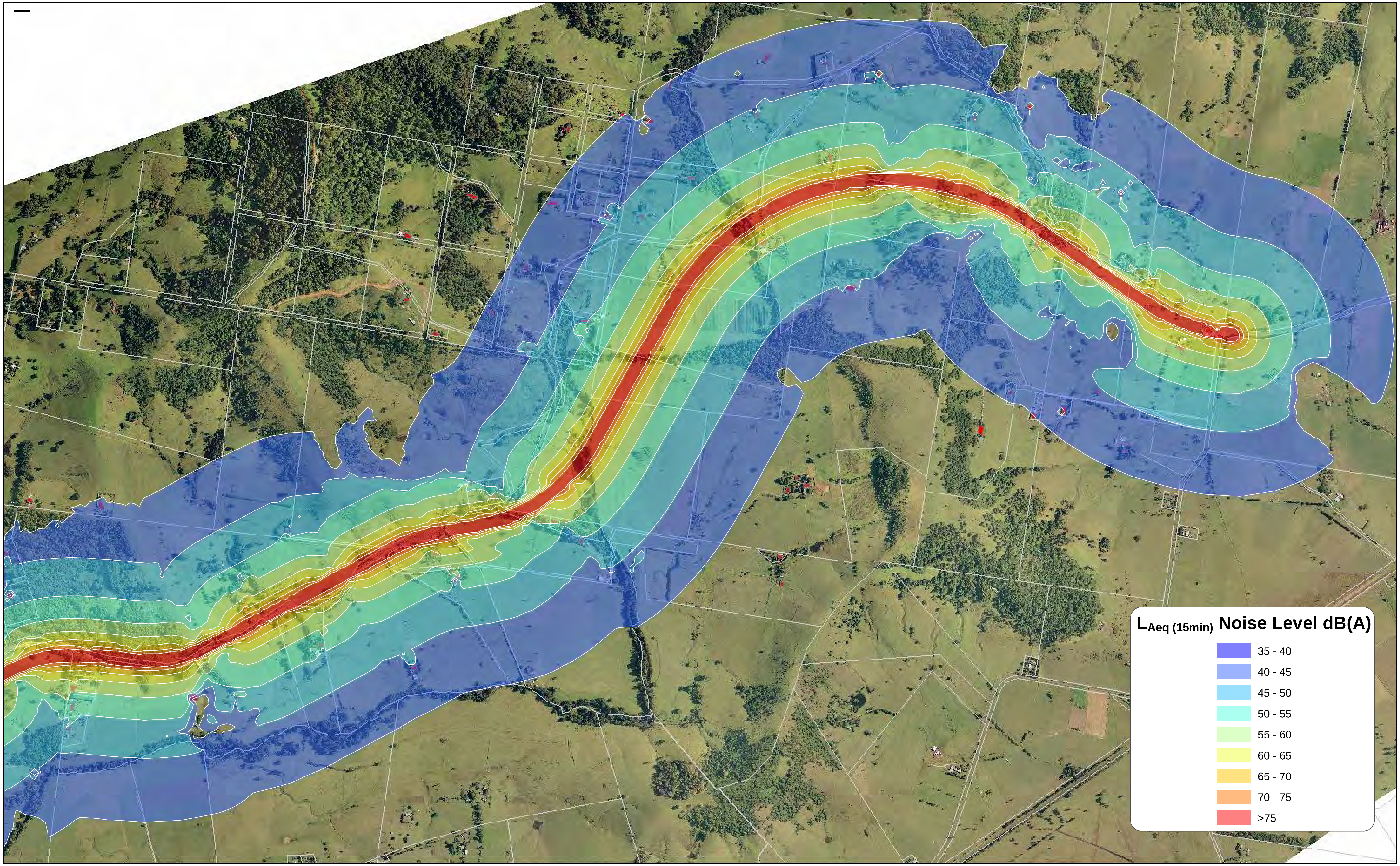
Earthworks - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



FOXGROUND AND BERRY BYPASS

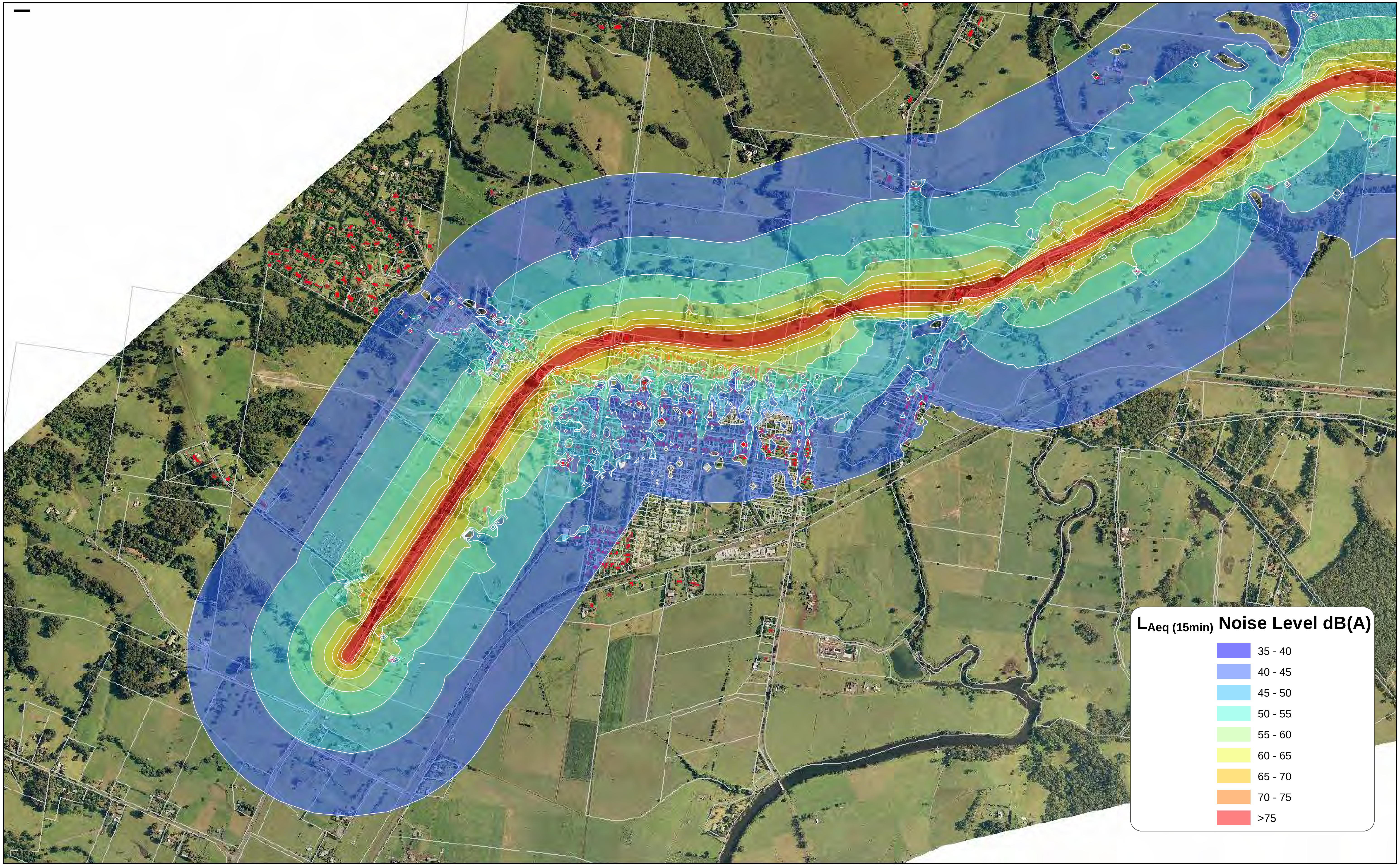
Earthworks - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



FOXGROUND AND BERRY BYPASS

Earthworks - Typical Noise Levels

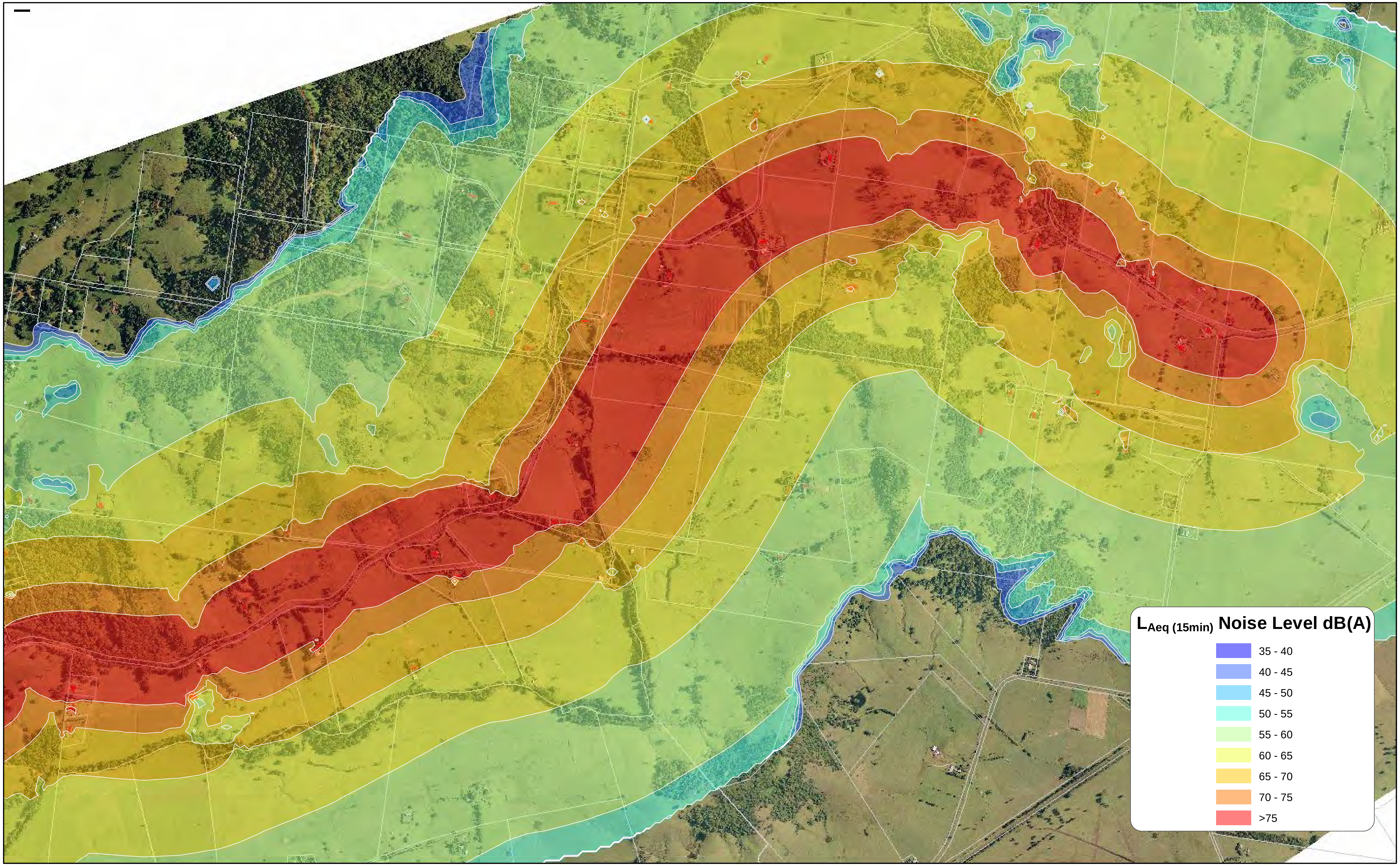
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



FOXGROUND AND BERRY BYPASS

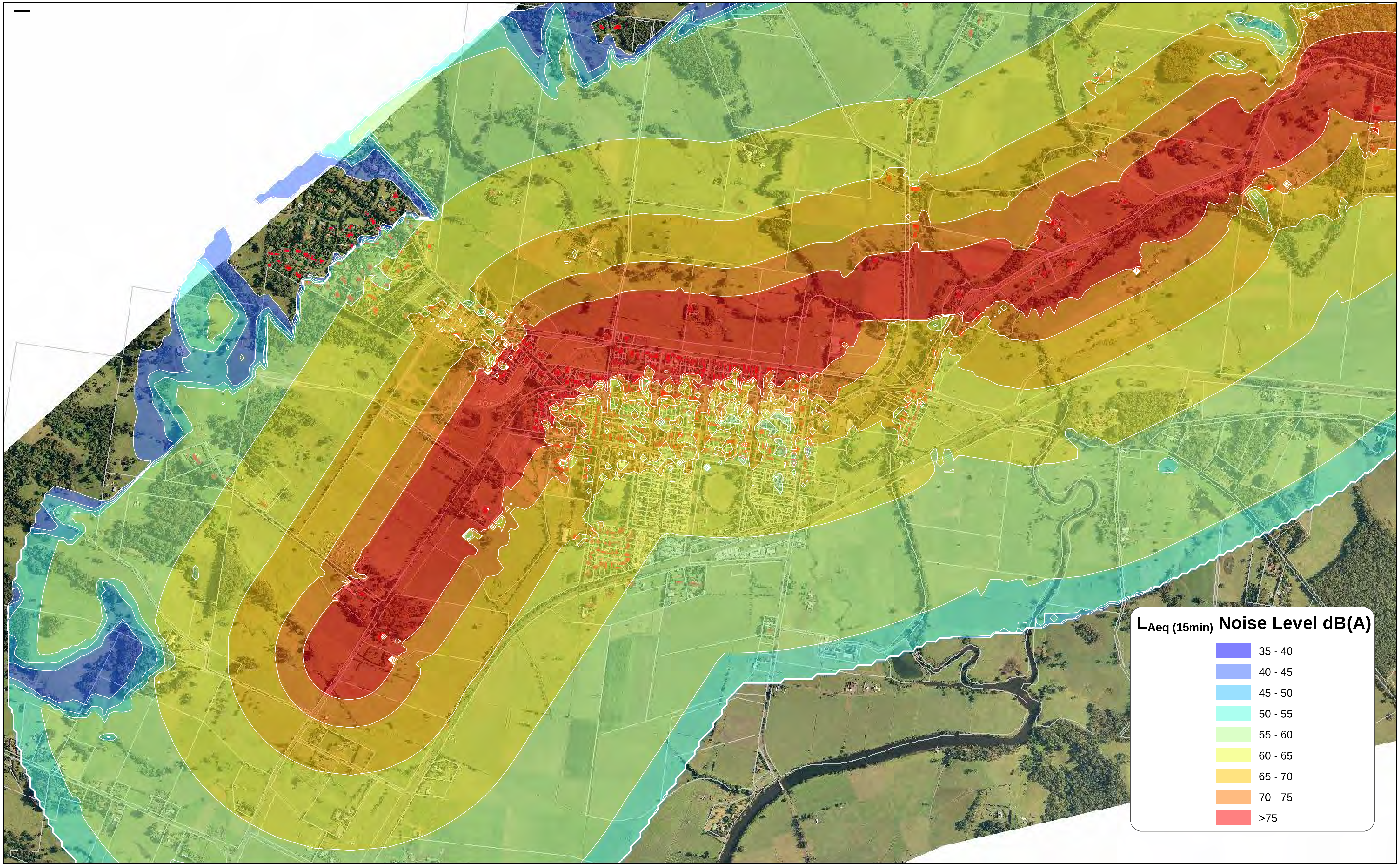
Impact Piling Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



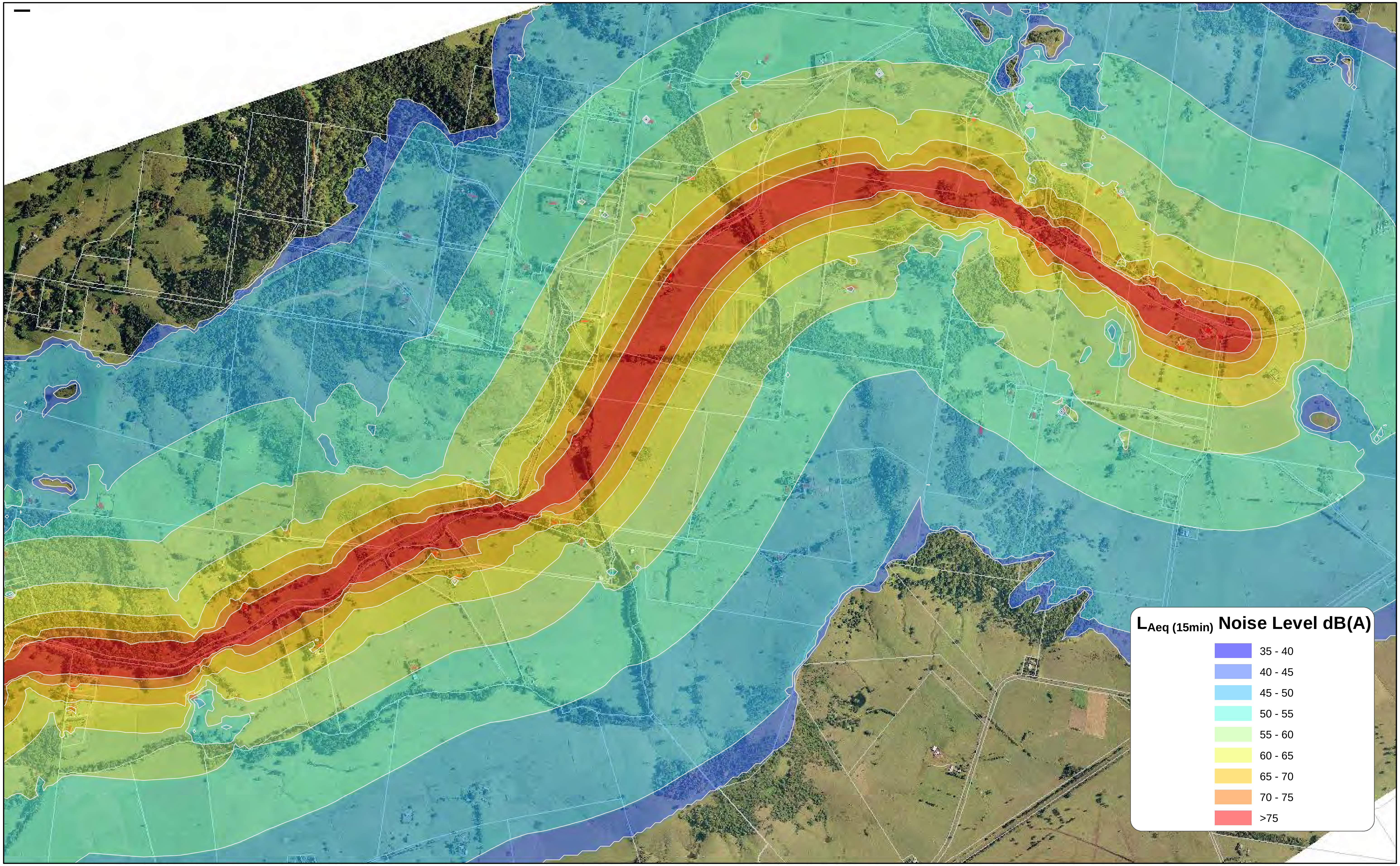
FOXGROUND AND BERRY BYPASS

Impact Piling Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



FOXGROUND AND BERRY BYPASS

Impact Piling Works - Typical Noise Levels

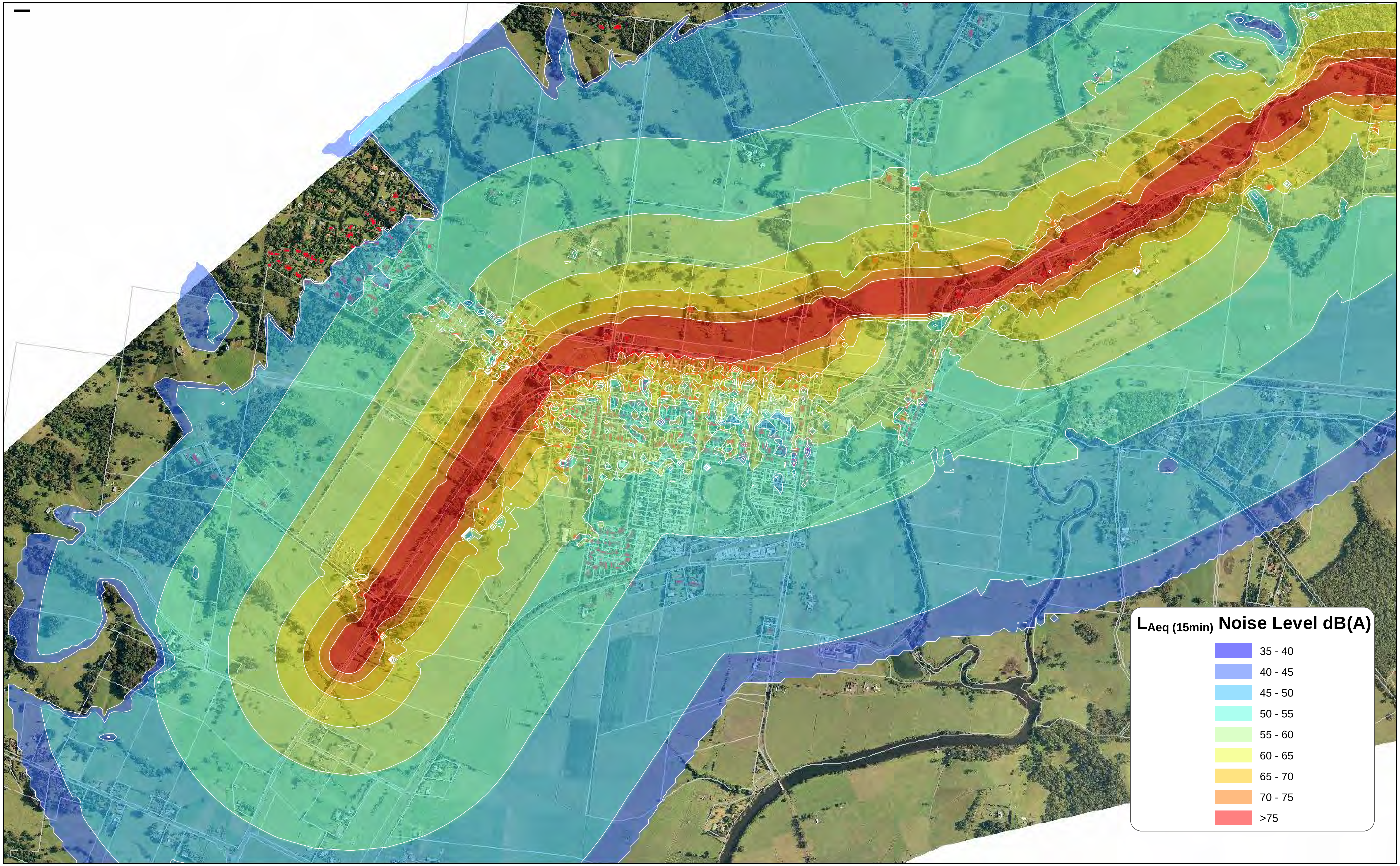
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



FOXGROUND AND BERRY BYPASS

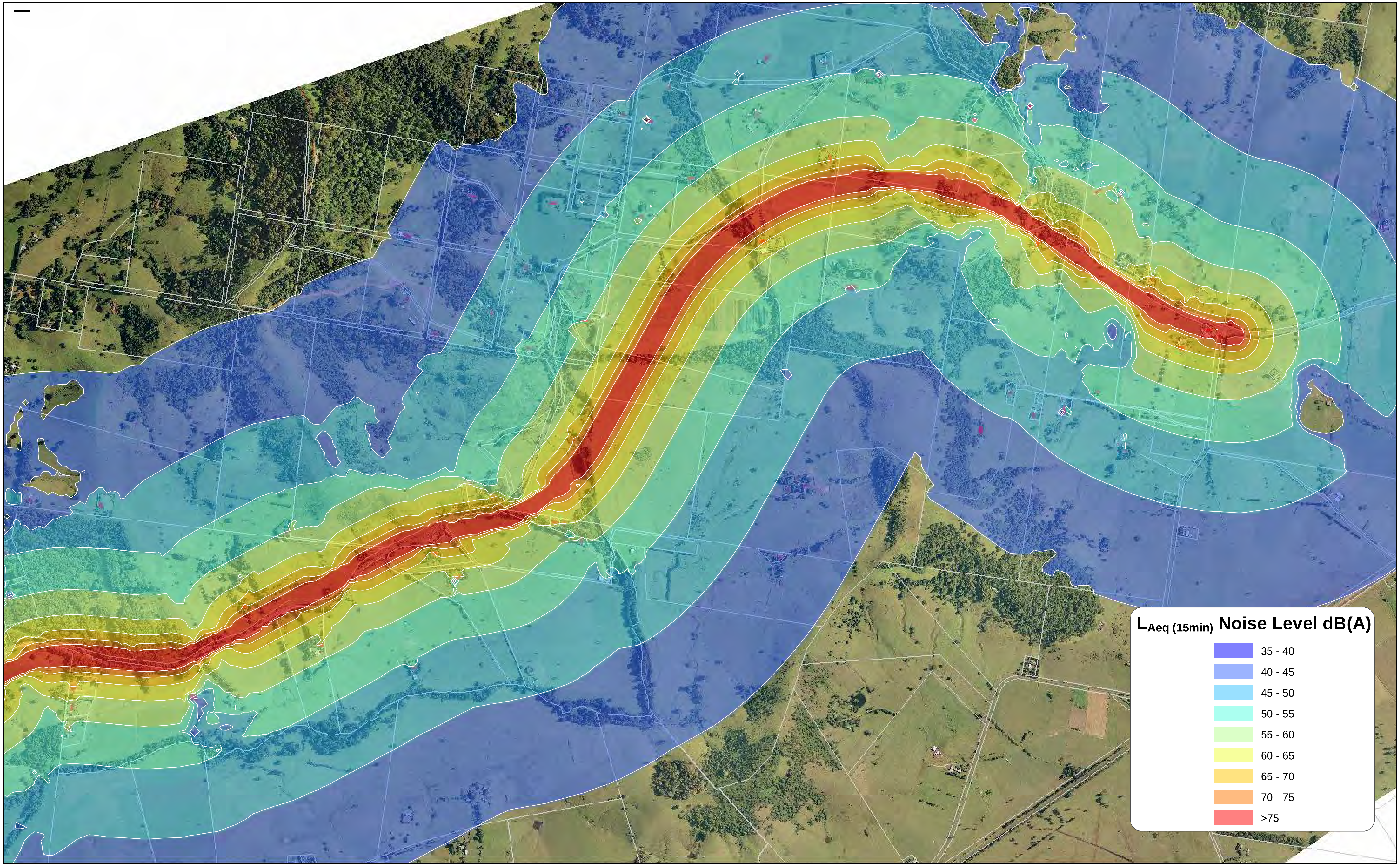
Impact Piling Works - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



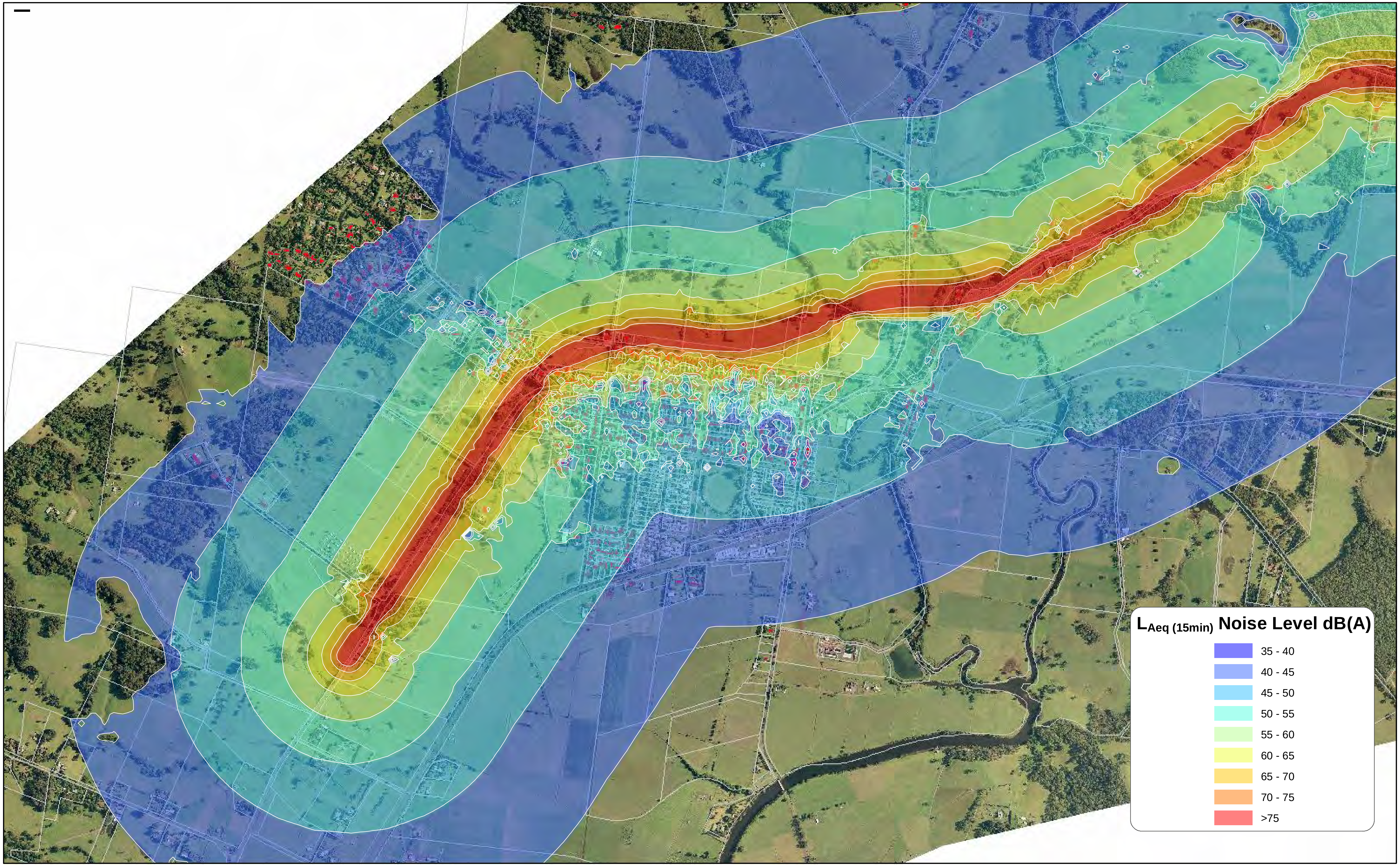
FOXGROUND AND BERRY BYPASS

Paving Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



FOXGROUND AND BERRY BYPASS

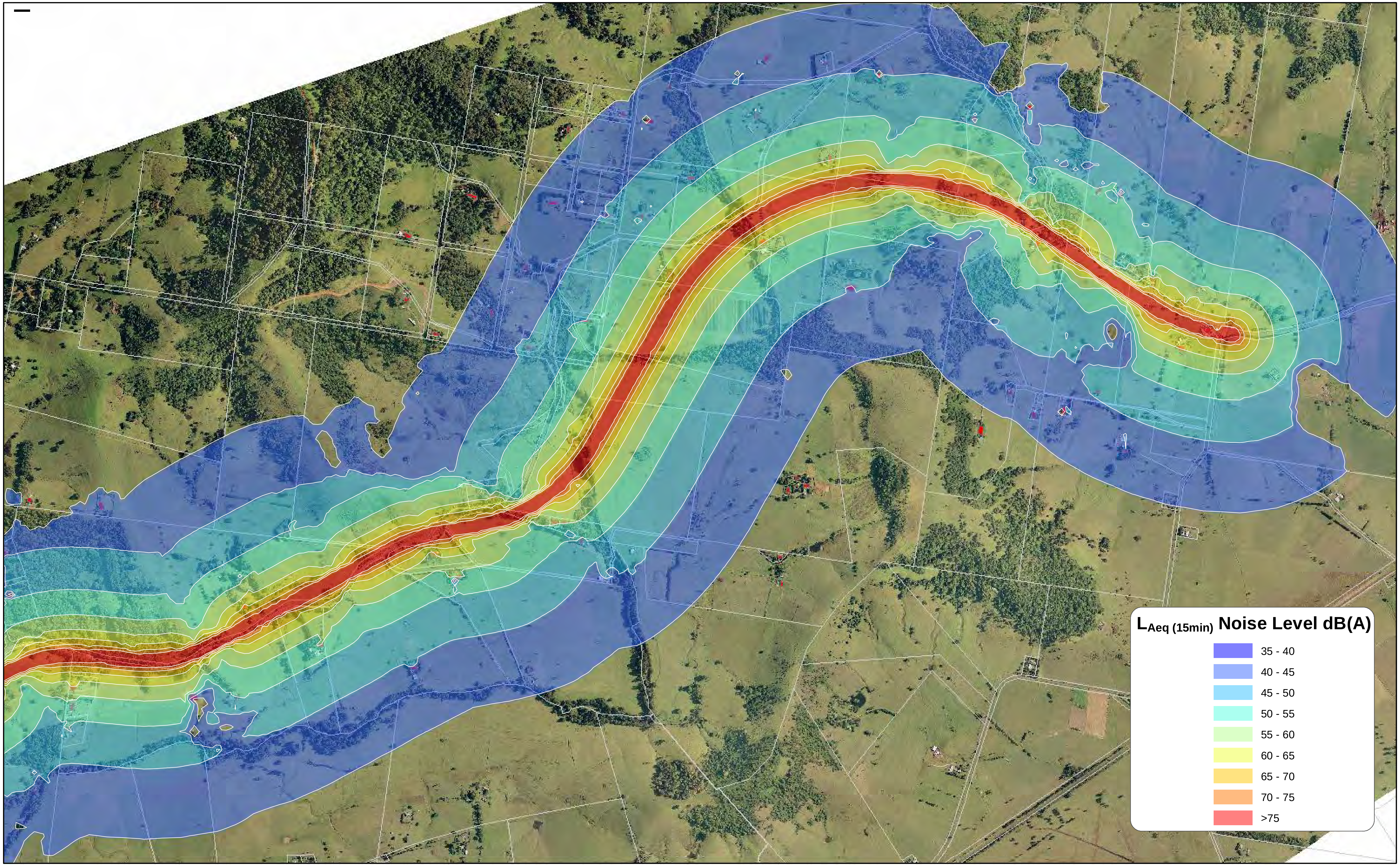
Paving Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



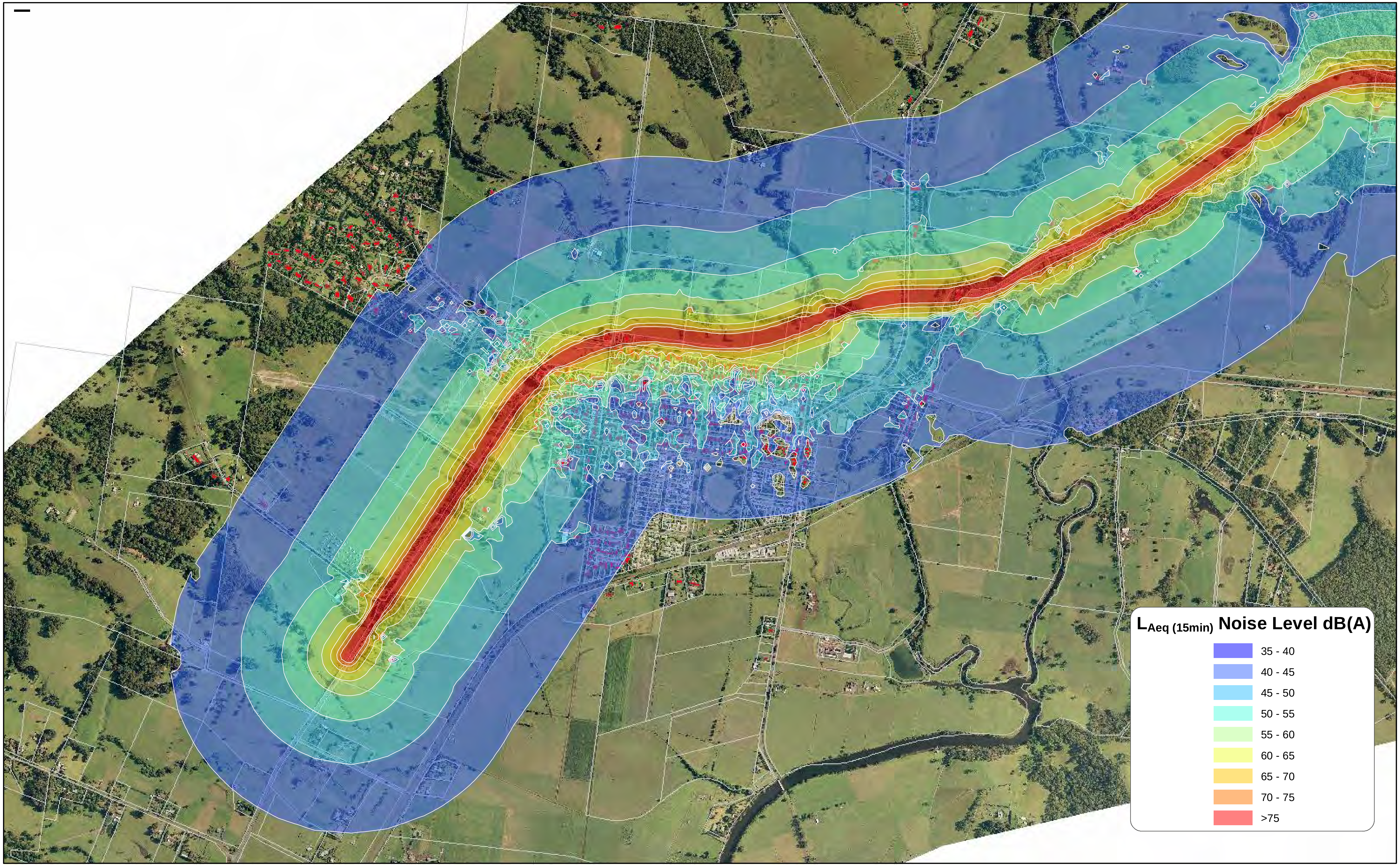
FOXGROUND AND BERRY BYPASS

Paving Works - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



FOXGROUND AND BERRY BYPASS

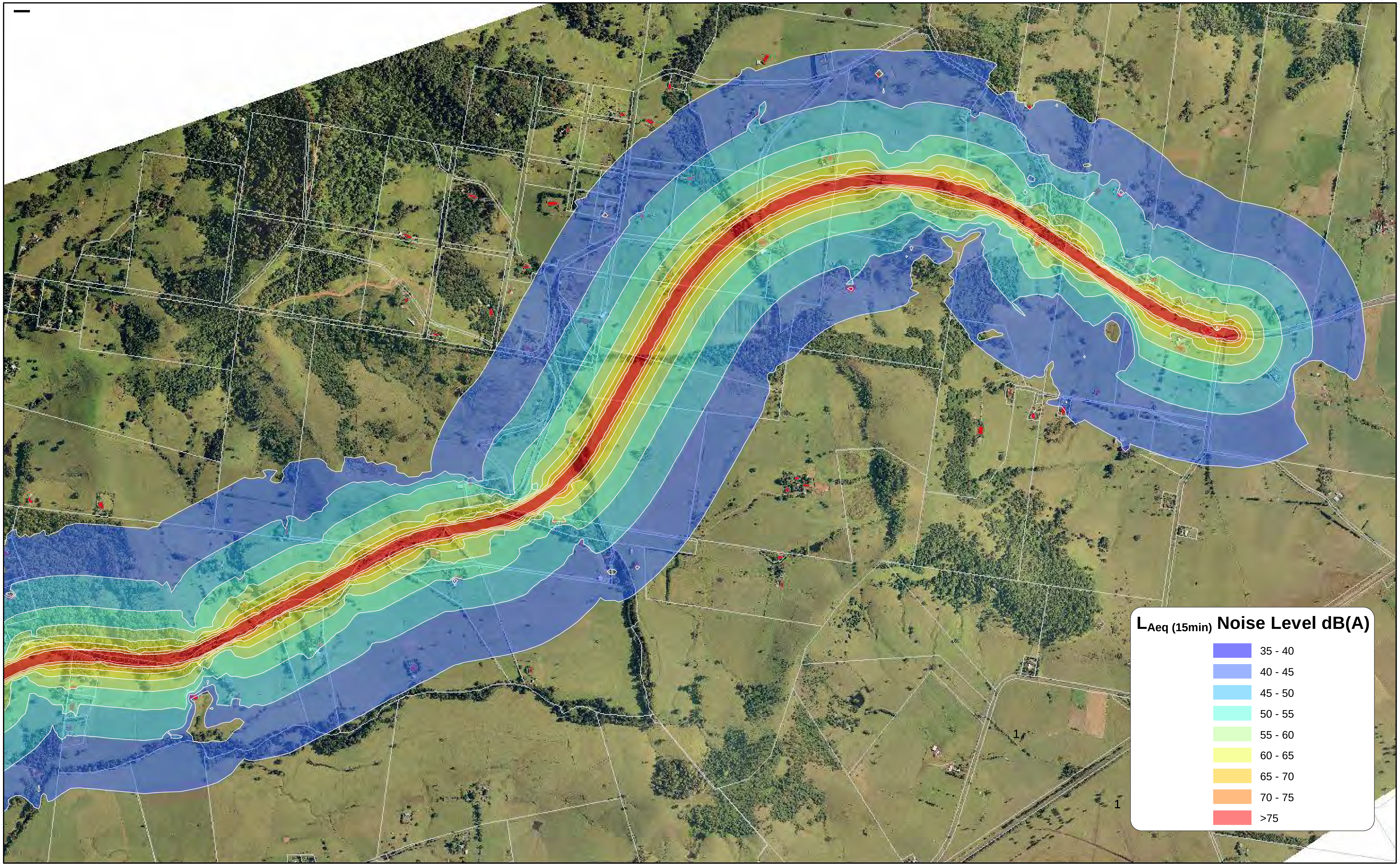
Paving Works - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



FOXGROUND AND BERRY BYPASS

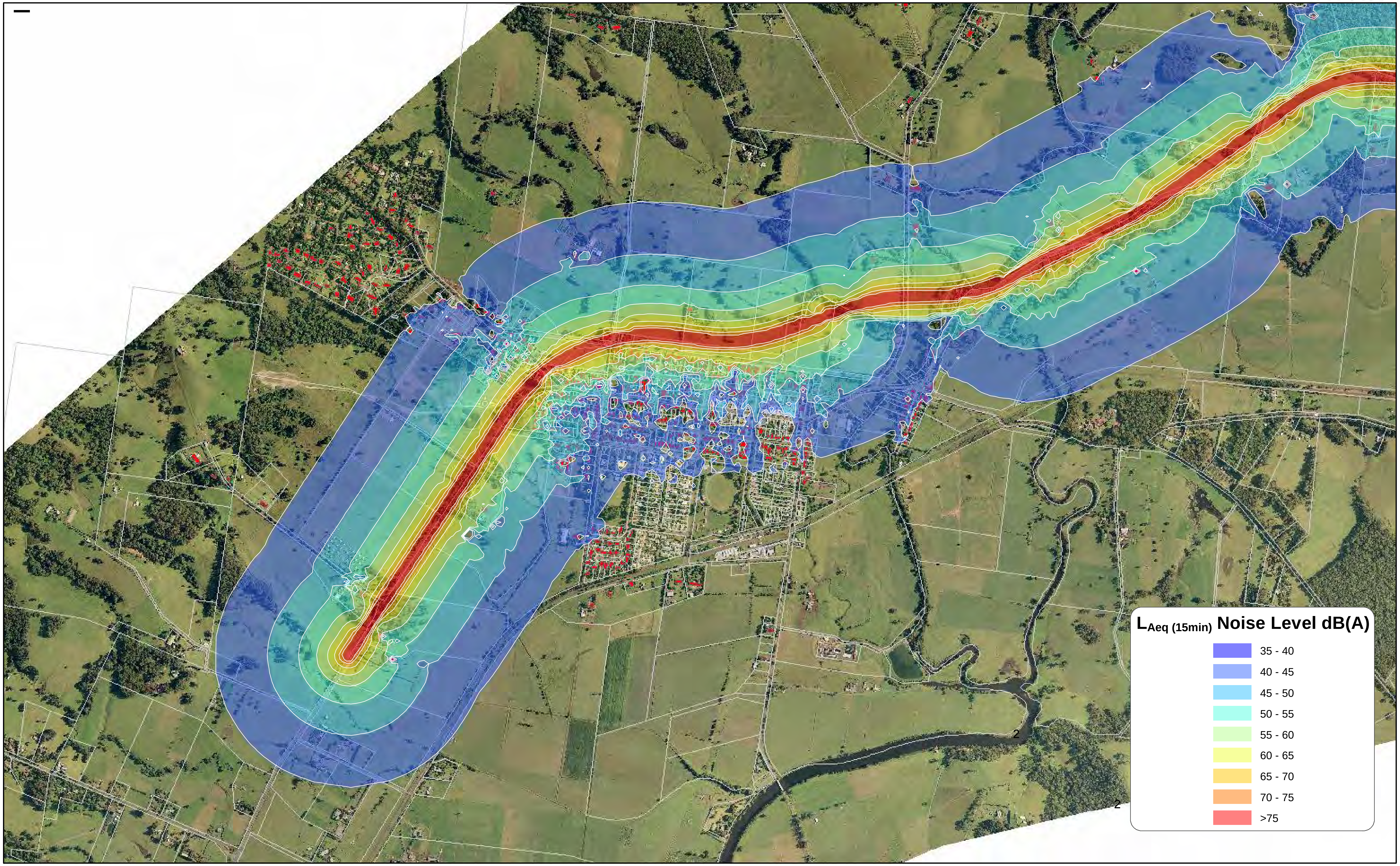
Site Establishment Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



FOXGROUND AND BERRY BYPASS

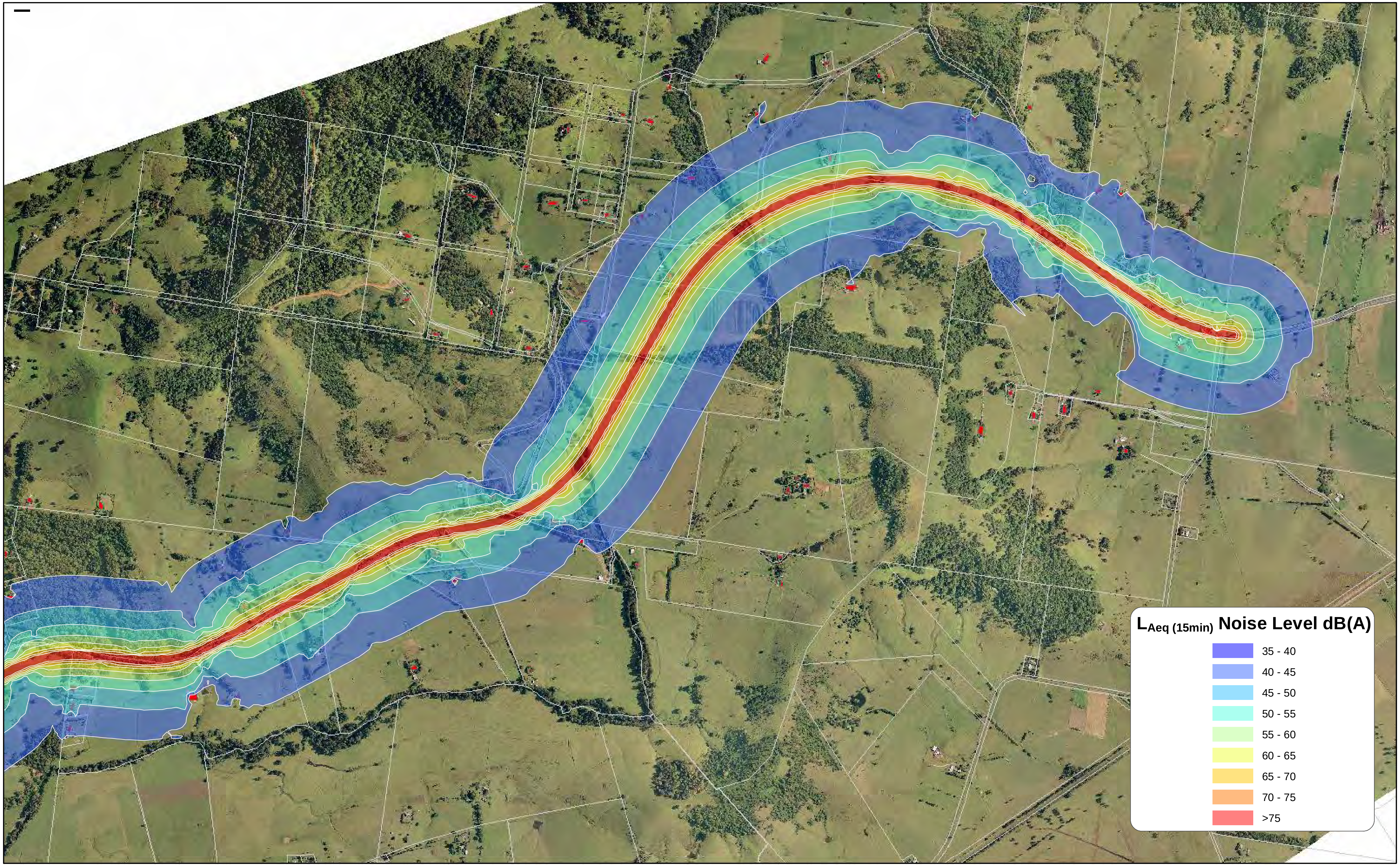
Site Establishment Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000
m



FOXGROUND AND BERRY BYPASS

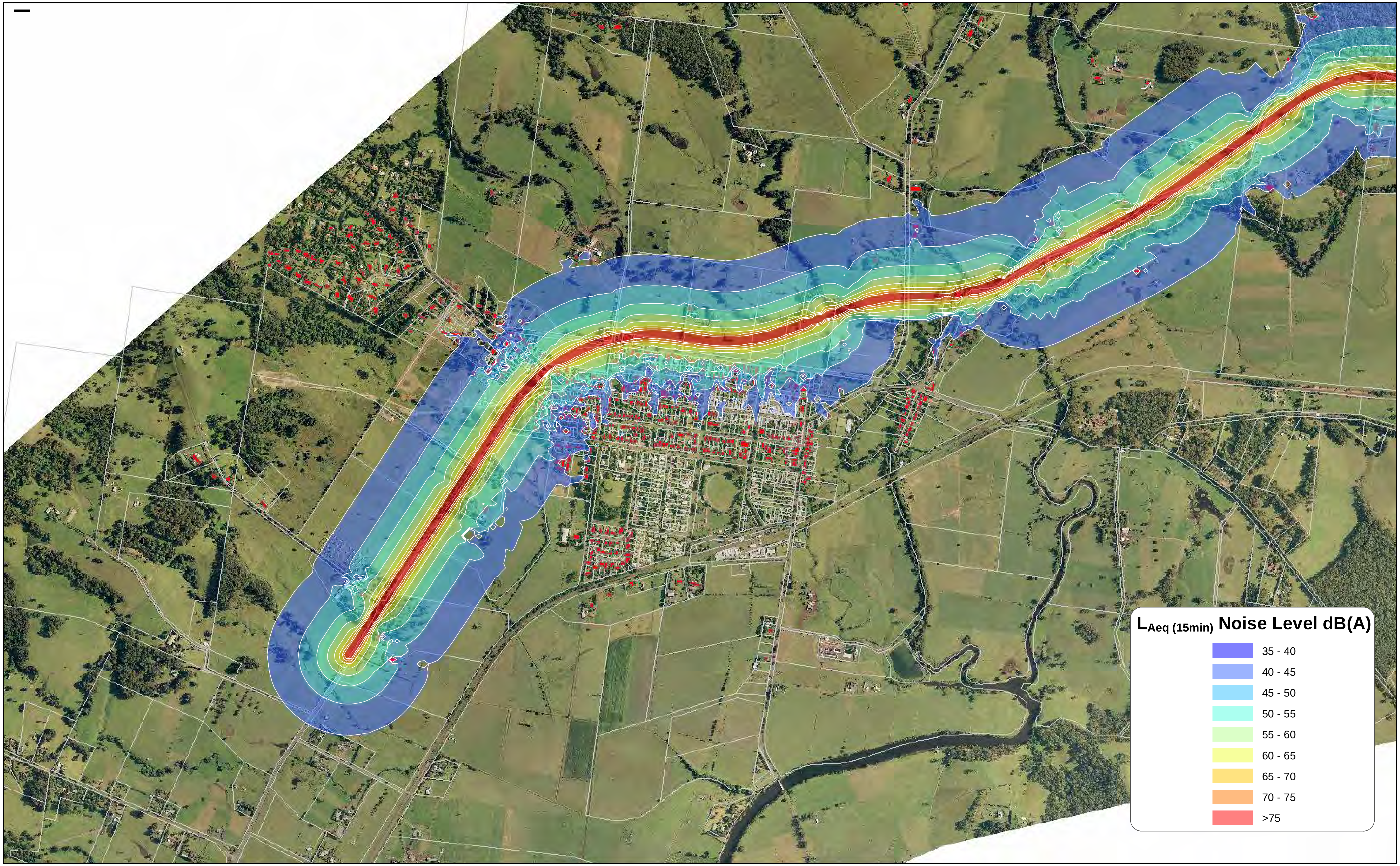
Site Establishment Works - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



FOXGROUND AND BERRY BYPASS

Site Establishment Works - Typical Noise Levels

Source: AECOM (2011)

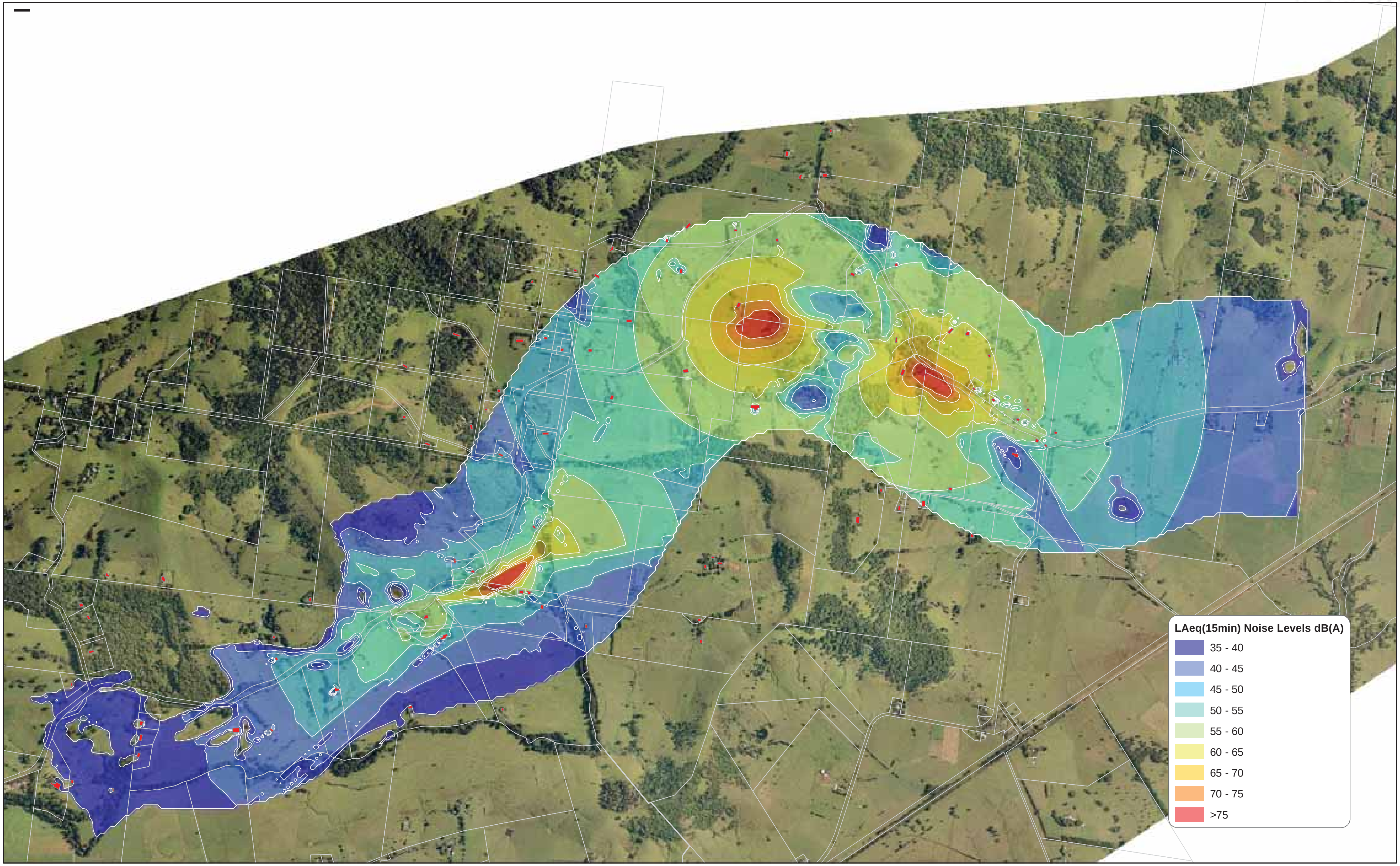
JAN 2012

60021933

0 250 500 1,000 m

Appendix G

Construction noise contours (specific works)



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

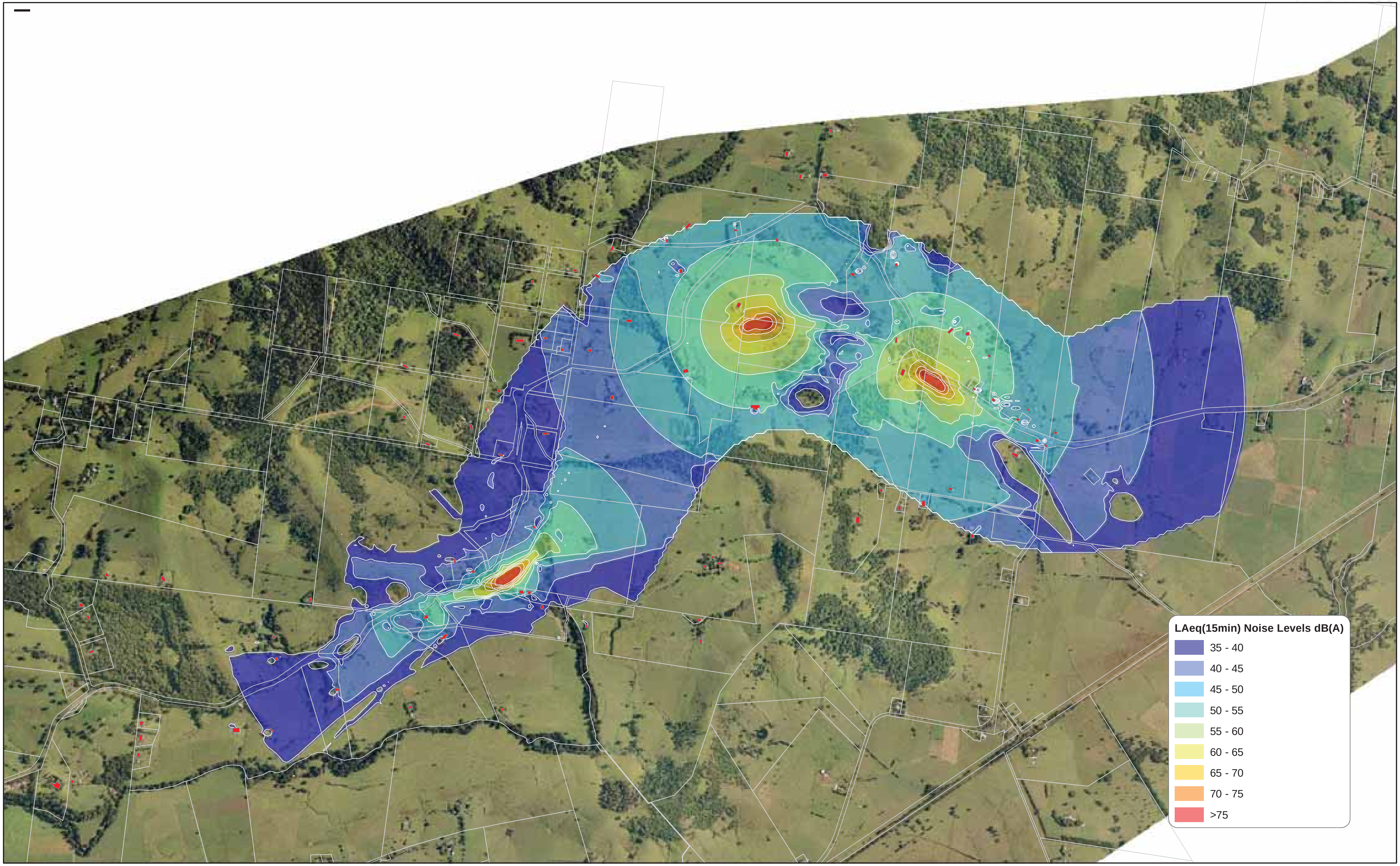
Access Underpass Works - Maximum Noise Levels

Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

60021933



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

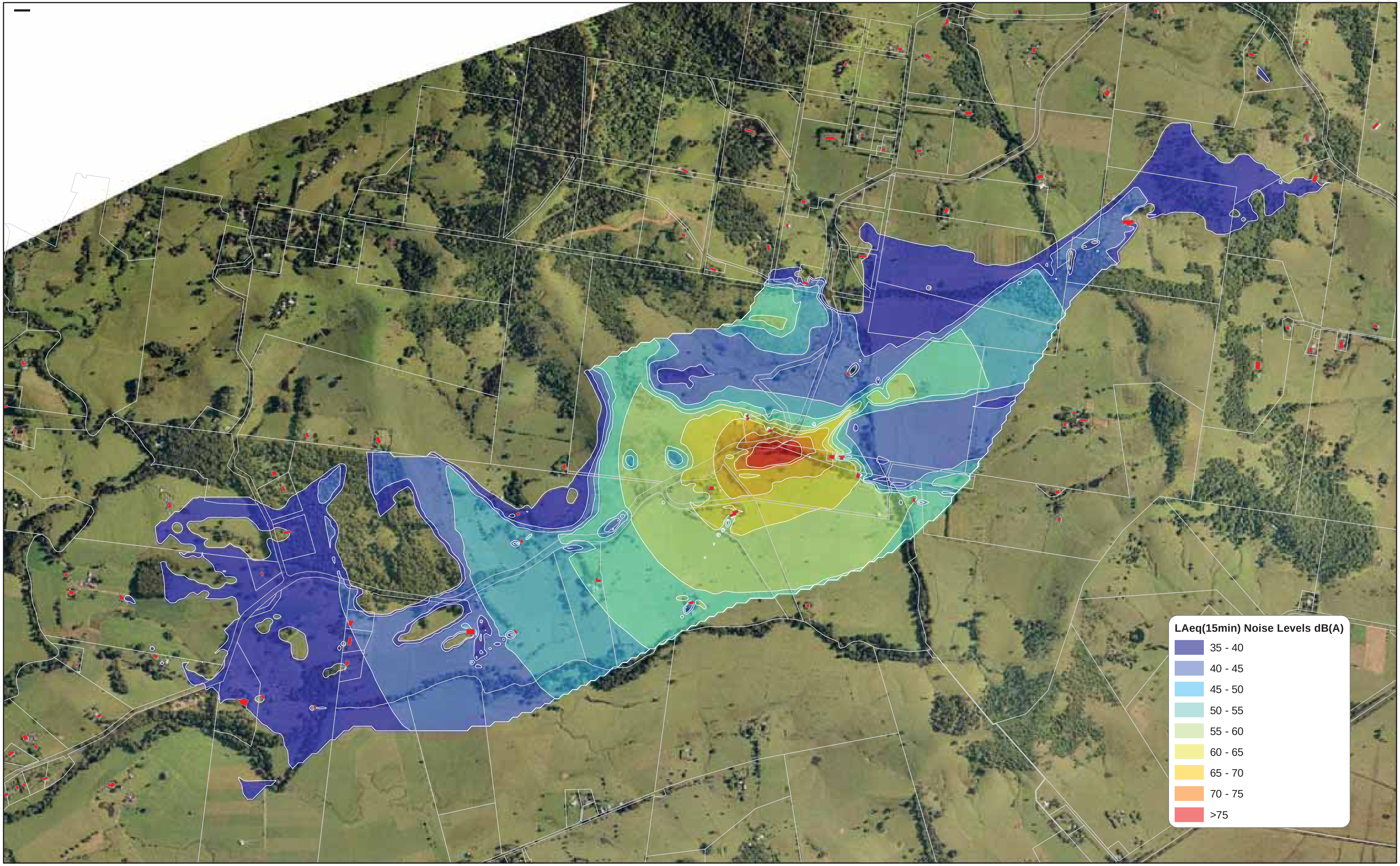
Access Underpass Works - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

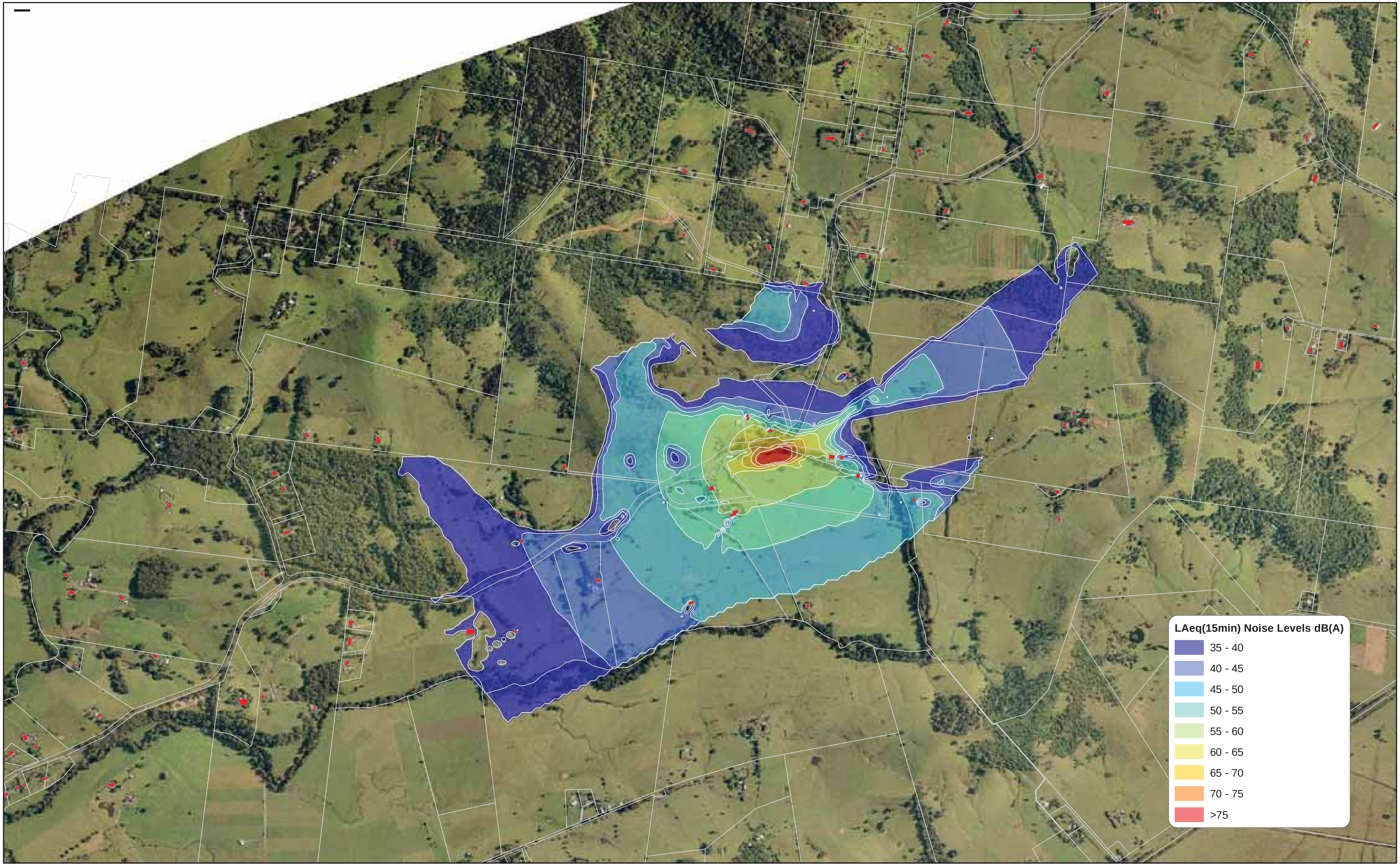
Austral Park Interchange - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Austral Park Interchange - Typical Noise Levels

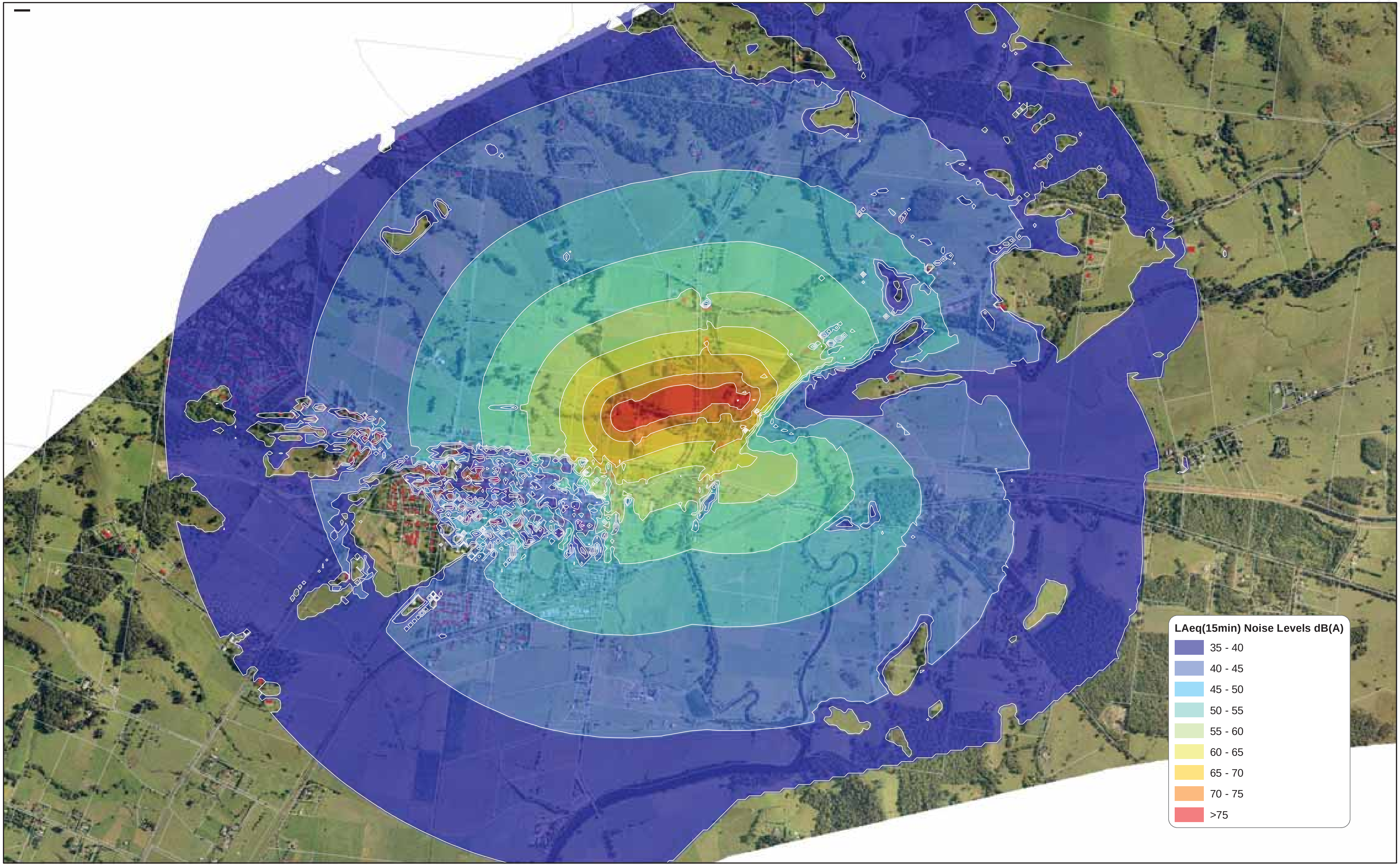
Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

60021933

AECOM



FOXGROUND AND BERRY BYPASS

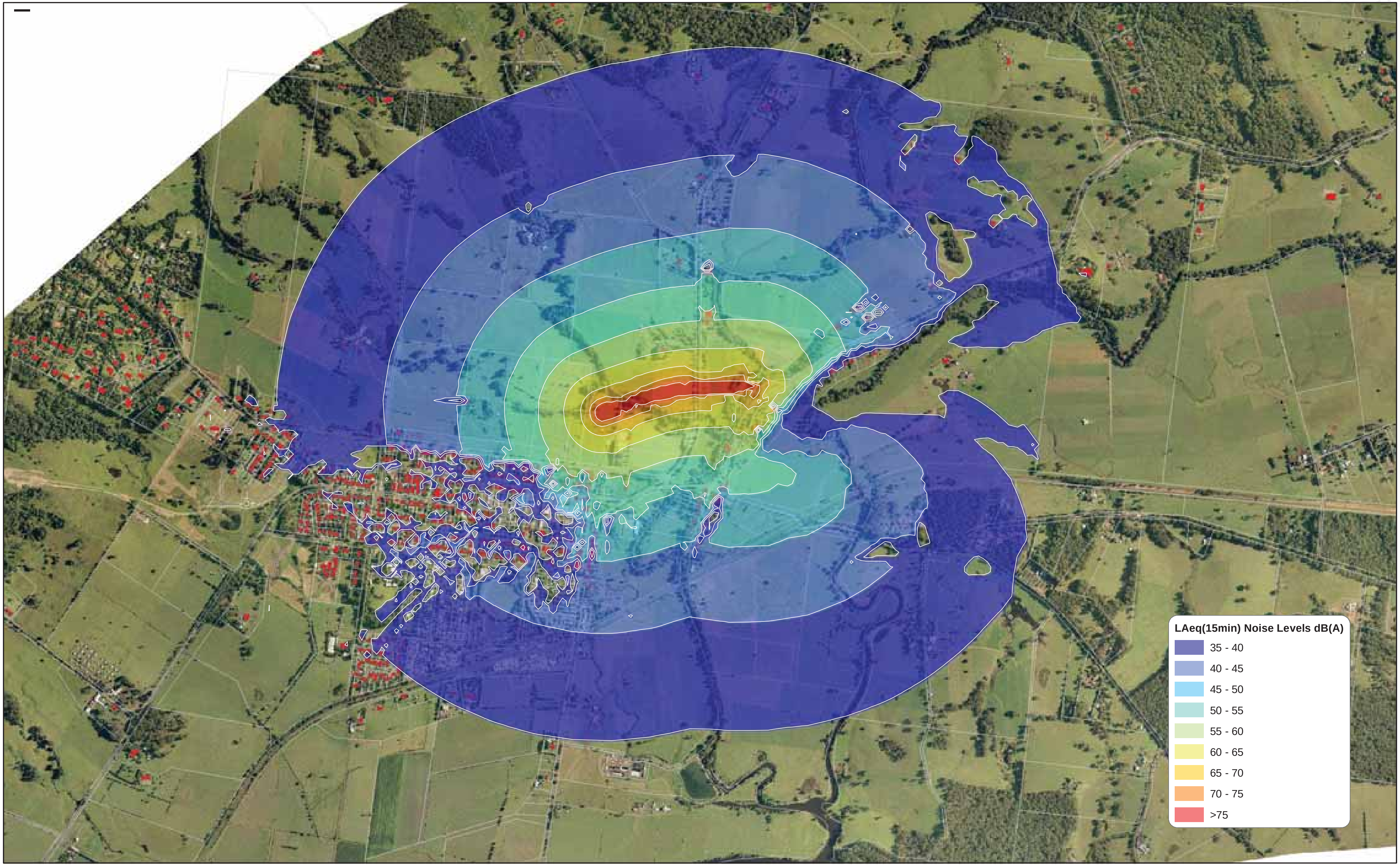
Berry - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



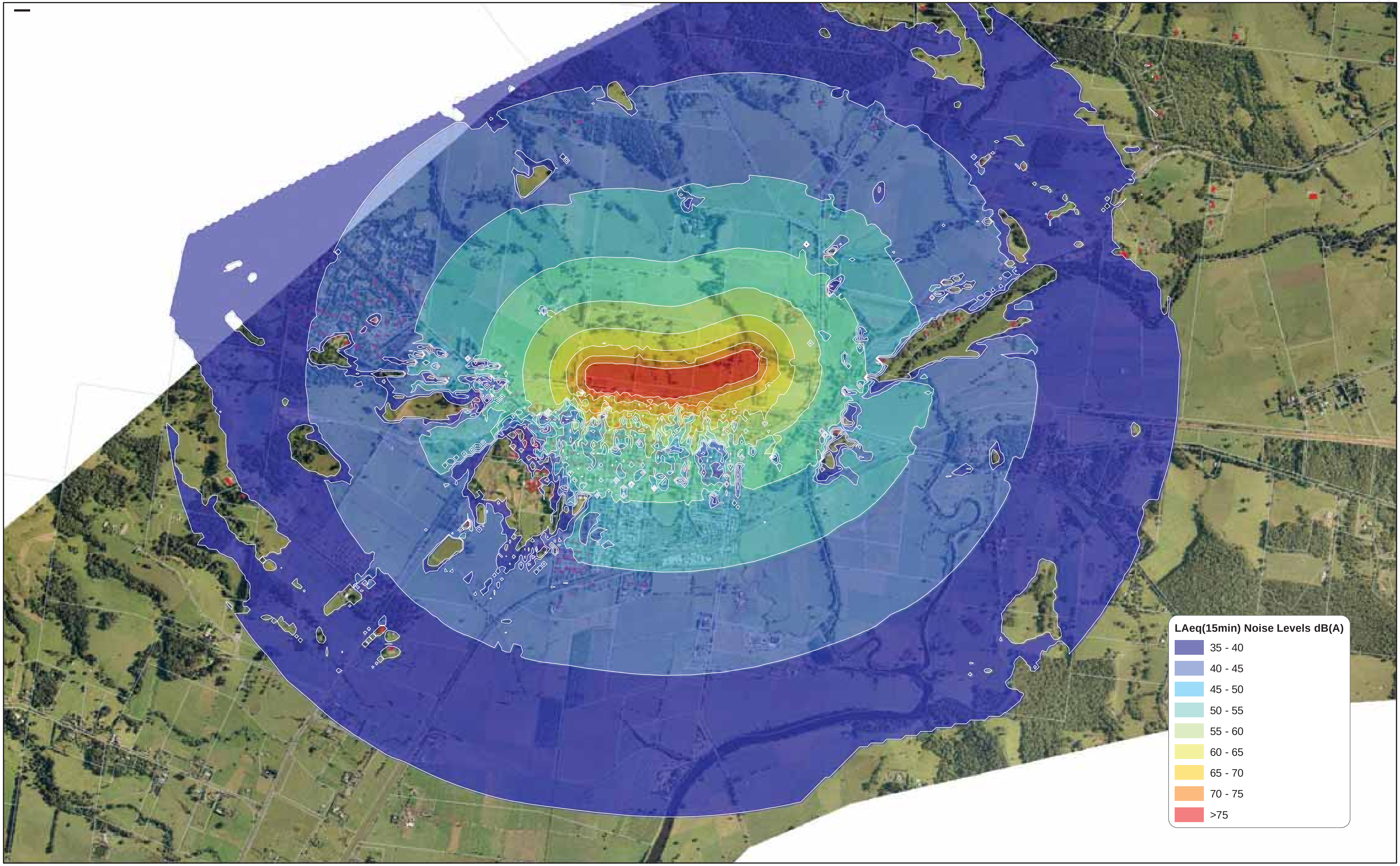
FOXGROUND AND BERRY BYPASS

Berry - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



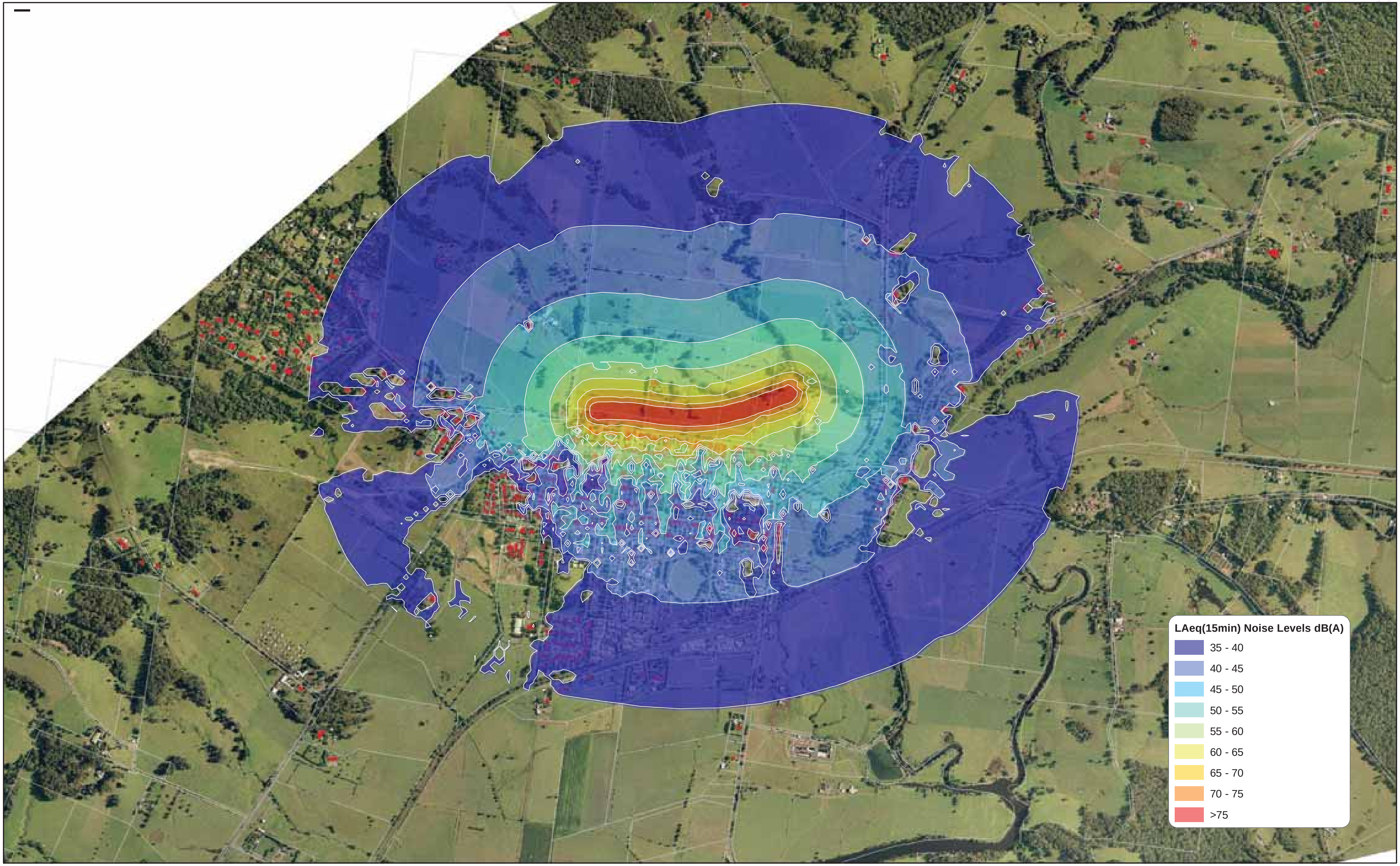
FOXGROUND AND BERRY BYPASS

Berry Embankment Works - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



FOXGROUND AND BERRY BYPASS

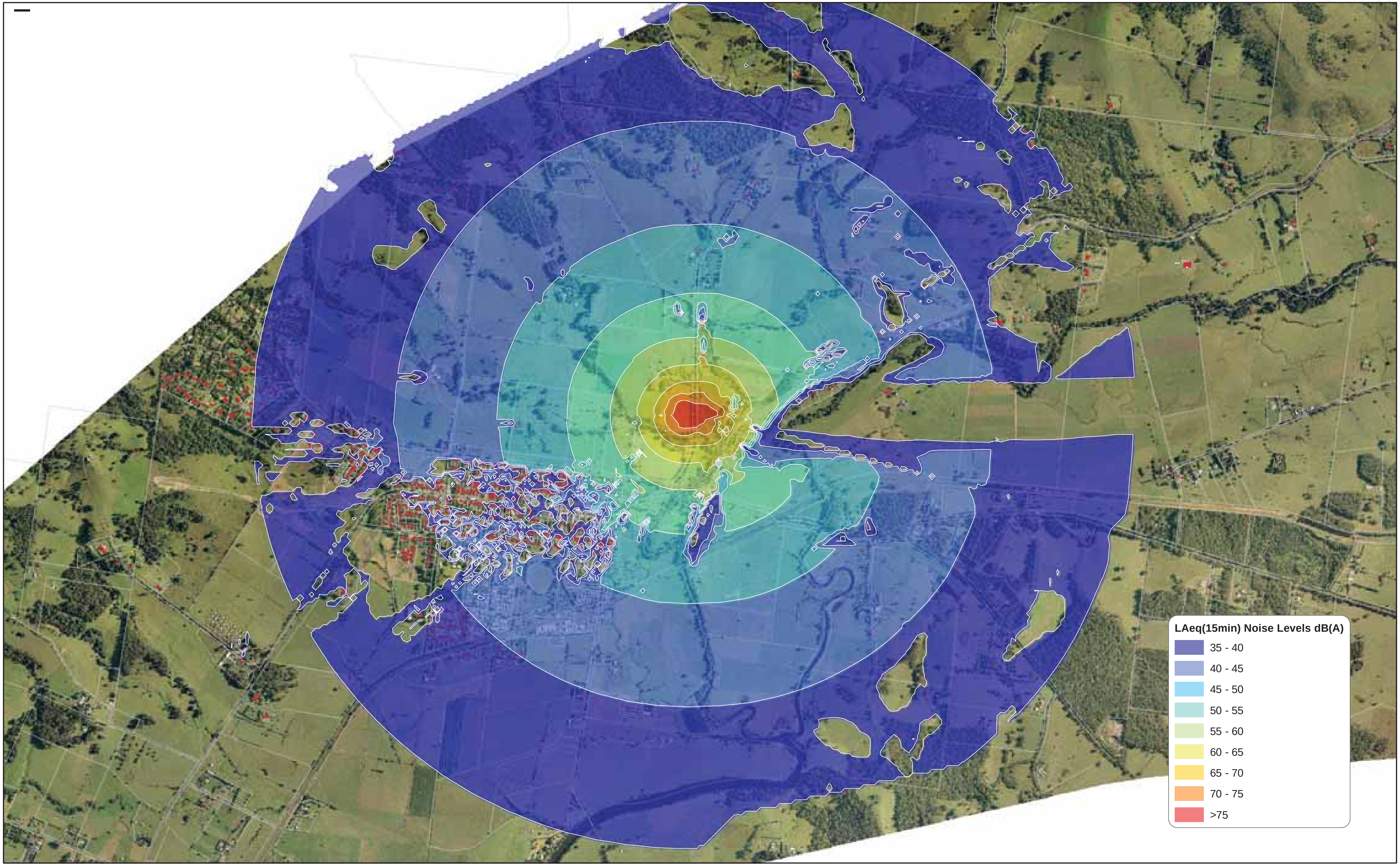
Berry Embankment Works - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



FOXGROUND AND BERRY BYPASS

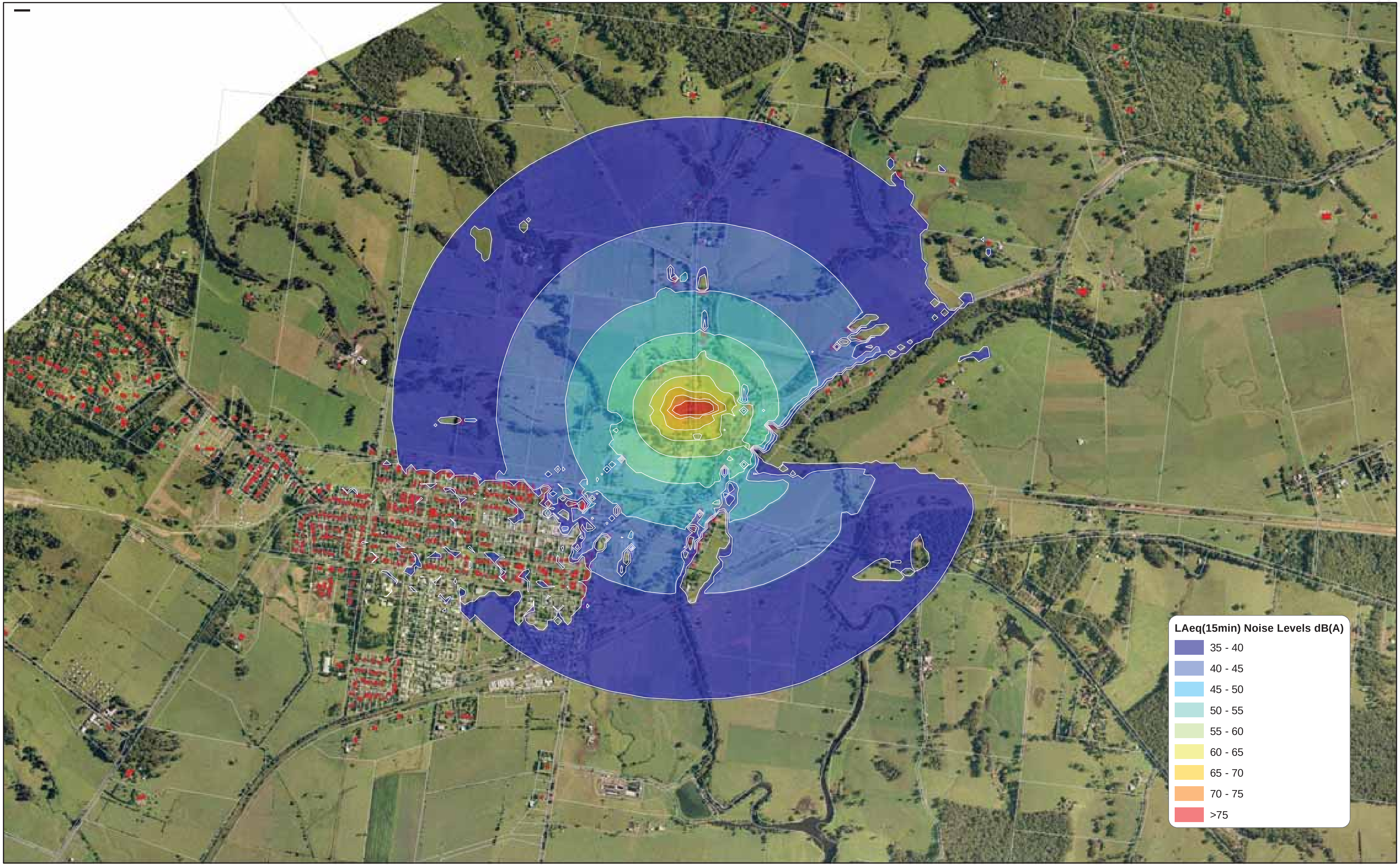
Berry Roundabout - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



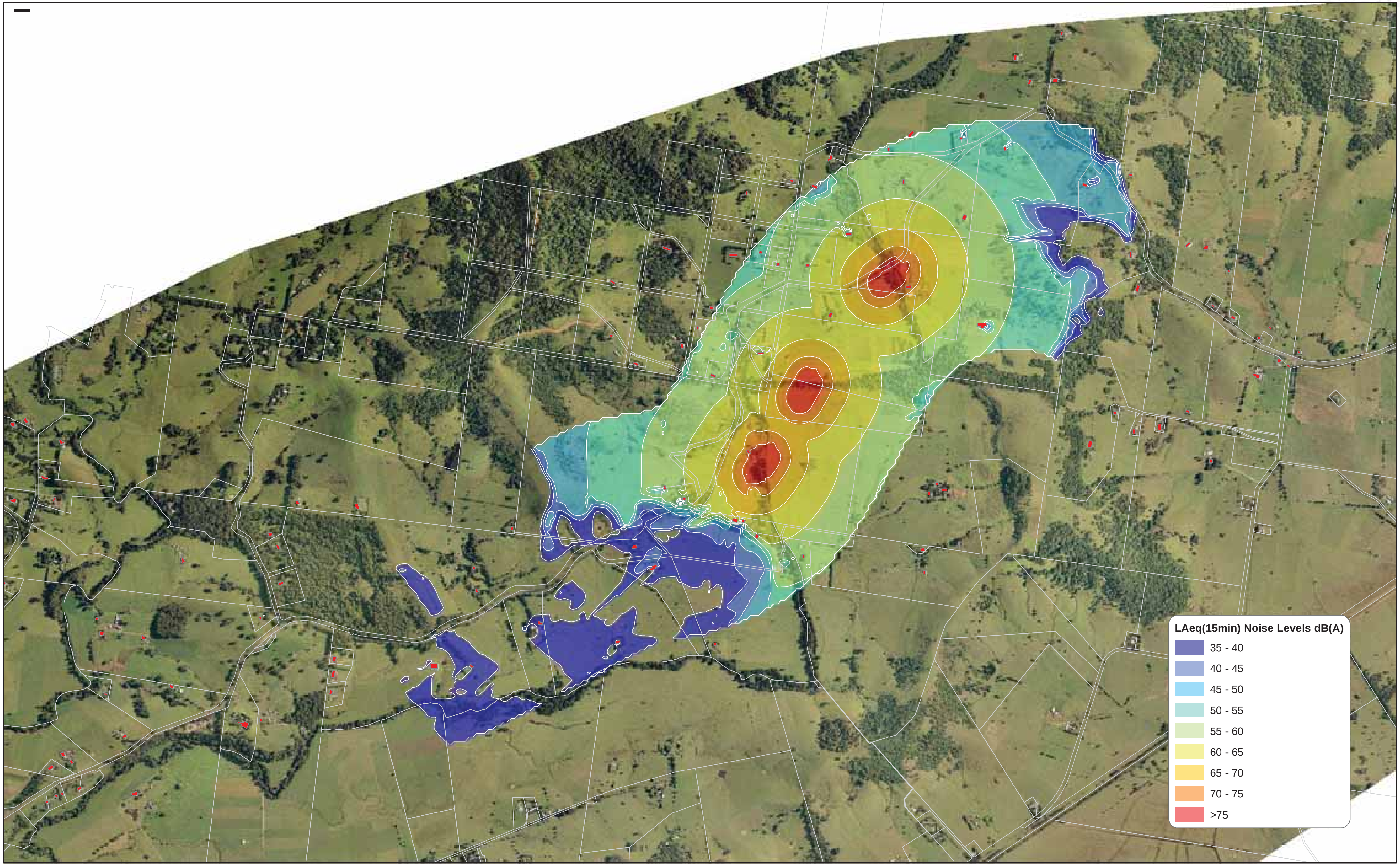
FOXGROUND AND BERRY BYPASS

Berry Roundabout - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

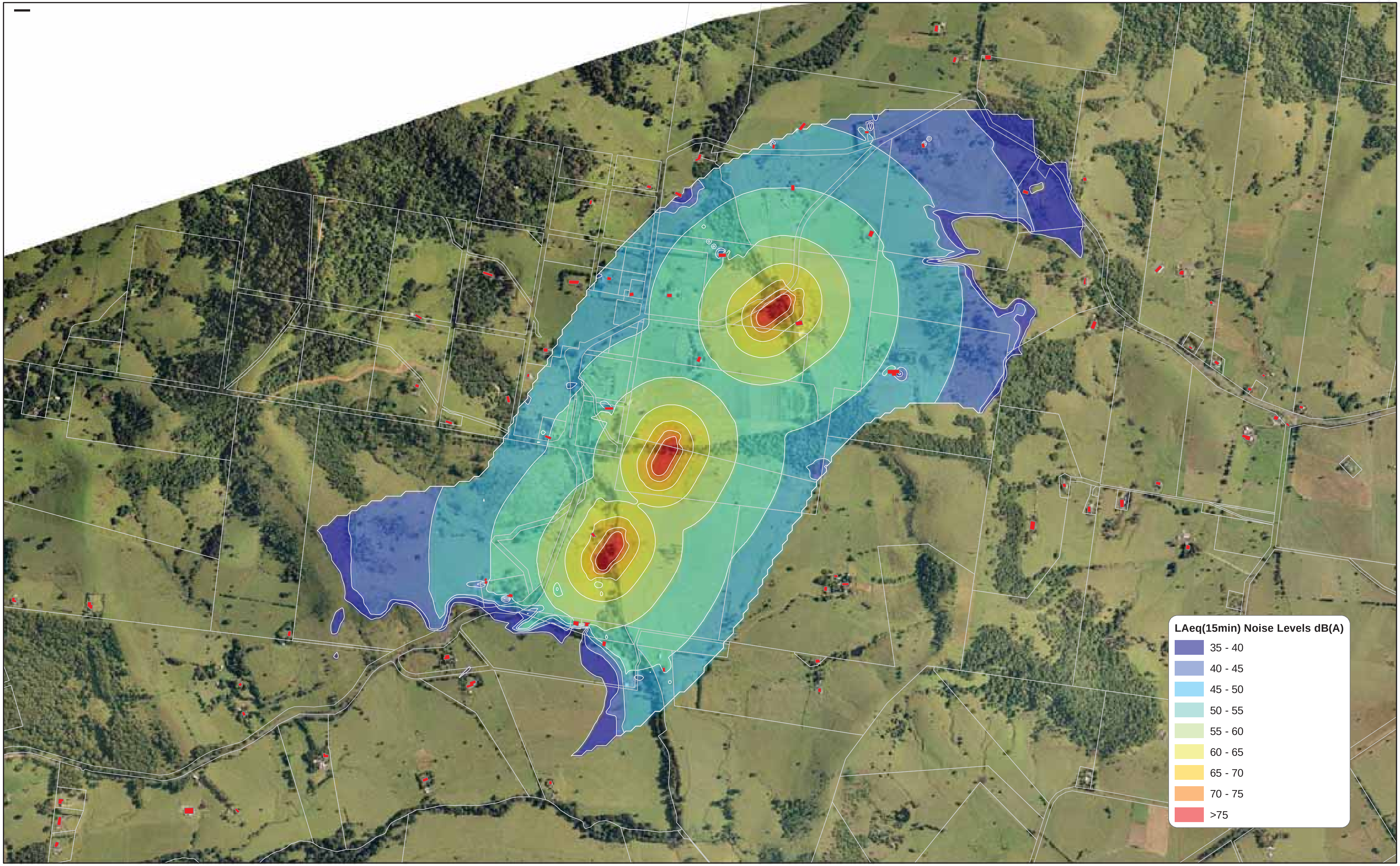
Broughton Creek Bridge - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

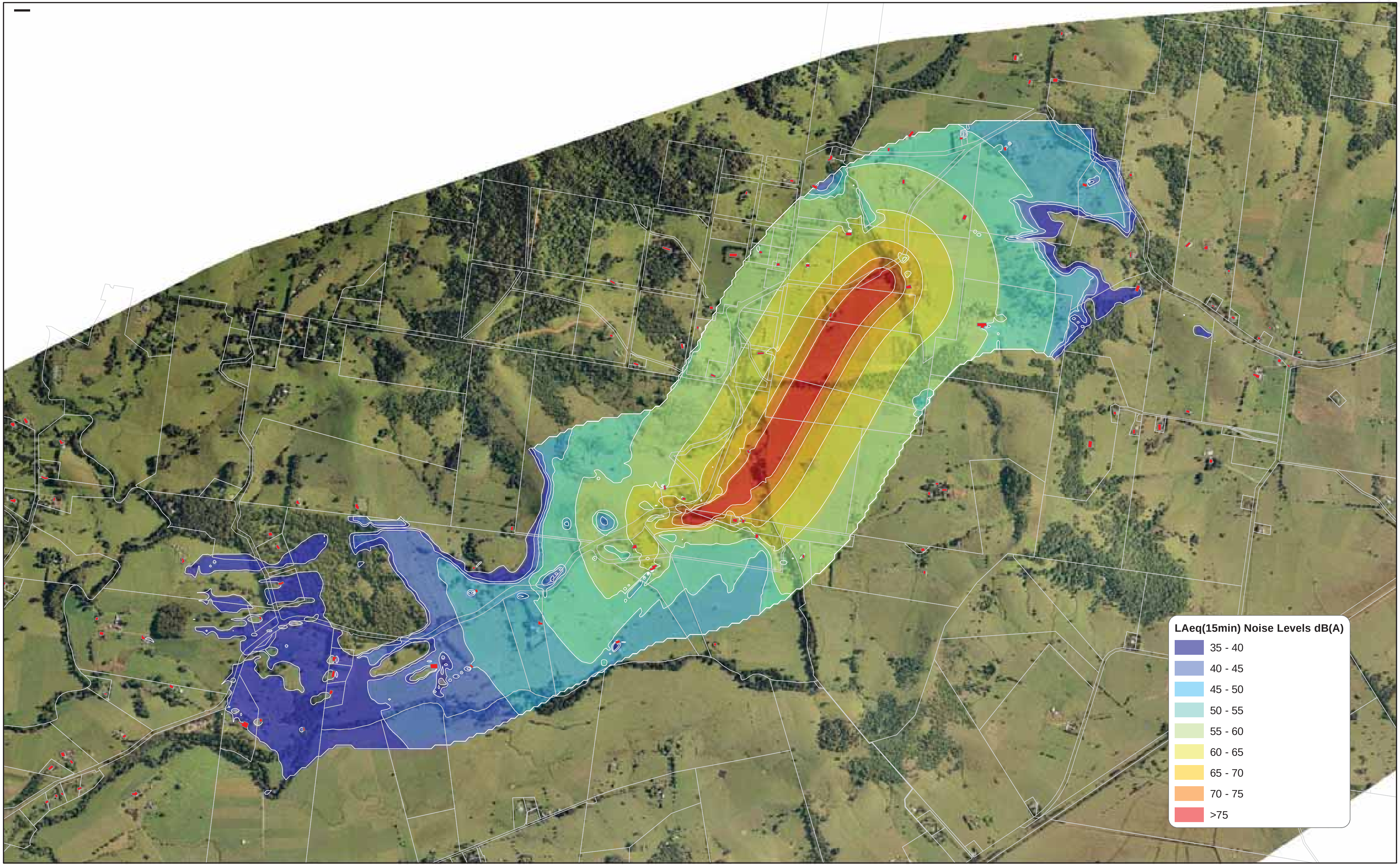
Broughton Creek Bridge - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Broughton Creek Embankment - Maximum Noise Levels

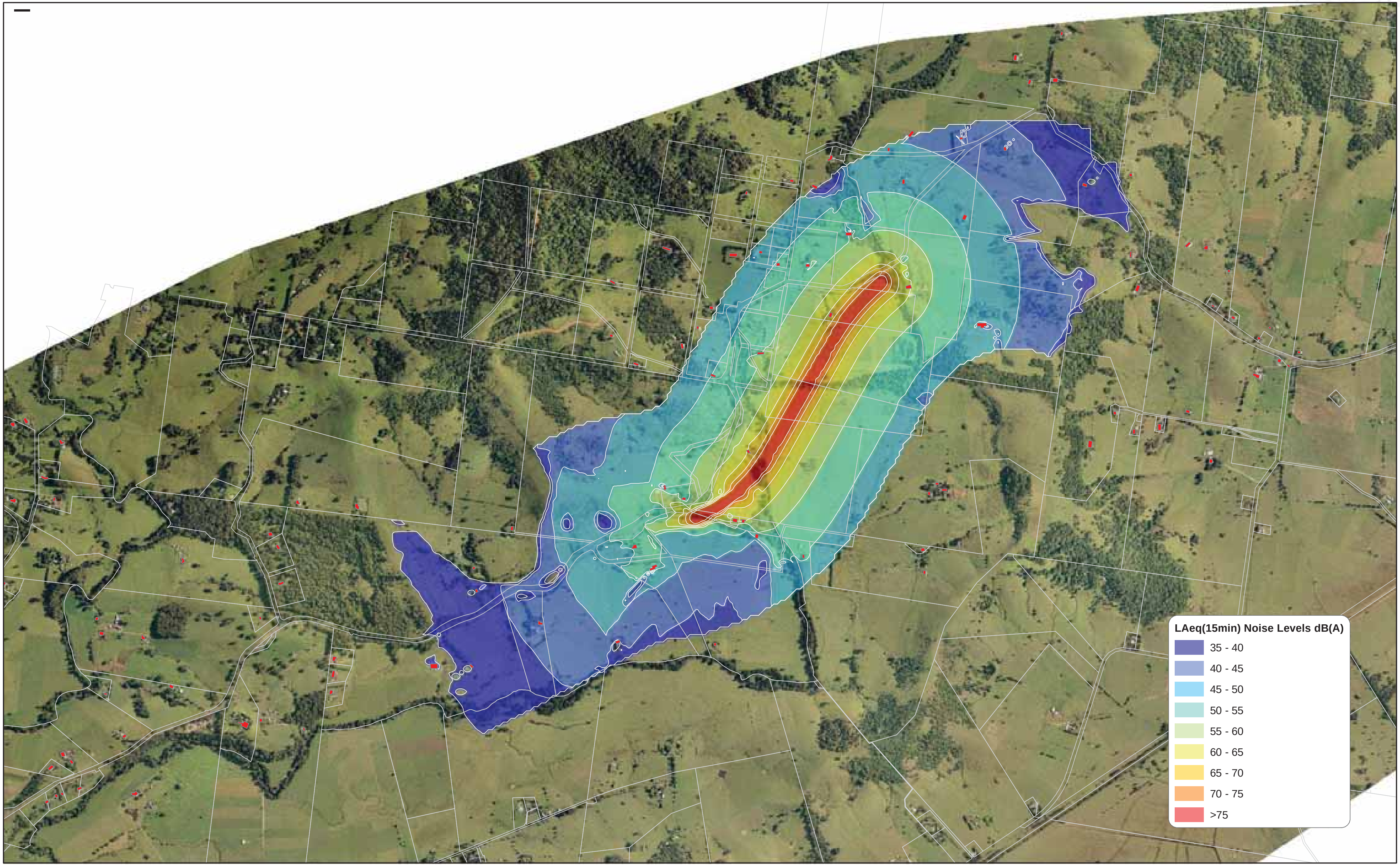
Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

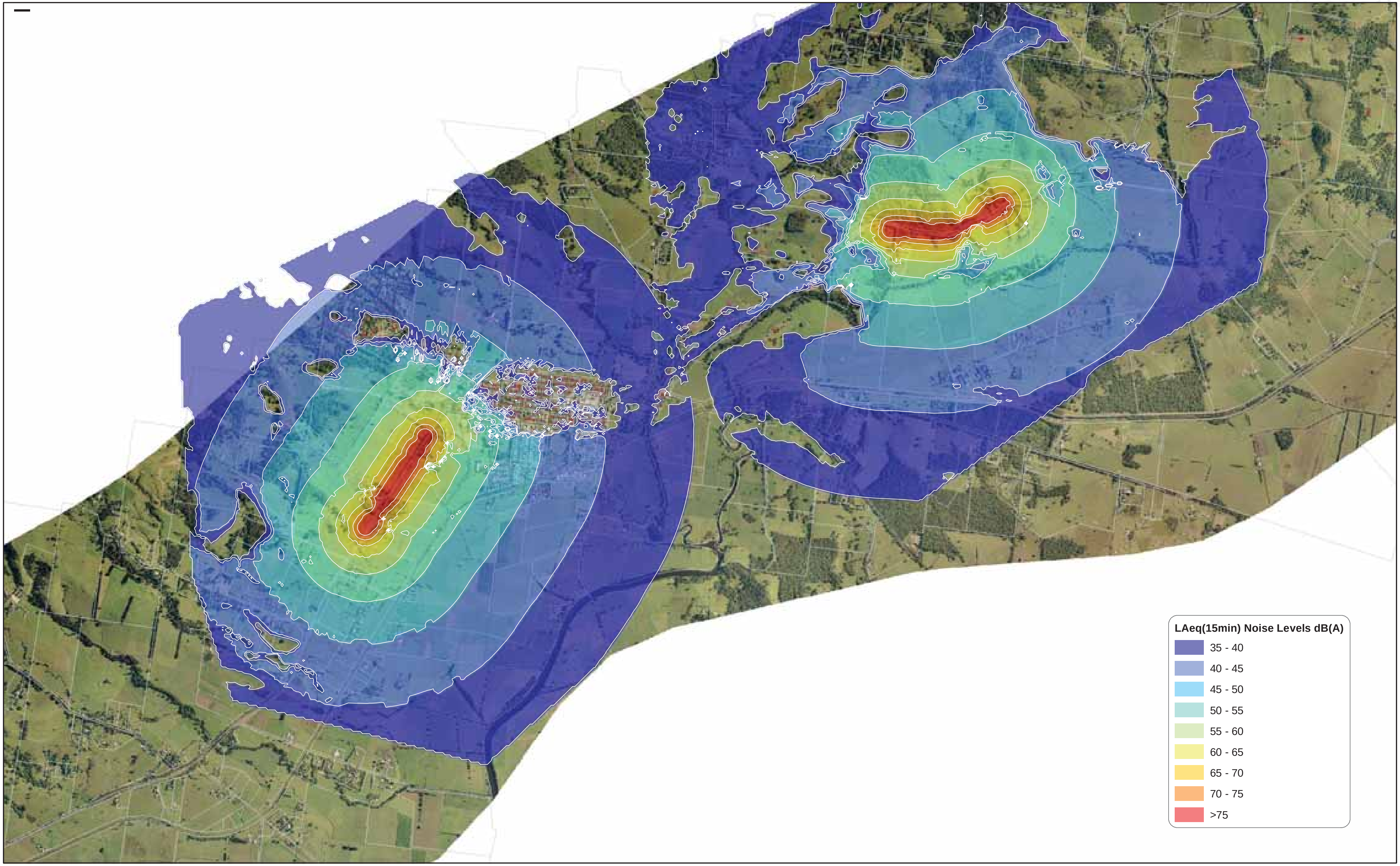
Broughton Creek Embankment - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



FOXGROUND AND BERRY BYPASS

General Alignment - Maximum Noise Levels

Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

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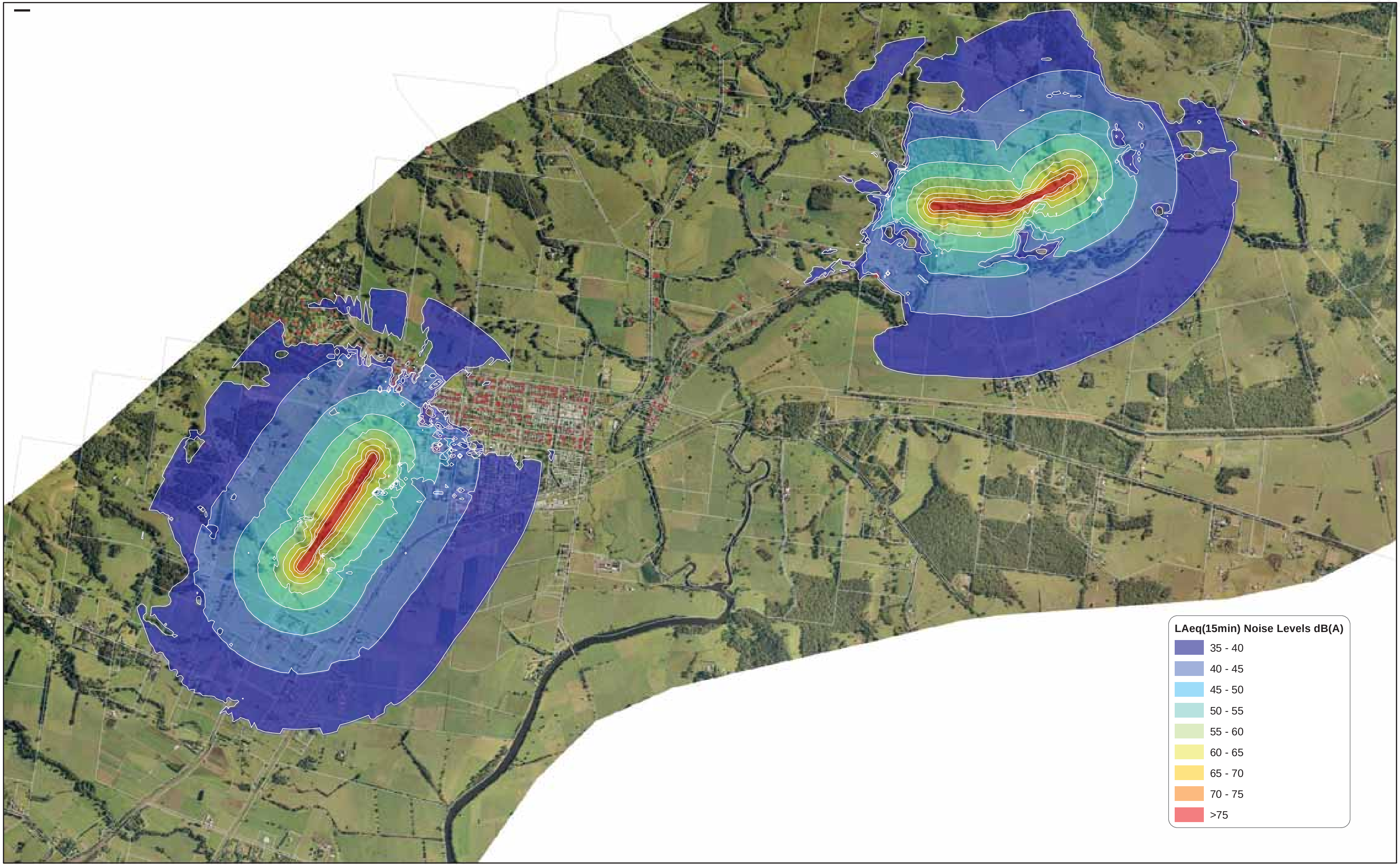

FOXGROUND AND BERRY BYPASS

General Alignment - Typical Noise Levels

Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

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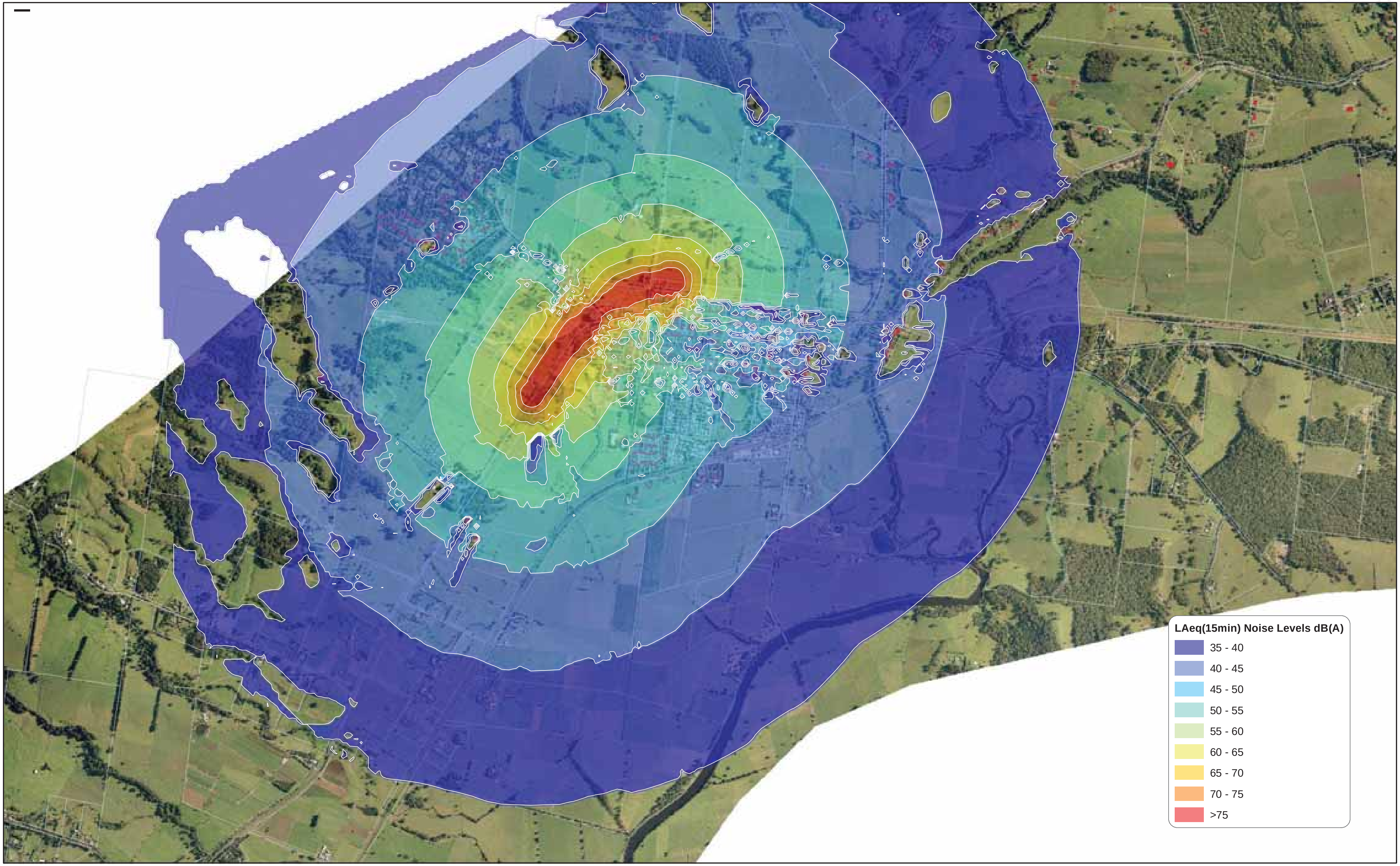


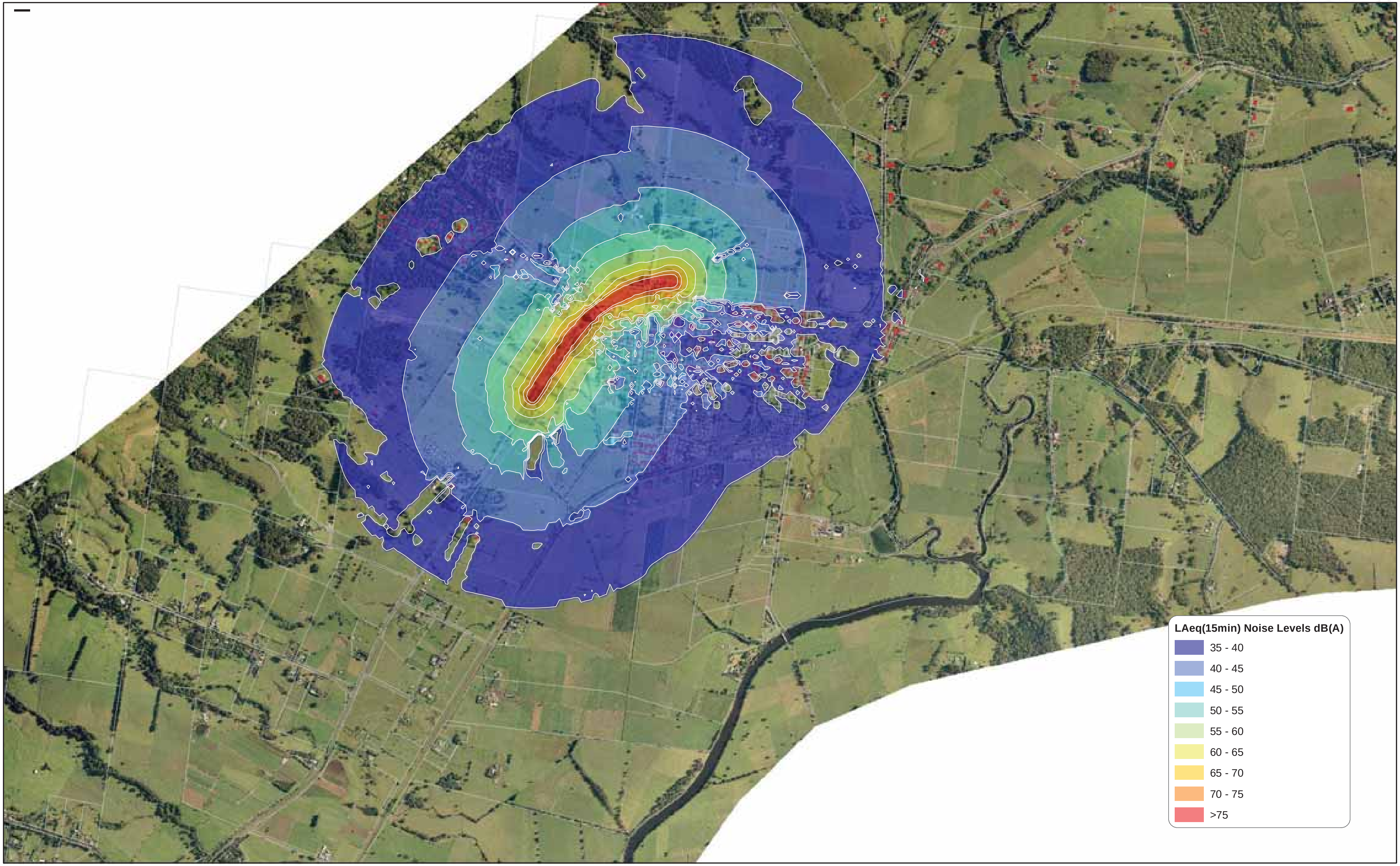
FOXGROUND AND BERRY BYPASS

Kangaroo Valley Road Interchange - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

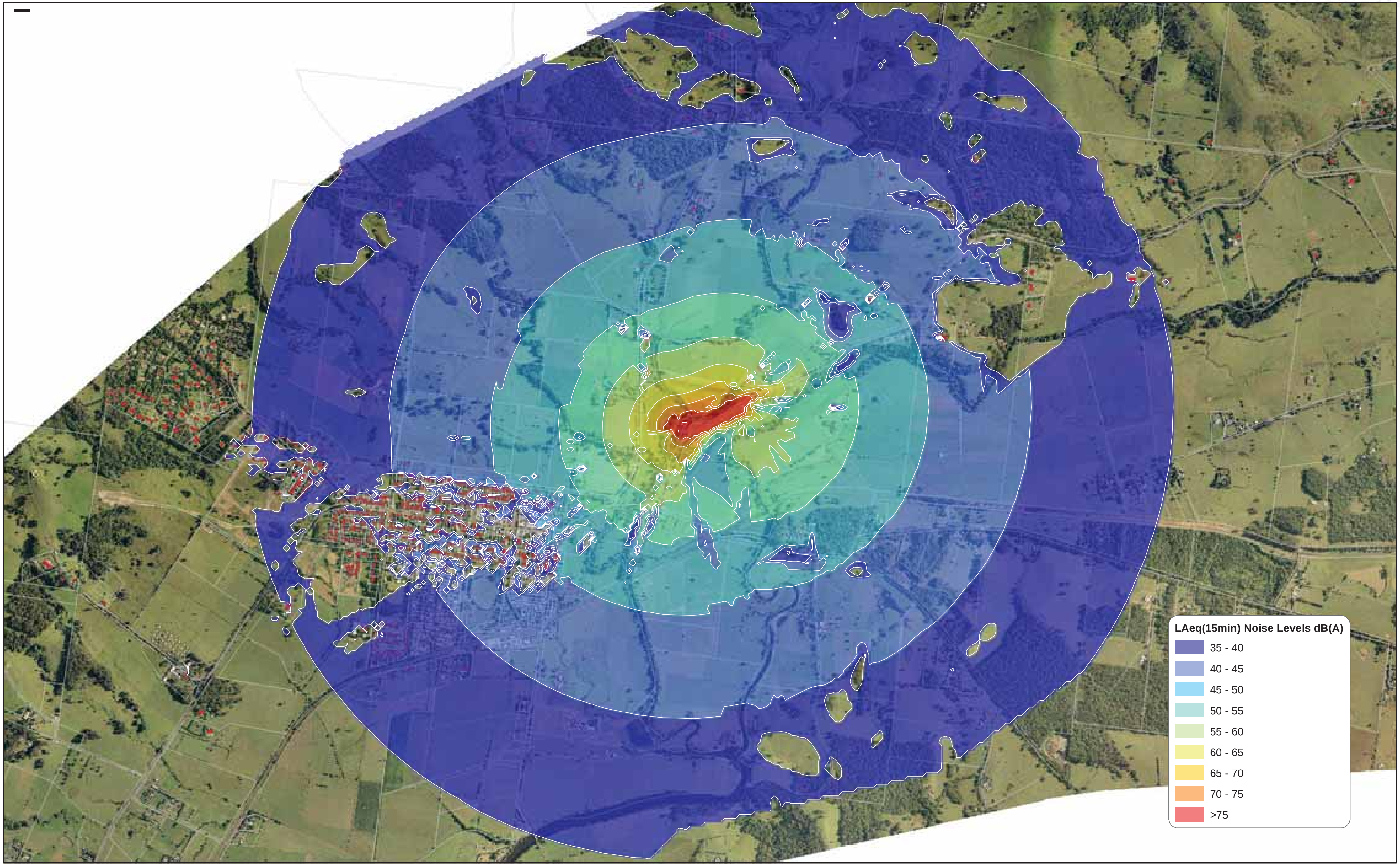
Kangaroo Valley Road Interchange - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

North Berry Interchange - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

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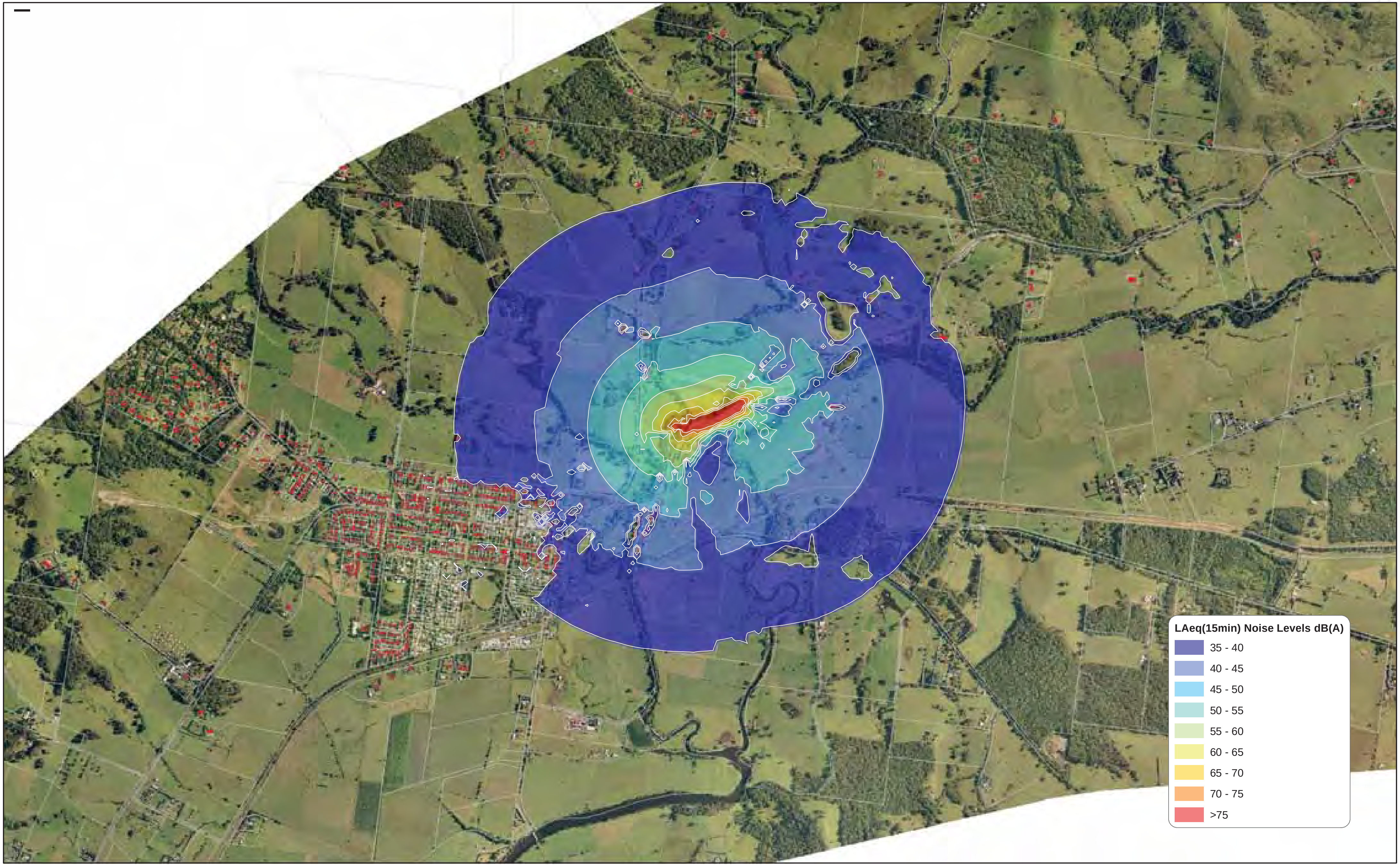
AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

North Berry Interchange - Typical Noise Levels

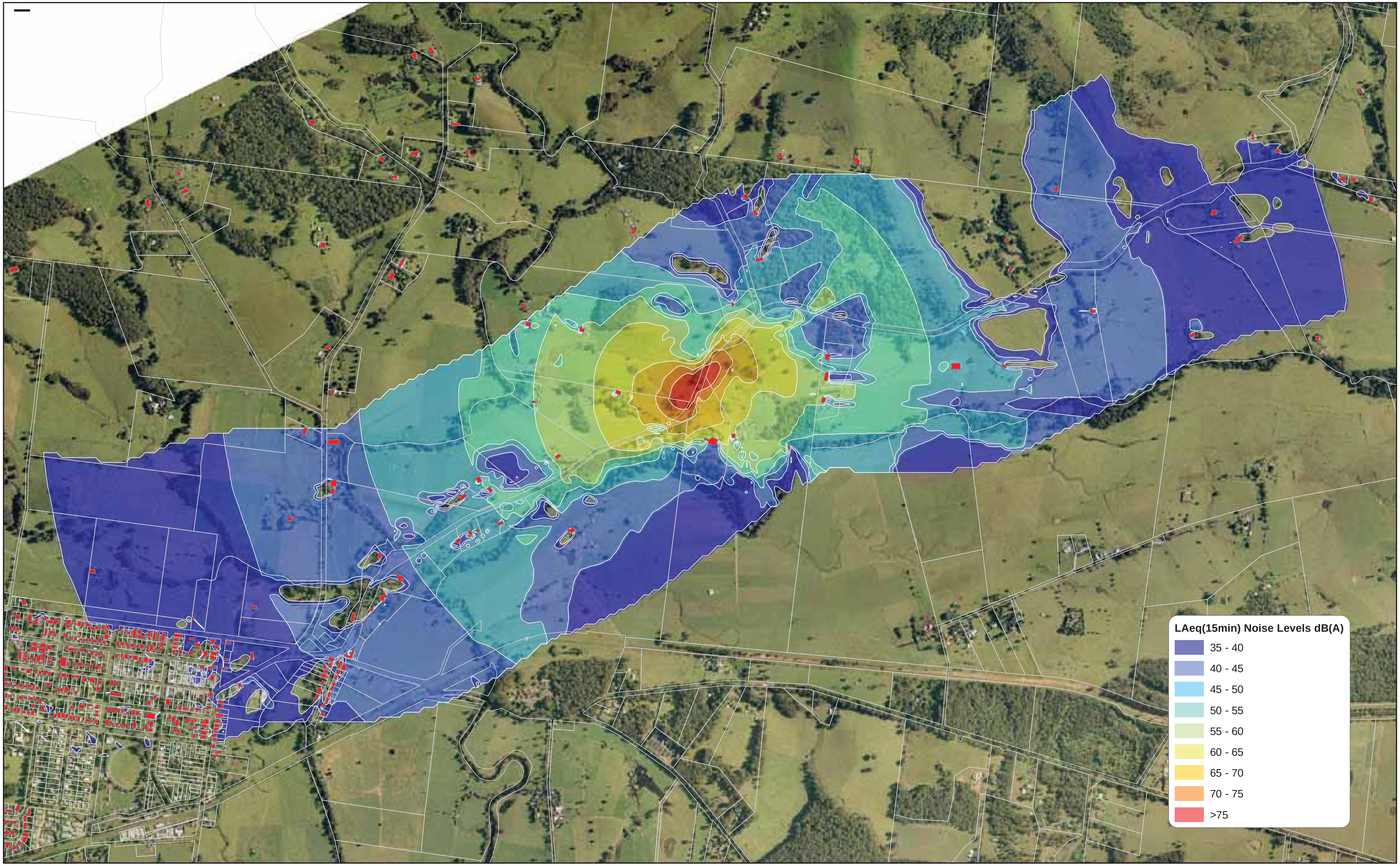
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Overpass - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

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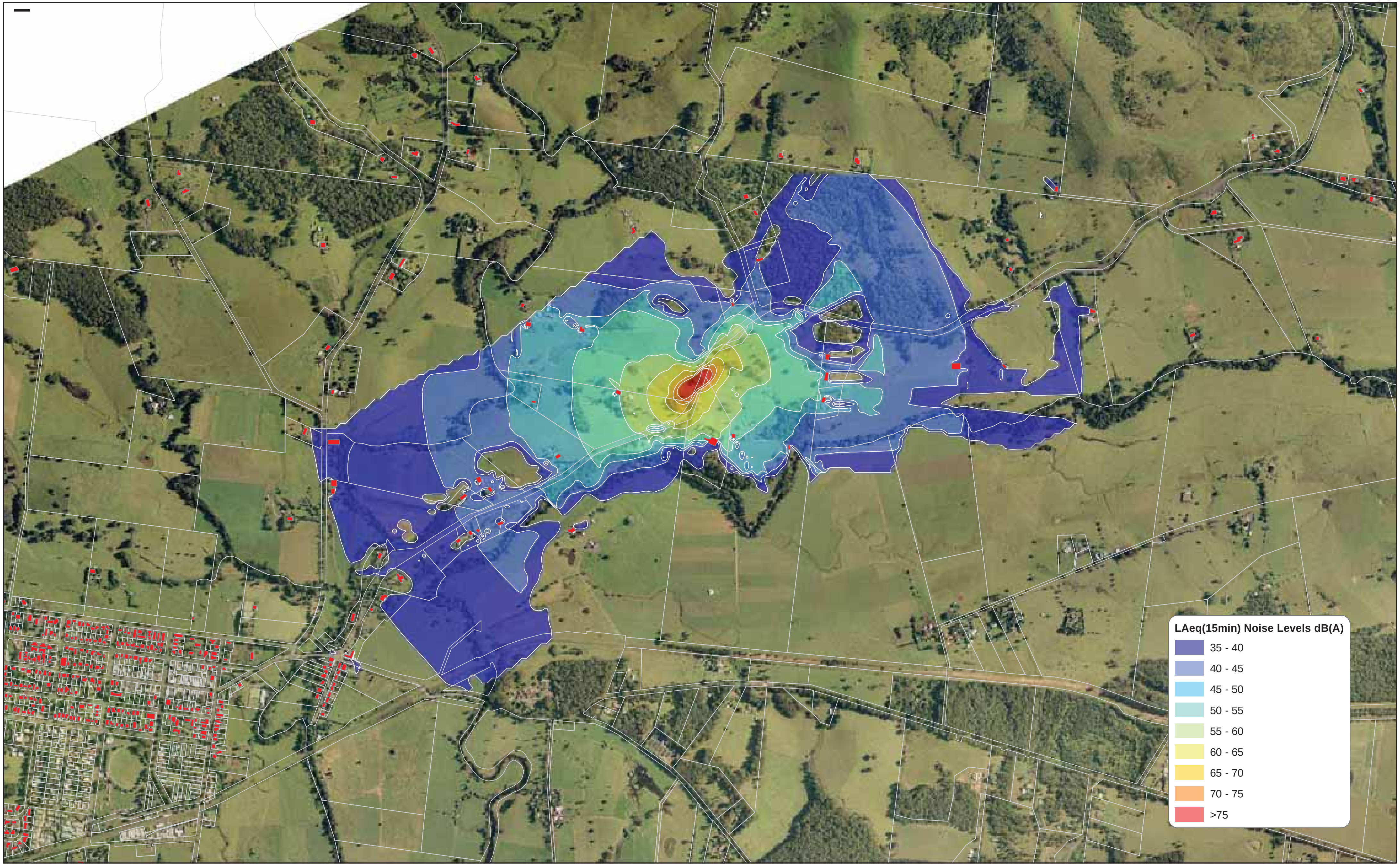
AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Overpass - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

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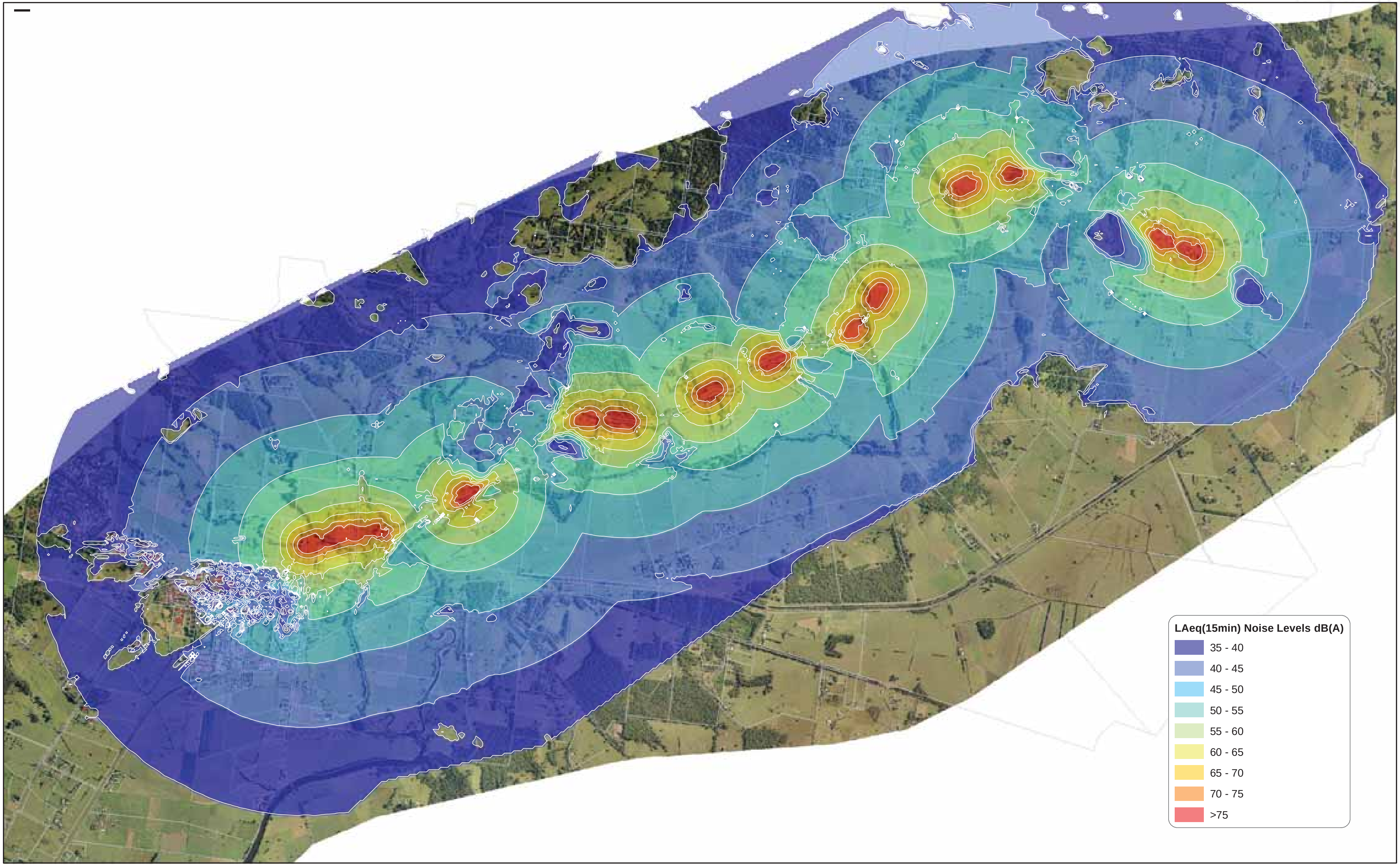
0 250 500 1,000 m



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

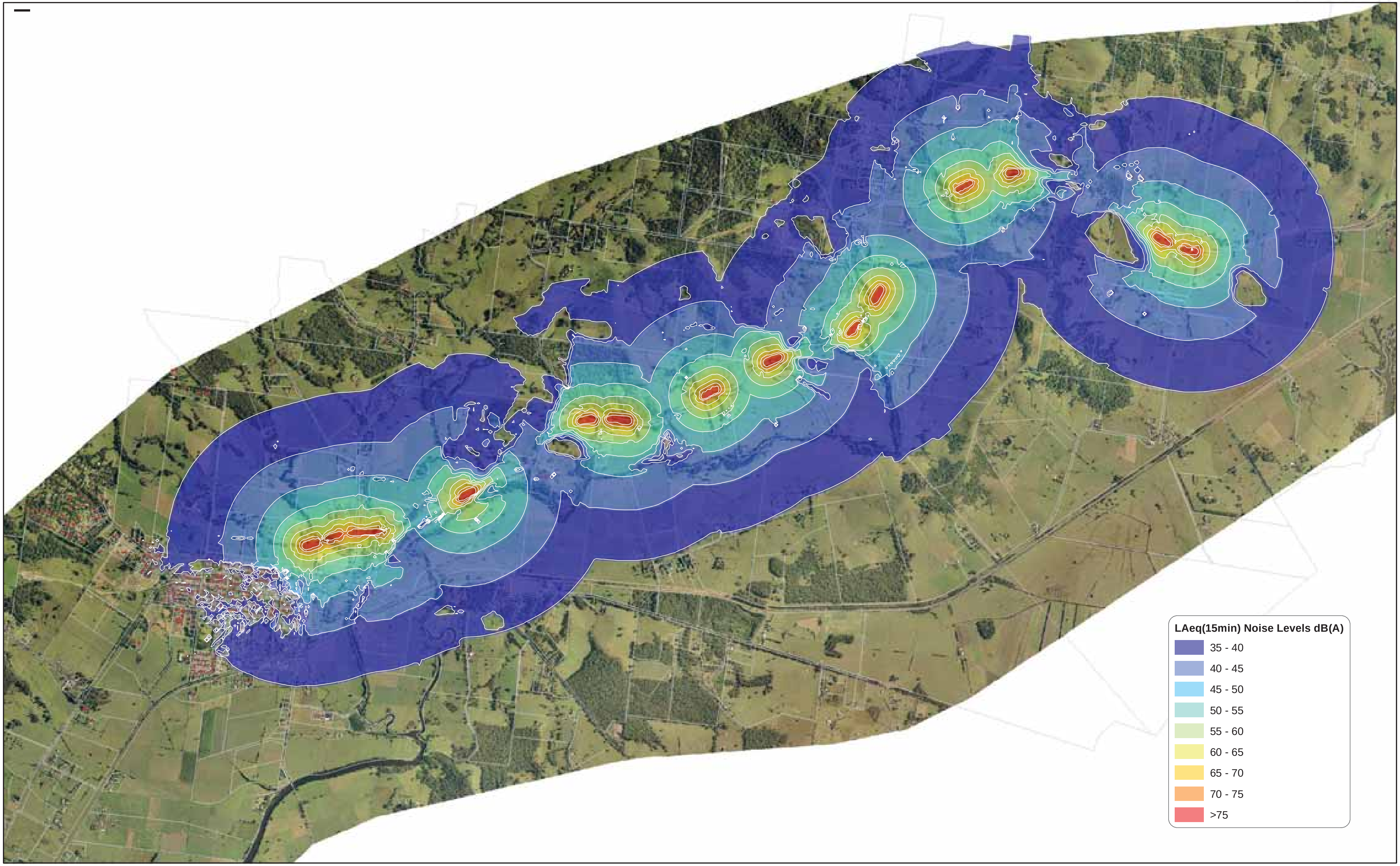
Sedimentary Basin - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000
m



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

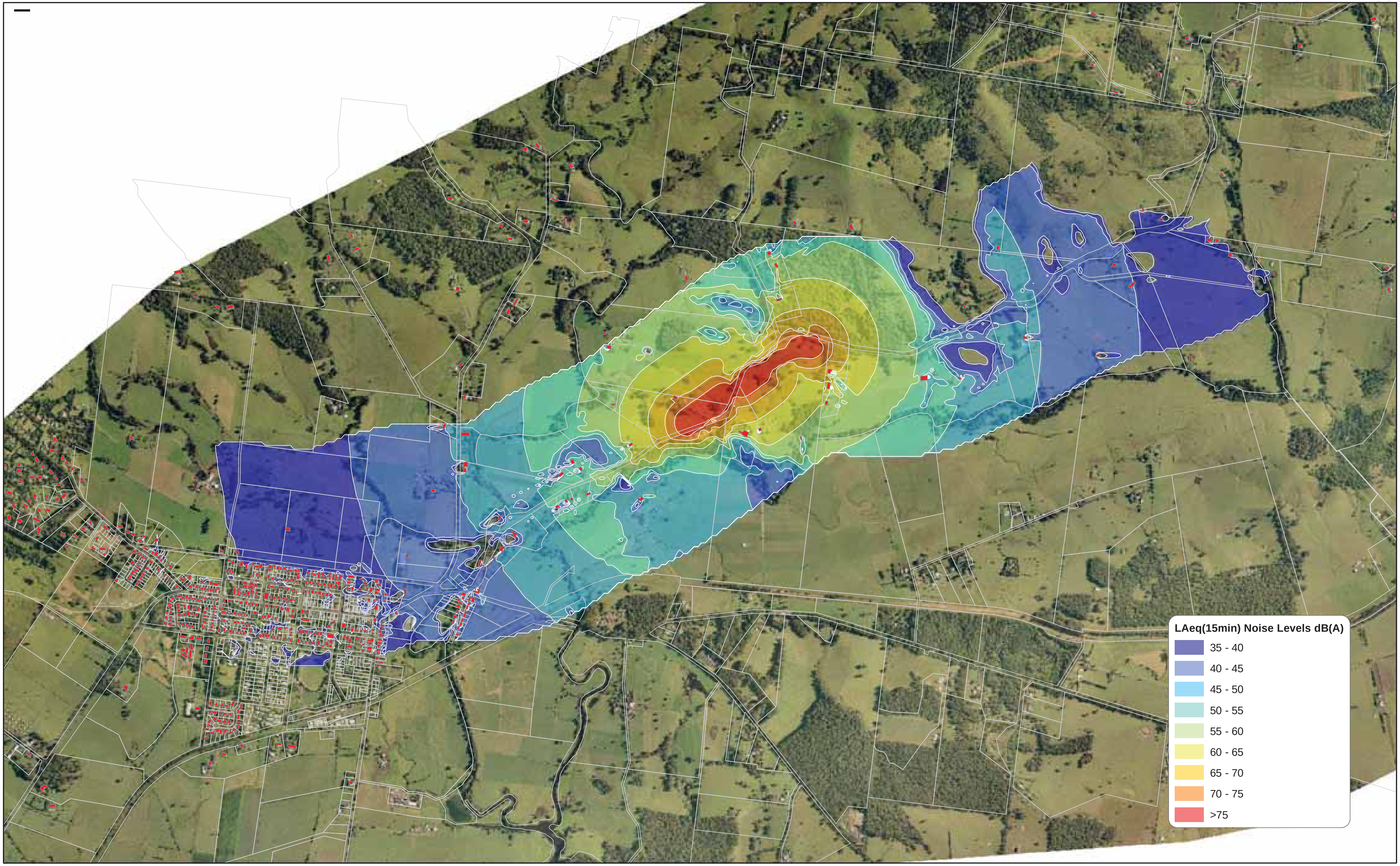
Sedimentary Basin - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000
m



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Tindalls Lane - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

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0 250 500 1,000 m

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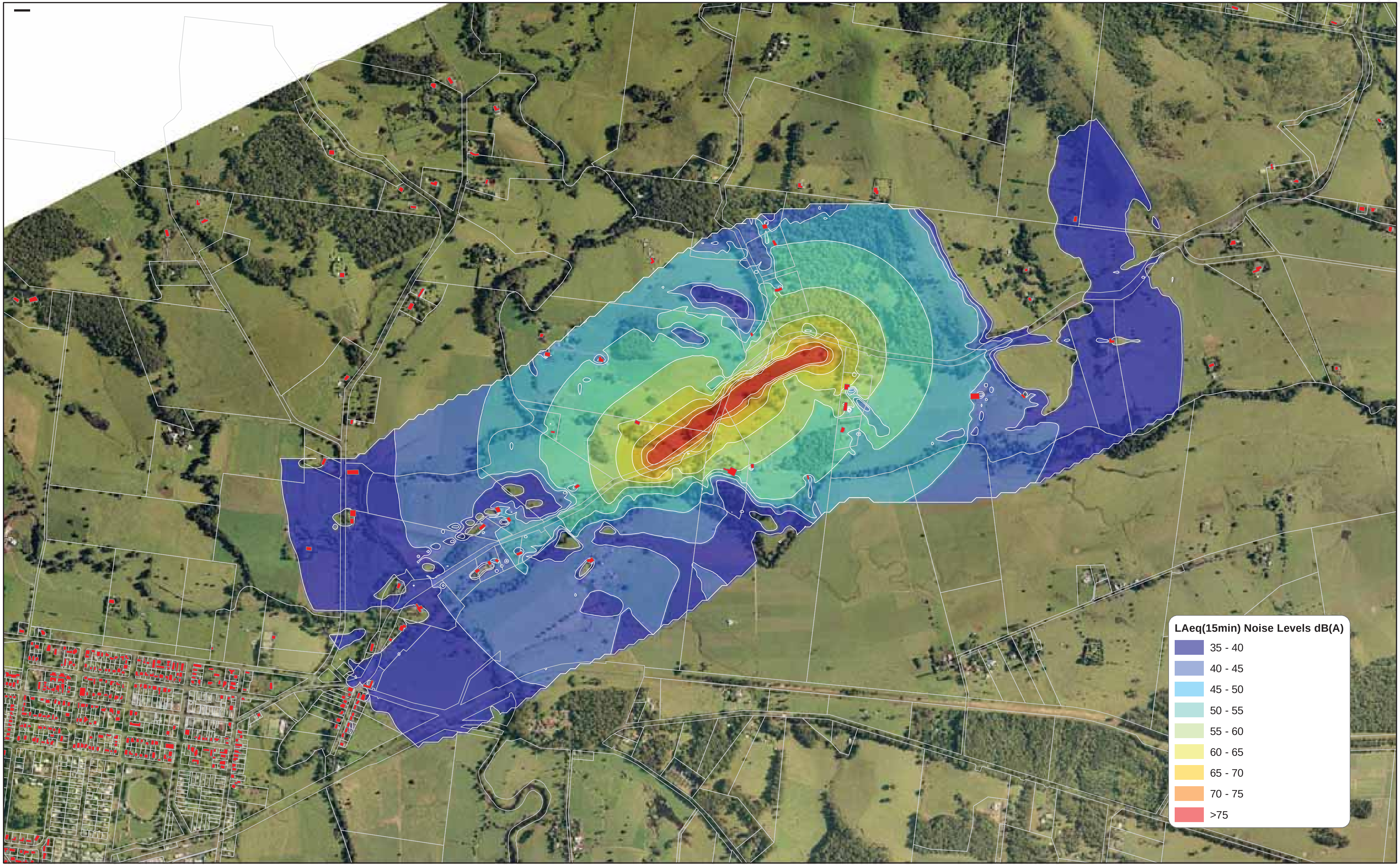


🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Tindalls Lane - Typical Noise Levels

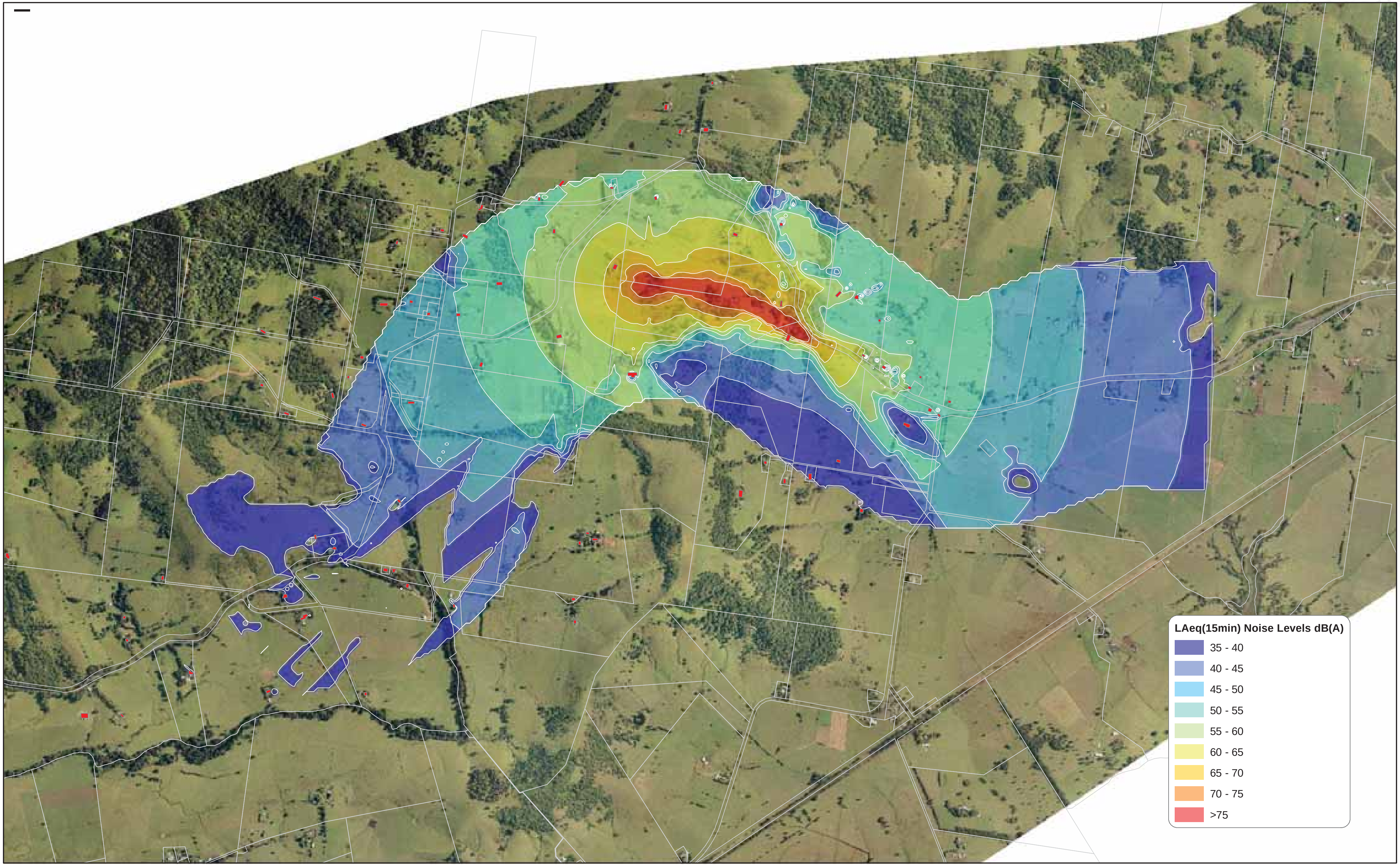
Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

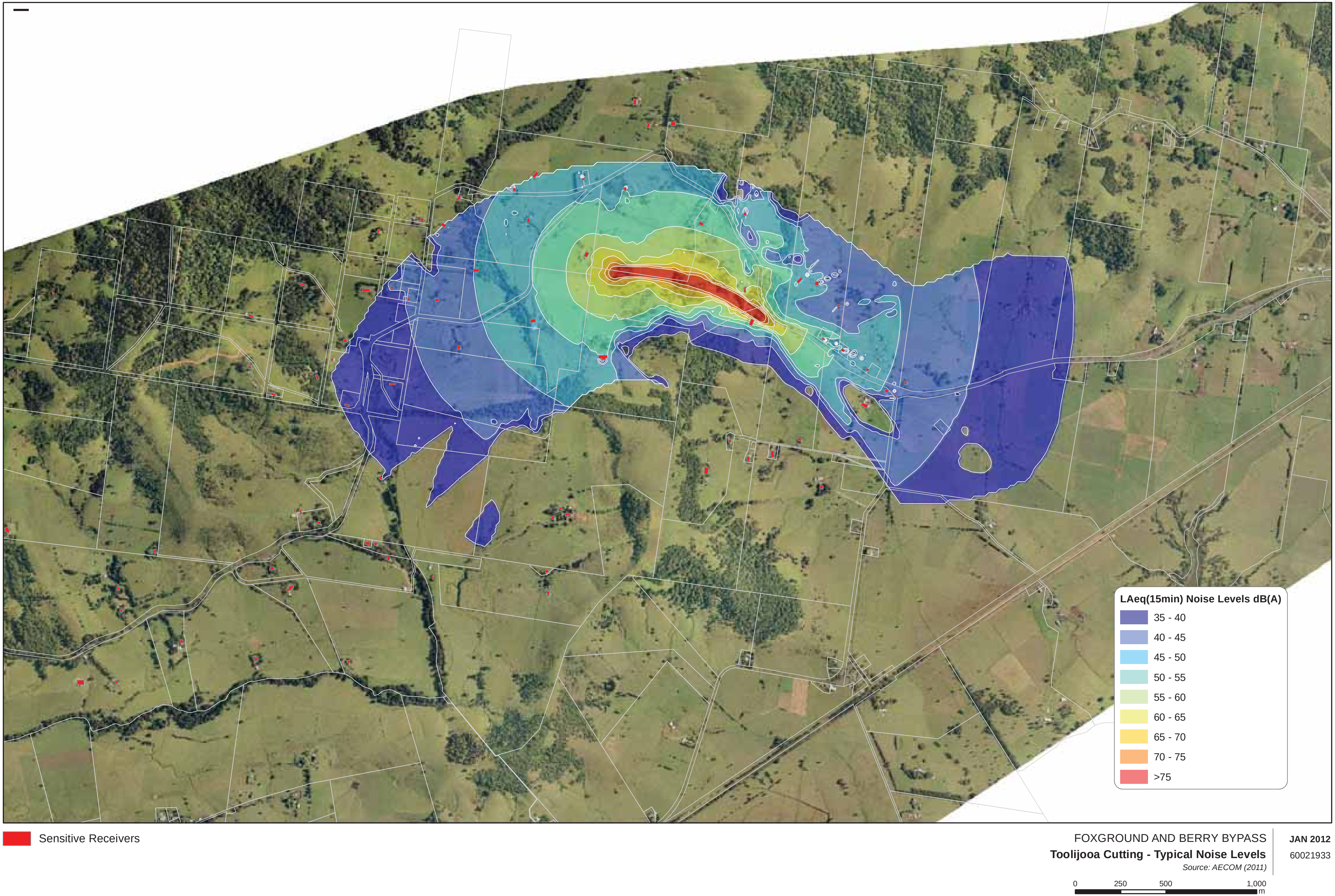
Toolijooa Cutting - Maximum Noise Levels

Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

60021933



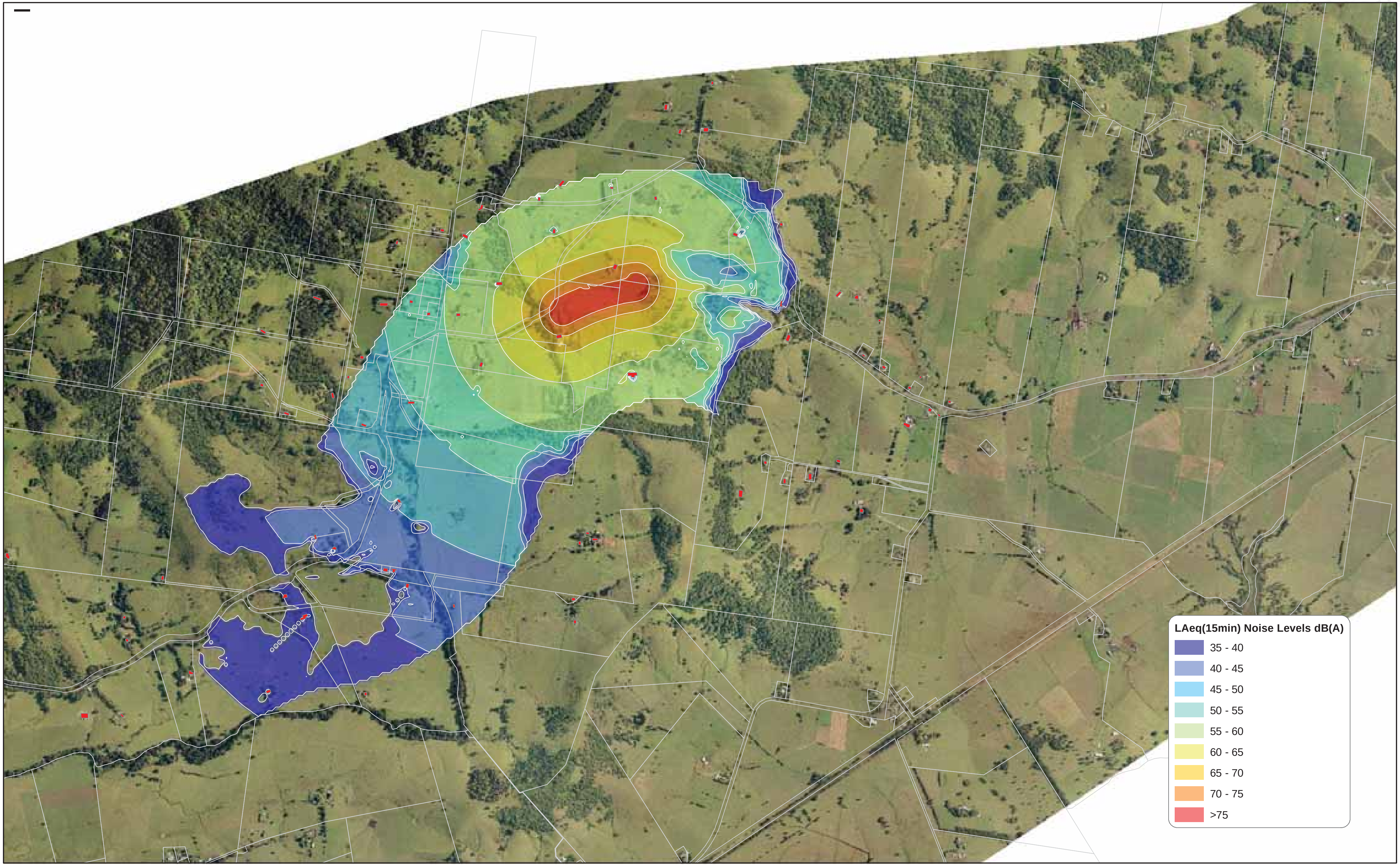
FOXGROUND AND BERRY BYPASS

Toolijooa Cutting - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Toolijooa Embankment - Maximum Noise Levels

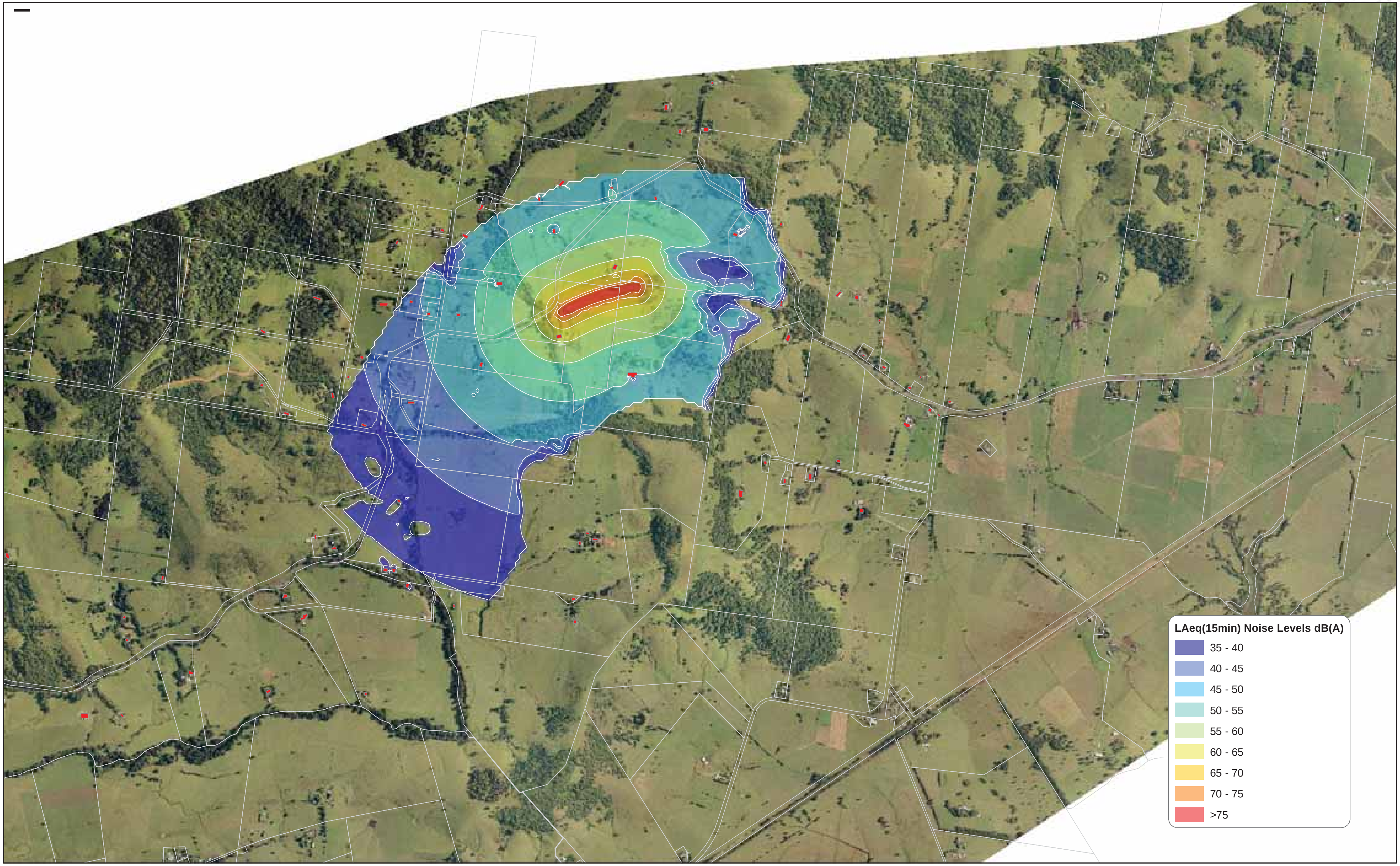
Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Toolijooa Embankment - Typical Noise Levels

Source: AECOM (2011)

0 250 500 1,000 m

JAN 2012

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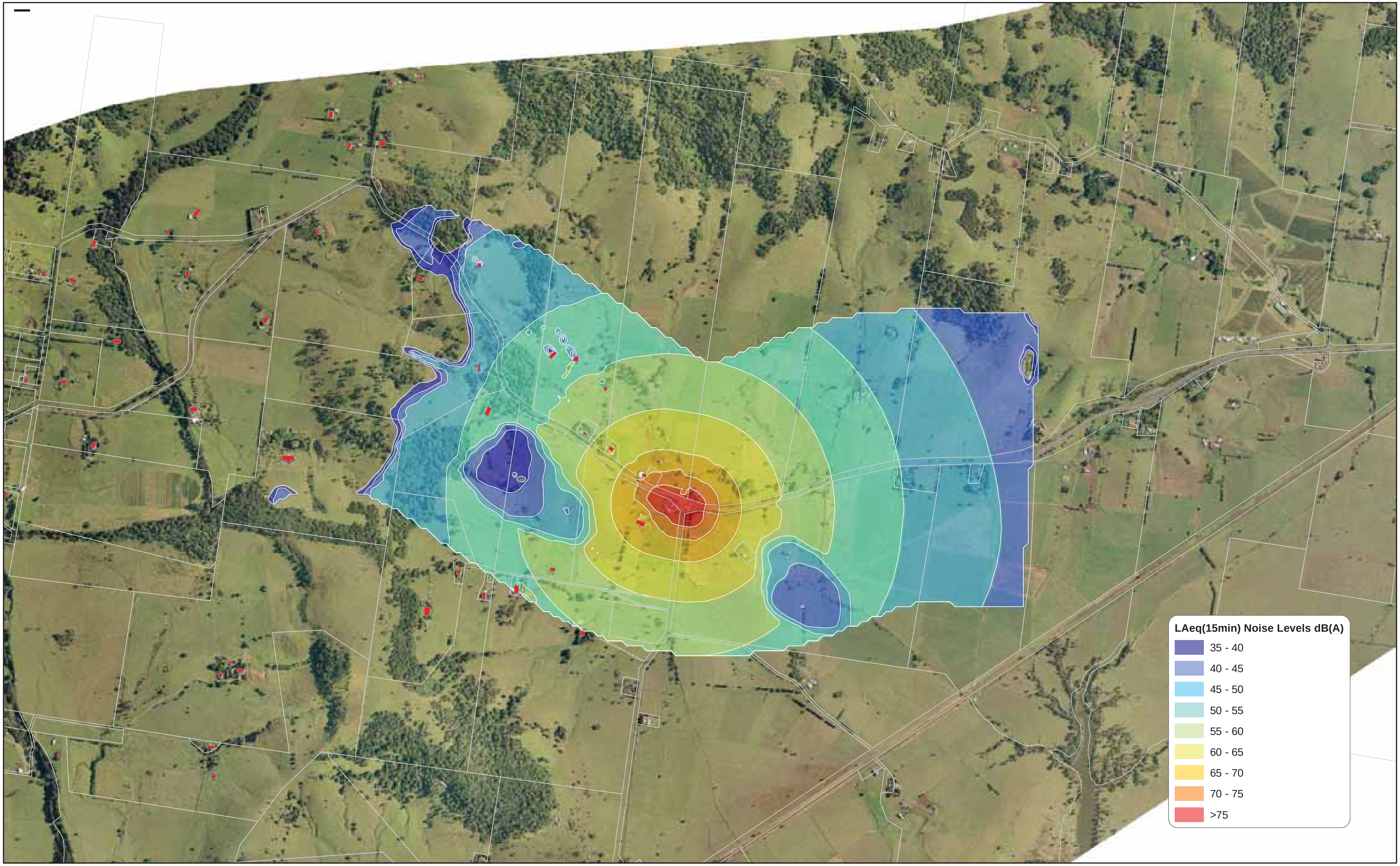


🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

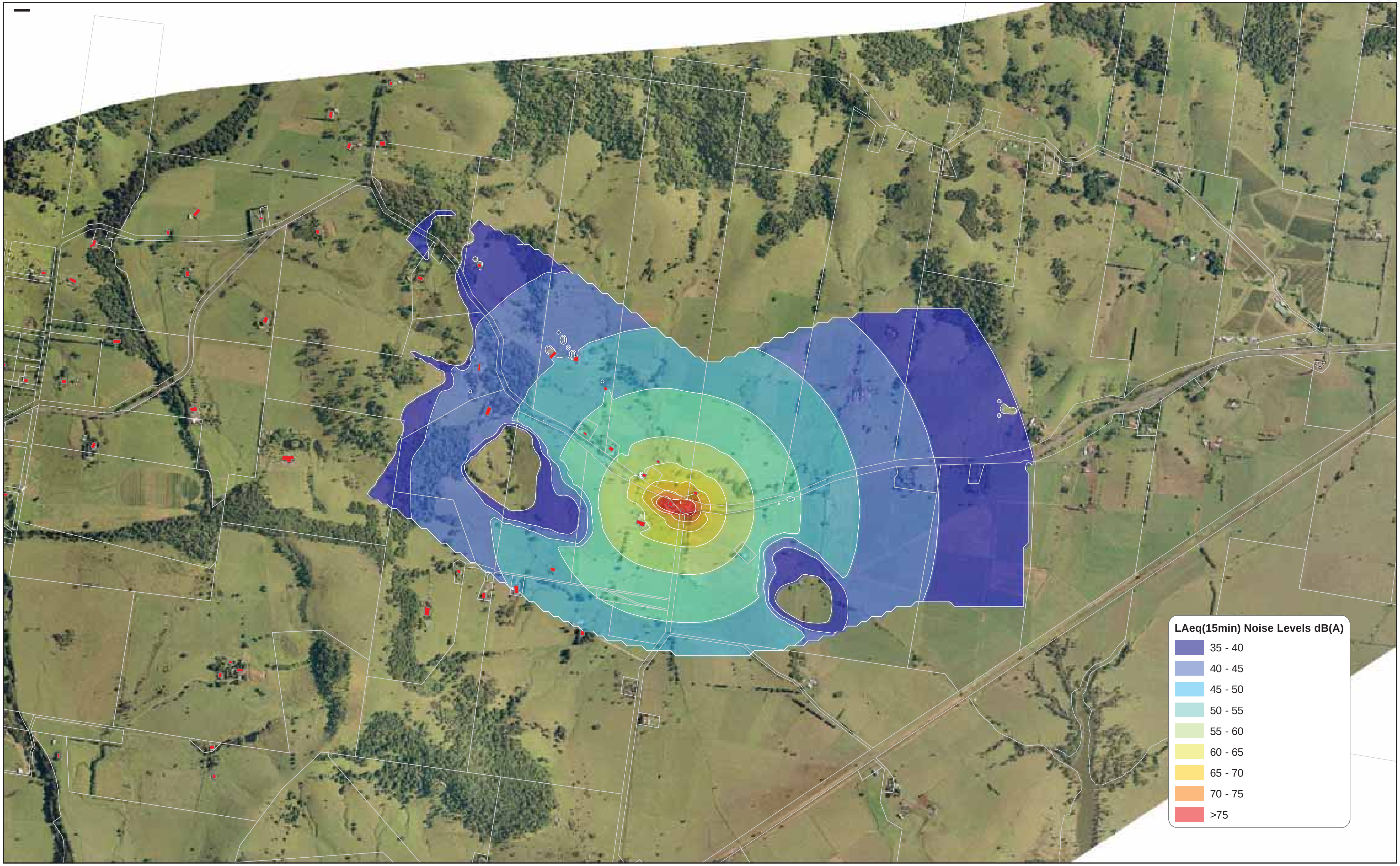
Toolijooa Interchange - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

AECOM



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

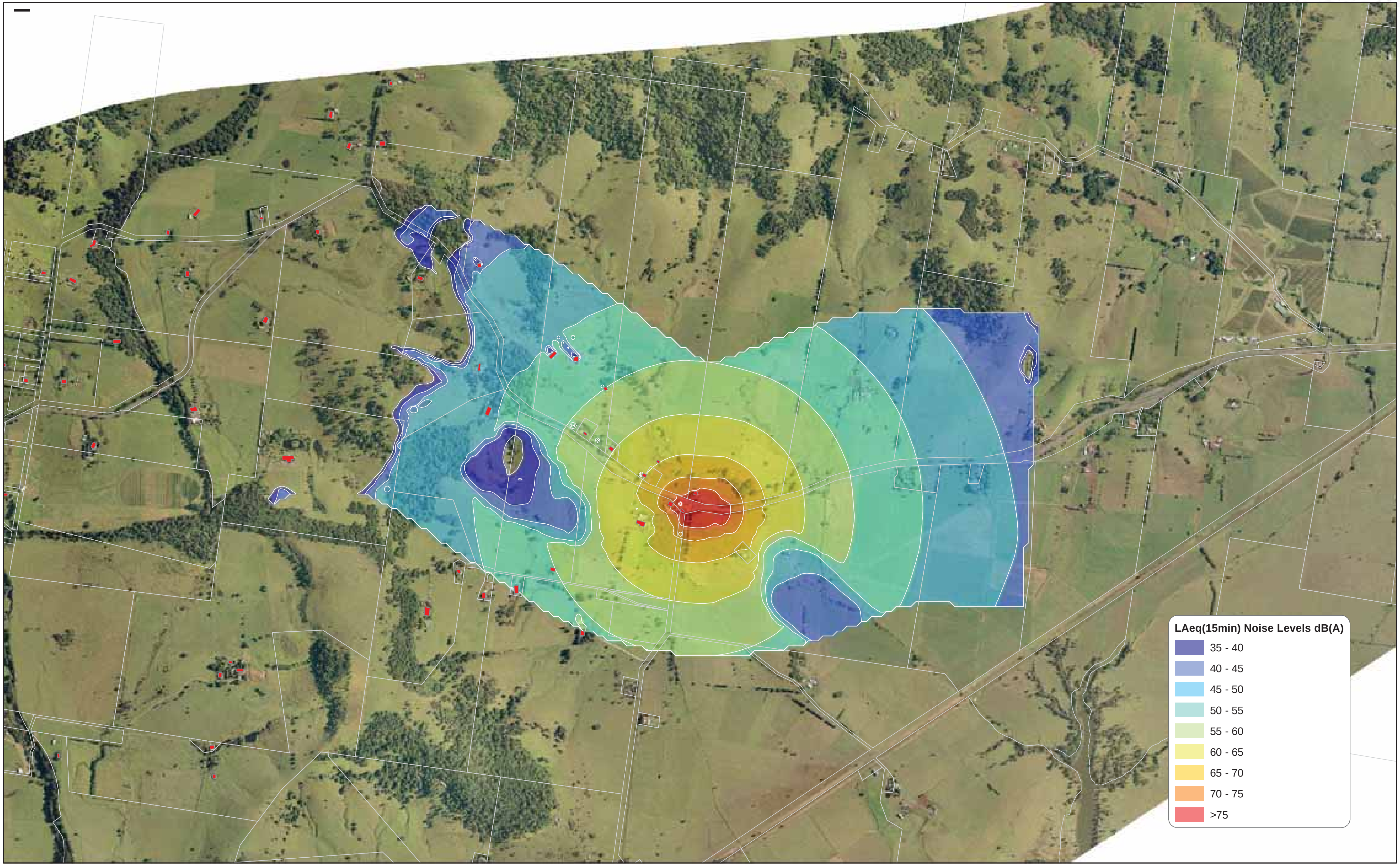
Toolijooa Interchange - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

60021933

0 250 500 1,000 m



🟥 Sensitive Receivers

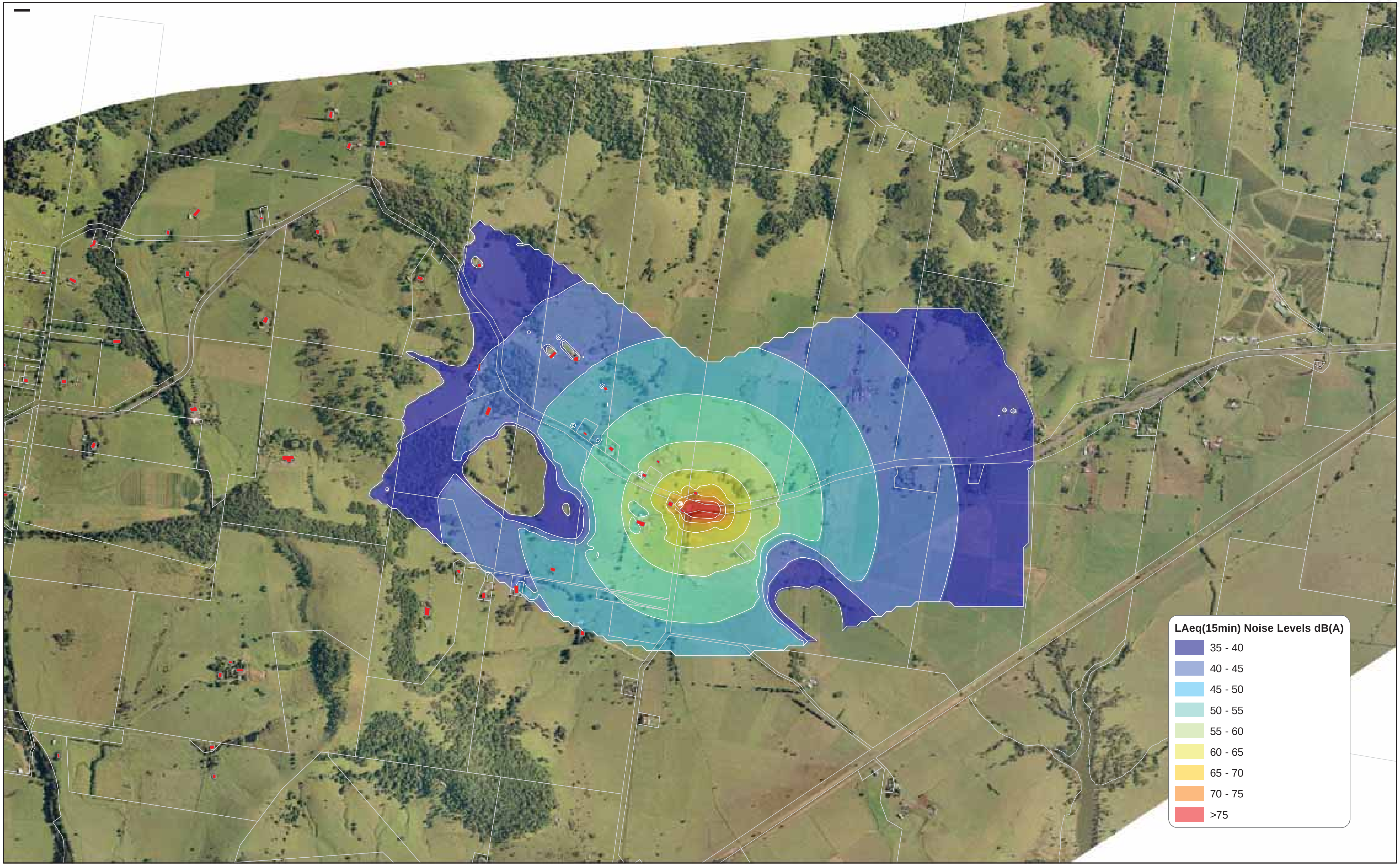
FOXGROUND AND BERRY BYPASS

Toolijooa Tie - In - Maximum Noise Levels

Source: AECOM (2011)

JAN 2012

60021933



🟥 Sensitive Receivers

FOXGROUND AND BERRY BYPASS

Toolijooa Tie - In - Typical Noise Levels

Source: AECOM (2011)

JAN 2012

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0 250 500 1,000 m

Appendix H

Traffic figures

Traffic figures

Table H-1: 2011 existing traffic data

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
Princes Hwy NB	North of Tannery Road	63	67	4,664	326	124	27	3,700	514	12
Princes Hwy SB		59	63	4,630	303	137	31	3,689	502	12
Princes Hwy EB	Queen Street (between Albany St and Alexandra St)	50	50	5,350	354	129	27	4,336	532	11
Princes Hwy WB		50	50	5,283	337	129	28	4,292	526	11
Princes Hwy NB	South of Hitchcocks Lane	90	95	5,826	385	140	27	4,721	579	11
Princes Hwy SB		90	94	5,753	367	141	28	4,673	572	11
Kangaroo Valley Road NB	North of North Street	61	64	741	35	2	4	662	42	6
Kangaroo Valley Road SB		60	65	744	33	0	1	674	37	5
Tannery Road NB	South of Princes Hwy	57	59	848	40	3	7	764	41	5
Tannery Road SB		56	58	832	47	2	4	737	45	6
Woodhill Mountain Road NB	North of North Street	72	79	490	20	0	2	445	25	5
Woodhill Mountain Road SB		75	77	479	22	1	5	426	30	7
Huntingdale Park Road NB	West of Kangaroo Valley Road	50	50	172	8	0	2	161	3	2
Huntingdale Park Road SB		50	50	172	9	0	1	160	3	2
North Street WB	East of Kangaroo Valley Road	50	50	414	20	1	4	370	24	6
North Street EB		50	50	280	12	0	1	254	14	5

Table H-2: 2017 “No build” traffic data

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
Princes Hwy NB	North of Tannery Road	63	67	6,455	373	141	27	5,328	612	10
Princes Hwy SB		59	63	6,248	392	159	29	5,057	640	11
Queen St EB	Queen Street (between Albany St and Alexandra St)	50	50	7,369	431	147	25	6,132	659	10
Queen St WB		50	50	7,127	432	147	25	5,840	708	11
Princes Hwy NB	South of Hitchcocks Lane	90	95	8,024	469	160	25	6,677	718	10
Princes Hwy SB		90	94	7,761	470	160	25	6,360	771	11
Kangaroo Valley Road NB	North of North Street	61	64	904	43	2	4	807	51	6
Kangaroo Valley Road SB		60	65	908	40	0	1	823	45	5
Tannery Road NB	South of Princes Hwy	57	59	1,084	51	4	7	977	52	5
Tannery Road SB		56	58	1,063	60	3	4	942	58	6
Woodhill Mountain Road NB	North of North Street	72	79	598	24	1	2	543	31	5
Woodhill Mountain Road SB		75	77	585	27	1	5	520	37	7
Huntingdale Park Road NB	West of Kangaroo Valley Road	50	50	860	41	1	2	802	17	2
Huntingdale Park Road SB		50	50	860	44	1	1	799	17	2
North Street WB	East of Kangaroo Valley Road	50	50	488	23	1	4	436	28	6
North Street EB		50	50	330	15	0	1	299	16	5

Table H-3: 2027 “No build” traffic data

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
Princes Hwy NB	North of Tannery Road	63	67	8,104	469	177	27	6,690	769	10
Princes Hwy SB		59	63	7,845	492	200	29	6,349	803	11
Queen St EB	Queen Street (between Albany St and Alexandra St)	50	50	9,225	539	184	25	7,677	825	10
Queen St WB		50	50	8,922	540	184	25	7,311	886	11
Princes Hwy NB	South of Hitchcocks Lane	90	95	10,044	587	200	25	8,359	899	10
Princes Hwy SB		90	94	9,715	588	200	25	7,961	965	11
Kangaroo Valley Road NB	North of North Street	61	64	1,175	56	2	4	1,050	67	6
Kangaroo Valley Road SB		60	65	1,181	52	0	1	1,070	58	5
Tannery Road NB	South of Princes Hwy	57	59	1,477	70	5	7	1,331	71	5
Tannery Road SB		56	58	1,448	82	4	4	1,284	79	6
Woodhill Mountain Road NB	North of North Street	72	79	778	31	1	2	706	40	5
Woodhill Mountain Road SB		75	77	761	35	2	5	677	48	7
Huntingdale Park Road NB	West of Kangaroo Valley Road	50	50	1,720	81	1	2	1,604	33	2
Huntingdale Park Road SB		50	50	1,720	88	1	1	1,597	33	2
North Street WB	East of Kangaroo Valley Road	50	50	611	29	1	4	546	35	6
North Street EB		50	50	414	18	0	1	375	20	5

Table H-4: 2017 “Build” traffic data

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
Princes Hwy NB	North of Berry	100	100	7,353	432	140	24	6,172	609	9
Princes Hwy SB		100	100	7,053	450	158	26	5,808	636	10
Princes Hwy NB	Berry Bypass	100	100	6,824	402	127	24	5,723	572	9
Princes Hwy SB		100	100	6,507	415	147	26	5,355	590	10
Queen St EB	Queen Street (between Albany St and Alexandra St)	50	50	1,947	114	37	24	1,629	167	9
Queen St WB		50	50	1,849	117	43	27	1,516	172	10
Princes Hwy NB	South of Berry	100	100	8,569	505	160	24	7,187	718	9
Princes Hwy SB		100	100	8,220	502	160	24	6,787	771	10
Princes Hwy NB On	Northern Interchange	80	80	529	31	10	24	444	44	9
Princes Hwy SB Off		60	60	546	35	12	26	449	49	10
Princes Hwy NB On	Kangaroo Valley Road Interchange	80	80	431	25	8	24	361	36	9
Princes Hwy SB Off		60	60	465	30	10	26	383	42	10
Princes Hwy NB Off		80	80	2,176	128	41	24	1,825	182	9
Princes Hwy SB On		60	60	2,178	133	42	24	1,799	204	10
North Street WB	East of Kangaroo Valley Road	50	50	678	45	16	27	549	67	11
North Street EB		50	50	668	43	16	28	542	66	11
Kangaroo Valley Road NB	North of North Street	61	64	904	43	2	4	807	51	6
Kangaroo Valley Road SB		60	65	908	40	0	1	823	45	5
Tannery Road NB	South of Princes Hwy	57	59	825	39	3	7	744	40	5
Tannery Road SB		56	58	809	46	2	4	717	44	6
Woodhill Mountain Road NB	North of North Street	72	79	598	24	1	2	543	31	5
Woodhill Mountain Road SB		75	77	585	27	1	5	520	37	7

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
Huntingdale Park Road NB	West of Kangaroo Valley Road	50	50	2,559	153	42	22	2,175	189	8
Huntingdale Park Road SB		50	50	383	25	1	5	351	6	2
North Street WB	East of Kangaroo Valley Road	50	50	488	23	1	4	436	28	6
North Street EB		50	50	330	15	0	1	299	16	5

Table H-5: 2027 “Build” traffic data

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
Princes Hwy NB	North of Berry	100	100	12,023	726	174	19	10,368	755	7
Princes Hwy SB		100	100	11,618	765	196	20	9,868	789	7
Princes Hwy NB	Berry Bypass	100	100	10,776	646	169	21	9,198	762	8
Princes Hwy SB		100	100	10,413	678	197	22	8,748	790	8
Queen St EB	Queen Street (between Albany St and Alexandra St)	50	50	3,074	184	49	21	2,618	222	8
Queen St WB		50	50	2,957	192	57	23	2,476	231	9
Princes Hwy NB	South of Berry	100	100	12,557	753	197	21	10,719	888	8
Princes Hwy SB		100	100	12,146	757	198	21	10,237	954	9
Princes Hwy NB On	Northern Interchange	80	80	1,247	75	18	19	1,075	78	7
Princes Hwy SB Off		60	60	1,205	79	20	20	1,023	82	7
Princes Hwy NB On	Kangaroo Valley Road Interchange	80	80	910	55	14	21	777	64	8
Princes Hwy SB Off		60	60	926	60	17	22	778	70	8
Princes Hwy NB Off		80	80	2,692	161	42	21	2,298	190	8
Princes Hwy SB On		60	60	2,659	166	43	21	2,241	209	9
Kangaroo Valley Road NB	North of North Street	61	64	1,175	56	2	4	1,050	67	6
Kangaroo Valley Road SB		60	65	1,181	52	0	1	1,070	58	5
Tannery Road NB	South of Princes Hwy	57	59	787	37	3	7	709	38	5
Tannery Road SB		56	58	772	44	2	4	684	42	6
Woodhill Mountain Road NB	North of North Street	72	79	778	31	1	2	706	40	5
Woodhill Mountain Road SB		75	77	761	35	2	5	677	48	7
Huntingdale Park Road NB	West of Kangaroo Valley Road	50	50	3,457	211	45	18	2,999	203	6
Huntingdale Park Road SB		50	50	766	49	3	5	701	13	2

Route | Direction	Location	Traffic Speed		Daily Total	9 Hour (10pm - 7am)			15 Hour (7am - 10pm)		
		Day km/hr	Night km/hr		Light	Heavy	% Heavy	Light	Heavy	% Heavy
North Street WB	East of Kangaroo Valley Road	50	50	678	45	16	27	549	67	11
North Street EB		50	50	668	43	16	28	542	66	11
Kangaroo Valley Road NB	North of North Street	61	64	611	29	1	4	546	35	6
Kangaroo Valley Road SB		60	65	414	18	0	1	375	20	5

Appendix I

Predicted noise levels (operational)

Predicted noise levels (operational)

The results provided in this Appendix should be interpreted as follows.

Noise criteria for redeveloped roads and for new roads, and for daytime and night-time periods are different.

During the daytime ($L_{Aeq(15hour)}$) period (**Tables I-1**, **I-3** and **I-5**), a noise criteria of 60 dB(A) indicates that the receiver is subject to the ‘redeveloped road’ noise criteria. A noise criteria of 55 dB(A) indicates that the receiver is subject to the ‘new road’ noise criteria. During the night-time ($L_{Aeq(9hour)}$) period (**Tables I-2**, **I-4** and **I-6**), a noise criteria of 55 dB(A) indicates that the receiver is subject to the ‘redeveloped road’ noise criteria. A noise criteria of 50 dB(A) indicates that the receiver is subject to the ‘new road’ noise criteria.

Noise levels presented in the ‘No Build’ column in the tables below represent noise levels at receivers if the project was not to go ahead. Noise levels presented in the ‘Build’ column represent noise levels at receivers from all roads (including local roads) if the project was to proceed. Noise levels presented in the ‘Increase’ column represent the difference between the ‘No Build’ and ‘Build’ noise levels to one decimal place. Noise levels presented in the ‘Project Noise Levels’ column represent noise levels at receivers from the project alignment only (not including noise from local roads).

Redeveloped road noise criteria

The noise level presented in the ‘Build’ column should be assessed against the noise criteria column for each time period. If the noise level presented in the ‘Build’ column exceeds the noise criteria and the noise level presented in the ‘Increase’ column is 2.1 dB(A) or greater, the receiver exceeds the noise criteria and is considered eligible for the consideration of additional mitigation.

A receiver is considered to be exposed to ‘acute’ noise levels if the daytime noise levels presented in the ‘Build’ column are equal to or exceed 65 dB(A) during the daytime period or 60 dB(A) during the night-time period.

New Road Noise Criteria

The noise level presented in the ‘Project Noise Levels’ column should be assessed against the noise criteria column for each time period. If the noise level presented in the ‘Build’ column exceeds the noise criteria the receiver is considered eligible for the consideration of additional mitigation. The ‘Increase’ column is not applicable to new roads.

A receiver is considered to be exposed to ‘acute’ noise levels if the daytime noise levels presented in the ‘Build’ column are equal to or exceed 65 dB(A) during the daytime period or 60 dB(A) during the night-time period.

Contribution analysis

A considerable number of receivers along Queen Street have been found to be acutely affected. These receivers have been found to be acutely affected as a result of the existing contribution from Queen Street, with noise from the project providing noise levels that clearly comply with the appropriate noise criteria. Considering these receivers would not be impacted directly by the project and would actually have reduced traffic flows, hence reduced noise levels, as a result of the project, they are not considered to be eligible for the consideration of noise mitigation.

Table I-1: Predicted daytime $L_{Aeq(15hour)}$ noise levels – DGA

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	'No build'	'Build'	Increase	Project noise levels	Acute	'No build'	'Build'	Increase	Project noise levels	Acute	Mitigation required
1	S	60	67	64	-3.2	64		68	66	-2.5	66	Yes	Yes
3	S	60	68	63	-5.4	63		69	64	-4.9	64		
11	W	55	52	55	2.9	55		53	57	3.7	57		Yes
14	N	55	52	55	2.4	55		53	57	3.2	57		Yes
23	E	55	53	57	4.9	57		54	59	5.7	59		Yes
25	SW	55	56	64	7.9	64		57	66	8.7	66	Yes	Yes
28	E	55	53	59	5.2	59		55	60	5.9	60		Yes
29	E	55	53	58	5.1	58		54	60	6	60		Yes
30	E	55	55	57	2.2	57		56	59	2.9	59		Yes
38	SW	60	60	63	2.7	63		61	65	3.5	65	Yes	Yes
41	E	60	59	61	2.1	61		60	63	2.9	63		Yes
53	SW	60	57	59	2.1	59		58	61	2.9	61		Yes
56	SW	60	59	61	2	61		60	62	2.8	62		Yes
62	NE	60	56	59	2.7	59		57	60	3.3	60		
63	NE	60	56	59	2.3	59		57	60	2.9	60		
64	SE	60	56	58	2.2	58		57	60	2.7	60		
65	SE	60	61	57	-4	57		62	59	-3.5	58		
65	SW	60	60	57	-3.1	57		61	59	-2.7	58		
67	NW	60	65	58	-6.4	58		66	60	-5.8	60		
68	E	60	68	59	-9.2	59		69	61	-8.3	61		
69	N	55	54	56	1.6	54		55	57	1.7	55		
70	W	60	65	58	-7.9	57		66	59	-7.2	59		
71	W	55	53	54	1.2	54		54	56	1.7	56		Yes
73	E	55	56	58	2.3	57		57	59	2.5	58		Yes
79	W	55	69	60	-9.4	54		70	61	-8.8	56		Yes
85	S	55	64	56	-7.6	54		65	59	-6.6	55		
95	S	55	56	56	0	55		57	58	0.8	57		Yes

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
96	N	55	58	60	2.2	57		59	62	3.2	58		Yes
97	S	55	68	60	-7.5	52		69	64	-4.9	53		
98	SW	55	71	63	-8	51		72	67	-5.2	52	Yes	
99	NW	55	52	54	2.1	54		53	56	2.8	55		
100	W	55	53	56	2.8	55		54	58	3.5	57		Yes
102	E	55	56	60	3.7	58		57	62	4.6	59		Yes
108	W	55	67	59	-7.4	51		68	63	-4.9	52		
109	W	55	50	54	4.1	54		51	56	4.7	55		
110	E	55	50	62	12.1	62		51	64	12.5	64		Yes
115	E	55	72	63	-8.6	41		73	67	-5.5	43	Yes	
116	W	55	52	57	5.6	57		53	59	6.2	58		Yes
117	E	55	50	54	3.6	54		51	56	4.2	55		
118	E	55	71	63	-8.5	41		72	67	-5.4	42	Yes	
119	E	55	55	60	4.9	58		56	62	5.8	60		Yes
125	W	55	73	65	-8.3	49	Yes	74	69	-5.3	51	Yes	
134	E	55	75	65	-9.2	41	Yes	76	69	-6.4	43	Yes	
138	SW	55	58	62	4.2	59		59	64	5.1	61		Yes
143	S	55	49	56	6.9	55		50	57	7.5	57		Yes
144	S	55	48	54	6.4	54		49	56	6.9	55		
145	W	55	50	54	4.5	54		51	56	5	55		
153	W	55	75	66	-8.4	46	Yes	76	70	-5.4	48	Yes	
163	E	55	74	65	-9.1	42	Yes	75	69	-6.2	43	Yes	
164	N	55	56	62	5.7	60		57	63	6.4	61		Yes
167	N	55	49	54	5	53		50	55	5.7	55		
171	W	55	56	62	6	60		57	63	6.7	62		Yes
179	E	55	55	61	6.3	60		56	63	7	62		Yes
181	W	55	72	64	-8.2	42		73	68	-5.1	43	Yes	Yes
183	E	55	57	62	5.7	61		58	64	6.4	62		Yes

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Mitigation required**
184	N	55	46	54	7.8	54		47	56	8.3	55		
185	E	55	72	63	-8.3	48		73	67	-5.2	49	Yes	
196	W	55	72	63	-8.4	42		73	67	-5.3	44	Yes	
198	E	55	55	62	7	61		56	64	7.6	63		Yes
199	E	55	47	56	9.1	55		48	57	9.6	57		Yes
204	W	55	72	63	-8.4	42		73	68	-5.3	44	Yes	
208	E	55	70	61	-8.3	47		71	65	-5.6	49	Yes	
209	W	55	72	64	-8.2	42		73	68	-5.1	44	Yes	
210	E	55	55	62	7.1	61		56	64	7.7	63		Yes
213	E	55	70	62	-8.3	47		71	66	-5.6	49	Yes	
219	E	55	50	60	9.9	60		51	62	10.5	61		Yes
223	E	55	70	62	-8.3	48		71	65	-5.5	49	Yes	
227	W	55	69	60	-8.4	42		70	64	-5.6	44		
228	E	55	56	63	6.7	62		57	64	7.4	63		Yes
231	W	55	72	63	-8.4	43		73	68	-5.3	44	Yes	
232	E	55	53	62	8.9	61		54	63	9.4	63		Yes
233	E	55	45	54	8.9	54		46	56	9.4	55		
237	E	55	46	55	9	55		47	56	9.3	56		Yes
240	W	55	72	63	-8.4	43		73	67	-5.3	44	Yes	
243	E	55	69	61	-8.1	48		70	64	-5.4	49		
247	E	55	70	62	-8.1	48		71	66	-5.4	49	Yes	
251	E	55	56	63	7.2	62		57	65	7.7	63	Yes	Yes
252	S	55	48	57	9.2	57		49	59	9.6	58		Yes
253	S	55	49	55	5.7	55		50	57	6.3	56		Yes
257	N	55	53	62	9	62		54	64	9.5	63		Yes
269	W	55	68	60	-8.3	43		69	64	-5.5	44		
272	E	55	53	62	9.4	62		54	64	9.8	63		Yes
274	E	55	69	61	-8.1	48		70	65	-5.4	50	Yes	

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
278	W	55	67	59	-8	43		68	63	-5.3	44		
280	N	55	51	61	10.3	61		52	62	10.7	62		Yes
284	N	55	68	60	-8	49		69	63	-5.3	50		
293	N	55	56	63	7.7	62		57	65	8	64	Yes	Yes
297	N	55	70	62	-8.3	48		71	65	-5.5	49	Yes	
299	S	55	48	60	12.3	60		49	61	12.5	61		Yes
300	N	55	55	63	8	62		56	65	8.3	63	Yes	Yes
304	N	55	56	64	7.5	63		57	65	7.8	64	Yes	Yes
305	S	55	68	60	-8	44		69	64	-5.2	45		
308	N	55	70	61	-8.3	48		71	65	-5.5	49	Yes	
316	N	55	58	64	6.4	63		59	66	6.8	64	Yes	Yes
320	N	55	71	63	-8.4	48		72	66	-5.6	49	Yes	
322	S	55	68	60	-8	43		69	63	-5.2	44		
324	N	55	71	63	-8.4	48		72	66	-5.6	49	Yes	
329	N	55	56	63	7.7	63		57	65	8	64	Yes	Yes
331	S	55	70	61	-8.5	43		71	65	-5.7	45	Yes	
334	N	55	71	63	-8	49		72	68	-4.9	50	Yes	
342	N	55	56	63	7.3	62		57	65	7.7	63	Yes	Yes
344	S	55	68	59	-8.4	44		69	63	-5.6	45		
345	N	55	69	61	-7.9	49		70	65	-5.2	50	Yes	
350	N	55	52	61	8.7	60		53	62	9	61		Yes
351	N	55	71	63	-8.2	49		72	67	-5.1	50	Yes	
353	N	55	46	54	7.7	54		47	55	8	55		
354	E	55	70	61	-8.4	44		71	65	-5.4	45	Yes	
355	W	55	57	64	6.4	62		58	65	6.8	63	Yes	Yes
356	W	55	68	60	-8.2	48		69	64	-5.4	50		
362	E	55	68	60	-8.2	44		69	64	-5.4	45		
363	W	55	71	63	-8.2	48		72	67	-5.3	50	Yes	

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
367	W	55	52	61	9.1	60		52	62	9.3	61		Yes
368	E	55	69	60	-8.2	44		70	64	-5.5	45		
374	W	55	56	64	7.2	63		57	65	7.6	64	Yes	Yes
375	W	55	69	61	-8.1	48		70	64	-5.4	50		
378	E	55	69	61	-8.2	44		70	65	-5.3	45	Yes	
380	W	55	70	62	-8.2	49		71	66	-5.4	50	Yes	
382	E	55	68	60	-8.1	44		69	64	-5.3	46		
383	W	55	46	56	10.1	56		47	58	10.4	57		Yes
384	W	55	53	63	9.2	62		54	64	9.5	64		Yes
385	S	55	51	56	4.9	56		52	58	5.4	58		Yes
386	W	55	57	68	10.6	67	Yes	58	69	10.9	69	Yes	Yes
388	W	55	48	58	10.7	58		49	60	11	60		Yes
392	W	55	48	59	11.4	59		49	60	11.8	60		Yes
393	S	55	69	61	-8.2	49		70	65	-5.4	50	Yes	
394	N	55	72	63	-8.5	45		73	67	-5.4	46	Yes	Yes
399	S	55	72	64	-8.3	49		73	68	-5.2	50	Yes	
403	S	55	48	58	9.5	58		49	59	9.8	59		Yes
404	N	55	70	62	-8.2	46		71	66	-5.4	47	Yes	
408	N	55	69	61	-8.4	46		70	64	-5.6	47		
409	S	55	68	60	-7.7	50		69	64	-5.1	51		
411	N	55	69	60	-8.3	46		70	64	-5.6	47		
413	S	55	68	60	-7.7	50		69	64	-5	52		
414	S	55	49	55	6	55		50	56	6.4	56		
414	N	55	69	60	-8.3	47		70	64	-5.6	48		
415	S	55	68	60	-7.6	51		69	64	-5	52		
416	S	55	49	59	9.7	59		50	60	10.1	60		Yes
417	S	55	50	56	6	56		51	57	6.3	57		
417	N	55	68	60	-8.2	47		69	64	-5.6	48		

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Mitigation required**
421	S	55	49	55	6.1	55		50	56	6.5	56		
421	S	55	69	61	-8.2	48		70	64	-5.6	49		
423	S	55	68	60	-7.5	51		69	64	-4.9	52		
425	S	55	67	60	-7.3	52		68	64	-4.7	53		
426	S	55	51	56	5.4	56		52	57	5.8	57		
426	N	55	68	60	-8	48		69	64	-5.4	49		
427	S	55	50	58	7.4	58		51	59	7.8	59		Yes
429	S	55	69	61	-7.8	52		70	65	-5.2	53	Yes	
430	S	55	53	59	6.2	59		54	61	6.7	60		Yes
434	S	55	53	59	5.9	59		54	60	6.3	60		Yes
435	E	55	53	54	1.2	54		54	55	1.5	55		
438	SE	55	62	61	-0.9	60		63	63	-0.5	61		Yes
438	SW	55	68	62	-6.2	57		69	63	-5.7	58		Yes
439	N	55	55	59	3.7	58		56	60	3.9	60		Yes
445	W	55	52	58	5.7	57		53	59	5.9	59		Yes
451	N	55	60	60	0	59		61	61	0.2	60		Yes
453	E	55	52	54	1.7	53		53	55	2.1	55		
454	E	55	53	54	1	54		54	55	1.3	55		
459	NE	55	57	54	-3.3	53		58	55	-2.9	55		
468	E	55	53	54	1.2	54		54	55	1.5	55		
469	E	55	59	57	-1.1	57		60	59	-0.8	59		
474	W	55	53	54	1.5	54		54	55	1.8	55		
489	SE	60	66	62	-3.5	62		67	64	-3.3	64		
500	SE	60	64	63	-1.1	63		65	64	-1	64		
505	S	55	53	54	1.1	54		54	55	1.2	55		
510	S	60	63	63	0.7	63		64	65	0.9	65	Yes	Yes
513	SE	60	57	60	2.4	60		59	61	2.5	61		Yes
514	S	60	59	61	2	61		60	63	2.3	63		Yes

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
514	S	60	57	60	2.7	60		58	61	2.9	61		Yes
522	E	55	53	54	0.5	54		54	55	0.8	55		
523	SW	55	52	54	1.9	54		53	55	2.1	55		
527	S	60	60	62	1.9	62		61	64	2.2	64		Yes
528	E	55	54	54	0.2	54		55	55	0.5	55		
532	S	55	54	55	0.7	55		55	56	0.9	56		Yes
536	W	60	56	59	3	59		57	60	3.3	60		
536	S	60	60	62	2.1	62		61	63	2.2	63		Yes
542	W	60	56	59	3.2	59		57	60	3.4	60		
542	S	60	59	61	1.8	61		60	62	2.1	62		Yes
551	SW	55	54	55	0.8	54		55	56	0.9	56		Yes
552	SW	55	53	54	0.7	54		54	55	1	55		
564	W	60	66	63	-3.3	63		67	64	-3.2	64		
581	N/A	60	65	63	-1.6	63		67	64	-2.4	64		
582	N/A	60	64	64	-0.7	64		66	65	-1.6	65	Yes	Yes
583	N/A	60	64	64	0.3	64		66	65	-0.5	65	Yes	Yes
584	N/A	60	63	65	1.3	65	Yes	65	66	0.7	66	Yes	Yes
585	N/A	60	63	65	1.7	65	Yes	65	66	1.1	66	Yes	Yes
586	N/A	60	63	64	1.5	64		65	66	1	65	Yes	Yes
587	N/A	60	62	63	1.3	63		64	65	0.9	65	Yes	Yes

Table I-2: Predicted night time $L_{Aeq(9hour)}$ noise levels – DGA

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
1	S	55	64	60	-3.3	60	Yes	65	62	-2.9	62	Yes	Yes
3	S	55	65	59	-5.3	59		66	61	-5.1	61	Yes	Yes
11	W	50	49	52	2.4	52		50	53	2.9	53		Yes
14	N	50	49	51	2	51		50	53	2.5	53		Yes
23	E	50	49	54	4.5	54		50	55	5	55		Yes
25	SW	50	53	60	7.6	60	Yes	54	62	8.1	62	Yes	Yes
28	E	50	50	55	4.8	55		51	56	5.2	56		Yes
29	E	50	49	54	4.9	54		50	56	5.3	56		Yes
30	E	50	51	53	1.8	53		52	55	2.1	55		Yes
38	SW	55	57	59	2.3	59		58	61	2.7	61	Yes	Yes
41	E	55	56	57	1.7	57		57	59	2.2	59		Yes
53	SW	55	54	55	1.7	55		55	57	2.1	57		Yes
56	SW	55	55	57	1.7	57		56	59	2.1	59		Yes
62	NE	55	53	56	3	56		54	57	3.2	57		Yes
63	NE	55	53	56	2.5	56		54	57	2.7	57		Yes
64	SE	55	53	56	2.1	56		54	57	2.3	57		Yes
65	SE	55	58	53	-4.5	53		59	54	-4.6	54		
65	SW	55	57	53	-3.6	53		58	54	-3.6	54		
67	NW	55	61	55	-6.6	55		62	56	-6.5	56		
68	E	55	65	56	-9.5	55		66	57	-9	57		
69	N	50	49	51	1.5	50		50	52	1.3	51		Yes
70	W	55	62	54	-8.1	54		63	55	-7.9	55		
71	W	50	50	51	0.8	51		51	52	0.9	52		Yes
73	E	50	51	54	2.4	53		52	54	2.1	54		Yes
79	W	50	66	55	-10.5	51		67	57	-9.5	52		Yes
85	S	50	62	53	-8.7	50		63	55	-7.9	51		Yes

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	'No build'	'build'	Increase	Project noise levels	Acute	'No build'	'Build'	Increase	Project noise levels	Acute	Mitigation required
95	S	50	53	53	0.1	51		54	54	0.6	52		Yes
96	N	50	52	57	5.1	53		53	59	6.2	54		Yes
97	S	50	65	58	-6.1	48		66	61	-4.9	49	Yes	
98	SW	50	68	62	-6.3	47	Yes	69	64	-5.1	48	Yes	
99	NW	50	49	51	2.3	50		50	52	2.5	51		Yes
100	W	50	49	53	3.4	52		50	54	3.9	52		Yes
102	E	50	49	57	7.6	54		50	59	8.5	55		Yes
108	W	50	64	57	-6.1	47		64	60	-4.8	48	Yes	Yes
109	W	50	47	51	4.1	50		48	52	4.4	51		Yes
110	E	50	47	59	12.2	59		48	60	12.1	60	Yes	Yes
115	E	50	69	62	-7	37	Yes	70	64	-5.6	38	Yes	
116	W	50	47	54	6.9	53		48	55	7.2	54		Yes
117	E	50	47	50	3.6	50		48	52	3.8	51		Yes
118	E	50	68	61	-6.7	37	Yes	69	64	-5.3	38	Yes	
119	E	50	48	57	8.4	55		49	58	9.1	56		Yes
125	W	50	70	63	-6.6	46	Yes	71	65	-5.2	47	Yes	
134	E	50	71	64	-7.4	37	Yes	72	66	-6.1	38	Yes	
138	SW	50	50	58	8.2	56		51	60	9.2	57	Yes	Yes
143	S	50	44	52	8.5	52		45	54	8.8	53		Yes
144	S	50	44	51	7.3	50		45	52	7.4	51		Yes
145	W	50	46	51	4.6	50		47	52	4.7	51		Yes
153	W	50	72	65	-6.7	43	Yes	73	67	-5.3	43	Yes	
163	E	50	71	64	-7.3	38	Yes	72	66	-6	39	Yes	
164	N	50	48	58	9.8	57		49	60	10.4	57	Yes	Yes
167	N	50	45	50	5.2	50		46	51	5.5	51		Yes
171	W	50	48	58	10.1	57		49	60	10.6	58	Yes	Yes
179	E	50	48	58	10.3	57		49	60	10.9	58	Yes	Yes
181	W	50	69	62	-6.6	38	Yes	70	64	-5.2	39	Yes	Yes

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	'No build'	'build'	Increase	Project noise levels	Acute	'No build'	'Build'	Increase	Project noise levels	Acute	Mitigation required
183	E	50	49	59	10.1	57		50	61	10.6	58	Yes	Yes
184	N	50	42	51	9	50		43	52	9.1	51		Yes
185	E	50	68	62	-6.6	44	Yes	69	64	-5.1	45	Yes	
196	W	50	68	62	-6.7	38	Yes	69	64	-5.2	39	Yes	
198	E	50	48	59	11.1	58		49	60	11.5	59	Yes	Yes
199	E	50	41	52	11.3	52		42	53	11.4	53		Yes
204	W	50	69	62	-6.6	38	Yes	70	64	-5.2	39	Yes	
208	E	50	67	60	-6.7	43	Yes	68	62	-5.5	44	Yes	
209	W	50	69	62	-6.5	39	Yes	70	64	-5.1	39	Yes	
210	E	50	48	59	11.1	58		49	60	11.5	59	Yes	Yes
213	E	50	67	60	-6.7	44	Yes	68	63	-5.5	44	Yes	
219	E	50	43	57	13.9	56		44	58	14.1	57		Yes
223	E	50	67	60	-6.7	44	Yes	68	62	-5.3	45	Yes	
227	W	50	66	59	-6.8	39		67	61	-5.5	39	Yes	
228	E	50	48	59	10.9	58		49	61	11.4	59	Yes	Yes
231	W	50	69	62	-6.7	39	Yes	70	64	-5.3	40	Yes	
232	E	50	46	58	12.8	58		47	60	13	59	Yes	Yes
233	E	50	41	51	9.7	50		42	52	9.7	51		Yes
237	E	50	42	51	9.7	51		43	52	9.6	52		Yes
240	W	50	68	62	-6.6	39	Yes	69	64	-5.2	40	Yes	
243	E	50	66	59	-6.5	44		67	61	-5.3	45	Yes	
247	E	50	67	61	-6.5	44	Yes	68	63	-5.3	45	Yes	
251	E	50	48	60	11.4	59	Yes	49	61	11.8	59	Yes	Yes
252	S	50	43	54	10.6	53		44	55	10.6	54		Yes
253	S	50	46	52	6	51		47	53	6.1	52		Yes
257	N	50	46	59	13.2	58		47	60	13.3	59	Yes	Yes
269	W	50	65	58	-6.7	39		66	61	-5.4	40	Yes	
272	E	50	46	59	13.1	58		47	60	13.2	59	Yes	Yes

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
274	E	50	66	60	-6.5	45	Yes	67	62	-5.3	46	Yes	
278	W	50	64	58	-6.5	39		65	60	-5.1	40	Yes	
280	N	50	44	57	13.6	57		45	58	13.5	58		Yes
284	N	50	64	58	-6.4	45		65	60	-5.2	46	Yes	
293	N	50	48	60	11.7	59	Yes	49	61	12	59	Yes	Yes
297	N	50	67	60	-6.7	44	Yes	68	62	-5.3	45	Yes	
299	S	50	44	56	12.3	56		45	57	12.1	57		Yes
300	N	50	48	60	12.1	59	Yes	49	61	12.3	59	Yes	Yes
304	N	50	48	60	11.6	59	Yes	49	61	11.9	59	Yes	Yes
305	S	50	65	58	-6.4	40		66	60	-5.1	40	Yes	
308	N	50	66	60	-6.7	44	Yes	67	62	-5.4	45	Yes	
316	N	50	50	61	10.8	59	Yes	51	62	11.2	60	Yes	Yes
320	N	50	68	61	-6.7	44	Yes	69	63	-5.5	45	Yes	
322	S	50	64	58	-6.5	39		65	60	-5.1	40	Yes	
324	N	50	68	61	-6.7	44	Yes	69	63	-5.4	45	Yes	
329	N	50	48	60	12.1	59	Yes	49	61	12.2	59	Yes	Yes
331	S	50	66	60	-6.9	40	Yes	67	62	-5.6	40	Yes	
334	N	50	68	62	-6.4	45	Yes	69	64	-4.9	46	Yes	
342	N	50	48	60	11.5	58	Yes	49	61	11.8	59	Yes	Yes
344	S	50	65	58	-6.9	40		66	60	-5.6	41	Yes	
345	N	50	66	60	-6.4	45	Yes	67	62	-5.1	46	Yes	
350	N	50	44	57	13	56		45	58	13	57		Yes
351	N	50	68	61	-6.5	45	Yes	69	64	-5.1	46	Yes	
353	N	50	42	50	8.2	50		43	51	8.1	51		Yes
354	E	50	66	60	-6.7	40	Yes	67	62	-5.4	41	Yes	
355	W	50	49	60	11	59	Yes	50	62	11.4	59	Yes	Yes
356	W	50	65	59	-6.7	45		66	61	-5.3	46	Yes	
362	E	50	65	59	-6.6	40		66	61	-5.3	41	Yes	

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Mitigation required
363	W	50	68	61	-6.6	45	Yes	69	64	-5.2	45	Yes	
367	W	50	44	57	13.2	56		45	58	13.3	57		Yes
368	E	50	65	59	-6.6	40		66	61	-5.4	41	Yes	
374	W	50	49	60	11.7	59	Yes	50	62	12	60	Yes	Yes
375	W	50	65	59	-6.6	45		66	61	-5.3	45	Yes	
378	E	50	66	59	-6.6	40		67	62	-5.2	41	Yes	
380	W	50	67	60	-6.6	45	Yes	68	62	-5.4	46	Yes	
382	E	50	65	59	-6.5	41		66	61	-5.2	41	Yes	
383	W	50	42	53	11.2	53		43	54	11	54		Yes
384	W	50	46	59	13.4	59		47	60	13.3	60	Yes	Yes
385	S	50	48	53	4.8	53		49	54	4.7	54		Yes
386	W	50	49	64	15	64	Yes	50	65	14.9	65	Yes	Yes
388	W	50	44	55	11.3	55		45	56	11.2	56		Yes
392	W	50	43	56	12.3	56		44	57	12.2	56		Yes
393	S	50	66	60	-6.6	45	Yes	67	62	-5.3	46	Yes	
394	N	50	69	62	-6.8	41	Yes	70	64	-5.4	42	Yes	Yes
399	S	50	69	62	-6.6	45	Yes	70	65	-5.2	46	Yes	
403	S	50	45	54	9.2	54		46	55	9.2	55		Yes
404	N	50	67	60	-6.6	42	Yes	68	63	-5.2	43	Yes	
408	N	50	66	59	-6.8	42		67	61	-5.5	43	Yes	
409	S	50	65	59	-6.3	46		66	61	-5	47	Yes	
411	N	50	65	59	-6.7	42		66	61	-5.5	43	Yes	
413	S	50	65	58	-6.2	47		66	61	-5	47	Yes	
414	S	50	46	51	5.8	51		47	52	5.7	52		
414	N	50	66	59	-6.8	43		66	61	-5.5	44	Yes	
415	S	50	64	58	-6.2	47		65	60	-5	48	Yes	
416	S	50	46	56	9.3	56		47	57	9.3	57		Yes
417	S	50	47	52	5.3	52		48	53	5.3	53		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Mitigation required**
417	N	50	65	58	-6.8	43		66	61	-5.6	44	Yes	
421	S	50	46	52	6	51		46	53	6.1	52		
421	S	50	66	59	-6.6	44		67	61	-5.4	45	Yes	
423	S	50	65	58	-6.1	47		66	61	-4.9	48	Yes	
425	S	50	64	58	-6	48		65	60	-4.8	49	Yes	
426	S	50	48	53	4.7	52		49	54	4.7	53		
426	N	50	65	59	-6.6	44		66	61	-5.4	45	Yes	
427	S	50	48	54	6.8	54		49	55	6.8	55		Yes
429	S	50	66	60	-6.4	48	Yes	67	62	-5.1	49	Yes	
430	S	50	51	56	5.1	56		52	57	5.2	57		Yes
434	S	50	51	55	4.5	55		52	56	4.7	56		Yes
435	E	50	48	51	2.6	50		49	51	2.5	51		Yes
438	SE	50	60	57	-3.1	57		61	58	-3	58		Yes
438	SW	50	66	56	-9.5	53		67	57	-9.2	54		Yes
439	N	50	52	55	2.8	55		53	56	2.8	56		Yes
445	W	50	50	54	4.2	54		51	55	4.3	55		Yes
451	N	50	58	56	-2.3	55		59	56	-2.4	56		Yes
453	E	50	48	50	1.5	50		49	51	1.3	51		Yes
454	E	50	49	50	0.9	50		50	51	0.7	51		Yes
459	NE	50	51	50	-0.9	50		52	51	-1	51		Yes
468	E	50	49	50	1	50		50	51	0.9	51		Yes
469	E	50	55	54	-1.8	54		56	54	-2	54		
474	W	50	49	50	1.2	50		50	51	1	51		Yes
489	SE	55	63	59	-4	59		64	60	-4.3	59		
500	SE	55	61	59	-1.7	59		62	60	-1.9	60	Yes	Yes
505	S	50	50	50	0.6	50		51	51	0.4	51		Yes
510	S	55	59	60	0.4	60	Yes	60	60	0.1	60	Yes	Yes
513	SE	55	54	56	2.4	56		55	57	2.2	57		Yes

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Mitigation required**
514	S	55	56	58	1.8	58		57	59	1.5	59		
514	S	55	54	56	2.3	56		55	57	2.1	57		Yes
522	E	50	49	50	0.6	50		50	51	0.3	51		Yes
523	SW	50	49	50	1.6	50		50	51	1.4	51		Yes
527	S	55	57	59	1.7	59		58	59	1.4	59		
528	E	50	50	50	0.2	50		51	51	0.1	51		Yes
532	S	50	50	51	0.5	51		51	52	0.4	52		Yes
536	W	55	52	55	2.7	55		53	56	2.4	56		Yes
536	S	55	56	58	1.8	58		57	59	1.6	59		
542	W	55	53	55	2.9	55		54	56	2.6	56		Yes
542	S	55	56	57	1.7	57		57	58	1.4	58		
551	SW	50	50	51	0.7	51		51	52	0.4	52		Yes
552	SW	50	50	50	0.7	50		51	51	0.5	51		Yes
564	W	55	62	59	-3.5	59		63	60	-3.8	60	Yes	Yes
581	N/A	55	59	59	0.7	59		60	60	0	60	Yes	Yes
582	N/A	55	59	60	1.4	60	Yes	60	61	0.8	61	Yes	Yes
583	N/A	55	58	60	2	60	Yes	60	61	1.5	61	Yes	Yes
584	N/A	55	58	61	2.7	61	Yes	60	62	2.1	62	Yes	Yes
585	N/A	55	58	61	2.9	61	Yes	59	62	2.4	62	Yes	Yes
586	N/A	55	58	61	2.8	61	Yes	59	61	2.3	61	Yes	Yes
587	N/A	55	57	60	2.6	60	Yes	58	60	2.1	60	Yes	Yes

Table I-3 Predicted daytime $L_{Aeq(15hour)}$ noise levels – SMA

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	'No build'	'Build'	Increase	Project noise levels	Acute	'No build'	'Build'	Increase	Project noise levels	Acute	Additional mitigation required
1	S	60	67	61	-5.6	61		68	63	-4.8	63		
3	S	60	68	60	-7.9	60		69	62	-7.3	62		
11	W	55	52	53	0.5	53		53	55	1.4	55		
14	N	55	52	52	0	52		53	54	0.9	54		
23	E	55	53	55	2.5	55		54	57	3.4	57		Yes
25	SW	55	56	61	5.5	61		57	63	6.4	63		Yes
28	E	55	53	56	2.8	56		55	58	3.6	58		Yes
29	E	55	53	55	2.7	55		54	57	3.6	57		Yes
30	E	55	55	54	-0.1	54		56	56	0.6	56		Yes
38	SW	60	60	60	0.3	60		61	62	1.2	62		
41	E	60	59	59	-0.3	59		60	61	0.6	61		
53	SW	60	57	57	-0.3	57		58	58	0.5	58		
56	SW	60	59	58	-0.3	58		60	60	0.5	60		
62	NE	60	56	57	0.5	57		57	58	1.3	58		
63	NE	60	56	56	0.1	56		57	58	1	58		
64	SE	60	56	56	-0.1	56		57	58	0.9	58		
65	SE	60	61	55	-6.2	54		62	57	-5.1	57		
65	SW	60	60	55	-5.3	54		61	57	-4.3	57		
67	NW	60	65	56	-8.6	56		66	58	-7.4	58		
68	E	60	68	57	-11.4	56		69	60	-9.8	59		
69	N	55	54	54	0.2	51		55	55	0.4	53		
70	W	60	65	55	-10.1	55		66	58	-8.8	57		
71	W	55	53	52	-1.2	52		54	54	-0.1	54		
73	E	55	56	56	0.6	55		57	58	1.1	57		Yes
79	W	55	69	59	-10	52		70	61	-9.2	54		
85	S	55	64	55	-8.8	52		65	58	-7.3	54		

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
95	S	55	56	55	-1.6	53		57	57	-0.3	55		
96	N	55	58	59	1.2	55		59	61	2.6	57		Yes
97	S	55	68	60	-7.7	49		69	64	-5	51		
98	SW	55	71	63	-8.1	49		72	67	-5.2	51	Yes	
99	NW	55	52	53	0.2	51		53	55	1.4	53		
100	W	55	53	54	1	53		54	57	2.2	55		
102	E	55	56	59	2.5	55		57	61	3.8	57		Yes
108	W	55	67	59	-7.7	48		68	63	-5	50		
109	W	55	50	52	2.1	51		51	55	3.3	53		
110	E	55	50	60	9.8	60		51	62	10.8	62		Yes
115	E	55	72	63	-8.6	39		73	67	-5.5	41	Yes	
116	W	55	52	55	3.7	54		53	58	4.9	56		Yes
117	E	55	50	52	1.6	51		51	54	2.7	53		
118	E	55	71	63	-8.5	39		72	67	-5.4	40	Yes	
119	E	55	55	58	3.4	56		56	61	4.7	58		Yes
125	W	55	73	65	-8.3	47	Yes	74	69	-5.3	49	Yes	
134	E	55	75	65	-9.2	39	Yes	76	69	-6.4	41	Yes	
138	SW	55	58	61	3	57		59	63	4.2	59		Yes
143	S	55	49	54	4.9	53		50	56	6.1	55		
144	S	55	48	52	4.3	52		49	55	5.5	54		
145	W	55	50	52	2.4	52		51	54	3.5	54		
153	W	55	75	66	-8.4	44	Yes	76	70	-5.4	46	Yes	
163	E	55	74	65	-9.1	40	Yes	75	69	-6.2	41	Yes	
164	N	55	56	60	4.1	58		57	62	5.3	60		Yes
167	N	55	49	52	2.9	51		50	54	4.2	53		
171	W	55	56	60	4.4	58		57	62	5.6	60		Yes
179	E	55	55	60	4.7	58		56	62	5.9	60		Yes
181	W	55	72	63	-8.3	40		73	68	-5.2	42	Yes	Yes

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
183	E	55	57	61	4.1	59		58	63	5.3	61		Yes
184	N	55	46	52	5.7	51		47	54	6.8	54		
185	E	55	72	63	-8.3	45		73	67	-5.2	47	Yes	
196	W	55	72	63	-8.4	40		73	67	-5.3	42	Yes	
198	E	55	55	61	5.3	59		56	63	6.4	61		Yes
199	E	55	47	54	7	53		48	56	8.1	55		
204	W	55	72	63	-8.4	40		73	68	-5.3	42	Yes	
208	E	55	70	61	-8.4	45		71	65	-5.6	47	Yes	
209	W	55	72	64	-8.2	40		73	68	-5.1	42	Yes	
210	E	55	55	61	5.4	59		56	63	6.5	61		Yes
213	E	55	70	62	-8.4	45		71	66	-5.6	47	Yes	
219	E	55	50	58	7.8	57		51	60	9.1	59		Yes
223	E	55	70	62	-8.3	46		71	65	-5.5	48	Yes	
227	W	55	69	60	-8.5	40		70	64	-5.6	42		
228	E	55	56	61	5	59		57	63	6.2	61		Yes
231	W	55	72	63	-8.4	41		73	68	-5.3	42	Yes	
232	E	55	53	60	7	59		54	62	8	61		Yes
233	E	55	45	52	7	52		46	54	7.9	54		
237	E	55	46	53	6.8	52		47	55	7.7	54		
240	W	55	72	63	-8.4	40		73	67	-5.3	42	Yes	
243	E	55	69	61	-8.2	46		70	64	-5.4	48		
247	E	55	70	62	-8.2	46		71	66	-5.4	48	Yes	
251	E	55	56	62	5.6	60		57	64	6.6	62		Yes
252	S	55	48	55	7	54		49	57	8.1	56		Yes
253	S	55	49	53	3.6	52		50	55	4.8	54		
257	N	55	53	61	7.4	60		54	63	8.2	62		Yes
269	W	55	68	60	-8.3	41		69	64	-5.5	43		
272	E	55	53	61	7.8	60		54	62	8.5	61		Yes

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
274	E	55	69	61	-8.2	46		70	65	-5.4	48	Yes	
278	W	55	67	59	-8.1	41		68	63	-5.3	43		
280	N	55	51	59	8.6	59		52	61	9.3	60		Yes
284	N	55	68	60	-8.1	47		69	63	-5.4	48		
293	N	55	56	62	6.4	61		57	64	7.1	62		Yes
297	N	55	70	61	-8.4	46		71	65	-5.6	48	Yes	
299	S	55	48	58	10.5	58		49	60	11.1	60		Yes
300	N	55	55	62	6.7	61		56	64	7.4	62		Yes
304	N	55	56	62	6.3	61		57	64	6.9	62		Yes
305	S	55	68	60	-8.1	41		69	63	-5.3	43		
308	N	55	70	61	-8.3	46		71	65	-5.6	48	Yes	
316	N	55	58	63	5.3	61		59	65	6	63	Yes	Yes
320	N	55	71	62	-8.5	46		72	66	-5.6	48	Yes	
322	S	55	68	60	-8	41		69	63	-5.2	43		
324	N	55	71	62	-8.5	46		72	66	-5.6	48	Yes	
329	N	55	56	62	6.6	61		57	64	7.2	62		Yes
331	S	55	70	61	-8.5	41		71	65	-5.7	43	Yes	
334	N	55	71	63	-8	47		72	67	-5	48	Yes	
342	N	55	56	62	6.3	61		57	64	6.8	62		Yes
344	S	55	68	59	-8.4	42		69	63	-5.6	43		
345	N	55	69	61	-8	47		70	65	-5.2	49	Yes	
350	N	55	52	60	7.7	59		53	61	8.1	60		Yes
351	N	55	71	63	-8.2	47		72	67	-5.2	48	Yes	
353	N	55	46	52	6.2	52		47	54	6.8	53		
354	E	55	70	61	-8.4	42		71	65	-5.5	44	Yes	
355	W	55	57	63	5.4	61		58	64	6.1	62		Yes
356	W	55	68	60	-8.3	46		69	64	-5.5	48		
362	E	55	68	60	-8.2	42		69	64	-5.4	44		

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
363	W	55	71	63	-8.2	46		72	67	-5.3	48	Yes	
367	W	55	52	59	7.9	59		52	61	8.4	60		Yes
368	E	55	69	60	-8.3	42		70	64	-5.5	44		
374	W	55	56	62	6	61		57	64	6.7	62		Yes
375	W	55	69	60	-8.2	46		70	64	-5.5	48		
378	E	55	69	61	-8.3	42		70	65	-5.3	44	Yes	
380	W	55	70	62	-8.3	46		71	66	-5.5	48	Yes	
382	E	55	68	60	-8.1	42		69	64	-5.3	44		
383	W	55	46	54	8.1	54		47	56	8.9	56		Yes
384	W	55	53	61	7.3	60		54	62	8.1	62		Yes
385	S	55	51	54	2.7	54		52	56	3.8	56		Yes
386	W	55	57	65	8.3	65	Yes	58	67	9.2	67	Yes	Yes
388	W	55	48	56	8.5	56		49	58	9.4	58		Yes
392	W	55	48	57	9.1	57		49	59	10.1	59		Yes
393	S	55	69	61	-8.2	47		70	65	-5.5	48	Yes	
394	N	55	72	63	-8.5	42		73	67	-5.4	44	Yes	Yes
399	S	55	72	64	-8.3	47		73	68	-5.2	49	Yes	
403	S	55	48	56	7.3	55		49	58	8.1	57		Yes
404	N	55	70	62	-8.2	43		71	66	-5.4	45	Yes	
408	N	55	69	61	-8.4	44		70	64	-5.7	45		
409	S	55	68	60	-7.9	48		69	64	-5.2	50		
411	N	55	69	60	-8.4	44		70	64	-5.6	46		
413	S	55	68	60	-7.9	48		69	64	-5.1	50		
414	S	55	49	53	3.7	52		50	55	4.8	54		
414	N	55	69	60	-8.4	44		70	64	-5.6	46		
415	S	55	68	60	-7.8	49		69	64	-5.1	50		
416	S	55	49	57	7.4	57		50	59	8.4	59		Yes
417	S	55	50	54	3.8	53		51	56	4.7	55		

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
417	N	55	68	60	-8.3	45		69	64	-5.6	46		
421	S	55	49	53	3.9	53		50	55	4.9	54		
421	S	55	69	61	-8.3	45		70	64	-5.6	47		
423	S	55	68	60	-7.7	49		69	64	-5	51		
425	S	55	67	60	-7.6	50		68	63	-4.9	52		
426	S	55	51	54	3.2	53		52	56	4.2	55		
426	N	55	68	60	-8.1	46		69	64	-5.5	47		
427	S	55	50	56	5.2	55		51	57	6.1	57		Yes
429	S	55	69	61	-8	50		70	65	-5.3	52	Yes	
430	S	55	53	57	4.1	57		54	59	5	59		Yes
434	S	55	53	57	3.7	56		54	59	4.6	58		Yes
435	E	55	53	52	-0.8	51		54	54	-0.1	53		
438	SE	55	62	60	-2.3	58		63	61	-1.9	60		Yes
438	SW	55	68	62	-6.2	54		69	63	-6.1	56		Yes
439	N	55	55	57	1.7	56		56	58	2.2	58		Yes
445	W	55	52	56	3.6	55		53	57	4.1	57		Yes
451	N	55	60	59	-1.3	56		61	60	-1.2	58		Yes
453	E	55	52	51	-0.6	51		53	53	0.4	53		
454	E	55	53	51	-1.3	51		54	53	-0.4	53		
459	NE	55	57	52	-5	51		58	54	-4.4	53		
468	E	55	53	52	-1.1	51		54	53	-0.2	53		
469	E	55	59	55	-3.2	55		60	57	-2.5	57		
474	W	55	53	52	-0.8	52		54	54	0.1	53		
489	SE	60	66	60	-5.8	60		67	62	-5.2	62		
500	SE	60	64	61	-3.5	60		65	62	-2.9	62		
505	S	55	53	52	-1.2	51		54	53	-0.5	53		
510	S	60	63	61	-1.6	61		64	63	-0.9	63		
513	SE	60	57	57	0	57		59	59	0.6	59		

			2017 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
514	S	60	59	59	-0.4	59		60	61	0.5	61		
514	S	60	57	57	0.3	57		58	59	1	59		
522	E	55	53	51	-1.9	51		54	53	-1	53		
523	SW	55	52	52	-0.4	51		53	54	0.4	53		
527	S	60	60	60	-0.5	60		61	62	0.3	62		
528	E	55	54	51	-2.1	51		55	53	-1.3	53		
532	S	55	54	52	-1.7	52		55	54	-0.8	54		
536	W	60	56	56	0.6	56		57	58	1.5	58		
536	S	60	60	59	-0.3	59		61	61	0.4	61		
542	W	60	56	57	0.9	57		57	59	1.6	58		
542	S	60	59	59	-0.5	59		60	60	0.3	60		
551	SW	55	54	52	-1.6	52		55	54	-0.8	54		
552	SW	55	53	52	-1.7	52		54	53	-0.8	53		
564	W	60	66	60	-5.6	60		67	62	-4.9	62		
581	N/A	60	65	61	-3.9	61		67	63	-4.2	62		
582	N/A	60	64	61	-3	61		66	63	-3.4	63		
583	N/A	60	64	62	-2.1	62		66	64	-2.2	64		
584	N/A	60	63	62	-1	62		65	64	-1	64		
585	N/A	60	63	62	-0.7	62		65	64	-0.7	64		
586	N/A	60	63	62	-0.9	62		65	64	-0.8	64		
587	N/A	60	62	61	-1	61		64	63	-0.8	63		

Table I-4 Predicted night time $L_{Aeq(9hour)}$ noise levels – SMA

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No Build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
1	S	55	64	58	-5.9	58		65	59	-5.5	59		
3	S	55	65	57	-8	57		66	58	-7.7	58		
11	W	50	49	49	-0.3	49		50	50	0.3	50		
14	N	50	49	48	-0.7	48		50	50	-0.2	50		
23	E	50	49	51	1.8	51		50	53	2.3	53		Yes
25	SW	50	53	58	4.9	58		54	59	5.5	59		Yes
28	E	50	50	52	2.1	52		51	54	2.6	54		Yes
29	E	50	49	51	2.2	51		50	53	2.7	53		Yes
30	E	50	51	50	-0.9	50		52	52	-0.5	52		Yes
38	SW	55	57	56	-0.4	56		58	58	0.1	58		
41	E	55	56	55	-1	55		57	56	-0.5	56		
53	SW	55	54	53	-1	53		55	54	-0.5	54		
56	SW	55	55	55	-0.9	55		56	56	-0.4	56		
62	NE	55	53	54	0.7	54		54	55	1.1	55		
63	NE	55	53	54	0.2	54		54	55	0.9	55		
64	SE	55	53	53	-0.3	53		54	55	0.6	55		
65	SE	55	58	51	-7	51		59	53	-6	53		
65	SW	55	57	51	-6.2	51		58	53	-5.1	53		
67	NW	55	61	52	-9.1	52		62	55	-7.9	54		
68	E	55	65	53	-11.9	52		66	56	-10.3	55		
69	N	50	49	49	-0.6	47		50	50	-0.2	49		
70	W	55	62	51	-10.7	51		63	54	-9.4	54		
71	W	50	50	48	-1.9	48		51	50	-0.8	50		
73	E	50	51	51	0.1	51		52	53	0.7	53		Yes
79	W	50	66	55	-11.3	48		67	57	-10	50		
85	S	50	62	52	-9.9	48		63	54	-8.6	50		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No Build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
95	S	50	53	51	-1.6	49		54	54	-0.2	51		Yes
96	N	50	52	56	4	51		53	58	5.8	53		Yes
97	S	50	65	58	-6.2	45		66	61	-5	47	Yes	
98	SW	50	68	61	-6.4	45	Yes	69	64	-5.1	47	Yes	
99	NW	50	49	49	0.2	47		50	51	1.4	49		
100	W	50	49	51	1.5	49		50	53	2.9	51		Yes
102	E	50	49	55	6.4	52		50	58	7.9	53		Yes
108	W	50	64	57	-6.3	44		64	60	-4.9	46	Yes	Yes
109	W	50	47	49	1.9	47		48	51	3.2	49		
110	E	50	47	56	9.5	56		48	58	10.6	58		Yes
115	E	50	69	62	-7	35	Yes	70	64	-5.6	37	Yes	
116	W	50	47	52	4.8	50		48	54	6.1	52		Yes
117	E	50	47	48	1.4	47		48	50	2.6	49		
118	E	50	68	61	-6.8	34	Yes	69	64	-5.3	36	Yes	
119	E	50	48	55	6.7	52		49	57	8.3	54		Yes
125	W	50	70	63	-6.6	43	Yes	71	65	-5.3	45	Yes	
134	E	50	71	64	-7.4	35	Yes	72	66	-6.1	37	Yes	
138	SW	50	50	57	6.9	53		51	60	8.6	55	Yes	Yes
143	S	50	44	50	6.3	49		45	53	7.6	51		Yes
144	S	50	44	49	5.1	48		45	51	6.3	50		
145	W	50	46	48	2.3	48		47	51	3.4	50		
153	W	50	72	65	-6.7	40	Yes	73	67	-5.3	42	Yes	
163	E	50	71	64	-7.3	35	Yes	72	66	-6	37	Yes	
164	N	50	48	56	8.1	54		49	59	9.6	56		Yes
167	N	50	45	48	3	47		46	50	4.2	49		
171	W	50	48	56	8.4	54		49	59	9.7	56		Yes
179	E	50	48	56	8.5	54		49	59	10	56		Yes
181	W	50	69	62	-6.6	36	Yes	70	64	-5.2	38	Yes	Yes

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No Build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
183	E	50	49	57	8.4	55		50	60	9.8	57	Yes	Yes
184	N	50	42	49	6.7	48		43	51	7.9	50		
185	E	50	68	62	-6.6	41	Yes	69	64	-5.1	43	Yes	
196	W	50	68	62	-6.7	36	Yes	69	64	-5.2	38	Yes	
198	E	50	48	57	9.2	55		49	59	10.6	57		Yes
199	E	50	41	50	9	49		42	52	10.2	51		Yes
204	W	50	69	62	-6.6	36	Yes	70	64	-5.2	38	Yes	
208	E	50	67	60	-6.7	41	Yes	68	62	-5.5	43	Yes	
209	W	50	69	62	-6.5	36	Yes	70	64	-5.1	38	Yes	
210	E	50	48	57	9.2	55		49	59	10.6	57		Yes
213	E	50	67	60	-6.7	41	Yes	68	63	-5.5	43	Yes	
219	E	50	43	54	11.6	54		44	57	12.9	56		Yes
223	E	50	67	60	-6.7	42	Yes	68	62	-5.3	43	Yes	
227	W	50	66	59	-6.8	36		67	61	-5.5	38	Yes	
228	E	50	48	58	9.1	56		49	60	10.5	58	Yes	Yes
231	W	50	69	62	-6.7	36	Yes	70	64	-5.3	38	Yes	
232	E	50	46	56	10.7	55		47	59	11.9	57		Yes
233	E	50	41	48	7.5	48		42	50	8.5	50		
237	E	50	42	49	7.2	49		43	51	8.3	50		
240	W	50	68	62	-6.6	36	Yes	69	64	-5.2	38	Yes	
243	E	50	66	59	-6.5	42		67	61	-5.3	44	Yes	
247	E	50	67	60	-6.6	42	Yes	68	63	-5.3	44	Yes	
251	E	50	48	58	9.6	56		49	60	10.9	58	Yes	Yes
252	S	50	43	51	8.2	51		44	53	9.3	53		Yes
253	S	50	46	49	3.7	49		47	52	4.8	51		Yes
257	N	50	46	57	11.3	56		47	59	12.3	58		Yes
269	W	50	65	58	-6.7	37		66	61	-5.4	39	Yes	
272	E	50	46	57	11.3	56		47	59	12.2	58		Yes

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**'No Build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
274	E	50	66	59	-6.6	42		67	62	-5.3	44	Yes	
278	W	50	64	58	-6.5	37		65	60	-5.2	38	Yes	
280	N	50	44	55	11.6	55		45	57	12.4	56		Yes
284	N	50	64	58	-6.5	43		65	60	-5.3	44	Yes	
293	N	50	48	58	10.3	57		49	60	11.2	58	Yes	Yes
297	N	50	67	60	-6.7	42	Yes	68	62	-5.4	44	Yes	
299	S	50	44	54	10.3	54		45	56	10.9	56		Yes
300	N	50	48	58	10.7	57		49	60	11.6	58	Yes	Yes
304	N	50	48	59	10.4	57		49	60	11.2	58	Yes	Yes
305	S	50	65	58	-6.4	37		66	60	-5.2	39	Yes	
308	N	50	66	60	-6.7	42	Yes	67	62	-5.5	44	Yes	
316	N	50	50	59	9.7	58		51	61	10.6	59	Yes	Yes
320	N	50	68	61	-6.8	42	Yes	69	63	-5.5	44	Yes	
322	S	50	64	58	-6.5	37		65	60	-5.1	38	Yes	
324	N	50	68	61	-6.8	42	Yes	69	63	-5.4	44	Yes	
329	N	50	48	59	10.9	57		49	60	11.5	58	Yes	Yes
331	S	50	66	60	-6.9	37	Yes	67	62	-5.6	39	Yes	
334	N	50	68	62	-6.4	43	Yes	69	64	-4.9	44	Yes	
342	N	50	48	58	10.4	57		49	60	11.2	58	Yes	Yes
344	S	50	65	58	-6.9	38		66	60	-5.6	39	Yes	
345	N	50	66	60	-6.4	43	Yes	67	62	-5.1	45	Yes	
350	N	50	44	56	11.9	55		45	57	12.4	56		Yes
351	N	50	68	61	-6.5	43	Yes	69	64	-5.1	44	Yes	
353	N	50	42	49	6.5	48		43	50	7.1	50		
354	E	50	66	60	-6.8	38	Yes	67	62	-5.4	39	Yes	
355	W	50	49	59	9.9	57		50	61	10.9	58	Yes	Yes
356	W	50	65	59	-6.7	42		66	61	-5.4	44	Yes	
362	E	50	65	59	-6.6	38		66	61	-5.3	40	Yes	

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No Build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
363	W	50	68	61	-6.6	42	Yes	69	64	-5.2	44	Yes	
367	W	50	44	56	12	55		45	57	12.6	56		Yes
368	E	50	65	59	-6.7	38		66	61	-5.4	39	Yes	
374	W	50	49	59	10.3	57		50	61	11.2	59	Yes	Yes
375	W	50	65	59	-6.6	42		66	61	-5.4	44	Yes	
378	E	50	66	59	-6.6	38		67	62	-5.2	40	Yes	
380	W	50	67	60	-6.7	42	Yes	68	62	-5.4	44	Yes	
382	E	50	65	59	-6.5	38		66	61	-5.2	40	Yes	
383	W	50	42	51	8.9	50		43	52	9.7	52		Yes
384	W	50	46	57	11.3	57		47	59	12.1	59		Yes
385	S	50	48	51	2.3	50		49	53	3.3	52		Yes
386	W	50	49	61	12.4	61	Yes	50	63	13.3	63	Yes	Yes
388	W	50	44	52	8.9	52		45	54	9.8	54		Yes
392	W	50	43	53	9.8	53		44	55	10.7	55		Yes
393	S	50	66	60	-6.6	43	Yes	67	62	-5.4	44	Yes	
394	N	50	69	62	-6.8	38	Yes	70	64	-5.4	40	Yes	Yes
399	S	50	69	62	-6.7	43	Yes	70	65	-5.2	45	Yes	
403	S	50	45	52	6.6	52		46	54	7.7	54		Yes
404	N	50	67	60	-6.6	39	Yes	68	63	-5.2	41	Yes	
408	N	50	66	59	-6.8	40		67	61	-5.5	41	Yes	
409	S	50	65	59	-6.4	44		66	61	-5.1	46	Yes	
411	N	50	65	59	-6.8	40		66	61	-5.5	42	Yes	
413	S	50	65	58	-6.3	44		66	61	-5.1	46	Yes	
414	S	50	46	49	3.3	49		47	51	4.2	50		
414	N	50	66	59	-6.8	40		66	61	-5.5	42	Yes	
415	S	50	64	58	-6.3	45		65	60	-5.1	46	Yes	
416	S	50	46	53	6.7	53		47	55	7.7	55		Yes
417	S	50	47	50	2.8	50		48	52	3.8	51		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No Build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
417	N	50	65	58	-6.8	41		66	61	-5.6	42	Yes	
421	S	50	46	49	3.6	49		46	51	4.7	51		
421	S	50	66	59	-6.7	41		67	61	-5.5	43	Yes	
423	S	50	65	58	-6.2	45		66	61	-4.9	47	Yes	
425	S	50	64	58	-6.2	46		65	60	-4.9	48	Yes	
426	S	50	48	50	2.2	50		49	52	3.2	52		
426	N	50	65	58	-6.7	42		66	61	-5.4	43	Yes	
427	S	50	48	52	4.2	52		49	54	5.2	54		Yes
429	S	50	66	60	-6.6	46	Yes	67	62	-5.2	48	Yes	
430	S	50	51	53	2.6	53		52	55	3.6	55		Yes
434	S	50	51	53	2	53		52	55	3	55		Yes
435	E	50	48	48	0.2	48		49	50	0.9	50		
438	SE	50	60	55	-5.4	54		61	57	-4.5	56		Yes
438	SW	50	66	55	-10.6	50		67	57	-9.8	52		Yes
439	N	50	52	53	0.3	52		53	54	0.9	54		Yes
445	W	50	50	51	1.8	51		51	53	2.5	53		Yes
451	N	50	58	53	-4.6	53		59	55	-4	54		Yes
453	E	50	48	47	-1	47		49	49	-0.2	49		
454	E	50	49	48	-1.6	47		50	49	-0.8	49		
459	NE	50	51	48	-3.1	47		52	49	-2.4	49		
468	E	50	49	48	-1.5	47		50	49	-0.7	49		
469	E	50	55	51	-4.4	51		56	53	-3.6	53		
474	W	50	49	48	-1.4	48		50	50	-0.5	49		
489	SE	55	63	56	-6.6	56		64	58	-6.1	58		
500	SE	55	61	57	-4.3	57		62	58	-3.7	58		
505	S	50	50	48	-2	47		51	49	-1.2	49		
510	S	55	59	57	-2.3	57		60	59	-1.6	59		
513	SE	55	54	53	-0.3	53		55	55	0.5	55		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No Build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
514	S	55	56	55	-0.9	55		57	57	-0.2	57		
514	S	55	54	53	-0.4	53		55	55	0.4	55		
522	E	50	49	47	-2.1	47		50	49	-1.3	49		
523	SW	50	49	48	-1	48		50	50	-0.1	49		
527	S	55	57	56	-1	56		58	58	-0.3	58		
528	E	50	50	47	-2.4	47		51	49	-1.5	49		
532	S	50	50	48	-2.1	48		51	50	-1.2	50		
536	W	55	52	52	-0.1	52		53	54	0.7	54		
536	S	55	56	55	-0.9	55		57	57	-0.1	57		
542	W	55	53	53	0.2	53		54	54	0.9	54		
542	S	55	56	55	-1	55		57	56	-0.3	56		
551	SW	50	50	48	-2	48		51	50	-1.2	50		
552	SW	50	50	48	-2	48		51	49	-1.1	49		
564	W	55	62	56	-6	56		63	58	-5.3	58		
581	N/A	55	59	57	-2	57		60	59	-1.6	59		
582	N/A	55	59	57	-1.3	57		60	59	-0.8	59		
583	N/A	55	58	58	-0.6	58		60	60	-0.1	60	Yes	Yes
584	N/A	55	58	58	0	58		60	60	0.5	60	Yes	Yes
585	N/A	55	58	58	0.2	58		59	60	0.8	60	Yes	Yes
586	N/A	55	58	58	0.1	58		59	60	0.7	60	Yes	Yes
587	N/A	55	57	57	-0.1	57		58	59	0.6	59		

Table I-5: Predicted daytime $L_{Aeq(15hour)}$ noise – SMA with North Street and Huntingdale Park Road noise barriers

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**'No Build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
1	S	60	67	61	-5.6	61		68	63	-4.8	63		
3	S	60	68	60	-7.9	60		69	62	-7.3	62		
11	W	55	52	53	0.5	53		53	55	1.3	55		
14	N	55	52	52	0	52		53	54	0.9	54		
23	E	55	53	55	2.5	55		54	57	3.4	57		Yes
25	SW	55	56	61	5.5	61		57	63	6.4	63		Yes
28	E	55	53	56	2.8	56		55	58	3.6	58		Yes
29	E	55	53	55	2.7	55		54	57	3.6	57		Yes
30	E	55	55	54	-0.1	54		56	56	0.6	56		Yes
38	SW	60	60	60	0.3	60		61	62	1.2	62		
41	E	60	59	59	-0.3	59		60	61	0.6	61		
53	SW	60	57	57	-0.3	57		58	58	0.6	58		
56	SW	60	59	58	-0.3	58		60	60	0.5	60		
62	NE	60	56	57	0.5	57		57	58	1.3	58		
63	NE	60	56	56	0.1	56		57	58	1	58		
64	SE	60	56	56	-0.1	56		57	58	0.9	58		
65	SE	60	61	55	-6.4	54		62	57	-5.3	56		
65	SW	60	60	55	-5.5	54		61	57	-4.6	56		
67	NW	60	65	56	-8.9	55		66	58	-7.6	58		
68	E	60	68	57	-11.6	56		69	59	-10	59		
69	N	55	54	54	0.2	51		55	55	0.4	53		
70	W	60	65	55	-10.3	55		66	57	-9	57		
71	W	55	53	52	-1.2	52		54	54	-0.1	54		
73	E	55	56	56	0.6	55		57	58	1.1	57		Yes
79	W	55	69	59	-10.1	52		70	61	-9.4	54		
85	S	55	64	55	-9.3	50		65	57	-7.8	52		

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No Build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
95	S	55	56	54	-2.5	51		57	56	-1.2	53		
96	N	55	58	58	0.4	52		59	61	1.8	54		
97	S	55	68	60	-7.8	48		69	64	-5.1	50		
98	SW	55	71	63	-8.1	48		72	67	-5.2	50	Yes	
99	NW	55	52	51	-1.2	49		53	53	0.1	52		
100	W	55	53	53	-0.1	51		54	56	1.2	53		
102	E	55	56	58	1.3	52		57	60	2.7	54		
108	W	55	67	59	-7.7	47		68	63	-5.1	49		
109	W	55	50	49	-0.8	47		51	52	0.5	49		
110	E	55	50	54	3.6	54		51	56	4.7	56		Yes
115	E	55	72	63	-8.6	39		73	67	-5.5	40	Yes	
116	W	55	52	53	1.7	51		53	56	2.9	53		
117	E	55	50	50	-0.4	49		51	52	0.8	51		
118	E	55	71	63	-8.5	38		72	67	-5.4	40	Yes	
119	E	55	55	56	1.4	52		56	59	2.9	54		
125	W	55	73	65	-8.3	46	Yes	74	69	-5.3	48	Yes	
134	E	55	75	65	-9.2	39	Yes	76	69	-6.4	40	Yes	
138	SW	55	58	59	1.2	52		59	61	2.7	54		
143	S	55	49	50	0.9	46		50	52	2.3	49		
144	S	55	48	48	0.4	46		49	51	1.8	48		
145	W	55	50	50	0.1	49		51	52	1.1	51		
153	W	55	75	66	-8.4	43	Yes	76	70	-5.4	45	Yes	
163	E	55	74	65	-9.1	39	Yes	75	69	-6.2	41	Yes	
164	N	55	56	57	1.4	51		57	60	2.8	53		
167	N	55	49	48	-0.9	46		50	50	0.6	48		
171	W	55	56	57	1.4	51		57	59	2.8	53		
179	E	55	55	57	1.4	51		56	59	2.9	53		
181	W	55	72	63	-8.3	40		73	68	-5.2	41	Yes	

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No Build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
183	E	55	57	58	1.2	52		58	60	2.6	54		
184	N	55	46	48	1.5	46		47	50	2.8	48		
185	E	55	72	63	-8.4	44		73	67	-5.2	46	Yes	
196	W	55	72	63	-8.4	40		73	67	-5.3	41	Yes	
198	E	55	55	57	1.6	52		56	59	3	54		
199	E	55	47	49	2.6	47		48	52	3.9	49		
204	W	55	72	63	-8.4	40		73	68	-5.3	41	Yes	
208	E	55	70	61	-8.4	44		71	65	-5.6	45	Yes	
209	W	55	72	64	-8.2	40		73	68	-5.1	42	Yes	
210	E	55	55	57	1.5	52		56	59	2.9	54		
213	E	55	70	62	-8.4	44		71	66	-5.6	45	Yes	
219	E	55	50	53	2.6	49		51	55	4	51		
223	E	55	70	62	-8.4	44		71	65	-5.6	46	Yes	
227	W	55	69	60	-8.5	40		70	64	-5.6	42		
228	E	55	56	57	1.3	52		57	60	2.8	54		
231	W	55	72	63	-8.4	40		73	68	-5.3	42	Yes	
232	E	55	53	55	2.2	51		54	57	3.5	53		
233	E	55	45	49	3.3	48		46	51	4.4	49		
237	E	55	46	49	2.9	48		47	51	3.9	50		
240	W	55	72	63	-8.4	40		73	67	-5.3	42	Yes	
243	E	55	69	61	-8.2	44		70	64	-5.4	46		
247	E	55	70	62	-8.2	44		71	66	-5.5	46	Yes	
251	E	55	56	57	1.5	52		57	60	2.8	54		
252	S	55	48	50	1.7	48		49	52	3	50		
253	S	55	49	49	-0.8	47		50	51	0.6	49		
257	N	55	53	56	2.3	52		54	58	3.6	54		
269	W	55	68	60	-8.3	41		69	64	-5.5	42		
272	E	55	53	55	2.3	52		54	57	3.5	53		

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No Build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
274	E	55	69	61	-8.2	45		70	65	-5.4	46	Yes	
278	W	55	67	59	-8.1	41		68	63	-5.3	42		
280	N	55	51	53	2.8	51		52	56	4	53		
284	N	55	68	59	-8.2	45		69	63	-5.4	47		
293	N	55	56	58	1.9	52		57	60	3.2	54		
297	N	55	70	61	-8.4	45		71	65	-5.6	46	Yes	
299	S	55	48	58	10.4	58		49	60	11	60		Yes
300	N	55	55	57	2	52		56	60	3.3	54		
304	N	55	56	58	1.9	53		57	60	3.1	54		
305	S	55	68	60	-8.1	41		69	63	-5.3	43		
308	N	55	70	61	-8.4	45		71	65	-5.6	46	Yes	
316	N	55	58	59	1.6	53		59	62	2.9	55		
320	N	55	71	62	-8.5	45		72	66	-5.6	46	Yes	
322	S	55	68	60	-8	41		69	63	-5.2	42		
324	N	55	71	62	-8.5	45		72	66	-5.6	46	Yes	
329	N	55	56	58	2.2	53		57	60	3.4	55		
331	S	55	70	61	-8.5	41		71	65	-5.7	43	Yes	
334	N	55	71	63	-8.1	45		72	67	-5	47	Yes	
342	N	55	56	58	2.3	54		57	60	3.4	55		
344	S	55	68	59	-8.4	42		69	63	-5.6	43		
345	N	55	69	61	-8.1	45		70	65	-5.3	47	Yes	
350	N	55	52	55	3.4	52		53	57	4.5	54		
351	N	55	71	63	-8.2	45		72	67	-5.2	47	Yes	
353	N	55	46	50	4.1	50		47	52	4.8	51		
354	E	55	70	61	-8.4	42		71	65	-5.5	43	Yes	
355	W	55	57	59	2	54		58	61	3.2	56		Yes
356	W	55	68	60	-8.4	45		69	64	-5.5	47		
362	E	55	68	60	-8.2	42		69	64	-5.4	43		

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No Build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
363	W	55	71	63	-8.3	45		72	67	-5.3	47	Yes	
367	W	55	52	55	3.9	53		52	57	4.9	54		
368	E	55	69	60	-8.3	42		70	64	-5.5	43		
374	W	55	56	59	2.3	55		57	61	3.5	56		Yes
375	W	55	69	60	-8.3	45		70	64	-5.5	47		
378	E	55	69	61	-8.3	42		70	65	-5.4	43	Yes	
380	W	55	70	62	-8.3	45		71	66	-5.5	47	Yes	
382	E	55	68	60	-8.1	42		69	64	-5.3	44		
383	W	55	46	51	4.4	50		47	52	5.3	52		
384	W	55	53	55	1.6	54		54	57	2.5	56		Yes
385	S	55	51	50	-1.9	48		52	52	-0.6	50		
386	W	55	57	56	-0.6	56		58	58	0.4	58		Yes
388	W	55	48	51	3.8	51		49	53	4.7	53		
392	W	55	48	52	3.9	51		49	53	4.8	53		
393	S	55	69	61	-8.3	45		70	65	-5.5	47	Yes	
394	N	55	72	63	-8.5	42		73	67	-5.4	44	Yes	
399	S	55	72	64	-8.4	46		73	68	-5.2	47	Yes	
403	S	55	48	50	1.9	50		49	52	2.8	52		
404	N	55	70	62	-8.2	43		71	66	-5.4	45	Yes	
408	N	55	69	61	-8.4	44		70	64	-5.7	45		
409	S	55	68	60	-8	47		69	64	-5.2	48		
411	N	55	69	60	-8.4	44		70	64	-5.6	46		
413	S	55	68	60	-8	47		69	64	-5.1	48		
414	S	55	49	49	0.2	49		50	51	1.3	50		
414	N	55	69	60	-8.4	44		70	64	-5.6	46		
415	S	55	68	60	-7.9	47		69	63	-5.2	49		
416	S	55	49	51	1.8	51		50	53	2.7	53		
417	S	55	50	50	-0.3	49		51	52	0.7	51		

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No Build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
417	N	55	68	60	-8.3	44		69	64	-5.6	46		
421	S	55	49	50	0.6	49		50	52	1.6	51		
421	S	55	69	61	-8.3	45		70	64	-5.6	47		
423	S	55	68	60	-7.8	48		69	64	-5.1	49		
425	S	55	67	60	-7.8	48		68	63	-5	50		
426	S	55	51	50	-0.5	50		52	52	0.5	51		
426	N	55	68	60	-8.1	46		69	64	-5.5	47		
427	S	55	50	51	0.4	50		51	53	1.5	52		
429	S	55	69	61	-8	49		70	65	-5.3	50	Yes	
430	S	55	53	52	-1	51		54	54	-0.1	53		
434	S	55	53	52	-1.1	51		54	54	-0.3	53		
435	E	55	53	52	-0.7	52		54	54	-0.1	53		
438	SE	55	62	58	-3.6	55		63	60	-3.5	57		Yes
438	SW	55	68	62	-6.2	54		69	63	-6.1	56		Yes
439	N	55	55	57	1.6	56		56	58	1.9	57		Yes
445	W	55	52	55	3.4	55		53	57	3.9	57		Yes
451	N	55	60	58	-1.5	56		61	60	-1.4	58		Yes
453	E	55	52	51	-0.6	51		53	53	0.3	53		
454	E	55	53	51	-1.5	51		54	53	-0.7	53		
459	NE	55	57	52	-5.2	51		58	54	-4.6	53		
468	E	55	53	51	-1.2	51		54	53	-0.4	53		
469	E	55	59	55	-3.2	55		60	57	-2.5	57		
474	W	55	53	52	-0.9	52		54	53	-0.1	53		
489	SE	60	66	60	-5.8	60		67	62	-5.2	62		
500	SE	60	64	61	-3.5	60		65	62	-2.9	62		
505	S	55	53	52	-1.2	51		54	53	-0.6	53		
510	S	60	63	61	-1.6	61		64	63	-0.9	63		
513	SE	60	57	55	-2.5	55		59	57	-1.9	57		

			2017 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(15hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**'No Build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
514	S	60	59	59	-0.4	59		60	61	0.4	61		
514	S	60	57	57	0.3	57		58	59	1	59		
522	E	55	53	51	-1.9	51		54	53	-1.1	53		
523	SW	55	52	52	-0.4	51		53	54	0.4	53		
527	S	60	60	60	-0.5	60		61	62	0.3	62		
528	E	55	54	51	-2.1	51		55	53	-1.3	53		
532	S	55	54	52	-1.7	52		55	54	-0.9	54		
536	W	60	56	56	0.6	56		57	58	1.5	58		
536	S	60	60	59	-0.3	59		61	61	0.4	61		
542	W	60	56	57	0.9	57		57	59	1.6	58		
542	S	60	59	59	-0.6	59		60	60	0.2	60		
551	SW	55	54	52	-1.6	52		55	54	-0.9	54		
552	SW	55	53	52	-1.7	52		54	53	-0.8	53		
564	W	60	66	60	-5.6	60		67	62	-4.9	62		
581	N/A	60	65	58	-6.8	58		67	60	-7.1	59		
582	N/A	60	64	58	-6.7	57		66	59	-7.1	59		
583	N/A	60	64	57	-6.6	57		66	59	-6.8	59		
584	N/A	60	63	57	-6.1	57		65	59	-6.2	59		
585	N/A	60	63	57	-5.7	57		65	59	-5.7	59		
586	N/A	60	63	58	-5.1	57		65	59	-5.1	59		
587	N/A	60	62	58	-4.3	58		64	60	-4.1	59		

Table I-6: Predicted night time $L_{Aeq(9hour)}$ noise levels – SMA with North Street and Huntingdale Park Road noise barriers

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	'No build'	'Build'	Increase	Project noise levels	Acute	'No build'	'Build'	Increase	Project noise levels	Acute	Additional mitigation required
1	S	55	64	58	-5.9	58		65	59	-5.5	59		
3	S	55	65	57	-8	57		66	58	-7.7	58		
11	W	50	49	49	-0.3	49		50	50	0.3	50		
14	N	50	49	48	-0.7	48		50	50	-0.2	50		
23	E	50	49	51	1.8	51		50	53	2.3	53		Yes
25	SW	50	53	58	4.9	58		54	59	5.5	59		Yes
28	E	50	50	52	2.1	52		51	54	2.6	54		Yes
29	E	50	49	51	2.2	51		50	53	2.7	53		Yes
30	E	50	51	50	-0.9	50		52	52	-0.5	52		Yes
38	SW	55	57	56	-0.4	56		58	58	0.1	58		
41	E	55	56	55	-1	55		57	56	-0.5	56		
53	SW	55	54	53	-1	53		55	54	-0.5	54		
56	SW	55	55	55	-0.9	55		56	56	-0.4	56		
62	NE	55	53	54	0.7	54		54	55	1.1	55		
63	NE	55	53	54	0.2	54		54	55	0.9	55		
64	SE	55	53	53	-0.3	53		54	55	0.6	55		
65	SE	55	58	51	-7.2	50		59	53	-6.2	52		
65	SW	55	57	51	-6.4	50		58	53	-5.3	52		
67	NW	55	61	52	-9.4	52		62	54	-8.2	54		
68	E	55	65	53	-12.1	52		66	56	-10.5	55		
69	N	50	49	49	-0.6	47		50	50	-0.2	49		
70	W	55	62	51	-10.8	51		63	54	-9.5	53		
71	W	50	50	48	-1.9	48		51	50	-0.8	50		
73	E	50	51	51	0.1	51		52	53	0.7	53		Yes
79	W	50	66	55	-11.4	48		67	57	-10.1	50		
85	S	50	62	51	-10.4	46		63	54	-9	48		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
95	S	50	53	50	-2.5	47		54	53	-1	49		
96	N	50	52	55	3.2	48		53	58	5.2	50		
97	S	50	65	58	-6.3	44		66	61	-5	46	Yes	
98	SW	50	68	61	-6.4	44	Yes	69	64	-5.1	46	Yes	
99	NW	50	49	48	-1	46		50	50	0.3	48		
100	W	50	49	50	0.5	47		50	52	2	49		
102	E	50	49	54	5.3	48		50	57	7	50		
108	W	50	64	57	-6.3	43		64	59	-5	45		
109	W	50	47	46	-0.6	44		48	49	0.9	46		
110	E	50	47	50	3.4	50		48	52	4.6	52		Yes
115	E	50	69	62	-7	35	Yes	70	64	-5.6	36	Yes	
116	W	50	47	50	2.9	47		48	52	4.4	50		
117	E	50	47	46	-0.3	45		48	49	1	47		
118	E	50	68	61	-6.8	34	Yes	69	64	-5.3	36	Yes	
119	E	50	48	53	4.9	48		49	56	6.7	50		
125	W	50	70	63	-6.6	42	Yes	71	65	-5.3	44	Yes	
134	E	50	71	64	-7.5	35	Yes	72	66	-6.1	36	Yes	
138	SW	50	50	56	5.4	48		51	58	7.3	50		
143	S	50	44	47	2.7	43		45	49	4.4	45		
144	S	50	44	45	1.6	42		45	48	3.1	45		
145	W	50	46	46	0.2	45		47	49	1.4	47		
153	W	50	72	65	-6.7	39	Yes	73	67	-5.3	41	Yes	
163	E	50	71	64	-7.3	35	Yes	72	66	-6	37	Yes	
164	N	50	48	54	5.7	48		49	57	7.6	50		
167	N	50	45	45	-0.4	42		46	47	1.1	44		
171	W	50	48	54	5.6	48		49	57	7.4	50		
179	E	50	48	53	5.6	48		49	56	7.5	50		
181	W	50	69	62	-6.6	35	Yes	70	64	-5.2	37	Yes	

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
183	E	50	49	55	5.8	48		50	58	7.6	50		
184	N	50	42	45	2.8	42		43	47	4.3	44		
185	E	50	68	62	-6.6	40	Yes	69	64	-5.1	42	Yes	
196	W	50	68	62	-6.7	36	Yes	69	64	-5.2	37	Yes	
198	E	50	48	54	5.8	48		49	57	7.7	50		
199	E	50	41	46	4.9	44		42	48	6.4	46		
204	W	50	69	62	-6.6	36	Yes	70	64	-5.2	37	Yes	
208	E	50	67	60	-6.7	40	Yes	68	62	-5.5	42	Yes	
209	W	50	69	62	-6.5	36	Yes	70	64	-5.1	37	Yes	
210	E	50	48	54	5.7	48		49	56	7.6	50		
213	E	50	67	60	-6.8	40	Yes	68	63	-5.5	42	Yes	
219	E	50	43	50	6.7	46		44	52	8.5	48		
223	E	50	67	60	-6.7	40	Yes	68	62	-5.4	42	Yes	
227	W	50	66	59	-6.8	36		67	61	-5.5	38	Yes	
228	E	50	48	54	5.7	48		49	57	7.6	50		
231	W	50	69	62	-6.7	36	Yes	70	64	-5.3	38	Yes	
232	E	50	46	52	6.2	48		47	55	7.9	50		
233	E	50	41	45	4.2	44		42	47	5.4	46		
237	E	50	42	45	3.7	44		43	48	4.9	46		
240	W	50	68	62	-6.7	36	Yes	69	64	-5.2	38	Yes	
243	E	50	66	59	-6.6	40		67	61	-5.3	42	Yes	
247	E	50	67	60	-6.6	40	Yes	68	63	-5.3	42	Yes	
251	E	50	48	54	5.9	48		49	57	7.7	50		
252	S	50	43	46	3.2	44		44	49	4.6	46		
253	S	50	46	45	-0.3	43		47	48	1.1	45		
257	N	50	46	53	6.7	48		47	55	8.4	50		
269	W	50	65	58	-6.7	37		66	61	-5.4	38	Yes	
272	E	50	46	52	6.3	48		47	55	7.9	50		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
274	E	50	66	59	-6.6	41		67	62	-5.3	43	Yes	
278	W	50	64	58	-6.5	37		65	60	-5.2	38	Yes	
280	N	50	44	50	6.4	47		45	53	7.7	49		
284	N	50	64	58	-6.6	41		65	60	-5.3	43	Yes	
293	N	50	48	54	6.3	49		49	57	8	50		
297	N	50	67	60	-6.8	41	Yes	68	62	-5.4	43	Yes	
299	S	50	44	54	10.2	54		45	56	10.8	56		Yes
300	N	50	48	54	6.5	49		49	57	8.2	50		
304	N	50	48	55	6.4	49		49	57	8.1	51		
305	S	50	65	58	-6.4	37		66	60	-5.2	39	Yes	
308	N	50	66	60	-6.8	41	Yes	67	62	-5.5	43	Yes	
316	N	50	50	56	6.5	50		51	59	8.2	51		
320	N	50	68	61	-6.8	41	Yes	69	63	-5.5	43	Yes	
322	S	50	64	58	-6.5	37		65	60	-5.1	38	Yes	
324	N	50	68	61	-6.8	41	Yes	69	63	-5.4	43	Yes	
329	N	50	48	55	7	50		49	57	8.5	51		
331	S	50	66	60	-6.9	37	Yes	67	62	-5.6	39	Yes	
334	N	50	68	62	-6.5	41	Yes	69	64	-4.9	43	Yes	
342	N	50	48	55	6.8	50		49	57	8.4	52		
344	S	50	65	58	-6.9	37		66	60	-5.6	39	Yes	
345	N	50	66	60	-6.5	42	Yes	67	62	-5.2	43	Yes	
350	N	50	44	52	8	49		45	54	9.3	50		
351	N	50	68	61	-6.5	41	Yes	69	64	-5.1	43	Yes	
353	N	50	42	47	4.5	46		43	48	5.2	47		
354	E	50	66	60	-6.8	38	Yes	67	62	-5.4	39	Yes	
355	W	50	49	56	6.9	51		50	59	8.6	52		Yes
356	W	50	65	58	-6.8	41		66	61	-5.4	43	Yes	
362	E	50	65	59	-6.6	38		66	61	-5.3	39	Yes	

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	Most affected facade	Noise criteria dB(A)	‘No build’	‘Build’	Increase	Project noise levels	Acute	‘No build’	‘Build’	Increase	Project noise levels	Acute	Additional mitigation required
363	W	50	68	61	-6.6	41	Yes	69	64	-5.2	43	Yes	
367	W	50	44	52	8.3	50		45	54	9.6	51		
368	E	50	65	59	-6.7	38		66	61	-5.4	39	Yes	
374	W	50	49	55	6.9	51		50	58	8.5	53		Yes
375	W	50	65	59	-6.7	41		66	61	-5.4	43	Yes	
378	E	50	66	59	-6.6	38		67	62	-5.3	39	Yes	
380	W	50	67	60	-6.7	41	Yes	68	62	-5.4	43	Yes	
382	E	50	65	59	-6.5	38		66	61	-5.2	40	Yes	
383	W	50	42	47	5.3	47		43	49	6.2	48		
384	W	50	46	51	5.7	51		47	53	6.7	53		Yes
385	S	50	48	46	-2	45		49	48	-0.9	47		
386	W	50	49	53	3.8	52		50	55	4.9	54		Yes
388	W	50	44	48	4.3	48		45	50	5.3	49		
392	W	50	43	48	4.6	48		44	50	5.6	50		
393	S	50	66	59	-6.7	42		67	62	-5.4	43	Yes	
394	N	50	69	62	-6.8	38	Yes	70	64	-5.4	40	Yes	
399	S	50	69	62	-6.7	42	Yes	70	65	-5.2	44	Yes	
403	S	50	45	47	1.4	46		46	49	2.4	48		
404	N	50	67	60	-6.6	39	Yes	68	63	-5.2	41	Yes	
408	N	50	66	59	-6.8	40		67	61	-5.5	41	Yes	
409	S	50	65	58	-6.5	43		66	61	-5.1	44	Yes	
411	N	50	65	59	-6.8	40		66	61	-5.5	42	Yes	
413	S	50	65	58	-6.4	43		66	61	-5.1	45	Yes	
414	S	50	46	46	0.1	45		47	48	1	47		
414	N	50	66	59	-6.8	40		66	61	-5.5	42	Yes	
415	S	50	64	58	-6.4	43		65	60	-5.1	45	Yes	
416	S	50	46	47	1.1	47		47	49	2.1	49		
417	S	50	47	46	-0.9	45		48	48	0.1	47		

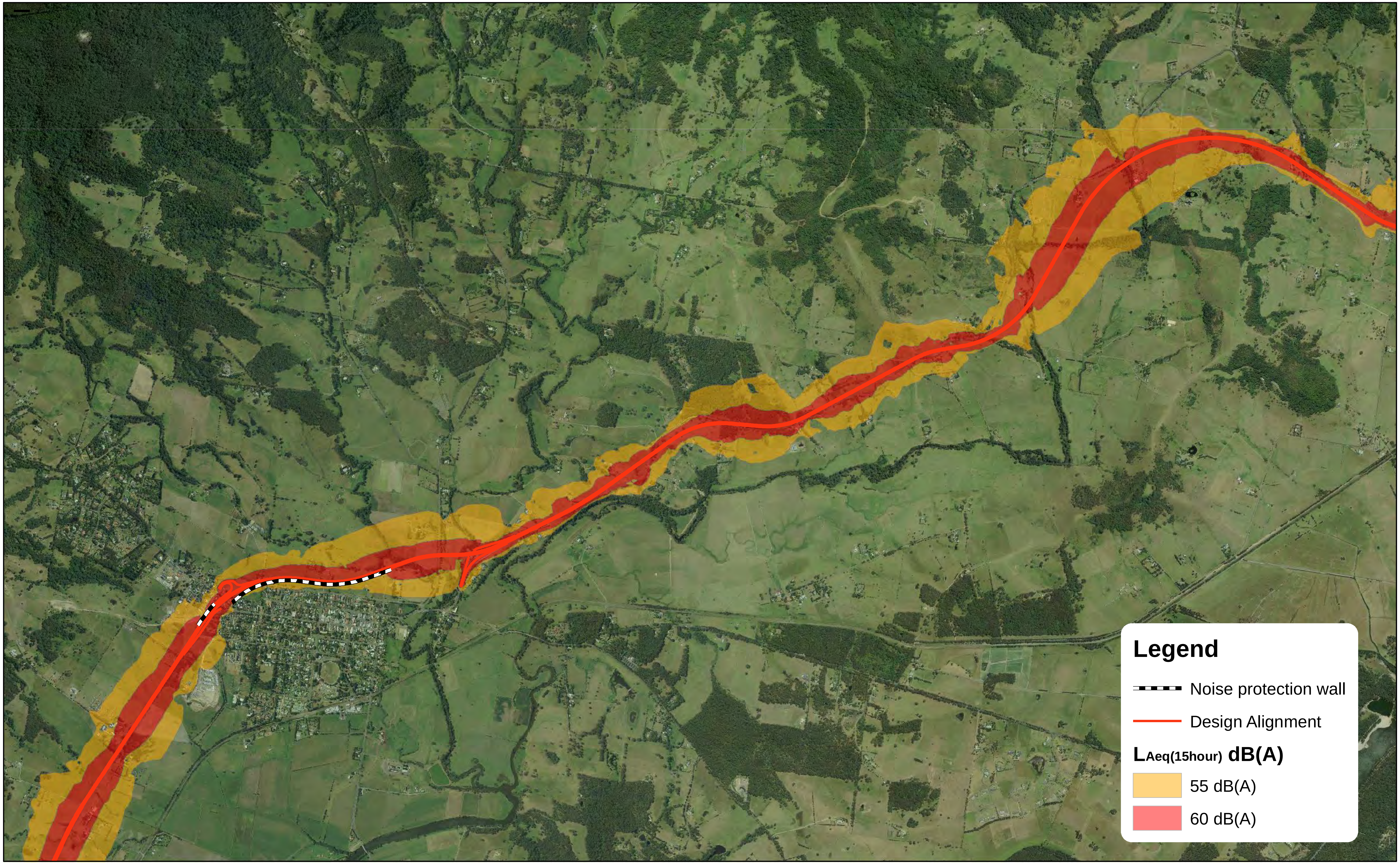
			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**‘No build’**	**‘Build’**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
417	N	50	65	58	-6.8	40		66	61	-5.6	42	Yes	
421	S	50	46	46	0.5	45		46	48	1.5	47		
421	S	50	66	59	-6.7	41		67	61	-5.5	43	Yes	
423	S	50	65	58	-6.3	44		66	61	-5	46	Yes	
425	S	50	64	58	-6.3	44		65	60	-5	46	Yes	
426	S	50	48	46	-1.5	46		49	48	-0.6	48		
426	N	50	65	58	-6.7	42		66	61	-5.4	43	Yes	
427	S	50	48	47	-0.4	47		49	49	0.6	49		
429	S	50	66	60	-6.6	45	Yes	67	62	-5.2	47	Yes	
430	S	50	51	48	-2.4	48		52	50	-1.5	50		
434	S	50	51	48	-2.9	47		52	50	-1.9	49		
435	E	50	48	48	0.2	48		49	50	0.8	50		
438	SE	50	60	53	-7.5	52		61	54	-6.7	53		Yes
438	SW	50	66	55	-10.6	50		67	57	-9.8	52		Yes
439	N	50	52	52	0.1	52		53	54	0.6	54		Yes
445	W	50	50	51	1.5	51		51	53	2.2	53		Yes
451	N	50	58	53	-4.8	52		59	55	-4.3	54		Yes
453	E	50	48	47	-1	47		49	49	-0.2	49		
454	E	50	49	47	-1.8	47		50	49	-1.1	49		
459	NE	50	51	48	-3.3	47		52	49	-2.7	49		
468	E	50	49	48	-1.6	47		50	49	-0.8	49		
469	E	50	55	51	-4.4	51		56	53	-3.6	53		
474	W	50	49	48	-1.5	47		50	49	-0.7	49		
489	SE	55	63	56	-6.6	56		64	58	-6	58		
500	SE	55	61	57	-4.3	57		62	58	-3.7	58		
505	S	50	50	48	-2	47		51	49	-1.3	49		
510	S	55	59	57	-2.3	57		60	59	-1.6	59		
513	SE	55	54	51	-2.5	51		55	53	-1.7	53		

			2017 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					2027 $L_{Aeq(9hour)}$ Predicted noise levels – dB(A)					
Receiver	**Most affected facade**	**Noise criteria dB(A)**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**'No build'**	**'Build'**	**Increase**	**Project noise levels**	**Acute**	**Additional mitigation required**
514	S	55	56	55	-0.9	55		57	57	-0.2	57		
514	S	55	54	53	-0.4	53		55	55	0.4	55		
522	E	50	49	47	-2.1	47		50	49	-1.4	49		
523	SW	50	49	48	-1	48		50	50	-0.1	49		
527	S	55	57	56	-1	56		58	58	-0.3	58		
528	E	50	50	47	-2.4	47		51	49	-1.6	49		
532	S	50	50	48	-2.1	48		51	50	-1.2	50		
536	W	55	52	52	-0.1	52		53	54	0.7	54		
536	S	55	56	55	-0.9	55		57	57	-0.2	57		
542	W	55	53	53	0.2	53		54	54	0.9	54		
542	S	55	56	55	-1	55		57	56	-0.3	56		
551	SW	50	50	48	-2	48		51	50	-1.2	50		
552	SW	50	50	48	-2	48		51	49	-1.2	49		
564	W	55	62	56	-6	56		63	58	-5.3	58		
581	N/A	55	59	54	-4.6	54		60	56	-4.1	56		
582	N/A	55	59	54	-4.7	54		60	56	-4.2	56		
583	N/A	55	58	54	-4.9	53		60	55	-4.3	55		
584	N/A	55	58	54	-4.8	54		60	56	-4.2	55		
585	N/A	55	58	54	-4.6	54		59	56	-3.9	55		
586	N/A	55	58	54	-4	54		59	56	-3.4	56		
587	N/A	55	57	54	-3.2	54		58	56	-2.5	56		

Appendix J

Operational noise contours (with and without a noise barrier)

AECOM



Foxground and Berry Bypass

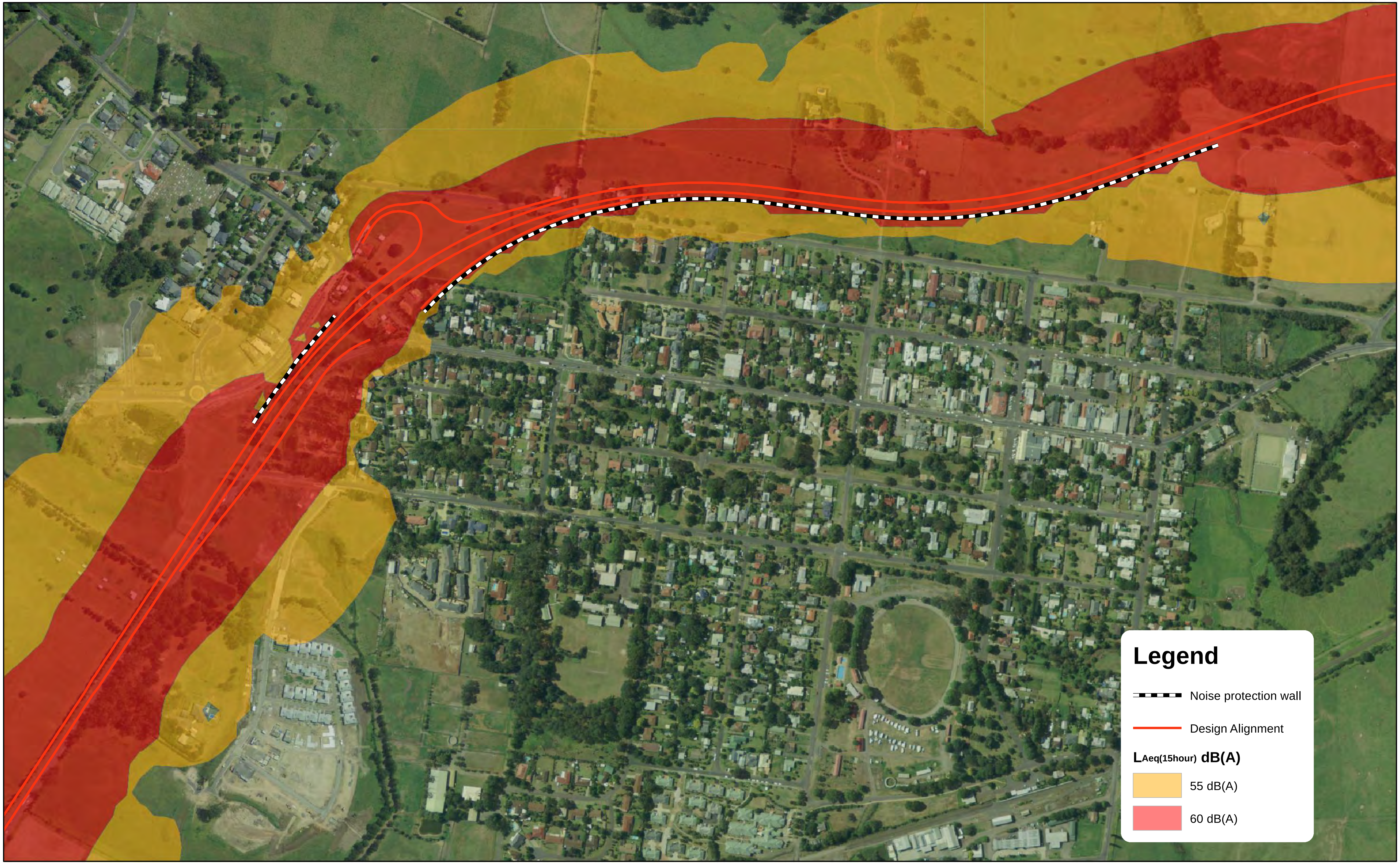
Traffic Noise Contours - Daytime

Source: AECOM (2012)

JAN 2012

60021933

Fig. **1**



Foxground and Berry Bypass

Traffic Noise Contours - Daytime - Berry Township

Source: AECOM (2012)

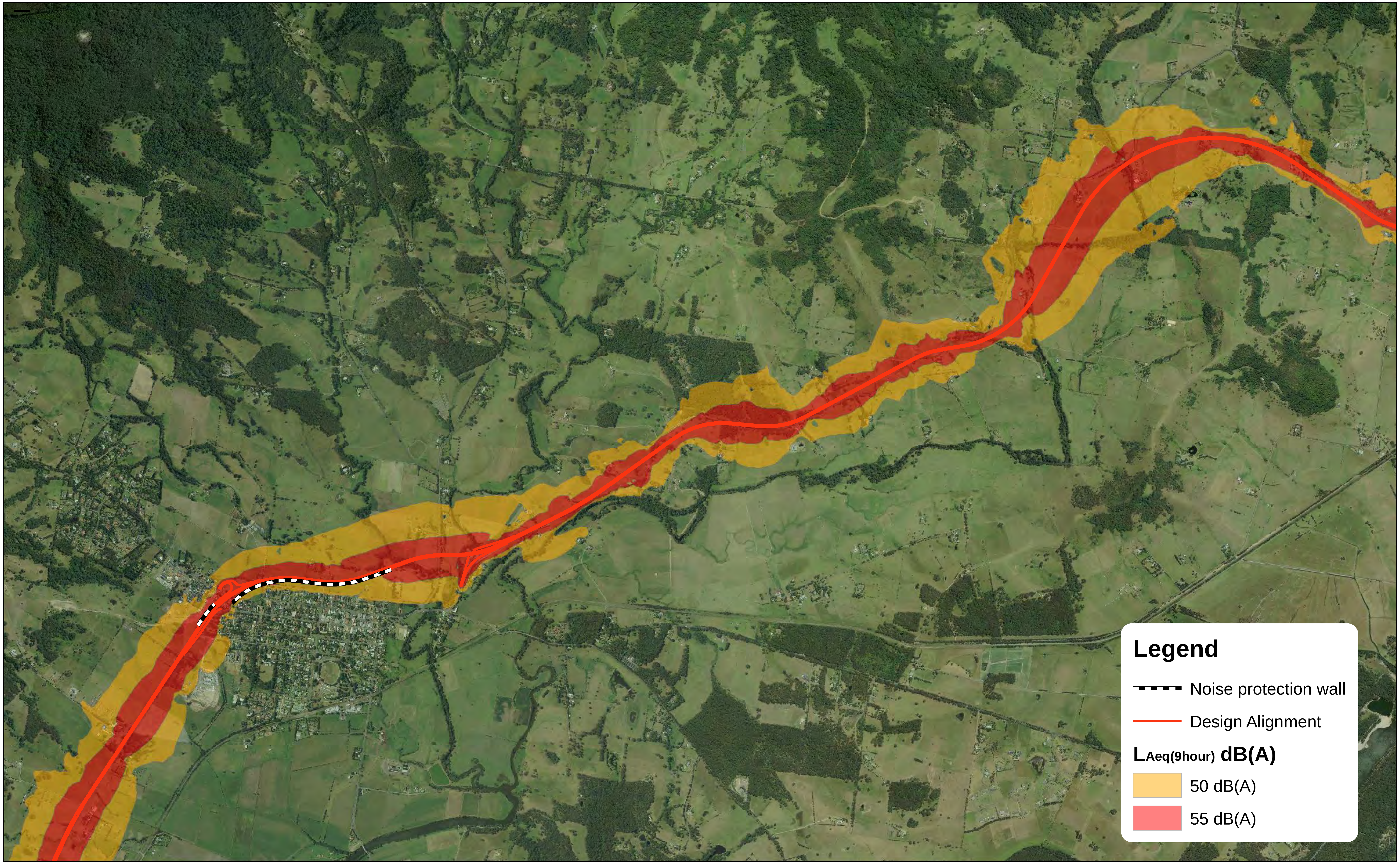
0 50 100 200 300 400 m

JUL 2012

60021933

Fig. **2**

AECOM



Foxground and Berry Bypass

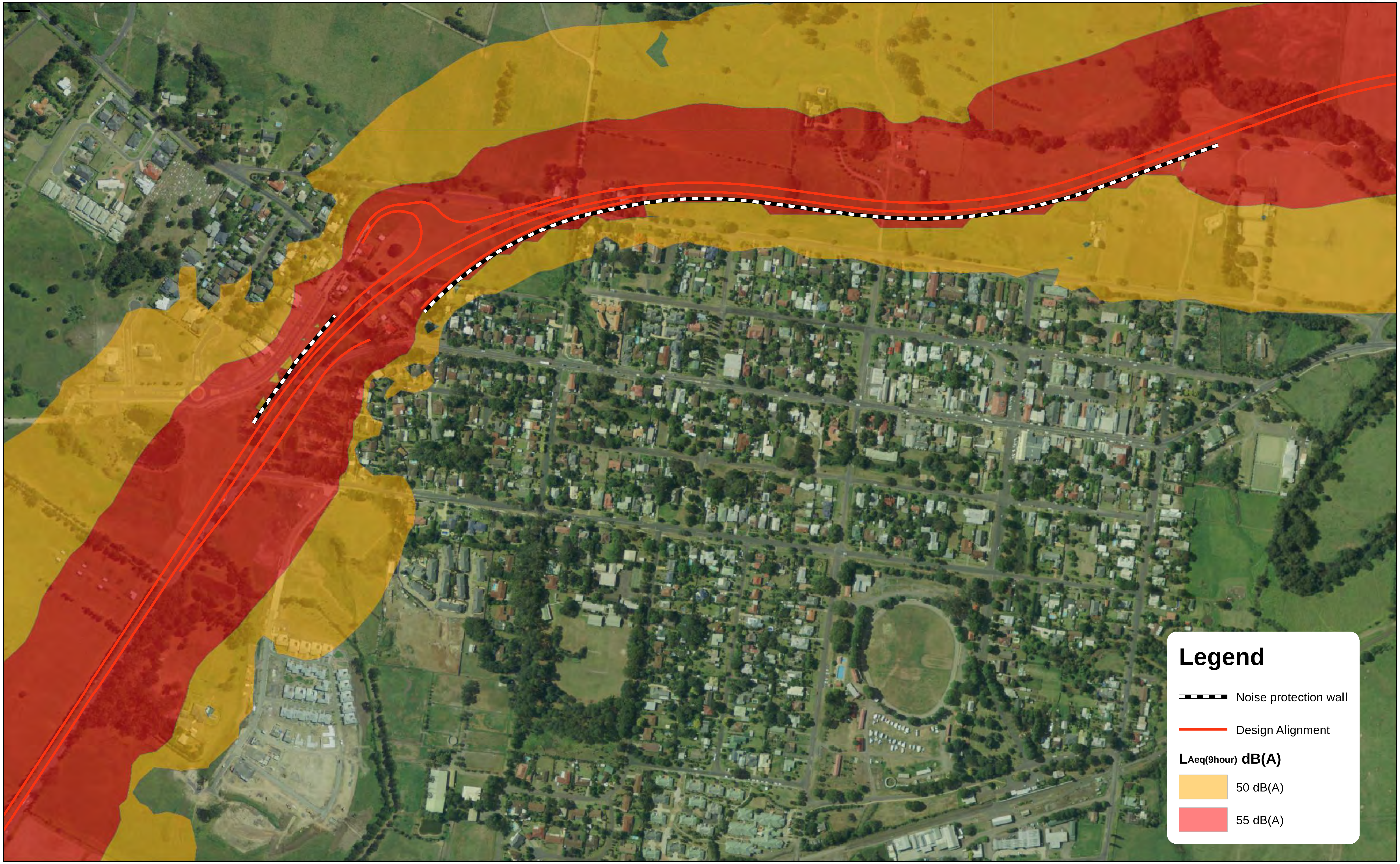
Traffic Noise Contours - Night time

Source: AECOM (2012)

JUL 2012

60021933

Fig. **3**



Foxground and Berry Bypass

Traffic Noise Contours - Night time - Berry Township

Source: AECOM (2012)

0 50 100 200 300 400 m

JUL 2012

60021933

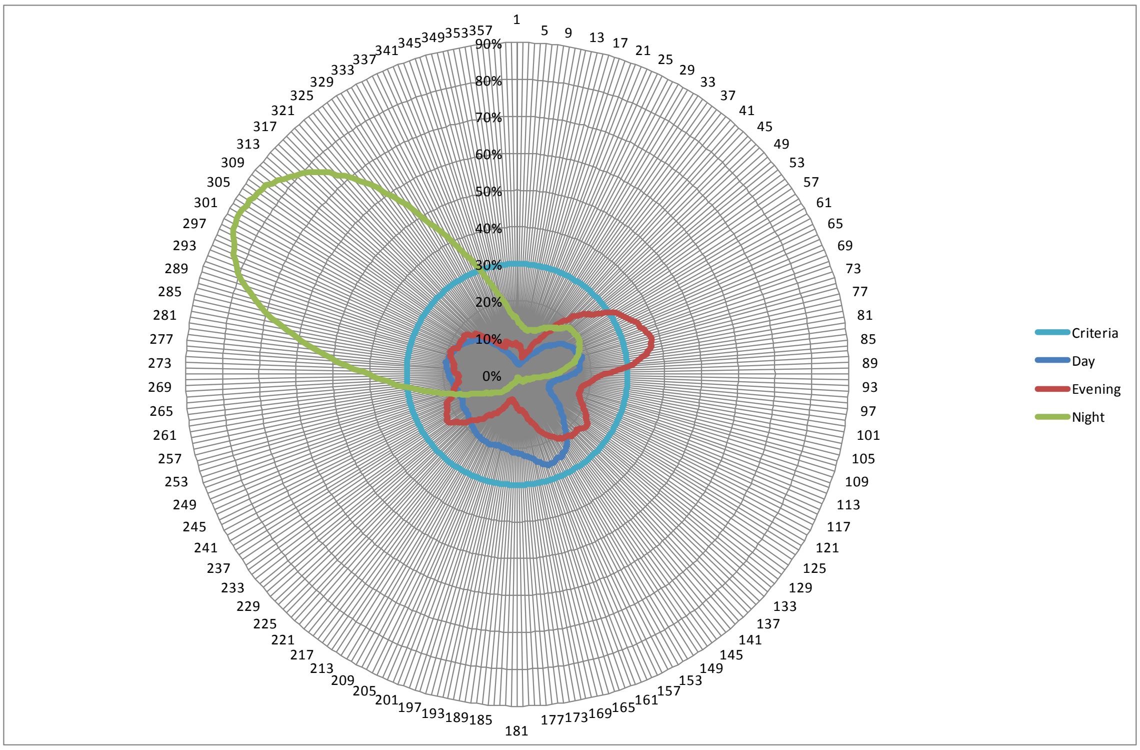
Fig. **4**

Appendix K

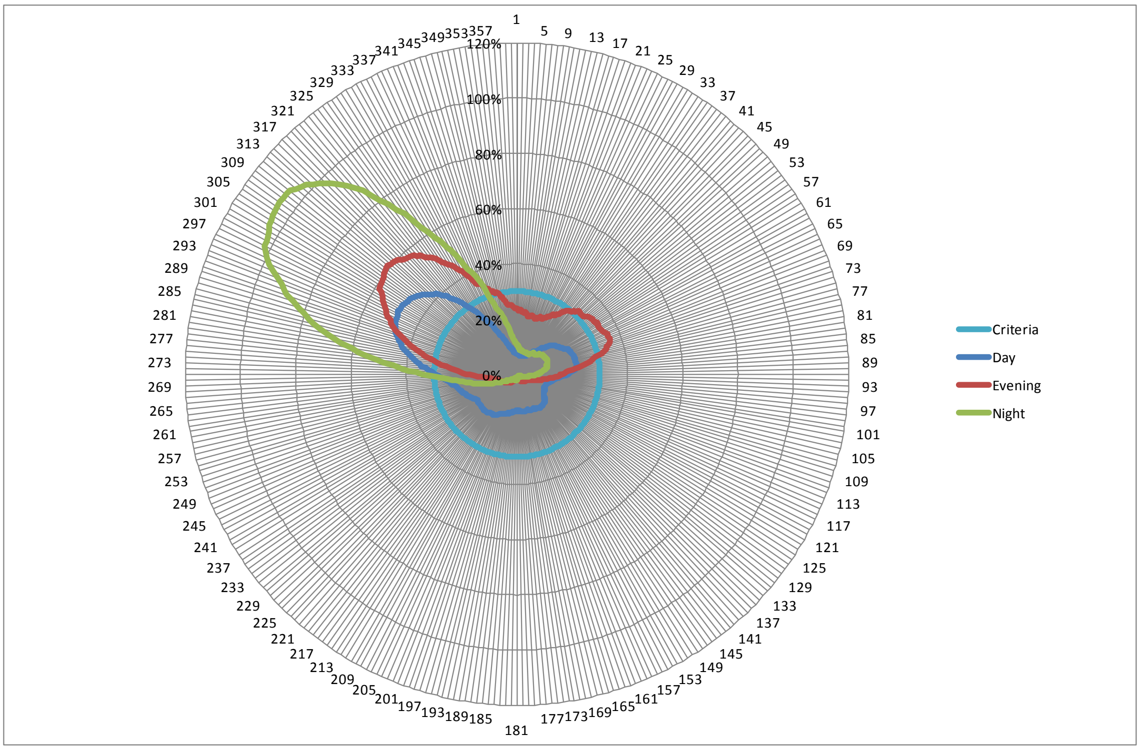
Meteorological data (wind)

Meteorological data (Wind)

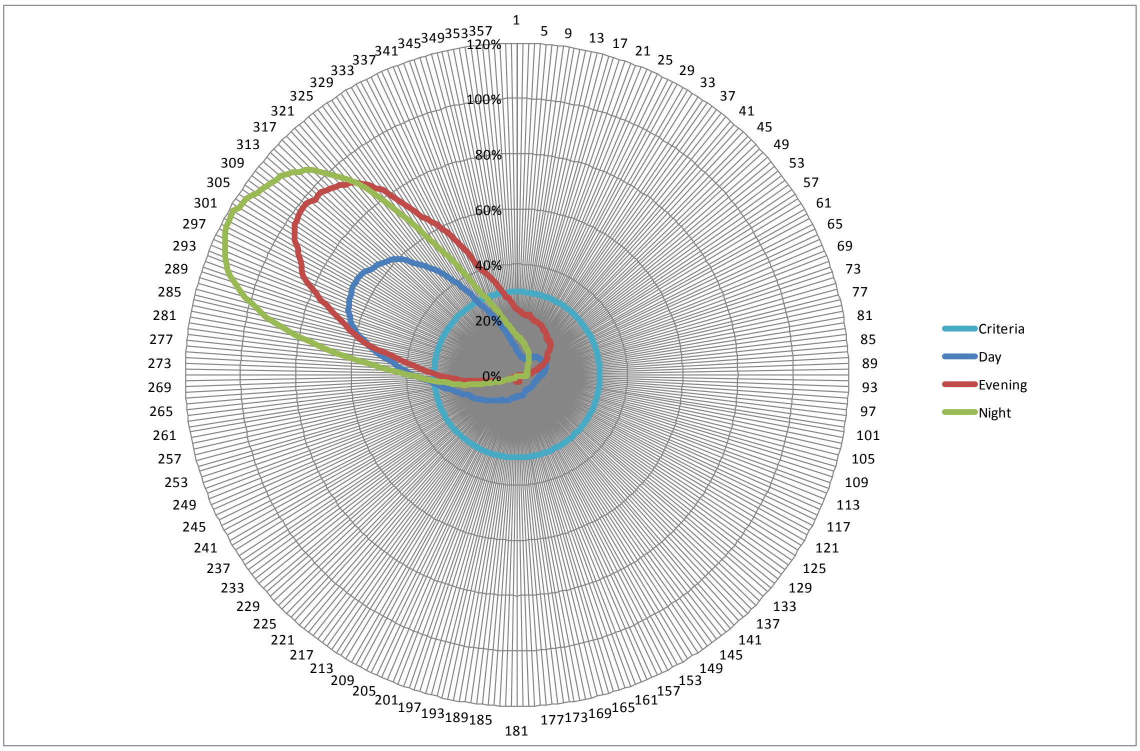
Summer



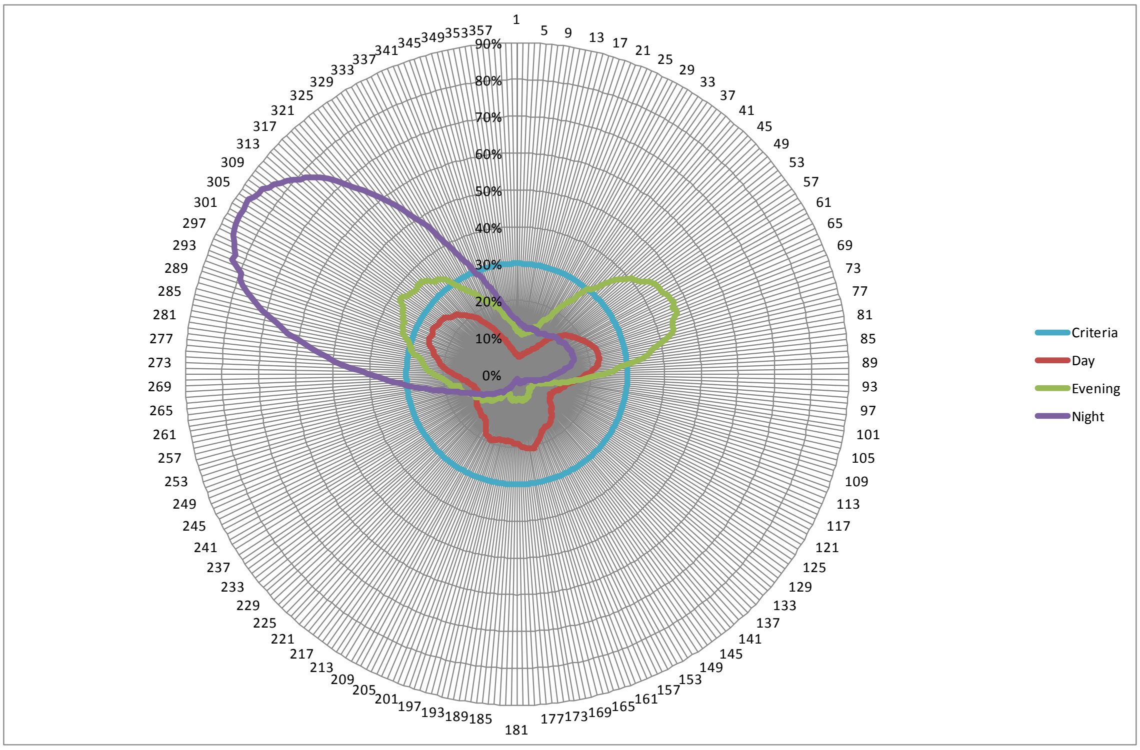
Autumn



Winter



Spring



Appendix L

Noise barrier location

AECOM

Foxground and Berry Bypass

Noise Protection Barrier Locations

Source: AECOM (2012)

JUL 2012

60021933

Fig.