REVIEW OF ENVIRONMENTAL FACTORS

FOR PROPOSED EASTBOUND ENTRY RAMP FROM HAWKESBURY ROAD TO THE GREAT WESTERN HIGHWAY AT SPRINGWOOD

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for
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November 1996

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SECTION A - PRELIMINARIES

1. Introduction

The Roads and Traffic Authority (RTA) proposes to construct an eastbound entry ramp from Hawkesbury Road to the Great Western Highway at Springwood.

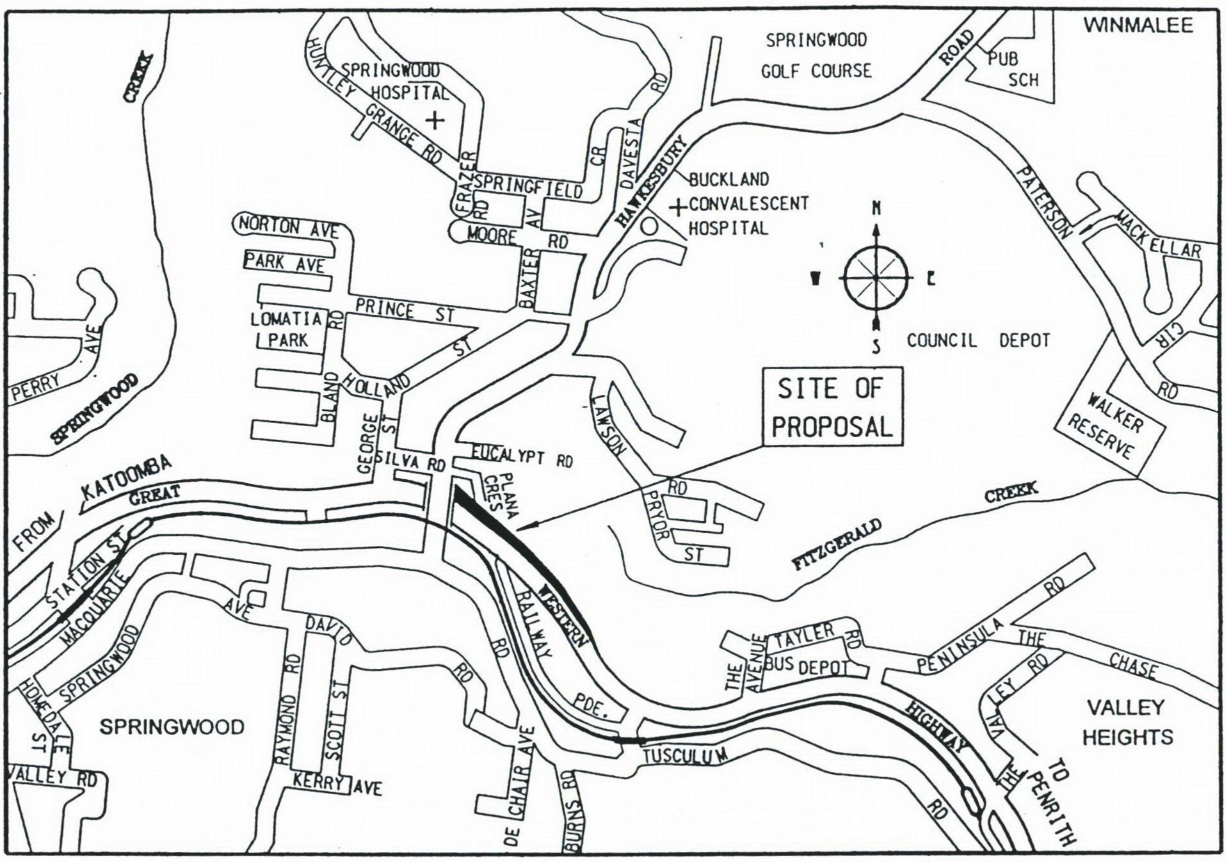
The Great Western Highway (State Highway No. 5) runs 210 kms from central Sydney to Penrith and Katoomba over the Blue Mountains to Bathurst and is the main inland route for traffic between Sydney and the central west region of NSW. Hawkesbury Road (Main Road No. 570) is a regional road that runs 22 kms between Richmond and Springwood in the lower Blue Mountains. The provision of an entry ramp at Springwood to improve eastbound access from Hawkesbury Road to the Great Western Highway has been a long term strategy of the Roads and Traffic Authority of NSW (RTA). The Blue Mountains City Council and the RTA jointly funded a *Springwood Traffic Study* (Final Report, May 1996) which included an entry ramp as one of the preferred options to improve traffic flow along Hawkesbury Road.

The proposal is for the construction and operation of a one lane eastbound entry ramp from the intersection of Silva Road and Hawkesbury Road that would merge onto the Great Western Highway at Springwood. The proposal would also include the provision of a roundabout, signalised pedestrian crossing and other road safety measures at and near the Silva Road and Hawkesbury Road intersection. The proposal would improve access to the Great Western Highway and improve traffic flow, capacity and safety for motorists and pedestrians along Hawkesbury Road.

2. Proposal Identification

Name of Proposal:	An Eastbound Entry Ramp from Hawkesbury Road to the Great Western Highway at Springwood.
Directorate:	Sydney.
Local Government Area:	Blue Mountains City Council.
Construction Program:	Western Sydney Roads and Transport Programme.
Plan Registration Number:	0005.044.CD.0014.
Roadloc Co-ordinates:	Start R[0005 1260 B1 0.200] Finish R[0005 1260 B1 0.619].

Figure 1. Location Plan of Proposal



3. Proposal Description

3.1 Location

The proposal would be located on the northern side of Springwood as shown in Figure 1. The ramp would run from the intersection of Silva Road and Hawkesbury Road and merge with the Great Western Highway eastbound towards metropolitan Sydney.

3.2 General Features

The general features of the proposal are:

- The construction of a one lane entry ramp approximately 200 metres long and 3 metres wide with sealed shoulders (2 metres on the left side for cyclists and emergencies and 1 metre on the right side) plus a 250 metres long merge lane to the Great Western Highway. The pavement would be dense grade asphalt.
- The ramp would be supported by a 180 metre long reinforced soil wall up to 7.5 metres high with a 1 metre high concrete parapet on the top for vehicle safety which would also help noise attenuation.
- The installation of a roundabout at the intersection of Silva Road with Hawkesbury Road and a signalised pedestrian crossing immediately north of Eucalypt Road.
- Incorporation of road safety features including concrete splitter islands and pedestrian refuges in Hawkesbury Road and Silva Road, pedestrian fences at the entry to the ramp and provision for cyclists in Hawkesbury Road and on the ramp.
- Relocation and adjustment of utilities and infrastructure.
- The proposal would be generally contained within the existing road reserve although partial acquisition of one private property near the ramp would be required.
- Some loss of vegetation in the ramp location.
- Revegetation of exposed earthworks areas not required for the ramp.
- The existing left and right hand turns from George Street to the Great Western Highway would be retained for local traffic from the George Street precinct. Linemarking near the George Street and Great Western Highway intersection would be adjusted to take into account the reduced traffic flows using this route.

A plan and typical section of the proposal is shown in Figure 2. The RTA is the proponent. The ramp construction would be designed in detail by the RTA.

3.3 Costs and Timing

The estimated cost for the concept development, environmental impact assessment, detail design and construction of the proposal is in the order of $1.5 million. Subject to favourable determination of the proposal construction would commence in early 1997 over a period of 12 to 15 months.

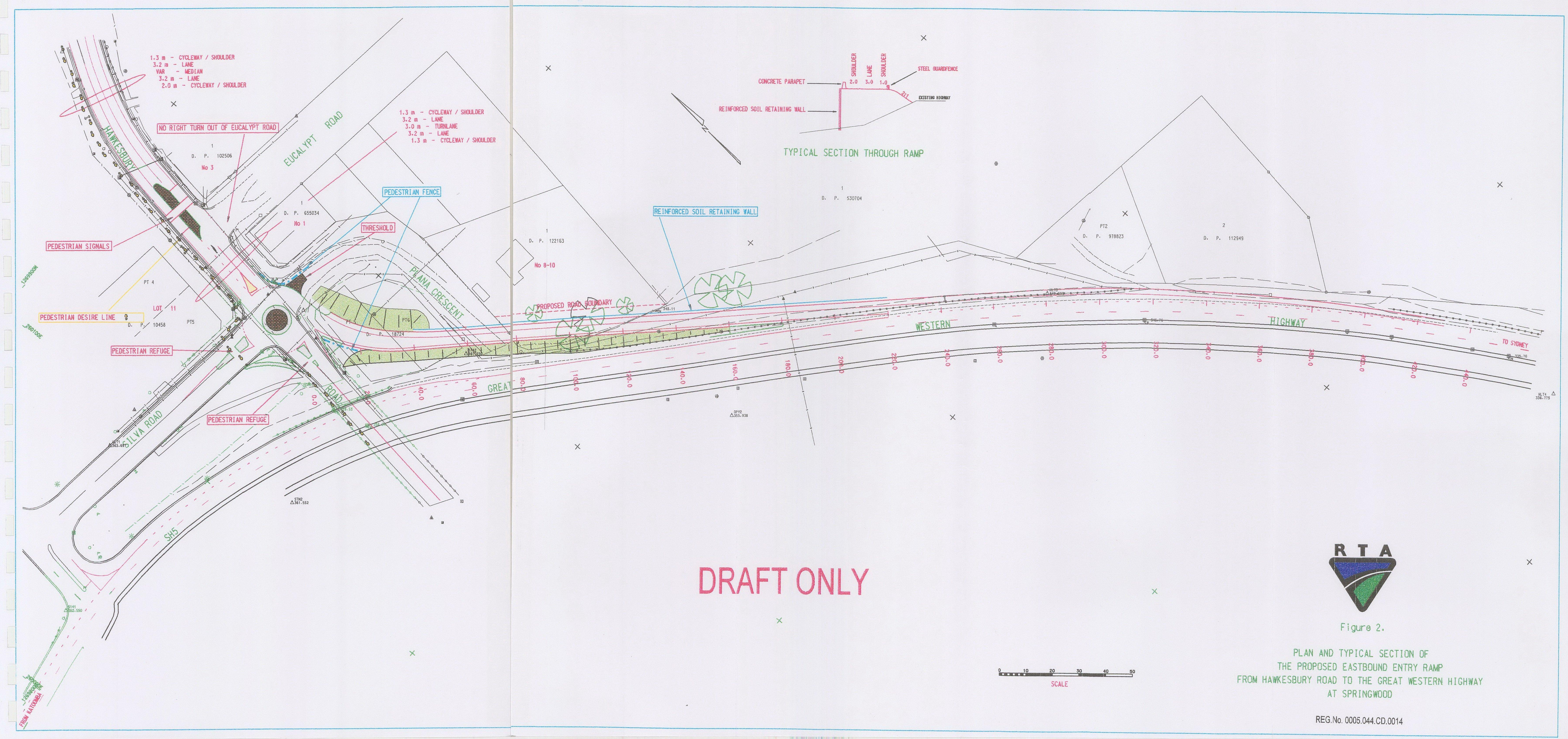


Figure 2.

PLAN AND TYPICAL SECTION OF
THE PROPOSED EASTBOUND ENTRY RAMP
FROM HAWKESBURY ROAD TO THE GREAT WESTERN HIGHWAY
AT SPRINGWOOD

REG.No. 0005.044.CD.0014

4. Specialist Studies and Community Involvement

4.1 Specialist Studies

Engineering studies have been completed for the concept design of the ramp construction including traffic and pedestrian studies and analysis. Specialist environmental studies completed include noise measurements and predicted noise levels and identification of flora and fauna in the area of the ramp. A safety audit would be completed before commissioning of the proposal.

4.2 Community Involvement

A Community Involvement Program was undertaken in late 1994 to allow interested stakeholders to provide input to the early planning of the proposal. The aim of this Program was to ensure that the local community's needs were understood and that the major environmental issues could be identified for further consideration in the environmental impact assessment process.

Objectives

The objectives of the community consultation process were to:

- To obtain community feedback (including public authorities) so that all conceivable issues were addressed in the final concept development stage.
- To evaluate community feedback so that appropriate responses could be made to community concerns and suggestions determined via the community consultation process.
- To determine the issues that would need to be addressed in the environmental impact assessment and concept development.
- To report back to the community the results of the "Have Your Say" responses and to advise what would happen next.

Action Plan

The community consultation program of the proposal was designed and undertaken as the first step in the Concept Development Process. The program involved the following:

- Newsletter No.1 was distributed in Faulconbridge - Springwood - Valley Heights - Winmalee - Hawkesbury Heights - Yellow Rock to 6,800 households on 16 November 1994.
- Advertisements were placed in *The Blue Mountains Gazette*.
- A display was help at Springwood Library from 18 November to 16 December 1994.
- Seven Community Groups were invited by letter to participate in the program.

Tasks

Assessment of the community consultation program has been based on the following tasks:

1. Consideration and classification into 'benefits/disbenefits', 'concerns' and 'suggestions' as perceived by the community at large.
2. To summarise, assess and respond to the written submissions received in each of the above categories.

A number of public organisations, utility and service providers with a potential interest in the proposal have been consulted. The public organisations and service providers that were consulted in relation to the proposal and their comments are summarised below.

Blue Mountains City Council

Consultation with the Blue Mountains City Council has taken place with regard to the Springwood Traffic Study, review of plans and through meetings. Blue Mountains City Council officers have reviewed the concept and agreed with the selection of the proposal in October 1996.

Environment Protection Authority

The EPA expects that the REF would justify that an REF is sufficient and that an EIS is not required. The REF should demonstrate that the predicted impacts of the proposal are not significant.

The EPA expects that the REF would investigate the relationship of this proposal to existing and proposed roads in the region for the purpose of assessing the combined traffic growth potential, support for road based public transport and the cumulative environmental impact of the proposal.

The EPA recognises that the proponent purposes to prepare an REF rather than an EIS. However, we expect that the REF will address, but not necessarily be limited to addressing, all issues outlined in the Department of Urban Affairs and Planning *Practice Guideline for the Preparation of an Environmental Impact Statement for Roads and Related Facilities* that are relevant to the proposal. In particular, the EPA expects that the REF will address erosion and sediment control measures during construction, long term water quality control measures and construction noise and traffic noise levels.

Department of Land and Water Conservation

It is essential to minimise on-site erosion and prevent the off-site sedimentation of adjacent properties, streams and water bodies. Any REF should outline a progressive erosion and sediment control program which should be implemented from the initial planning stage, throughout the construction stage and until the project has been completed and the site fully stabilised and/or landscaped. The erosion and sediment control program should be carried out in accordance with the principles detailed in the Department's publication *Urban Erosion and Sediment Control.* The Department encourages the adoption of construction procedures/options that minimise the area of disturbance, the length of time that an area will be exposed, and that minimise temporary and permanent impacts and modifications to the environment.

Revegetation

Experience in other road construction projects throughout the Blue Mountains has shown that native vegetation of the Blue Mountains does not have the same soil binding properties as many more invasive, less desirable, exotic grass species, such as kikuyu or couch. This is especially relevant to steep cut and fill embankments, and areas of concentrated water flow such as drainage lines. The REF should include a commitment to progressive revegetation of the project.

SECTION B - ENVIRONMENTAL IMPACT ASSESSMENT

5. Strategic Stage

5.1 General

The Great Western Highway is a State Highway which fulfils a role as a vital link in the NSW main road network as well as catering for the needs of the local community and the increasing importance of tourism. Hawkesbury Road is also an important link in the main road network between Richmond and Springwood and the lower Blue Mountains. As part of an on-going development programme the Great Western Highway is being significantly upgraded by the RTA. An extensive safety and traffic management programme and measures to improve traffic flow and safety is also being implemented. The RTA's operational strategy for the Great Western Highway including links such as the proposal is to:

- provide a high standard link between urban centres.
- develop and implement a safety strategy for the Highway.
- promote safe travel by providing continuity of standard along the Highway.
- adopt measures to reduce accident potential and improve traffic flow.

The result including the proposal would be improved safety, higher level of service and capacity for future growth along Hawkesbury Road and the Great Western Highway.

5.2 Planning and Environmental Background

The draft *State Road Network Strategy* was released by the RTA in January 1995 and set out a framework for planning and managing the NSW road network over the next 20 to 30 years. The draft *Strategy* is based on analyses of population growth and distribution, urban growth, economic change, development opportunities, environmental constraints and the total transport needs of passengers and freight - all within a framework of ecologically sustainable development objectives. The main themes of the draft *Strategy* are to facilitate and support State and regional economic development; moderate traffic growth, rather than strive to satisfy unrestrained demand for travel; and progress towards the achievement of ecologically sustainable development objectives. The draft *Strategy* identifies the Great Western Highway as part of the State's strategic road network including being a strategic road freight link, strategic road link between major urban centres and a strategic road link supporting inter-regional tourism.

The RTA's February 1995 *Roadside Environment Strategic Plan* forms part of the commitment expressed in the RTA's Environmental Vision being *a roads and traffic system in harmony with the natural and social environment, while meeting community mobility needs.* In addition the Roadside Environment Policy states *in partnership with local government, other agencies and the community, the RTA will work to improve the management and enhancement of the roadside environment.*

- Protect adjoining catchment areas by controlling erosion and sedimentation from the highway corridor.
- Avoid direct and indirect effects on items of identified heritage within and adjacent to the highway corridor.

Social and Commercial Goal

To maintain or improve the social cohesion and commercial viability of the Blue Mountains townships so as to fulfil the needs and expectations of residents and visitors, as well as to provide opportunities for resident involvement in planning the future of the highway corridor.

Objectives

- Investigate road designs and traffic management measures that encourage smooth flowing traffic movement consistent with environmental constraints, to minimise acoustic impacts.

The proposal is in accord with these goals and objectives of the Great Western Highway Management Plan.

5.3 Strategic Justification and Needs Definition

The following extracts from the *Springwood Traffic Study* sum up the strategic justification of the proposal and define the needs of the Hawkesbury Road and Silva Road intersection and nearby area.

Based on the INTANAL[1] analysis the Hawkesbury Road and Silva Road intersection currently operates at an acceptable Level of Service 'B'[2] in both peak periods. The right turn movement out of Silva Road suffers the highest delays. However this is not a critical movement, given the route alternatives available for this movement. Observations suggest that the actual delay to the right turn movement into Silva Road is higher than predicted, with the queue observed to extend beyond the 100 metres long right turn storage bay. With the projected year 2001 flows, the Level of Service is predicted to reduce to 'F' in both peak periods. The removal of the Hawkesbury Road regional through traffic growth does not improve this Level of Service. Thus, some improvement to this intersection will be essential in the medium term.

The traffic efficiency review did not cover all of the problems with this intersection. There have been three accidents involving bicycles in three years. Public feedback indicates some concern about pedestrian safety, and residents at Eucalypt Road and Plana Crescent have expressed concern about their safety in egressing onto Hawkesbury Road. Treatments

[1] *INTANAL is a traffic management and traffic engineering computer program that analyses the operation of intersections controlled by traffic signals, Give Way signs, Stop signs and roundabouts.*

[2] *In accordance with AUSTROADS 2 - Level of Service A is a condition of free flow with high speeds and low traffic volumes. Level of Service B is stable flow where drivers have reasonable freedom to select their speed. Level of Service C also has stable flow but most drivers have restricted freedom to select their speed, change lanes and overtake. Level of Service D approaches unstable flow with nearly all drivers restricted corresponding to tolerable capacity. Level of Service E is for traffic volumes at or near capacity with unstable flow and momentary stoppages. Level of Service F is forced flow operation at low speeds caused by demand exceeding capacity.*

would be desirable regardless of whether traffic signals were installed at the Great Western Highway and George Street.

Other related issues considered in the *Springwood Traffic Study* were:

- traffic signals with the issue of safe pedestrian/cyclist crossings in mind.
- traffic and pedestrians/cyclists needs to be addressed.
- providing the opportunity for safe pedestrian crossings.
- access to Eucalypt Road and Plana Crescent.
- access westbound from the Highway to the Winmalee area.
- a safe merge length for the ramp.

6. Concept Stage

6.1 Objectives

The six objectives of the draft *State Road Network Strategy* for the road network are:

- moderated demand for roads and balanced use of transport.
- a road network promoting economic development and meeting community needs.
- a road network maintained in acceptable condition at minimum long-term cost.
- reduced transport costs and improved vehicle efficiency.
- road safety with fewer road deaths and serious injuries.
- care for the environment during road planning, construction, maintenance and use.

The regional and local objectives of the RTA's forward strategy for the area are:

- provide increased infrastructure capacity for East Springwood/Winmalee.
- maximise community benefits to ensure value for money for expenditure of funds.
- improve pavement condition to provide safer and trafficable travel for the community and reduce long term maintenance costs.
- improve network efficiency by reducing congestion across the network.
- improve road safety by reducing congestion across the network.
- reduce through traffic from local residential streets.
- protect the existing environment and plan for future expansion of its environmental qualities.
- ensure a specialist route is created for Regional Roads in a positive way for the general environment.
- improve through and local access by reducing delays.
- improve pedestrian and cyclist safety for the local community.
- reduce accidents.
- improve environmental amenity for the local community.
- achieve continued community support for the project.

The objectives of the *Springwood Traffic Study* for management of Hawkesbury Road were:

- increase the safety of all vehicle movements, particularly right turn movements, and to increase the safety of pedestrians and cyclists;

- reduce delays to traffic entering Hawkesbury Road from side streets and properties;
- reduce conflicts between through and local traffic;
- improve the visual qualities of Hawkesbury Road.

The objectives of the proposal are as follows:
- to improve access from Hawkesbury Road to the Great Western Highway by providing an eastbound entry ramp.
- to improve safety for motorists, pedestrians and cyclists.
- to reduce accidents.
- to achieve community acceptance.
- to satisfy environmental requirements.
- to minimise disturbances and delays to traffic during construction.

The above objectives for the proposal are in accord with the draft *State Road Network Strategy*, the *Springwood Traffic Study* and the RTA's strategy for the area and environmental policy which states *the RTA is committed to using best practical environmental technology, planning and management techniques in all its activities.*

6.2 Options

The feasible options considered were:
- improving the existing intersection of George Street and the Great Western Highway.
- installing traffic signals at the intersection of Hawkesbury Road and Silva Road.
- the 'do nothing' or 'do minimum' option.
- a channelised signposted intersection with ramp.

If the intersection provided a free left turn, with a generous radius on the corner, with two approach lanes along Hawkesbury Road north, one approach lane along Hawkesbury Road south and a left and right turn lane on the Silva Road approach, INTANAL indicates that current traffic flows would result in a Level of Service of 'A' in the morning and Level of Service 'B' in the afternoon. With the year 2001 flows, but excluding regional through traffic growth, the Levels of Service would be 'A' in the morning and 'C' in the afternoon. As a sensitivity test, increasing the Hawkesbury Road regional through traffic by 50% increased the afternoon Level of Service to 'D', a marginally acceptable result. The average intersection delay would be 18 seconds while the maximum movement delay average would be 44 seconds, just over the Level of Service 'C' threshold of 42 seconds. Improving the intersection of George Street and the Great Western Highway would not improve the Silva Road and Hawkesbury Road intersection. The disbenefit of this option would be no improvement to road and pedestrian safety in the area.

6.3 Proposal Selection

Table 1 provides a comparison between the provision of a roundabout with a signalised pedestrian crossing immediately north of Eucalypt Road and traffic signals which incorporate pedestrian crossings at the Hawkesbury Road and Silva Road intersection. Given the need to resolve traffic delays and safety problems in the area the 'do nothing' or 'do minimum' option was considered not acceptable. The option of a ramp incorporating a roundabout at the intersection was selected because it best meets the immediate and recognised needs for the Great Western Highway and Hawkesbury Road area while considering the social, economic, environmental and engineering constraints.

Any significant enlargement of the roundabout would involve greater impact on adjacent residential and public property. This would require further property acquisition. Alternative transport modes such as upgrading public transport systems including bus and rail were considered beyond the scope of the study.

Having selected a feasible ramp location, alignment and form there are also numerous alternatives available with regard to design elements such as materials, finishes and colour. These elements would be refined in the detailed design. The design elements to be selected would be compatible with and match materials in the surrounding built environment.

Table 1 Comparison Between Roundabout with Signalised Pedestrian Crossing and Traffic Lights at Hawkesbury Road and Silva Road Intersection

Selection Criteria	Roundabout With Signalised Pedestrian Crossing	Traffic Lights
Engineering		
Design Standards	Meets desirable standards	Meets desirable standards
Road Safety	Meets desirable standards	Meets desirable standards
Pedestrian Safety	Meets acceptable standards	Meets desirable standards
Bicycle Safety	Meets acceptable standards	Meets desirable standards
Practicality	√√	√√
Strategic Planning	√√	√√
Utilities Relocation	x	√√
Economic		
Costs	√√	√
Cost Benefit Ratio	√√	√
Growth Potential	√	√
Environmental		
Noise Impact	x	√
Visual Impact	x	xx
Air Quality	√	√
Neighbourhood Amenity	√	√
Ecologically Sustainable	√	x
Social		
Public Authority Support	√	√
Community Support	√√	√
Local Access	√√	√√
Expectations	√√	√
Emergency Vehicle Access	√√	√

√ minor advantage x minor disadvantage
√√ major advantage xx major disadvantage

The proposal best meets community and RTA objectives and is an economic solution that can be constructed safely generally within the existing road reserve. The proposal can be justified on strategic, environmental, engineering and community grounds. In addition the proposal is in accord with some of the principles of ecologically sustainable development.

6.4 Statutory Planning

6.4.1 Zoning

The proposal is located within the Blue Mountains City Council area. The Great Western Highway road reserve is specified as Arterial Road Existing under the provisions of the Blue Mountains Local Environmental Plans No. 4 and 1991 as amended. Road construction can take place without the consent of Council in this zone. Outside the road reserve the area immediately east and west of Plana Crescent is zoned 2A1 Residential. Road construction normally can only take place with the consent of Council in this zone. The proposal would be generally contained within the Great Western Highway road reserve and would not require council consent.

6.4.2 State Environmental Planning Policies

The provisions of State Environmental Planning Policy No.4 *Development Without Consent* enables the RTA to construct those sections of the proposal that are within the 2A1 Residential zone and outside the road reserve without the consent of Blue Mountains City Council. There are no other provisions of any other State Environmental Planning Policies that apply to the proposal.

6.4.3 Regional Environmental Planning Policies

There are no provisions of any Sydney Regional Environmental Plans that apply to the proposal.

6.4.4 Legislation

The requirements of the following legislation and regulations apply to the proposal and would be complied with.

Clean Air Act, 1961
Clean Waters Act, 1970
Dangerous Goods Act, 1975
Environmental Offences and Penalties Act, 1989
Environmental Planning and Assessment Act, 1979
Environmentally Hazardous Chemicals Act, 1985
Heritage Act, 1977
Land Acquisition (Just Terms Compensation) Act, 1991
National Parks and Wildlife Act, 1974
Noise Control Act, 1975
Noxious Weeds Act, 1993
Pollution Control Act, 1970
Roads Act, 1993
Soil Conservation Act, 1938
Threatened Species Conservation Act, 1995
Waste Minimisation and Management Act, 1995
Waste Recycling and Processing Service Act, 1970.

6.4.5 Roads Act 1993

Of particular note is the definition of *road work* in the *Roads Act, 1993* which "includes any kind of work, building or structure that is constructed or installed on or in the vicinity of a road for the purpose of facilitating the use of the road as a road...." In turn *carry out road work* " includes carry out any activity in connection with the construction, erection, installation, maintenance, repair, removal or replacement of a road work". The proposal is considered as part of *carrying out road work* and ancillary to the operations of the Great Western Highway.

Blue Mountains City Council has Tree Preservation requirements under Clause 47 of Blue Mountains Local Environmental Plan No. 4 and 1991 as amended. Section 88 of the *Roads Act* allows the RTA to remove trees from the road reserve for the purpose of carrying out road works.

7. Detailed Assessment Stage

7.1 Design Considerations

7.1.1 Existing Roads

The Great Western Highway and Hawkesbury Road are the major roads in the Springwood area linked by Silva Road and part of George Street. Eucalypt Road and Plana Crescent are local roads serving adjacent residential development. Plana Crescent is unformed and unsealed and provides access to only one dwelling. The single span two lane Hawkesbury Road overbridge opened in 1967 over the four lane Great Western Highway provides direct access to the Springwood shopping centre. Footpaths abut both sides of Hawkesbury Road and the overbridge although the western side footpath north of Silva Road is unformed but well used. North of Eucalypt Road, Hawkesbury Road curves north east and forms a 'blind corner' for motorists and pedestrians using the road. Access to Hawkesbury Road from the local roads are restricted by a Give Way sign at Eucalypt Road, a Stop sign at Plana Crescent and a 'silent policeman' at Silva Road. The statutory speed limit on the Great Western Highway near the proposal is 80 km/hour and 60 km/hour on all other local roads near the proposal.

7.1.2 Existing and Forecast Traffic

The Great Western Highway has an Annual Average Daily Traffic volume of approximately 26,500 vehicles per day in the vicinity of the proposed ramp. Hawkesbury Road has an Annual Average Daily Traffic volume of approximately 18,600 vehicles per day in the vicinity of the proposed ramp. Table 2 shows the RTA measured traffic flows along these roads. Approximately 10% of traffic using the Great Western Highway are heavy vehicles.

Table 2 Average Annual Daily Traffic Flows

Year	Great Western Highway	Hawkesbury Road
1984	18,450	N/A
1988	21,980	15,504
1992	24,882	19,020
1996	26,500	18,630

The *Springwood Traffic Study* assumed traffic growth along the Great Western Highway of 3.8% per annum from 1994 to 2001 and 2.3% per annum from 2001 to 2011. More realistic growth rates, based on recent growth figures, of 2% linear growth per annum over the forecast period of 10 years have been assumed for the Great Western Highway for this Review of Environmental Factors. A growth rate of 3.5% linear growth per annum over the same period has also been assumed as a worst case scenario for noise impact assessment. With 2% and 3.5% linear growth per annum, Annual Average Daily Traffic volumes on the Great Western Highway would increase to approximately 32,300 and 36,700 respectively in 2007. With full development in the area north of the Great Western Highway (from the *Springwood Traffic Study*) Annual Average Daily Traffic volumes on Hawkesbury Road would increase to approximately 20,900 in 2007. With opening of the proposal in 1997 Annual Average Daily Traffic on the proposed entry ramp would be approximately 7550 vehicles rising to 8400 vehicles a day in 2007 assuming full development.

The construction of the eastbound entry ramp would relieve the Hawkesbury Road and Silva Road intersection by changing the major flow, with the right turn from Hawkesbury Road north into Silva Road to become a left turn onto the ramp.

7.1.3 Design Parameters

All RTA road design criteria would be meet for the proposal. The ramp design would use criteria to encourage vehicles to enter the Great Western Highway at the Highway traffic speed and to merge as safely and gradually as possible. Vehicles would accelerate on the ramp itself without interference to through traffic on the Great Western Highway. The ramp and acceleration length would be 430 metres including a merge taper length of 125 metres. Existing speed limits would be retained with the proposal. The ramp and roundabout would be designed in accordance with RTA criteria, other specifications including requirements of this document are:

- Roads and Traffic Authority Road Design Guide
- AUSTROADS Guides
- Australian Rainfall and Run-off 1987
- Roads and Traffic Authority Environment Manual
- Australian Standard 1742.3 (for traffic management).

There are no major constraints to the design of the ramp apart from the need to minimise any property acquisition and avoid the Deanei Forest as far as possible. Some utilities would need relocation. The design speed of the ramp would be 90 km/hour for horizontal and vertical alignment to provide improved level of service and safety. The grade of the ramp would be approximately 8.8%. The capacity of the ramp design would be sufficient to meet expected traffic growth for the next 20 years. The ramp would be designed to take highway traffic loadings. The detailed design would provide for:

- economy in construction costs.
- geometric design including horizontal and vertical alignment to 90 km/hr standard.
- earthworks.
- structural adequacy.
- pavement, pavement area, materials and wearing surface.
- line marking, sign posting, sign structures and lighting.
- guide posting and safety barriers.
- adjustments to location of utilities as required.
- implementation of safeguards specified in an Environmental Management Plan.

7.1.4 Construction Activities

If approval is given to the proposal and following completion of detailed design the proposal would be constructed in around 12 to 15 months from early 1997 to be ready for commissioning in 1998. Construction would be completed as one contract and would be supervised by the RTA.

The construction compound would be located in the road reserve between Plana Crescent and the proposed ramp or in vacant land owned by the RTA adjacent to the ramp. It would be security fenced and floodlight at night and include amenities sheds, portable toilets, plant and equipment storage areas, bunded areas for storage of petroleum, distillate and other chemicals to comply with Environment Protection Authority and WorkCover requirements. Any material stockpiles would be located in the road reserve between Plana Crescent and the ramp or on RTA owned land adjacent to the ramp and protected from possible erosion.

Construction hours would generally be from 7 am to 6 pm Monday to Friday and 7 am to 1 pm on Saturdays. From 7.00-8.00 am Saturdays, only inaudible work would be allowed. Work would not be permitted on Sundays and public holidays unless authorised by the RTA and EPA where required. However night work would be necessary for some activities to minimise inconvenience to road users at peak travel times. Any night work would follow the existing procedure used by the RTA Sydney Region and endorsed by the EPA with regard to night time road works noise. An estimated 1,500 cubic metres of excavation and 9,000 cubic metres of selected fill material would be required for the proposal.

Construction equipment expected to be used on-site includes the following mobile plant and equipment as required:

- front end loaders
- excavation plant
- back hoes
- trenching machines
- chain saws

- jack hammers
- dump trucks
- bulldozers
- low loader transporters
- graders
- vibrating rollers
- concrete agitator trucks
- concrete and asphaltic paving machines
- water tanker
- road sweeper
- line marking vehicles
- trucks delivering construction materials
- light commercial and passenger vehicles.

Construction of the ramp would follow normal road and ramp works procedures including the following general sequence of activities:

- installation of temporary erosion, sedimentation and drainage controls.
- removal of vegetation to a waste disposal area.
- relocation of all affected utilities and services to suit construction programme requirements.
- drainage lines excavated by backhoe or excavator.
- topsoil stripped and stockpiled on-site by bulldozers, graders, loaders and trucks.
- surface preparation by graders.
- recycling of suitable excavated material and incorporation of unsuitable material in earthworks within the road reserve.
- import of select material for earthworks for the ramp.
- compaction by rollers and vibrating compactors with trimming by graders.
- batched concrete and asphalt placed on-site by pavers, autograde machines and graders and compacted by rollers.
- application of asphaltic concrete wearing surface by pavers and rollers.
- planting for revegetation and landscaping along the ramp.
- installation of line marking, lighting, sign structures and sign posting.
- site clean up and disposal of all surplus waste materials.
- commissioning.

The RTA would be responsible for the overall implementation of the proposal. Construction would conform to Quality Assurance in accordance with AS 2990-1987 or AS/NZS ISO 9001-1994 and RTA specification Part Q *Quality System Requirements*. The safeguards in this Review of Environmental Factors would be implemented by the RTA and contractor(s) throughout the sequence of activities described above.

No blasting or on-site batching of concrete or asphaltic concrete would be permitted. The construction site would be maintained in a clean and tidy state at all times. Construction equipment would be maintained to meet EPA requirements. No vehicle maintenance would be permitted outside the construction compound. Cleaning out of batched concrete mixing plant would only be permitted in designated areas or off-site at approved facilities. Some construction would be carried out under traffic. Professional and diligent traffic management would be required to construct the proposal and avoid disruption to traffic. Two lanes on Hawkesbury Road would be available for traffic at all times except the southbound traffic lane may be closed in off-peak hours to enable essential work to be carried out in safety. Traffic arrangements would be subject to RTA approval. Disruption of access to properties would be minimised and prior arrangement would be made with affected owners in the event of any short term disruption.

7.1.5 Waste Disposal

Any surplus waste material would be disposed of in a legal manner. Construction works would include clearing of introduced and native vegetation from the ramp embankments and road reserve. The number of trees to be removed would be the minimum necessary for the safe excavation and construction operations. Trees with limbs overhanging the Great Western Highway would not be removed unless absolutely necessary for safety reasons. Any overhanging limbs would be cut back where possible. Any suitable vegetation would be provided to community groups as firewood as a first priority and then disposed of at a nearby legally operating tip site (for example, Blaxland waste disposal site). The vegetation, leaf litter and soil cleared for the construction works would not be used in the revegetation of the disturbed areas. This excess vegetation would be disposed of at a nearby legally operating tip site.

Any excavated or excess pavement material and concrete would be incorporated in the earthworks for the ramp approaches as a first priority or transported off-site for recycling. If any contaminated material was encountered it would be disposed of at the direction of the Environment Protection Authority.

All other waste generated during construction (for example, unsuitable spoil, domestic waste and surplus unsuitable construction material) would be removed from the site for disposal at a nearby legally operating tip site. Workmen would use a portable toilet facility located within the construction compound. No waste would be buried or burnt on-site.

7.1.6 Demand Upon Resources

In addition to labour, plant, equipment and energy inputs the proposal would require concrete, steel, select fill material and asphaltic concrete. Any prefabricated ramp components, metalwork and signs required would be transported to the site. The off-site batched concrete and asphaltic concrete would be sourced from commercial outlets in or near the lower Blue Mountains. Import of these resources would mainly involve a number of heavy vehicle loads to be transported along the Great Western Highway, Hawkesbury Road, Silva Road and Plana Crescent with minimal impact. The fill would be sourced from nearby legally operating quarries located in the western Sydney metropolitan area. Actual quantities and number of loads may vary depending on the final ramp construction design. The proposal would not affect any resources in short supply.

7.2 Description of Site and Surroundings

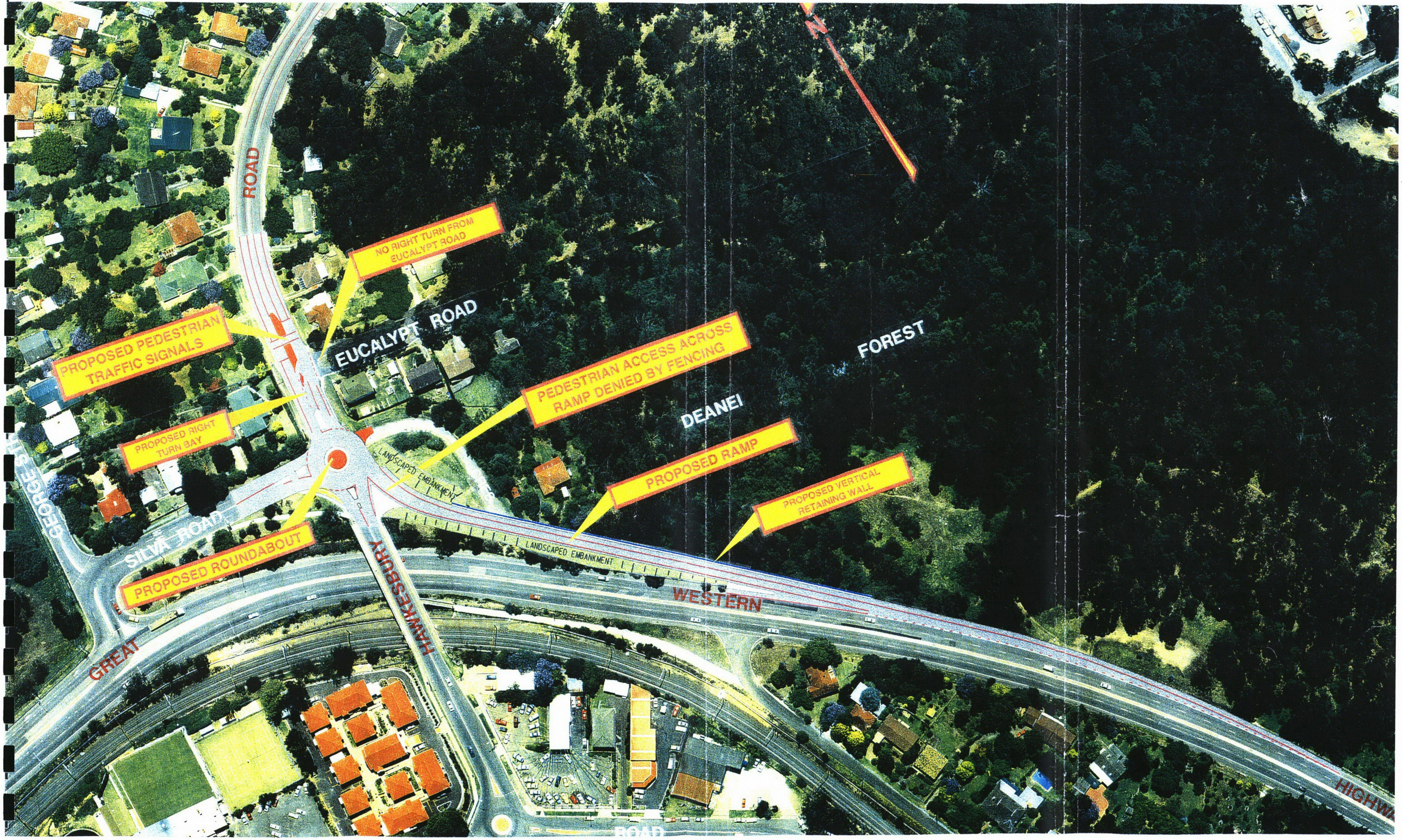
Photograph 1 provides an overhead aerial view of the area around the proposal with an outline of the ramp and associated general features. Photographs of the existing and proposed ramp locality and surroundings are shown in Photographs 2 to 5.

Springwood is one of the largest residential areas in the Blue Mountains and is located along a wide section of the ridge traversed by the Great Western Highway and Main Western Railway. The Springwood shopping centre is located south of the road and rail transport corridor. The low density residential areas of Springwood are surrounded by the steep and dissected heavily vegetated bushland areas of the Blue Mountains National Park. The area around the proposal and north of the transport corridor is typical of the Springwood area with one and two storey dwellings lining Hawkesbury Road, Silva Crescent and Plana Crescent. South of the transport corridor and near the Springwood shopping centre a range of land uses includes offices, shops, car yard, tennis courts, bowling greens and medium density aged persons housing. Utilities and services are located nearby the proposal to service the surrounding development.

The noise environment is dominated by rail and traffic noise from the Main Western Railway, Great Western Highway and Hawkesbury Road.

The proposal is located near the top of the Fitzgerald Creek catchment. There has been a high degree of physical and chemical disturbance along this section of Great Western Highway corridor including fill and cut areas for road and rail construction. Chemical disturbance is likely to include herbicides and pesticides from weed and pest control, hydrocarbons and heavy metals from road runoff.

PHOTOGRAPH 1: Aerial View of area around proposed ramp from Hawkesbury Road to the Great Western Highway at Springwood



Photograph 2 Hawkesbury Road and Silva Road Intersection Looking North

Photograph 3 Hawkesbury Road and Silva Road Intersection Looking South

Photograph 4 Area of Proposed Ramp Looking North from Overbridge

Photograph 5 Area of Proposed Ramp Looking East to Great Western Highway

7.3 Environmental Impacts

7.3.1 Landforms

Land form in the area of the proposal is undulating with slopes in excess of 10% and steep, near vertical embankments near the proposed ramp, Great Western Highway and Main Western Railway. Elevation at the start of the ramp is approximately 365 metres above sea level dropping approximately 25 metres over its 440 metre length with most of the fall occurring in the steeper 140 metre long section closest to Hawkesbury Road. Due to the proposal following the existing moderate to steep relief there would be potential adverse environmental impacts with land form during construction requiring appropriate safeguards to be implemented. These safeguards include the protection of earthworks for the ramp, revegetation of exposed earthworks areas and compaction of embankments (to a level consistent with loadings generated by heavy vehicles) to avoid erosion and consequent changes to land form.

7.3.2 Geology and Soils

The proposal is within the Lucas Heights soil landscape within the Mittagong Formation with alternating bands of shale and fine grained sandstones. Soils are generally moderately deep and hard setting yellow podzolic and soloth soils. Limitations are stony soil, low fertility and low available water capacity. A composite soil sample from the proposed ramp area adjacent to Plana Crescent showed a moderately structured sandy clay loam soil with small angular peds 1-2 mm in diameter. The Emerson Stability Class for the sample was 8 indicating stable aggregates that resist dispersion, slaking and hence erosion. Another composite soil sample from the proposed ramp area adjacent to the Great Western Highway was composed of a variety of materials with very poor structure and unconsolidated particles suggesting a high risk of erosion.

There are no known commercial mineral deposits within the area of the proposal or road reserve.

7.3.3 Climate

Climatic factors would not constrain the ramp construction except adverse weather conditions such as heavy rain, high winds or snow. Heavy and prolonged rainfall in the Fitzgerald Creek catchment would not affect the ramp construction provided appropriate safeguards to avoid erosion were installed around any excavated areas. The proposal would be linked to the existing Great Western Highway, the operations of which are not constrained by climatic factors except occasional snow and ice in winter. It is unlikely climatic factors would impact on operations of the ramp provided motorists took due care during adverse weather conditions.

7.3.4 Land Form Stability and Erosion Hazard

Components of the physical environment include steep relief and high erosion potential of some of the embankment soils. The erosion potential of the site would require safeguards to minimise the potential adverse impacts of construction works. These safeguards during construction would require installation of selected temporary sedimentation controls. The selected temporary sedimentation controls would include catch drains, diversion drains and banks, sedimentation basins, geofabric silt fences at the base of all earth works, geofabric covered hay or straw bales secured around all storm water inlets and soil stabilisation measures along the construction areas to be documented in an erosion and sediment control plan. The controls to prevent potential impacts on local watercourses would include the following:

- provision of silt fences and barriers to prevent sediment laden runoff from leaving the construction area;
- drainage structures to protect exposed embankment slopes during construction;
- progressive revegetation for all exposed areas;
- erosion prevention of topsoil stockpiles;
- provision of catch drains to prevent clean surface run off entering the construction area;
- provision of sediment traps at existing drain inlets;
- provision of sediment traps and catch drains along the Great Western Highway and Hawkesbury Road for the construction period;
- the provision of scour protection measures at drain outlets.

An erosion and sediment control plan would be prepared and detail surface water control, storm water drainage, revegetation and erosion sediment control measures required during construction to minimise sedimentation impacts. The sedimentation controls would need to be maintained in a functioning condition until all construction activities were completed over the 12 to 15 month construction period and the site was stabilised. Regular monitoring and maintenance of the sedimentation controls would be required to ensure they perform in a fully functioning condition at all times.

Installation of the selected sedimentation controls and revegetation of exposed earthworks areas would minimise adverse impacts both during construction and operations of the proposal. The moderate climate and growing season in the area would enhance the growth of landscaped and revegetated areas over time.

7.3.5 Air Quality

Local air quality could be affected at the construction stage by dust, construction vehicle emissions and odours and at the operational stage by vehicle emissions. Overall traffic growth in the area would be modest and the proposal is aimed at improving regional traffic flows rather than providing for large increases.

As anticipated in the Blue Mountains the existing air quality of the area is good. No significant additional adverse impact on air quality is expected from vehicular sources along the ramp during operations apart from localised vehicle emissions. As traffic flows increase over the years there would be a marginal reduction in local air quality due to increased volume of emissions. Although the main pollutants emitted by road traffic of concern to environmental, health and planning organisations are carbon monoxide, nitrogen dioxide, particulates, benzene and lead, improved traffic flows can have a beneficial effect on emissions. The operations of the ramp would result in the more efficient transfer of vehicles from Hawkesbury Road to the Great Western Highway compared to the existing situation with vehicles running more efficiently with lower emission rates due to less accelerating and decelerating.

Construction vehicle and dust emissions would be the main source of air pollutants during construction. There would be increases in the local incidence of dusts due to use of heavy plant and machinery. These adverse impacts would be short term and localised. Dust would be suppressed by a dedicated water tanker when required. No blasting would be undertaken at the construction site. Any odour from construction equipment and activities is not expected to have an environmental impact. All construction vehicles would comply with EPA emission standards and dust emissions from stockpiles, access tracks and construction areas would be minimised by adoption of appropriate dust suppression techniques. These would include:

- covering of loads during transport;
- watering stockpiles;
- watering or stabilising access tracks;
- spraying construction areas to minimise dust emission during grading and dozing operations.

On completion of the proposal the concentration of vehicle emissions in the area should be at or below the previous levels for a few years. This is expected due to the slightly improved fuel economy of vehicles travelling closer to optimum speeds due to the improved travelling conditions and the increased dispersion of emissions associated with these speeds. However, following completion of the proposal the air quality of the ramp area may decline marginally due to the increased traffic flows in the area. In the short to medium term the road construction would very marginally contribute towards a reduction in greenhouse gases and ozone depletion.

The RTA is developing strategies to help reduce greenhouse and other vehicle emissions and continues to engage in approaches to encourage the tightening of vehicle emissions standards. These approaches include:

- working with the Environment Protection Authority to implement the State's Motor Vehicle Maintenance Program for lowering emissions;
- making RTA fleet vehicles available to pilot test new technology with potential to reduce vehicle emissions; and
- continuing its role on the Advisory Committee on Vehicle Emissions and Noise to encourage the early implementation of more stringent Australian Design Rules, including the new standard for tightening current light vehicle emission standards.

7.3.6 Hydrology and Water Quality

The ramp construction would be above the existing Great Western Highway which provides flood immunity from at least a 1 in 100 year Average Recurrence Interval flow. The hydrology of the area indicates that the ramp can be safely constructed and operated above the 100 year Average Recurrence Interval flow.

All stormwater collected on the ramp and approach works would be discharged to the drainage system (a series of inlets with grates) within the Great Western Highway road reserve which in turn flows into natural waterways in the area. There would be increased flows as a result of more roadspace. The ramp drainage would not have any adverse impact except for a minor decrease in water quality due to increased leakages of fuel, lubricants, hydraulic fluids, coolants and particulate matter (tyre rubber, brake and clutch linings) being washed off as runoff from increased traffic flows in the future. The hydrology and water quality impacts would be similar for the existing situation and the proposal. Runoff from the Hawkesbury Road area would continue to discharge into Council's stormwater system and the adjacent grassed verge.

Recent studies completed by CSIRO for the RTA concluded that road runoff from roads with less than 30,000 vehicles per day exhibited minimal impact on receiving waters although it is desirable that discharges be kept as clean as possible. Although work on this issue is limited in Australia, the United States of America has undertaken a considerable amount of work and their experience suggests that water quality problems associated with road runoff are primarily related to lead from leaded petrol, zinc from vehicle tyres, and copper from vehicle brakes. Lead levels in leaded petrol have been reduced. Pollutants in water such as lead, zinc and copper often attach to fine particles of dirt and sediments. Therefore by effectively controlling sedimentation, lead, zinc and copper as well as tyre rubber, dirt and other particles from storm water runoff, water quality in the receiving waters of Fitzgerald Creek is not expected to be further affected by the ramp construction.

Works in relation to sediment control would generally conform to the system of pollution control approvals and licences administered by the EPA. The procedures for conforming to approval conditions and licences as set out in the EPA's *Pollution Control Manual for Urban Stormwater* would generally be complied with in the preparation of the erosion and sediment control plan during construction. The erosion and sediment control plan would also address information on storm water quality controls and include the location of existing natural and built drainage channels in relation to the proposed work.

Aquatic ecosystems in Fitzgerald Creek are not expected to be adversely affected by the proposal. No water would be drawn from Fitzgerald Creek for construction purposes.

7.3.7 Vegetation

A general botanical survey of the area around the proposal was carried out by Lesryk Environmental Consultants on 1 November 1996. All vegetation stands occurring within the area of the proposed works and for approximately 50 metres downslope of the area of direct impact were searched on foot. The gardens of the residence to be partly acquired for the proposal were not specifically searched but observations from the access road to the property and the highway indicated that only horticultural plantings plus two eucalypt trees occurred in the area to be acquired.

The results of the survey and flora impact assessment are summarised below and more detail is provided in Attachment 2. The existing batter slope and the road reserve area below the batter are densely covered by weed vegetation with only emergent trees and large shrubs remaining of the native vegetation cover. Dense weed cover also extends for some distance beyond the road reserve boundary but weeds have been recently cleared from this area and native species are beginning to regenerate. The natural vegetation communities that once would have covered the area has been greatly modified and only trees and large shrubs remain on the face and foot of the batter slope.

The vegetation to be affected by the proposed works is dominated by weed species, except for a small stand of native vegetation along the Great Western Highway below the Hawkesbury Road overpass. All other areas are heavily infested with weeds. However based on the species present two native vegetation communities can be identified within and adjacent to the proposed construction site. These broadly correspond to the vegetation units as:

- Map Unit 10ag Sydney Sandstone Gully Forest, sub-unit (i) Tall open-forest.
- Map Unit 10ar Sydney Sandstone Ridgetop Woodland, sub-unit (ii) Open-forest/woodland.

A list of plant species identified in survey area is provided in Appendix 1 of Attachment 2. No species of national or regional conservation significance as listed by Briggs and Leigh (1996) or Schedules 1 and 2 of the *Threatened Species Conservation Act 1995* were located during the survey. The NSW National Parks and Wildlife Service's Rare Or Threatened Australian Plants (ROTAP) database lists was also consulted for species of conservation significance that have been found in the locality. Given the type of natural habitats occurring in the area of the proposal, the species shown in Table 3 were considered possible occurrences within or adjacent to the site but were not located.

Table 3. Plant Species of Conservation Significance Occurring in the Springwood Area

Scientific Name	Regional Significance	ROTAP Code	TSC Act Schedule
Eucalyptus burgessiana	Local endemic, Linden Faulconbridge, and Springwood.	2RCa	
Chloanthes glandulosa	Main population Springwood to Kurrajong.		
Leucopogon fletcheri	Local population.	2RC-	
Persoonia hirsuta	Local population.	3KCi	
Zieria involucrata		2VCa	2
Grevillea longifolia	Disjunct local population.	2RC-	

All of the native plant species located within and adjacent to the proposed construction area are common in similar habitats throughout the Blue Mountains area. Several large individuals of Round-leaved Gum *Eucalyptus deanei* and Grey Gum *Eucalyptus punctata* and one Turpentine *Syncarpia glomulifera* occur on or below the existing batter slope within the proposed construction area and are valuable local amenity features. On a local and regional scale the vegetation type that occurs within and adjacent to the survey area is not significant. However, the loss of the larger trees would alter the local amenity of the site.

The proposed construction of the ramp would require the removal of up to 20 mature and semi-mature native trees and approximately 2,400m^2 of weed vegetation with one small stand of native vegetation located along the Great Western Highway. Any native trees to be removed are well represented within the nearby Blue Mountains National Park.

The proposed construction of the vertical concrete wall would limit the area directly affected by the work and would also reduce the on-going input of weed propagules and assist in the present efforts to clear the weeds from the area by largely eliminating the existing batter slope. The usual effects associated with road construction on native bushland such as weed invasion and dieback would not occur in the area due to the already heavily weed infested environs.

There are no ecological impediments, in terms of flora conservation to the roadworks proceeding as planned. It is not considered necessary to prepare a flora Species Impact Statement for the proposed work. However a number of recommendations are made including:

- The number of trees to be removed should be the minimum necessary for the safe excavation and construction operations. The retention of the existing trees is an important aspect of maintaining the existing character of the area.
- Trees with limbs overhanging the road should not be removed unless absolutely necessary for safety reasons. Rather, the overhanging limbs should be cut back.
- The boundary of the area to be cleared and the bushland to be retained should be clearly delineated and fenced by 'Paraweb' or similar fencing to prevent workers and machinery from entering the bushland to be retained.
- To prevent the erosion of soil and the further dispersal of weed propagules from the construction area, suitable erosion and sedimentation controls should be established and maintained until the area is stabilised.
- The vegetation, leaf litter and soil cleared for the construction should not be used in the revegetation of the disturbed areas.
- The RTA should investigate the possibility assisting the current weed clearing efforts downslope of the road reserve by clearing the adjacent road reserve area of weeds. This could be accomplished by relatively 'heavy-handed' methods such as a small bulldozer blade.

7.3.8 Wildlife and Habitat

A general fauna survey of the area around the proposal was carried out by Lesryk Environmental Consultants on 1 November 1996. Techniques employed for the investigation included habitat assessment, litter searches, bird watching and the identification of scats and indirect fauna evidence. A search of the NSW National Parks and Wildlife Service Atlas of NSW Wildlife and a review of previous studies undertaken in the area was also carried out to identify additional fauna species known to occur in the study region. The results of the survey and fauna impact assessment are summarised below and more detail is provided in Attachment 3.

Several habitat types occur within and adjacent to the boundaries of the proposed ramp and include open woodlands, grasslands and horticultural plantings. The habitat types to be affected by the proposed ramp are all highly degraded, having been impacted upon by weed infestation, clearing, residential development, urban expansion and its associated infrastructures. Those native habitats observed are all widespread in the area and in some cases are considered to be better conserved and more structurally developed. Those habitats observed are expected to be used by some native species during roosting or foraging periods, but in relation to similar habitats throughout the area the resources they provide are considered to be minimal. The habitats observed do not occur within any significant wildlife corridors and the proposed works are not expected to impact or fragment any large woodland tracts.

During the investigation of the study area 32 birds, 1 native mammal and 1 reptile were observed or recorded as using the survey site. Those species recorded are all known to be commonly encountered in nearby residential and woodland areas and all are highly adaptive to modified environments. None of those animals recorded are considered to be of conservation concern as defined by inclusion on Schedules 1 and/or 2 of the *Threatened Species Conservation Act 1995*. Also none are considered to reach their distribution limit in the vicinity of the study area. All species are considered to be commonly encountered throughout the region.

The cumulative impacts of residential and urban developments and their associated infrastructures along with feral pests, exotic weeds, urban rubbish and previous habitat destruction, is likely to have excluded all but a few tolerant and widespread native and introduced species. These species are generally tolerant of moderate levels of disturbance and all are expected to commonly observed through out the vegetated areas surrounding the study site.

Previous studies and fauna surveys undertaken within the vicinity of the current study area have identified an additional 49 birds, 17 reptiles, 14 frogs and 3 native mammals. Of these species previously recorded six, the Glossy Black-Cockatoo (*Calyptorhynchus lathami*), Turquoise Parrot (*Neophema pulchella*), Powerful Owl (*Ninox strenua*), Regent Honeyeater (*Xanthomyza phrygia*), Giant Burrowing Frog (*Heleiporous australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*), are listed under either Schedules 1 and/or 2 of the *Threatened Species Conservation Act 1995*. Each of these species is a habitat specialist, relying on a particular vegetation community or geological, hydrological and/or physical condition for their life cycle requirements. Within the boundaries of the proposed road works, no habitat critical to the life cycle of any of these species was observed and no impact on the local or regional survival of these animals is expected to occur.

In addition to these species there are a number of other threatened species known to occur within the Blue Mountains region. Of these species the Spotted-tailed Quoll (*Dasyurus maculatus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Common Bent-wing Bat (*Miniopterus schreibersii*) and Greater Broad-nosed Bat (*Scoteanax ruepellii*) have the potential to occur within the woodland areas adjacent to Fitzgerald Creek. Given the limited amount of clearing expected to occur as a result of the proposal and the highly disturbed nature of the existing environment these species are not expected to be adversely impacted upon by the proposal.

The proposed construction activities are not considered to remove, modify or fragment any habitat critical to the life cycle of any threatened fauna species. No habitats were observed within the study boundaries that are considered to be significant to the conservation of any native fauna species.

Within the boundaries of the proposed on ramp, no habitats were identified which would be of importance to the conservation of any threatened or "common-to-abundant" fauna species. No habitats of significance were observed which would be adversely impacted upon and no additional fragmentation or isolation of bushland remnants would occur. Those habitats recorded are similar to communities found throughout the region, none being restricted or unique to this location. Those habitats observed are expected to provide some foraging resources for a number of common native species, but in relation to adjacent areas, the value of this is considered minimal.

Based on an assessment of habitats present and a literature review of previous studies, none of the species of State conservation significance expected or known to occur are considered to be adversely impacted upon by the proposed construction activities. The construction of the ramp is not expected to have a significant impact on the environments of any protected or threatened fauna.

7.3.9 Threatened Species

There are no threatened flora or fauna species listed under Schedules 1, 2 or 3 of the *Threatened Species Conservation Act 1995* affected by the proposal. Section 5A of the *Environmental Planning and Assessment Act 1979* was used to decide whether there is likely to be a significant effect generally on any potential threatened fauna species, populations or ecological communities, or their habitats by taking into account a number of factors as listed in Attachment 3. Any native trees and vegetation to be removed are well represented within the nearby Blue Mountains National Park and none are of conservation significance. It is not considered necessary to prepare a flora or fauna Species Impact Statement for the proposal.

7.3.10 Socio-economic Considerations

The residents, workers and visitors to the nearby residential and commercial areas near the proposal would be likely to experience adverse impacts due to elevated levels of dust, noise, traffic generation and general disruption during the 12 to 15 months of construction. Construction traffic would be directed to use the Great Western Highway, Hawkesbury Road, Silva Road and Plana Crescent for site access. However Hawkesbury Road travellers through the area and users of Plana Crescent would be involved in short term inconvenience to travel during construction. Some utilities would require relocation during construction with possible minor inconvenience for nearby residential areas. There would be no property severance as a result of the proposal. No local access would be affected and disruption of access to residential and recreation areas would be minimised during construction.

During construction of the ramp the procedures for the installation and operation of traffic control devices established in AS 1742.3-1996 *Manual of Uniform Traffic Control Devices Part 3: Traffic Control Devices for Works on Roads* would be followed wherever possible. Only the minimum practicable length and width of Hawkesbury Road and Plana Crescent would be affected by construction at any one time to minimise disruption and inconvenience to road users.

Approximately 570 square metres of land would need to be acquired from the south western corner of 8-10 Plana Crescent for the proposal. Acquisition would be by negotiation under the terms of the *Land Acquisition (Just Terms Compensation) Act.* The land required is garden area of a private residential property and represents 18% of the total property area of 3135 square metres. Access to the property would need to be adjusted with the proposal. The occupants of the dwelling on 8-10 Plana Crescent and the three other properties abutting Plana Crescent would suffer a decline in visual quality and a loss in privacy with construction and operations of the ramp.

Following completion of the proposal the workers, visitors and residents would have improved access to destinations within and outside the region. There would be no significant changes to land use and local access. The proposal would not affect local businesses following completion of construction. Economic pursuits in the area would able to be maintained during construction and operation of the proposal.

7.3.11 European Heritage

The ramp construction would be constructed within areas already disturbed. The area was part of the original William Lawson land grant and was subdivided into the Silva Plana Estate. Archival evidence is that the area between Plana Crescent and Hawkesbury Road was occupied by 2 or 3 dwellings removed for construction of the Great Western Highway. Anecdotal information is that the nearby area was also occupied by brickworks and a quarry. There is physical evidence of concrete and sandstone building foundations and a weir in the area but the proposal would not affect these works. There are no items of environmental heritage or potential additions to the heritage register listed in the Blue Mountains Local Environmental Plan No. 4 within the proposed works area or nearby. However it is possible due to past development in the area that relics greater than 50 years old may be unearthed during construction. If this event occurred then the Heritage Council of NSW would be contacted for advice and/or a permit to remove or destroy the item.

7.3.12 Aboriginal Heritage

NSW National Parks and Wildlife Service has advised that there are no known Aboriginal sites recorded within the proposed works area. If any archaeological sites or relics were found during construction then NSW National Parks and Wildlife Service would be contacted immediately for further advice and action.

7.3.13 Landscape and Visual Considerations

The surrounding residential development and relatively steep topography and vegetation pattern of the area provides a localised landscape quality of moderate scenic quality. The ramp construction would increase the built form of the area with increased roadspace and loss of roadside vegetation. All exposed earthworks areas on the ramp embankments would be revegetated with appropriate local native shrubs and ground cover which would improve scenic quality for road users and viewers and help integrate the ramp into the adjacent urban environment. While the embankment would create some unattractive views initially, the revegetation and landscaped embankments would soften this and the construction would partly blend into and become part of the urban landscape over time. Overall the surrounding landscape character would remain largely intact and similar to the existing road corridor except for the greater built form of the ramp intruding in the landscape.

There would be a loss of visual quality for the residents of approximately 14 dwelling units in the area. In particular the residents of 6 nearby dwellings located on Hawkesbury Road, Eucalypt Road and Plana Crescent and near the ramp would have direct views of the ramp and retaining wall and associated traffic including partial headlight glare at night. There would a decline in visual amenity for these affected residents with increased roadspace in the area. The residents of 8 dwelling units located south of the Great Western Highway on Hawkesbury Road and Macquarie Road would have partial and less direct views of the ramp. Over time residents views of the ramp construction would be partially screened as the revegetation and landscaping works matured.

7.3.14 Noise and Vibration Effects

Current Policy

Pending release of the NSW Government guidelines on road traffic noise, the current agreement between the Environment Protection Authority and RTA is that Reviews of Environmental Factors should assess impacts using the traffic noise goals as identified in the EPA's *Environmental Noise Control Manual* or TNL 55[3] depending on the road classification. The EPA's *Environmental Noise Control Manual* is to be used for arterial or main roads such as Hawkesbury Road and the Great Western Highway. TNL 55 applies to limited access roads such as motorways. If mitigation measures are required, then these measures are to be designed to meet the traffic noise goals in the *Environmental Noise Control Manual*. The goal of TNL 55 is not applicable for the proposal. Where the criteria cannot be achieved then the traffic noise control measures should approach this criteria as far as is practicable while taking into account cost effectiveness and the RTA's *Interim Traffic Noise Policy* should be used only as an absolute minimum requirement.

Chapter 157 Environmental Goals of Road Traffic Noise of the EPA's *Environmental Noise Control Manual* considers three types of traffic carrying roads, arterial, non-arterial and intermittent or low traffic flow type roads. The EPA's goals for Arterial Roads is a

[3] *The Environment Protection Authority has been considering the use of a traffic noise descriptor called the Traffic Noise Level (TNL) which is defined as the L_{eq} (24 hours) level plus 10% of the average hourly heavy vehicle volume between 22:00 and 07:00 hours. To date the TNL has not been validated scientifically.*

maximum L_{A10} (18 hours) noise level of 63 dB(A) when measured 1 metre away from a residential facade or any other noise sensitive location.

The RTA's *Interim Traffic Noise Policy* considers two traffic noise descriptor levels:

- daytime L_{Aeq} (24 hours) calculated by taking the logarithmic average of all the L_{Aeq} (1 hour) levels between 00:00 and 24:00 hours, and
- night time L_{Aeq} (8 hours), calculated by taking the logarithmic average of all the L_{Aeq} (1 hour) levels between 22:00 and 06:00 hours.

The RTA's Noise Level Objectives for daytime is 60 dB(A) L_{Aeq} (24 hours) and for night time 55 dB(A) L_{Aeq} (8 hours). The daytime traffic noise descriptor level, L_{Aeq} (24 hours) is approximately equal to the EPA's L_{A10} (18 hours) level. Generally, the L_{Aeq} (24 hours) noise levels are 3.5 dB(A) lower than the L_{A10} (18 hours).

Traffic Noise Assessment

An acoustic and vibration assessment was completed by Koikas Acoustics Pty Ltd for the proposal in accordance with the RTA's *Interim Traffic Noise Policy*, EPA's *Environmental Noise Control Manual* and relevant Australian Standards. A summary of the assessments is provided below and full details are included in Attachment 4. The assessments provide:

- traffic noise measurements at three residential sites (No. 1 and 4 Hawkesbury Road and 8-10 Plana Crescent, Springwood) in October 1996 in the vicinity of the proposed new ramp.
- calculations of predicted L_{eq} (24 hours) noise levels using two scenarios of 2% and 3.5% linear traffic growth per annum along the Great Western Highway.
- a sensitivity analysis based on barriers of different heights. This was to facilitate a cost-benefit analysis for which the RTA would then determine whether traffic noise barriers would be erected to meet the EPA's goals and/or the RTA's noise level objectives for upgrading of existing roads.
- an assessment of construction noise.
- an assessment of ground vibration levels.

Traffic noise levels were calculated using a traffic noise prediction model called the 1988 version of the United Kingdom, Department of Transport, Calculation Of Road Traffic Noise and is the RTA's preferred method of calculation. Table 4 is a summary of the predicted traffic noise level results for No. 1, No. 4 Hawkesbury Road and No. 8-10 Plana Crescent, Springwood with varying barrier heights.

The EPA's Goal of 63 dB(A) L_{10} (18 hours) and the RTA's Noise Level Objective for night time 55 dB(A) L_{eq} (8 hours) would be met provided that the barrier heights for the noise affected residential properties are:

- a 1.0 metre high barrier at 1 Hawkesbury Road placed 5.5 metres from the building's front facade. The extent of this barrier would be required along the full length of the front boundary line and approximately 5 metres along the northern boundary line and 10 metres along the southern boundary line. The reduced level on top of the noise barrier along the northern and southern boundaries should be the same as the western barrier.

- a 1.5 metres high barrier at 4 Hawkesbury Road placed 10 metres from the building's front facade. The extent of this barrier would be required along the periphery of the Hawkesbury Road and Silva Road boundary.
- a 2.5 metres high barrier would be required along the top of the reinforced soil wall of the proposed ramp. It is noted, that the entry ramp would provide some noise relief from highway noise. The height of the parapet on the ramp would need to be raised to 2.5 metres to satisfactorily attenuate ramp traffic noise.

Table 4 Barrier Heights and Noise Attenuation for
No. 1 and No. 4 Hawkesbury Road and No. 8-10 Plana Crescent, Springwood

	Summary of the Measured L_{eq} (24 hours) and the Predicted L_{eq} (24 hours) Traffic Noise Levels in [dB(A)] Based on 2% Linear Traffic Growth to 2007		
Assessment Site	**1 Hawkesbury Road**	**4 Hawkesbury Road**	**8-10 Plana Crescent** (Note 1)
Measured 1996	62	65	61
Predicted 1997	62	65	61
Predicted 2007	63	66	65
Traffic Noise Increase (Note 2)	1	1	4
Barrier 1.0 metre, 2007	60	63	62
Barrier 1.5 metre, 2007	58	59	59
Barrier 2.0 metre, 2007	56	55	58
Barrier 2.5 metre, 2007	54	52	56
Barrier 3.0 metre, 2007	53	51	55

Note 1 The calculated Leq (24 hours) traffic noise level at 8-10 Plana Crescent was determined by subtracting 3 dB(A) from the measured/calculated L10 (18 hours) level of 64 dB(A). It has been found from experience, that for highway conditions, the difference between the L10 (18 hours) and the Leq (24 hours) is approximately 3 dB(A).

Note 2 Traffic noise increase between the year 1997 (before road construction begins) and the year 2007 (10 years after the completion of construction).

If the proposal is assessed in accordance with the EPA's Goal and the RTA's Noise Level Objectives then mitigation measures would be warranted provided they are cost effective and practical given the need for property access.

Construction Noise Assessment

Construction noise can cause a variety of problems for residents, such as interference with speech communication, disturbance of work or leisure, disturbance of sleep and possible effects of physical and mental health. The level of disturbance depends on the following:

- the difference between the intrusive nature of the noise source and the existing background noise level;
- the distance between the noise source to the receiver;
- the duration of the noise; and
- the nature of the noise.

The EPA recognise that construction and demolition operations are typically noisy. However, if these activities are of short duration, exceeding noise levels is accepted provided the adjustments to measured values are met. The EPA criteria for construction noise are as follows:

- for a construction period of 4 weeks or less, the L_{10} (20 minutes) noise level must not exceed the background noise level during the scheduled daytime hours by more than 20 dB(A);
- for a construction period of between 4 and 26 weeks, the L_{10} (20 minutes) level must not be exceeded by more than 10 dB(A); and
- for a construction period of greater than 26 weeks, the L_{10} (20 minutes) levels must not be exceeded by more than 5 dB(A).

These criteria are rarely met as in most cases the character of noise emitted from various plant and equipment during construction activities cannot always be shielded by practical means. The maximum permissible construction noise level for the site is 55 dB(A). The use of jackhammers, vibratory rollers and other noisy equipment would be about 10 to 12 metres from 1 Hawkesbury Road and 8-10 Plana Crescent. The loudest construction noise level is expected to occur from jackhammers. At these sites noise levels are expected to be about 100 dB(A). In terms of L_{10} (15 to 20 minutes) levels, that is, the noise that is exceeded for 10 % of the measurement period, noise levels are expected to be about 90 dB(A) with no corrections to facade reflections added.

It is likely that some construction activities would exceed the background levels by more than 20 dB(A). It would be required that a noise barrier at least 1 metre higher than the exhaust stack of any earth moving plant be erected along the property boundary lines prior to the roadworks to ensure the EPA criteria for construction noise is not exceeded. For those instances where noisy plant and equipment are used it is recommended that they be operated during specific daytime periods corresponding to the highest background noise level period. Also, it is recommended that residents are warned in advance of noisy construction periods so that they can plan their daily work and leisure periods accordingly.

For periods where construction noise activities are likely to take more than 28 days, temporary barriers should be erected as close as practically possible to the earth moving plant and stationary equipment. Barriers heights should be at least 1 metre above the exhaust stack of such plant and be constructed from solid materials capable of attenuating noise levels by at least 20 dB(A) at frequencies in the 125 Hertz 1/1 octave band. It is noted however, that for some noisy activities, construction noise level limits would not be met as the barriers would only practically attenuate noise by up to 20 dB(A).

Vibration Assessment

In the absence of Australian Standards, British Standard 6472 provides guidance on potential disturbance to persons exposed to building vibration in the frequency range of 8 to 80 Hertz, most applicable to excavation equipment and road traffic. In dwellings, adverse comment may arise during day time as a result of continuous floor vibration levels in the order of 0.3 to 0.6 mm/second. At night time the residential criterion is equivalent to a vertical peak vibration level of 0.2 mm/second. However, significantly higher levels of short term vibration can be tolerated by many people for construction projects.

German Standard DIN 4150-Part 3 1986 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The minimum "safe limit" of peak vibration velocity at low frequencies for dwellings is 5 mm/second. Over the frequency range typical vibration in buildings from excavation and construction equipment, the threshold for visible movement of susceptible building contents (for example, plants and hanging pictures) is approximately 0.5 mm/second.

The potential sources of ground vibration for construction of the ramp are vibratory rollers and jackhammers. The vibration levels from operation of construction plant and equipment should be limited to the levels set out in British Standard 6472 which would be consistent with recommended guidelines set out in Chapter 174 of the Environment Protection Authority's *Environmental Noise Control Manual.*

It is not expected that construction activities would exceed ground vibration level limits. This is primarily due to the relatively large distance between plant and equipment proposed for use to most residential dwellings. It is recommended that vibration monitoring be undertaken inside residential dwellings, before and during construction work, especially if the earth material required to be broken is hard rock or there is earth compaction activities undertaken with the use of vibratory rollers.

All other construction activities except that from vibratory rollers are unlikely to exceed the human thresholds of discomfort and thus not affect any residential dwelling from structural damage. Based on German Standard DIN 4150-Part 3 1986 structural damage would occur when vibration levels are likely to be about 10 times higher than the human threshold of discomfort. It is noted that most old homes over a period of time build up structural stresses. These structural stresses can be released by road construction activities in the form of hair-line cracks which are formed along concrete render, plasterboard cornices and ceilings. These hair-line cracks also appear when large temperature gradients exist between indoors and outdoors. Nevertheless, hair-line cracks do not reduce the structural integrity and thus do not give rise to structural damage. Typical vibration levels are included in Table 5.

Table 5 Typical Vibration Levels

Description of Construction Activities	**Vibration Levels [mm/s]**	**Distance [m]**
Heavy trucks passing over normal road surface, measured at the footings of building	0.01 to 0.2	10 to 20
Bulldozers operating 5 metres from the dwelling	1.0 to 2.0	5
Vibratory roller (25 Hertz, Low)	0.6 to 2	20 to 30

Levels of ground vibration caused by a 1 to 2 tonne vibratory roller 5 metres from a dwelling is not likely to exceed the maximum recommended structural damage criterion level. It is recommended however, that static load for such rollers be employed in order to minimise the release of hair-line cracks.

7.4 Cumulative Environmental Impacts

The cumulative impacts of the proposal would be beneficial in the long term with enhanced accessibility to the Great Western Highway, lower Blue Mountains and Sydney metropolitan area; and improved safety and better traffic flow for pedestrians and motorists along Hawkesbury Road. Since economic development in the Blue Mountains and metropolitan area would progress regardless of the construction of the proposal the cumulative impact for the proposal would be relatively minor. However, the proposal together with other nearby road improvements on the Great Western Highway at Faulconbridge, Valley Heights and Warrimoo would contribute towards the enhancement of the road network in the lower Blue Mountains. In addition the assessed bio-physical impact of the proposal is limited since most of the proposal is through ecologically degraded urban land and existing roadspace.

Cumulative impacts of the proposal include:

- enhanced accessibility to the lower Blue Mountains and western Sydney.
- improved traffic flow, safety and level of service along Hawkesbury Road.
- increased traffic on the ramp.
- reduced traffic flows along Silva Road and George Street.
- visual impact of the ramp and loss of some mature native trees.
- traffic noise impact of the ramp.
- improved safety for pedestrians, cyclists and motorists.
- reduced accidents, travel times and vehicle operating costs.

Based on the concept design and provided the safeguards are implemented it is considered that the cumulative environmental impacts of the proposal are generally positive.

8. Implementation Stage

8.1 Summary of Proposed Safeguards

There would be some short term, localised and adverse impacts particularly during construction requiring safeguards. Any adverse impacts of constructing the proposal would be outweighed by the long term beneficial effects of the proposal. In summary the safeguards that would be implemented for the proposal are listed below and would be included in an Environmental Management Plan[4].

◊ Inconvenience to Great Western Highway travellers and nearby Springwood residential and commercial communities would be minimised through best construction and traffic management practices.

◊ Use of current and best available design criteria to ensure the proposal is correctly constructed, maintained and operated with adequate safety and capacity to meet all reasonable traffic needs for the next 30 years.

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[4]*An Environmental Management Plan is a document prepared to ensure that all environmental requirements of a project arising from environmental impact assessments by the Review of Environmental Factors and Decision Report, RTA policies and all relevant legislative requirements are implemented during development of the project.*

◊ Implementation of environmental protection requirements of the RTA's Contract Manual and guidelines which includes the following model specifications as a minimum:

Part R1	Control of Erosion and Sedimentation
Part R2	Temporary Erosion and Sedimentation Control
Part R5	Stormwater Drainage - General
Part R13	Drainage Structures
Part R17	Clearing and Grubbing
Part R20	Earthworks (cut, fill, imported fill and imported selected material)
Part R24	Stabilisation of Earthworks
Part R80	Vegetation
Part G5.1.1	Requirements of Environmental Assessment
Part G5.1.2	Licences
Part G5.2.1	Legislation
Part G5.2.2	General
Part G5.2.3	Prevention of Nuisances
Part G5.2.4	Fire Precautions
Part G5.2.5	Herbicides and Other Toxic Chemicals
Part G5.2.6	Emergency Spillage Procedures.

◊ An architectural survey will be carried out at appropriate residences before construction commences.

◊ A safety audit of the proposal would be completed before commissioning of the proposal and any findings implemented prior to opening of the ramp.

◊ Traffic during construction would be managed in accordance with the requirements of Australian Standard 1742.3 - 1996 *Manual of Uniform Traffic Control Devices Part 3: Traffic Control Devices for Works on Roads.*

◊ Two lanes on Hawkesbury Road would be available for traffic at all times except the southbound traffic lane may be closed in off-peak hours to enable essential work to be carried out in safety.

◊ Traffic arrangements during construction would be subject to RTA approval.

◊ Disruption of access to properties would be minimised. Prior arrangement with affected owners in the event of any short term disruption.

◊ Maintenance of the Silva Road and Hawkesbury Road intersection near the construction area in a clean and tidy state at all times.

◊ Regular road sweeping of Silva Road and the Hawkesbury Road intersection area to ensure a clean and safe pavement.

◊ Sedimentation potential from construction works requiring installation of selected temporary sedimentation controls (for example, catch drains, diversion drains and banks, sedimentation basins, geofabric silt fences at the base of all earth works, geofabric covered hay or straw bales secured around all storm water inlets and soil stabilisation measures) along the construction areas and to be documented in an erosion and sediment control plan. The plan would detail surface water control, storm water drainage, revegetation and erosion sediment control measures required during construction to minimise sedimentation impacts.

◊ Regular monitoring and maintenance of the sedimentation controls to ensure they perform in a fully functioning condition at all times.

- ◊ Sediments and pollutants would be removed from temporary sedimentation basins on a regular basis and the contents disposed of in accordance with the requirements of the Environment Protection Authority.
- ◊ The construction compound may be located within the road reserve between Plana Crescent and the proposed ramp or at vacant land owned by the RTA adjacent to the proposed ramp.
- ◊ The construction compound would be security fenced and include amenities sheds, portable toilets, plant and equipment storage areas.
- ◊ Directional and hooded lighting would be used in the construction compound to avoid light spillage on residential areas.
- ◊ The construction compound would be screened to minimise impact on neighbours.
- ◊ On-site domestic waste and sullage facilities would be provided at the construction compound.
- ◊ A temporary earth bund would encompass any area where washing out of trucks or containers may occur. This area would be regraded to match surrounding landform and revegetated at completion of construction.
- ◊ No blasting would be permitted during construction.
- ◊ Any material stockpiles would be located within the road reserve between Plana Crescent and the ramp and protected from possible erosion.
- ◊ Exposed earthworks areas would be stabilised as quickly as possible.
- ◊ Materials transported in trucks travelling on public roads would be covered.
- ◊ Tailgates of all vehicles transporting materials would be securely fixed, sealed and loads covered.
- ◊ No contaminated material would be used in any earthworks regularly.
- ◊ Construction work would be regularly monitored and a dedicated water cart would suppress dust as required.
- ◊ Any excavated or excess pavement material and concrete would be incorporated in the earthworks for the ramps approaches as a first priority or transported off-site for recycling.
- ◊ No burning or burying of wastes permitted on-site.
- ◊ Disposal of all non-recyclable waste at legally operating waste disposal sites.
- ◊ All internal combustion motors would not be permitted to emit continuous visible smoke for greater than 10 seconds on public lands.
- ◊ Heavy duty vibratory rollers would not be permitted to operate within 30 metres of any dwelling.
- ◊ The number of trees to be removed would be the minimum necessary for the safe excavation and construction operations.
- ◊ Any suitable vegetation would be provided to community groups as firewood as a first priority and then disposed of at a nearby legally operating tip site.
- ◊ Trees with limbs overhanging the Great Western Highway would not be removed unless absolutely necessary for safety reasons. Any overhanging limbs would be cut back where possible.
- ◊ The vegetation, leaf litter and soil cleared for the construction works would not be used in the revegetation of the disturbed areas.

◊ The RTA would investigate the possibility of assisting the current weed clearing efforts downslope of the road reserve by clearing the project area of weeds. This could be accomplished by relatively 'heavy-handed' methods such as a small bulldozer blade.
◊ The boundary of the area to be cleared and the bushland to be retained would be clearly delineated and fenced by 'Paraweb' or similar fencing to prevent workers and machinery from entering the bushland that is not to be disturbed.
◊ Exposed earthworks construction areas would be progressively revegetated with native species as soon as possible following completion of stages of construction.
◊ Revegetated areas would be maintained for at least 12 months following completion of construction.
◊ Utilities and infrastructure would be relocated as required by the providers.
◊ Maintenance of construction equipment to meet Environment Protection Authority requirements.
◊ No vehicle maintenance permitted outside the construction compound except in emergencies.
◊ Construction hours would generally be from 7 am to 6 pm Monday to Friday and 7 am to 1 pm Saturday excluding Sundays and public holidays unless otherwise approved by the RTA and the Environment Protection Authority where required.
◊ From 7 am to 8 am on Saturdays only inaudible construction work would be permitted.
◊ Any night work would follow the existing procedure used by the RTA Sydney Region and endorsed by the Environment Protection Authority with regard to night time road works noise.
◊ Mufflers would be fitted to all construction plant and equipment to meet Environment Protection Authority requirements.
◊ Heavy vehicle traffic generation during construction being confined to Silva Road, Hawkesbury Road, Great Western Highway and other main roads wherever possible.
◊ Transport of concrete and asphaltic concrete from legally operating established batching plants located near the proposal.
◊ No batching plant would be permitted on-site.
◊ Cleaning out of batched concrete mixing plant at approved areas within the road reserve for drying out and incorporation in the earthworks.
◊ The RTA would check with public organisations and utility providers with a potential interest in the proposal for any relevant and reasonable issues that need addressing during the detailed design development prior to construction.
◊ Construction 'hold points' would be enforced where irreversible environmental damage may occur; relics, Aboriginal sites or contaminated material were encountered.
◊ If any Aboriginal archaeological sites or artefacts were found during construction then work would cease immediately in the vicinity and the NSW National Parks and Wildlife Service would be contacted promptly for further advice and action.
◊ If relics were unearthed during construction then the Heritage Council of NSW would be contacted for advice and/or a permit to remove or destroy the item.
◊ Construction noise to be limited to Environment Protection Authority requirements.
◊ Noisy construction plant and equipment (eg. use of rock breakers) would only be used during specific day time periods corresponding to the highest background noise levels from 1 pm to 4 pm.

- For periods where noise activities are likely to take a long period of time, temporary barriers should be erected as close as practically possible to the earth moving plant prior to the roadworks commencing. Barriers should be at least 1 metre above the exhaust stack of such plant. Barriers should be constructed from solid materials capable of attenuating noise levels by 20 dB(A) at frequencies in the 125 Hertz 1/1 octave band.
- Nearby residents would be warned in advance of noisy construction periods.
- The contractor would use the best available techniques not entailing excessive cost with the L_{10} level measured at residential buildings in Silva Road and Plana Crescent not to exceed 5 dBA above background noise levels.
- Further assessment of whether any recommended noise attenuation measures are cost effective and practical.
- Meeting the requirements of all relevant legislation relating to air quality, water quality and noise.
- Obtaining all approvals and licences needed to construct the proposal including any air, noise and water pollution approvals and licences from the Environment Protection Authority.
- Informing nearby residents by letter box drop of the proposal before construction commences.
- Rehabilitation of Silva Road, Hawkesbury Road and Plana Crescent to at least the condition existing prior to commencement of construction in consultation with Blue Mountains City Council.
- Consulting with nearby residents of Hawkesbury Road, Silva Road and Plana Crescent to advise of any night time construction work at least three days in advance.
- Informing the Environment Protection Authority's Hotline on 131 555 with advice of any night construction works and the name of the project or site manager to contact in an emergency.
- Implementation of procedures for monitoring community comments and taking appropriate actions.
- The RTA would obtain agreement with the Blue Mountains City Council concerning on-going maintenance of vegetated areas.
- Any land identified as surplus would be rationalised at the end of the project.
- Incorporation of all the safeguards in an Environmental Management Plan to be prepared by the contractor before construction commences to minimise adverse environmental impacts. The Environmental Management Plan would include provision for hold points where environmental damage may occur, regular reports and audits on the environmental management of the project, details of nonconformances, verification activities and emergency responses.

The above list of safeguards is a minimum for implementation and may not be exhaustive and change as a result of public authorities requirements, changes in legislation, community consultation and detailed design development.

8.2 Implementation Process

The safeguards include all measures that might reasonably be taken to minimise adverse environmental impacts. The safeguards for construction and operation of the proposal would be implemented and monitored to minimise adverse environmental impacts. Construction 'hold points' would be enforced where irreversible environmental damage may occur; relics or Aboriginal sites were exposed; or contaminated material was encountered.

The successful tenderer(s) for the construction of the proposal would be required as part of the contract to meet the specifications and safeguards detailed in this Review of Environmental Factors. The safeguards include all measures that might reasonably be taken to minimise adverse environmental impacts during construction and operations of the proposal. Specifically all activities must comply with the environmental provisions set out in this Review of Environmental Factors and Assessment Report for the proposal and project specifications. The collective safeguards would be included in an Environmental Management Plan to be prepared by the contractor for acceptance by the RTA before construction commences for implementation and monitoring. In addition, all activities carried out on site must comply with the relevant provisions of all legislation including regulations relating to construction, operations and maintenance of the project.

SECTION C - FINALISATION

9. Summary of Key Issues

9.1 Major Beneficial Effects

The major beneficial effects of the Hawkesbury Road ramp construction would be enhanced accessibility to the Great Western Highway, lower Blue Mountains, and the Sydney metropolitan area; and improved safety and better traffic flow for pedestrians and motorists along Hawkesbury Road. Other beneficial effects of the proposal include:

- improved local amenity by eliminating most through traffic from Silva Road and George Street.
- reduced traffic impacts on the local road network by focussing eastbound traffic onto the ramp and directly onto the major strategic route.
- contributes to the segregation of traffic flows related to the road hierarchy.
- improved traffic efficiency for regional and through traffic.
- provides new infrastructure at a satisfactory Level of Service for forecast traffic volumes.
- reduced travel times and vehicle operating costs.
- reduced conflicting traffic movements through traffic segregation.
- improved safety for pedestrians and cyclists.
- provides some attenuation for noise generated by vehicles along the ramp.
- reduced accidents at the Hawkesbury Road and Silva Road intersection by minimising right turn conflicts.
- provides a safer eastbound entry onto the Great Western Highway with a conventional ramp merge. Currently motorists do not use the existing ramp efficiently or safely.
- ramp attenuates noise from the Great Western Highway to residents of Plana Crescent.
- improved access for Eucalypt Road and Plana Crescent.
- relocation of traffic onto the ramp which would be directed away from the residential area of Silva Road.

9.2 Major Adverse Effects

The major adverse effects of the proposal include possible delays to pedestrians and motorists along Hawkesbury Road during construction and removal of large native trees and other vegetation from the Great Western Highway road reserve. Local residents would also have increased levels of noise, dusts, vibration, traffic generation and general disruption to daily activities during construction. Some minor property acquisition would be required. There would be also a medium term loss of visual amenity and privacy for some nearby residents until revegetated areas matured. Other adverse effects of the proposal include:

- delays to traffic during construction.
- additional road surface, signs and markings to maintain.
- visual impact of the ramp and parapet for nearby residents.
- relocation of traffic onto the ramp which would be closer to the residential area of Plana Crescent.

9.3 Characteristics

The characteristics of the proposal would be similar to the existing access via George Street to the Great Western Highway but with increased length, safety and capacity. The construction would be a ramp structure of modern design and appearance. The reinforced soil wall and parapet would provide a marked visual impact. The interactions between the proposal and the affected roadside environment would be localised except for Hawkesbury Road travellers inconvenienced during construction.

9.4 The Extent of the Impacts

The impacts during construction would be medium-term over a 12 to 15 month period, adverse and localised except for the inconvenience caused to Hawkesbury Road travellers. The main construction impacts include construction noise and vibration, dusts under windy conditions, minor loss of introduced and native vegetation, disruption to traffic and traffic generation. The extent of the positive impacts during operations would be long-term, beneficial and cumulative on a regional scale and include improved accessibility to the lower Blue Mountains and the Sydney metropolitan area, improved safety, better traffic flow and level of service along Hawkesbury Road. It is considered the long-term local and regional benefits of the proposal outweigh the medium-term localised and acceptable environmental impacts, provided the safeguards are implemented.

9.5 The Nature of the Impacts

Based on construction experience of similar ramp projects the level of confidence in the prediction of environmental impacts is relatively high. It is anticipated that the affected environment would have the resilience to cope with the predicted environmental impacts. With the safeguards implemented during construction it is considered the environmental impacts are manageable although irreversible.

Construction and operations of the proposal would comply with all relevant standards, plans, policies and legislation. The extent of public interest in the proposal is likely to be moderate to high due to the extent of community interest already expressed and the number of Hawkesbury Road and Great Western Highway travellers. The environmental impacts are likely to be acceptable to the public with implementation of the safeguards.

10. Consideration of Clause 82 Checklist

In assessing the impact of the proposal for the purposes of Part 5 of the *Environmental Planning and Assessment Act* the following Clause 82 factors for consideration of likely impact of an activity on the environment are summarised.

(a) any environmental impact on a community;

There would be minor adverse environmental impacts on the surrounding Springwood residential and commercial communities during construction and operation of the proposal.

(b) any transformation of a locality;

There would be a long term transformation of approximately 0.4 hectares of vegetated embankment and road reserve to ramp and pavement area and approaches which would change the views and appearance in the area of the proposal.

(c) any environmental impact on the ecosystems of the locality;

There would be minor environmental impact on local ecosystems due to the modified nature and managed land uses in the locality.

(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality;

There would be no known reduction in the recreational, scientific or other environmental quality or value of the locality due to the proposal. There would be a minor reduction in the aesthetic quality of the locality with construction of the ramp and approaches replacing vegetated areas.

(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations;

There would be no known adverse impacts on a locality, place or building of significance for present or future generations.

(f) any impact on the habitat of any protected or endangered fauna (within the meaning of the National Parks and Wildlife Act 1974);

With respect to the above Act and Section 5A of the *Environmental Planning and Assessment Act, 1979*, there would be no threat to any protected or endangered fauna, given the modified nature of the locality.

(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air;

No known endangering of any species as a consequence of the proposal is anticipated.

(h) any long-term effects on the environment;

There would be no long term effects on the environment apart from the visual impact of the ramp.

(i) any degradation of the quality of the environment;

No degradation of the quality of the environment would occur except for some loss in acoustic and visual amenity for residents and visitors to the nearby residential areas due to construction and operations of the ramp and increased traffic flows.

(j) any risk to the safety of the environment;

There would be increased risks to the safety of the environment during construction associated with increased potential for traffic accidents along the Hawkesbury Road and Silva Road intersection. Appropriate construction and traffic management safeguards would be implemented to minimise these risks.

(k) any reduction in the range of beneficial uses of the environment;

There would be no change to any beneficial use of the environment apart from the 0.4 hectares of vegetated road reserve changing to road works area.

(l) any pollution of the environment;

No additional pollution would be generated by the proposal except for increased air and noise emissions from increased traffic flows along Hawkesbury Road in future.

(m) any environmental problems associated with the disposal of waste;

All generated wastes except introduced vegetation would be recycled as a first priority, otherwise contained and removed from the construction site for safe disposal at a legally operating tip site according to statutory requirements. Any contaminated material would be disposed of according to Environment Protection Authority requirements. No environmental problems are anticipated with the disposal of waste.

(n) any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply;

No extraordinary demands would be made on the use of resources which are, or are likely to become in short supply.

(o) any cumulative environmental effect with other existing or likely future activities;

The cumulative environmental effects of the proposal together with the construction of other proposed road improvements along the Great Western Highway in the lower Blue Mountains would positively contribute towards the development of the road network in the Blue Mountains area.

11. Declarations

This Review of Environmental Factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Signed : B. R. Adcock Date 29th November 1996.

Environmental Planning Pty Ltd

Signed : [signature] Date: 29 November 1996.

Project Manager,
Sydney Operations Directorate
Roads and Traffic Authority.

ATTACHMENT 1

Summary of Past Community Consultation

Community Concerns

The Community Concerns raised in the "Have Your Say" responses have been grouped and assessed into economic, traffic, environmental and other areas. Responses to the issues are conditional upon a satisfactory determination by the RTA to proceed with the proposal.

Economic

Construction Timetable

Issues:

- No specific starting time given.

Response:

The timing of the proposal depends on the environmental assessment, the scope of work, the cost of the project and the availability of funds. The scope of the work would be determined during the detail concept development which would take into account the recently received community concerns and suggestions. This issue would need to be addressed by the RTA in it's future Development Program.

Property Effect

Issues:

- Adjoining properties will lose value.

Response:

Improvements to the road network and traffic flow would lead to an enhancement of the local amenity, with likely positive impact on property values following completion of the projects. Owners of properties affected by the ramp and approach roadways would be compensated having regard to the market value of the property as if it was unaffected by the road proposal under the *Just Terms Compensation Act*.

Traffic

Proposed Ramp

Issues:

- Close proximity of two merges.
- Length of safe merge.
- Provision for pedestrians across entry.
- Provision for cyclists.
- Close proximity to existing merge from George Street.

Response:

These issues would be investigated and assessed at the concept development stage.

Access westbound from the Highway to the Winmalee Area

Issues:

- Lengthy delays at the Macquarie Road Hawkesbury Road roundabout.
- Congestion at Springwood Shopping Centre.

- Residential growth in the Winmalee area, eg St Columba's development.
- Reinstate right turn from Highway to George Street.

Response:
These issues were addressed in the Springwood Traffic Study.

Hawkesbury Road/Silva Road Intersection
Issues:

- Traffic congestion.
- Lengthy delays turning right from Silva Road.
- Traffic calming.
- Pedestrians.

Response:
A traffic analysis would be undertaken during the concept development of the project to assess the most suitable traffic facility taking into account the community concerns and suggestions and issues raised in the Springwood Traffic Study.

Eucalypt Road
Issues:

- Access.

Response:
Difficulties with respect to access would be investigated and assessed at the concept development stage.

Plana Crescent
Issues:

- Access.

Response:
Difficulties with respect to access would be investigated and assessed at the concept development stage.

Increase in Traffic
Issues:

- Ongoing residential development along Hawkesbury Road to the north.

Response:
Development approvals are a matter for Blue Mountains City Council. However as development takes place the RTA assesses the impact of each development and provides advice to Council.

Environmental
Air and Noise Pollution
Issues:

- Increase in air and noise pollution adjacent to ramp.

Response:
Issues would be considered in the concept development and environmental assessment stages.

Deanei Forest
Issues:
- Loss of *Eucalyptus deanei* (Mountain Blue Gums).
- Loss of Bellbirds.

Response:
Effect on the forest would be addressed in the environmental impact assessment. The RTA would investigate ways of reducing any impact for the existing flora and fauna by for example using vertical retaining walls.

Other
Great Western Highway - Valley Heights to Warrimoo
Issues:
- Section of Highway is a bottleneck.
- Four lanes required now.

Response:
The Valley Heights to Blaxland widening project has commenced.

Need for new route from Winmalee to the east
Issues:
- Rapid residential expansion of the area.

Response:
A major review would be required to investigate any new route down the mountain; the current financial restrictions preclude this investigation; and it would appear to be a local issue which needs involvement of Blue Mountains City Council.

Traffic Management of Springwood Area
Issues:
- Defer ramp project until completion of Springwood Traffic Study.

Response:
This project has been included in the Springwood Traffic Study and any further traffic assessment will include outcomes from that study.

Community Suggestions
The community suggestions received in the "Have Your Say" responses have been grouped and assessed under economic/extension to scope of work and concept development groups. Responses to the issues are conditional upon a satisfactory environmental assessment being undertaken and a determination by the RTA to proceed with the project.

Economic/Extension to Scope of Work
- Extend the ramp as third lane eastbound on Highway as far as possible.
- Provide access from westbound on the Highway to Hawkesbury Road via a ramp.
- Reinstate the right turn westbound from the Highway to George Street and signalise.
- Upgrade Macquarie Road.
- Provide roundabout/traffic signals at Hawkesbury Road and Silva Road intersection.
- Provide right turn only out of George Street eliminating existing merge on the Highway.

- Redirect right turn traffic out of George Street to the Highway westbound via Hawkesbury Road and Macquarie Street.

Response:
A traffic analysis would be undertaken during the concept development for the project to assess the most suitable solution.

Concept Development

Hawkesbury Road/Silva Road Intersection

- Roundabout
- Signals
- Pedestrians.

Response:
A traffic analysis would be undertaken during the concept development of the project to assess the most suitable traffic facility.

Access to Eucalypt Road and Plana Crescent

- Access difficulties

Response:
Difficulties with respect to access will be investigated and assessed at the concept development stage.

Length of Ramp Merge

- Merge length as long as possible.
- Ramp to form third lane of Highway.

Response:
Investigation would be undertaken at the concept development stage to determine a safe merge length together with community concerns and suggestions.

Access Westbound from the Highway to the Winmalee Area

- Ramp from the Highway to Hawkesbury Road.
- Reinstate right turn from Highway into George Street.
- Upgrade Macquarie Road, including Hawkesbury Road roundabout.

Response:
A traffic analysis during the concept development for the project to assess the most suitable solution together with community concerns and suggestions as well as outcomes from the Springwood Traffic Study.

Access to Property on Highway 300m East of Hawkesbury Road

Response:
Access will be investigated and resolved at the concept development.

Submissions from Community Groups

The following is a summary of submissions from community groups.

Springwood Winmalee Action Group Inc.

1. The Group feels that the eastbound ramp is but a single issue in a complex situation in Springwood.

2. The Group suggests;
a. That a westbound entry ramp be constructed in conjunction with the eastbound entry ramp however this alone still does not address the return journey.
b. That an overall plan for an ultimate solution to the problems in the area be prioritised.

Response:

That outcomes from the Springwood Traffic Study together with community concerns and suggestions would be assessed jointly.

Blue Mountains Commuter and Transport Users Association

1. The Association agrees that the ramp would be an advantage.
2. The Association is concerned that more commuters will make use of the Car Park at Valley Heights, thus raising the problem of more people crossing the Highway where a problem already exists.
3. The Association suggests that pedestrian lights or an overbridge be installed at Valley Heights.

Response:

The concerns and suggestions at Valley Heights are being investigated separately.

City Rail

1. City Rail feels that the proposal is likely to change the pattern of their commuters from Winmalee who would now see Valley Heights Station as a more convenient interchange location than Springwood. This would have implications regarding safe access for pedestrians across the Highway together with safe exiting from the car park onto the Highway for the return trip to Winmalee.

Response:

The concerns and suggestions at Valley Heights are being investigated separately.

ATTACHMENT 2

Flora Impact Assessment
November 1996, Lesryk Environmental Consultants.

1. INTRODUCTION

This report provides an assessment of the flora occurring on the road batter slope and gully bushland below the Great Western Highway at Springwood NSW. The location of the study area is shown in Figure 1 in the REF, while the survey area boundaries are within 50 metres of the road reserve.

The RTA proposes to construct an entry ramp from Hawkesbury Road to the eastbound carriageway of the Great Western Highway. This would require the removal of an area of vegetation on the northern side of the road. A vertical concrete panel wall (reinforced earth wall) would be constructed to contain the fill for the entry ramp earthworks and to minimise the extent of the clearing necessary.

The aims of the flora survey were to:
- Identify plant communities within the survey area.
- Identify plant species occurring within the survey area.
- Identify the conservation significance of plant communities and species identified.
- Identify the likely impact of the proposal on the vegetation, including communities and species of conservation significance.
- Recommend measures which could be implemented to reduce the likely impacts on uncommon and rare species, and on the vegetation generally to ensure the long-term conservation of the bushland resources on the site.

2. ENVIRONMENTAL SETTING

The site occurs at the head of a gully on the northern slopes of a broad east-west trending ridge in the Blue Mountains. The landforms of the area have been greatly modified by infilling for the construction of the Great Western Highway, Hawkesbury Road and to a lesser extent, for residential developments. The highway crosses a natural gully at the site and a steep vegetated batter slope (approximately 20 degree drops to the natural ground level. Older (road?) earthworks with sandstone block retaining walls occur at the bottom of the existing batter. Natural slope gradients in the gully below the batter are around 8 to 12 degrees.

The site has a general north-easterly aspect. Elevation is approximately 450 metres AHD. Average annual rainfall in the area is 1050 mm.

The existing batter slope and the road reserve area below the batter are densely covered by weed vegetation with only emergent trees and large shrubs remaining of the native vegetation cover. Dense weed cover also extends for some distance beyond the road reserve boundary but weeds have been recently cleared from this area and native species are beginning to regenerate. The natural vegetation communities that once would have covered the area has been greatly modified and as mentioned, only trees and large shrubs remain on the face and foot of the batter slope.

The geology of the area is Hawkesbury Sandstone consisting of medium to coarse-grained quartz sandstone with minor shale and laminite lenses. The soils developed on the sandstone are earthy sands and yellow earths on the top of the ridge and on the upper slopes (Bannerman and Hazelton 1990). These soils have a generally very low fertility and have a high water permeability (Bannerman and Hazelton 1990).

3. METHODS

Previous general flora references of the region were searched for descriptions of similar vegetation types and for recordings of plant species of national or regional conservation significance. The main references used were *The Natural Vegetation of the Penrith 1:100,000 Map Sheet* (Benson 1992) and *The Natural Vegetation of the Katoomba 1:100,000 Map Sheet* (Keith and Benson 1988). The NPWS database of Rare Or Threatened Australian Plants (ROTAP) was also searched for previous recordings of plant species of conservation significance within the area.

A general botanical survey was carried out by John Speight on 1 November 1996. All vegetation stands occurring within the area of the proposed works and for approximately 50 metres downslope of the area of direct impact were searched on foot. The gardens of the residence to be partly acquired for the proposal were not specifically searched but observations from the access road to the property and the highway indicated that only horticultural plantings occurred in the area to be acquired.

The vegetation is described with reference to classifications made by Benson (1992). Plant identifications were made according to nomenclature in *Flora of New South Wales* (Harden 1990, 1991, 1992 and 1993). The conservation significance of the plant species and communities was determined with reference to the *Threatened Species Conservation Act 1995* and *Rare Or Threatened Australian Plants* (Briggs and Leigh 1996).

4. RESULTS

4.1 Plant Communities

The vegetation to be affected by the proposed works is dominated by weed species, except for a small stand of native vegetation along the Great Western Highway below the Hawkesbury, Road overpass. All other areas are heavily infested with weeds. However based on the species present two native vegetation communities can be identified within and adjacent to the proposed construction site. These broadly correspond to the vegetation units described by Benson (1992) as:

Map Unit 10ag Sydney Sandstone Gully Forest, sub-unit (i) Tall open-forest, and

Map Unit 10ar Sydney Sandstone Ridgetop Woodland, sub-unit (ii) Open-forest/woodland.

The Sydney Sandstone Gully Forest and the Sydney Sandstone Ridgetop Woodland comprise the Sydney Sandstone Complex of vegetation (Benson 1992). This is the most extensive remaining vegetation complex in the Sydney region and is well conserved in the nearby Blue Mountains National Park and Kanagra-Boyd National Park, Ku-ring-gai Chase National Park, Royal National Park and several other national parks in the Sydney region.

Benson (1992) maps the vegetation of the site and the surrounding area generally as 'C' Cleared Land. The vegetation on the batter slope is regrowth vegetation. A small area of remnant vegetation occurs on the top of the cutting below Hawkesbury Road on the highway. Adjacent areas are mapped by Benson (1992) as 10ar Sydney Sandstone Ridgetop Woodland which occurs on plateaus and ridges, and 10ag Sydney Sandstone Gully Forest which occurs on sheltered hillsides and gullies. Considerable local structural and floristic variation occurs within and between these two broad sub-units of the Sydney Sandstone Complex.

The extensive area beyond the road reserve that has been cleared of weed vegetation appears to be a continuing operation. In this area native shrub and groundcover species that are not found in the uncleared areas are regenerating. It is likely that propagules of these species also occur in the area to be directly affected by the works.

Community A: Tall open-forest: *Eucalyptus deanei; Syncarpia glomulifera.*

Occurrence:
This community occurs immediately below the road embankment and continues down the gully. Several individuals of Round-leaved Gum *Eucalyptus deanei* and the small tree/large shrub Black Wattle *Acacia mearnsii*, and the shrub Sydney Golden Wattle *Acacia longifolia* var. *longifolia* also occur on the batter slope.

Structure:
Trees to 30 metres high with a medium density canopy. The small tree and shrub layer is almost completely dominated by weed species, mainly Large-leaved Privet *Ligustrum lucidum*, Small-leaved Privet *Lucidum sinense*, and Lantana *Lantana camara*. The shrub layer height varies with species composition between 2 and 10 metres. Groundcover is composed almost entirely of Wandering Jew *Tradescantia albiflora* and Privet seedlings due to the heavy shading caused by the thick shrub layer, except in the more open areas where exotic grass species dominate.

Native Species:
Trees:
Round-leaved Gum *Eucalyptus deanei,* and Turpentine *Syncarpia glomulifera.* Black She-oak *Allocasuarina littoralis* and Black Wattle *Acacia mearnsii* are common small trees.

Shrubs:
Sweet Pittosporum *Pittosporum undulatum* is common and several individuals of Sydney Golden Wattle *Acacia longifolia* var. *longifolia* and Black Wattle *Acacia mearnsii* occur on the batter slope. Outside the road reserve in the areas cleared of weeds, or areas that are less densely weed infested Ball Everlasting *Ozothamnus diosmifolius*, Narrow-leaf

Geebung *Persoonia linearis*, Common Hop Bush *Dodonaea triquetra*, *Breynia oblongifolia* and Native Peach *Trema aspera* occur.

Groundcovers and Climbers:
Native groundcover species in cleared areas and less densely weed infested areas include Spiny Mat-rush *Lomandra longifolia*, Blue Flax Lily *Dianella caerulea* var. *producta*, Maidenhair Fern *Adiantum aethiopicum* and Rasp Fern *Doodia aspera*. Less common are Wombat Berry *Eustrephus latifolius*, Scrambling Lily *Geitonoplesium cymosum,* and Love Creeper *Glycine clandestina.*

Weeds:
Common weeds occurring on the batter slope and gully area are Large-leaved Privet *Ligustrum lucidum*, Small-leaved Privet *Lucidum sinense*, Lantana *Lantana camara*, Wandering Jew *Tradescantia albiflora*, Bamboo *Phyllostachys ?aurea*, Morning Glory *Ipomoea indica*, Moth Vine *Araujia hortorum*, Blackberry *Rubus ulmifolius*, Cape Ivy *Delairea odorata* and Honeysuckle *Lonicera japonica.* Grassed areas at the eastern end of the site are dominated by Kikuyu *Pennisetum clandestinum* and Blackberry.

Community B: Open-forest/woodland: *Eucalyptus punctata*, *Eucalyptus agglomerata, Syncarpia glomulifera.*

Occurrence:
This community occurs above the gully at eastern end of the site, and on the upper gully slopes downslope of the site. The community merges with the Tall open-forest community and occurs on the drier upper slopes of the gully. Very little of this community occurs within the proposed site and this is restricted to several Grey Gum *Eucalyptus punctata* and other native species on the top of the small cutting below the Hawkesbury Road overbridge at the western end of the site. Several individuals of Grey Gum also occur on the batter slope.

Structure:
Trees to 25 metres high with a medium density canopy. The small tree and shrub layer in areas outside the area of potential impact from the proposal mostly comprises species of families *Proteacae, Fabaceae* and *Myrtaceae* and shrub height varies with species composition between 0.5 and 6 metres. These areas are also moderately to heavily invaded by weeds. Within and adjacent to the proposed construction area native species are uncommon and restricted to the following.

Native Species:
Trees:
Grey Gum *Eucalyptus punctata* and Blue-leaved Stringybark *Eucalyptus agglomerata*.

Shrubs:
Sweet Pittosporum *Pittosporum undulatum*, Sydney Golden Wattle *Acacia longifolia* var. *longifolia*, Australian Indigo *Indigophora australis*, Bursaria *Bursaria spinosa* and Dwarf Currant *Exocarpos strictus*.

Groundcovers and Climbers:
Spiny Mat-rush *Lomandra longifolia*, Blue Flax Lily *Dianella caerulea* var. *producta*, Three-awn Speargrass *Aristida vagans* and Scrambling Lily *Geitonoplesium cymosum*.

Weeds:
Common weeds occurring on the batter slope and the roadside are Large-leaved Privet *Ligustrum lucidum*, Small-leaved Privet *Lucidum sinense*, Lantana *Lantana camara*, Coreopsis *Coreopsis lanceolata*, Cotoneaster *Cotoneaster pannosus*, Wandering Jew *Tradescantia albiflora*, Bamboo *Phyllostachys ?aurea*, Morning Glory *Ipomoea indica*, Moth Vine *Araujia hortorum*, Blackberry *Rubus ulmifolius*, Fishbone Fern *Nephrolepis cordifolia* and Honeysuckle *Lonicera japonica*.

4.2 Plant Species

A list of plant species identified in survey area is provided in Appendix 1. No species of national or regional conservation significance as listed by Briggs and Leigh (1996) or Schedules 1 and 2 of the *Threatened Species Conservation Act 1995* were located during the survey.

The National Parks and Wildlife Service's Rare Or Threatened Australian Plants (ROTAP) database lists was also consulted for species of conservation significance that have been found in the locality. Benson (1992) lists 20 species of particular conservation importance within the lower Blue Mountains area of the Penrith 1:100,000 map sheet. Given the type of natural habitats occurring in the area of the proposal, the following species were considered possible occurences within or adjacent to the site but were not located.

Table 1. Plant Species of Conservation Significance Occurring in the Springwood Area.

SCIENTIFIC NAME	Regional Significance	ROTAP CODE	TSC Act Schedule
Eucalyptus burgessiana	Local endemic, Linden Faulconbridge, and Springwood.	2RCa	
Chloanthes glandulosa	Main population Springwood to Kurrajong.		
Leucopogon fletcheri	Local population.	2RC-	
Persoonia hirsuta	Local population.	3KCi	
Zieria involucrata		2VCa	2
Grevillea longifolia	Disjunct local population.	2RC-	

5. VALUE OF THE VEGETATION IN THE STUDY AREA

The Sydney Sandstone vegetation complex is one of the most widespread and well conserved vegetation formations remaining from the original vegetation of the Sydney area. It occupies the extensive Hawkesbury Sandstone plateaux and gullies to the north and south of Sydney. Large areas of similar sandstone vegetation is conserved in the adjacent areas of Blue Mountains National Park and Kanagra-Boyd National Park and also in Ku-ring-gai Chase National Park, Sydney Harbour National Park and Royal National Park.

All of the native plant species located within and adjacent to the proposed construction area are common in similar habitats throughout the Blue Mountains area. Several large individuals of Round-leaved Gum *Eucalyptus deanei* and Grey Gum *Eucalyptus punctata* and one Turpentine *Syncarpia glomulifera* occur on or below the existing batter slope within the proposed construction area and are valuable local amenity features.

On a local and regional scale the vegetation type that occurs within and adjacent to the survey area is not significant. However, the loss of the larger trees would alter the local amenity of the site.

6. POTENTIAL IMPACT OF THE PROPOSED DEVELOPMENT ON THE VEGETATION

The proposed construction of the on ramp would require the removal of up to 20 mature and semi-mature native trees and approximately 2,400m^2 of weed vegetation with one small stand of native vegetation located along the Great Western Highway. Any native trees removed are well conserved within the adjacent Blue Mountains National Park.

The proposed construction of the vertical concrete wall would limit the area directly affected by the work and would also reduce the on-going input of weed propagules and assist in the present efforts to clear the weeds from the area by largely eliminating the existing batter slope.

The usual effects associated with road construction on native bushland such as weed invasion and dieback would not occur in the area due to the already heavily weed infested environs.

7. RECOMMENDATIONS

There are no ecological impediments, in terms of flora conservation to the roadworks proceeding as planned.

It is not considered necessary to prepare a flora Species Impact Statement for the proposed work.

- The number of trees to be removed should be the minimum necessary for the safe excavation and construction operations. The retention of the existing trees is an important aspect of maintaining the existing character of the area.

- Trees with limbs overhanging the road should not be removed unless absolutely necessary for safety reasons. Rather, the overhanging limbs should be cut back.
- The boundary of the area to be cleared and the bushland to be retained should be clearly delineated and fenced by 'Paraweb' or similar fencing to prevent workers and machinery from entering the bushland to be retained.
- To prevent the erosion of soil and the further dispersal of weed propagules from the construction area, suitable erosion and sedimentation controls should be established and maintained until the area is stabilised.
- The vegetation, leaf litter and soil cleared for the construction should not be used in the revegetation of the disturbed areas.
- The RTA should investigate the possibility assisting the current weed clearing efforts downslope of the road reserve by clearing the adjacent road reserve area of weeds. This could be accomplished by relatively 'heavy-handed' methods such as a small bulldozer blade.

Appendix 1. PLANT SPECIES LIST. Proposed Construction of an Eastbound Entry Ramp, Great Western Highway at Springwood.

KEY:

* Introduced species.
(Native species not locally endemic.
Plant species of conservation significance are in **bold** type.

FAMILY	GENUS SPECIES
FILICOPSIDA	
Adiantaceae	*Adiantum aethiopicum*
	Adiantum hispidulum
Blechnaceae	*Doodia aspera*
Davaliaceae	*Nephrolepis cordifolia* *
Dennstaedtiaeae	*Pteridium esculentum*
CONIFEROPSIDA	
Cupressaceae	*Cuppressus sp.* *
Pinaceae	*Pinus radiata* *
MAGNOLIOPSIDA - magnoliidae	
Acanthaceae	*Thunbergia alata* *
Apiaceae	*Foeniculum vulgare* *
Apocynaceae	*Nerium oleander* *
Asclepiadaceae	*Araujia hortorum* *
Asteraceae	*Conyza bonariensis* *
	Coreopsis lanceolata *
	Delairea odorata *
	Hypochaeris radicata *
	Ozothamnus diosmifolius
	Senecio madagascariensis *
	Sonchus oleraceus *
	Tagetes minuta *
	Taraxacum officinale *
Bignoniaceae	*Jacaranda mimosifolia* *
Brassicaceae	*Capsella bursa-pastoris* *
Caprifoliaceae	*Lonicera japonica* *
Casuarinaceae	*Allocasuarina littoralis*
Commelinaceae	*Tradescantia albiflora* *
Convolvulaceae	*Ipomoea indica* *
Euphorbiaceae	*Breynia oblongifolia*
Fabaceae: Caesalpiniaceae	*Senna coluteoides* var. *glabrata* *
Fabaceae: Faboideae	*Genista monspessulana* *

	Glycine clandestina species complex
	Glycine microphylla
	Indigophora australis
	Trifolium repens *
	Vicia sativa *
Fabaceae: Mimosoideae	*Acacia longifolia*
	Acacia mearnsii
Malaceae	*Cotoneaster pannosus* *
Meliaceae	*Melia azedarach* var. *australasica*

FAMILY	**GENUS SPECIES**
Myrtaceae	*Eucalyptus agglomerata*
	Eucalyptus deanei
	Eucalyptus punctata
	Syncarpia glomulifera
Ochnaceae	*Ochna serrulata* *
Oleaceae	*Ligustrum lucidum* *
	Ligustrum sinense *
	Olea africana *
Oxalidaceae	*Oxalis corniculata* *
Pittosporaceae	*Bursaria spinosa*
	Pittosporum undulatum
Plantaginaceae	*Plantago lanceolata* *
Proteaceae	*Grevillea robusta*
	Persoonia linearis
Rosaceae	*Rubus ulmifolius* species complex *
Santalaceae	*Exocarpos strictus*
Solanaceae	*Solanum mauritianum* *
	Solanum nigrum *
Ulmaceae	*Trema aspera*
Urticaceae	*Urtica incisa* *
Verbenaceae	*Lantana camara* *
	Verbena bonariensis *
MAGNOLIOPSIDA - LILIIDAE	
Asparagaceae	*Myrsiphyllum asparagoides* *
	Protasparagus aethiopicus *
Iridaceae	*Crocosmia X crocosmiiflora* *
Lomandraceae	*Lomandra longifolia*
Philesciaceae	*Eustrephus latifolius*
	Geitonoplesium cymosum
Phormiaceae	*Dianella caerulea* var. *producta*

Poaceae	*Anropogon virginicus* *
	Aristida vagans
	Avena sterilis *
	Briza minor *
	Chloris gayana *
	Cynodon dactylon
	Digitaria sanguinalis *
	Imperata cylindrica var *major*
	Paspalum dilatatum *
	Pennisetum clandestinum *
	Phyllostachys ?aurea *
	Rhynchelytrum repens *
	Setaria gracilis *

Appendix 2. Definition Of ROTAP Conservation Codes

Example: ***Rarus planticus*** **3ECi+**

3 Distribution Category for the species or taxon (can be 1,2 or 3).

1 = Known from one collection only.

2 = Geographic range <100 kilometres.

3. = Geographic range >100 kilometres.

E The Conservation Code (can be X, E, V, R, or K).

X = **Presumed Extinct.** The taxon has not been collected or otherwise verified over the past 50 years despite thorough searching, or all known wild populations have been destroyed more recently.

E = **Endangered.** The taxon is in serious risk of disappearing from the wild within 10-20 years if present landuse and other threats continue.

V = **Vulnerable.** The taxon is not presently endangered but is at risk of disappearing from the wild over a longer period (20-50 years) through continued depletion, or occurs on land whose future use is likely to change and threaten its survival.

R = **Rare.** A taxon which, while rare in Australia and hence usually the world is not currently threatened by ant identifiable factor.

K = **Poorly Known.** The taxon is suspected but not definitely known to belong to one of the above categories.

C = **Reserved.** The taxon has at least one population within a national park or other proclaimed conservation reserve.

i+ **Size Of Reserved Population (can be a, i, + or -)**

a = indicates that 1,000 plants or more are known to occur within a conservation reserve(s).

i = indicates that less than 1,000 plants are known to occur within a conservation reserve(s).

\+ = indicates that although recorded from within a reserve the population size is unknown.

\- = indicates that the taxon also has a natural distribution outside Australia.

ATTACHMENT 3

Fauna Impact Assessment
November 1996, Lesryk Environmental Consultants.

1.0 INTRODUCTION

This report describes a fauna assessment of the vegetation communities within and adjacent to the proposed entry ramp, at the intersection of Hawkesbury Road and the Great Western Highway, Springwood. The study has been carried out at the request of Environmental Planning Pty Ltd as part of a Review of Environmental Factors for the proposed construction of a one lane east bound entry ramp.

This report describes a fauna survey of the study area and an assessment of the potential impacts of the proposal on the ecology of the area. A literature review of previous studies carried out in the area was also undertaken to identify any species of conservation significance known for the region which may have been overlooked during the field survey.

2.0 METHODS

A survey of the study site was carried out by Deryk Engel on the 1st November 1996. The weather during the daytime search was fine, mild and still.

Techniques employed for this investigation included habitat assessment, litter searches, bird watching and the identification of scats and indirect fauna evidence. A search of the NSW National Parks and Wildlife Services Atlas of NSW Wildlife and a review of the previous studies undertaken in the area was also carried out to identify additional fauna species known to occur in the study region. Previous studies included fauna survey of the Blue Mountains by Smith and Smith (1990) and fauna assessments in relation to the Great Western Highway upgrades at Warrimoo (Connell Wagner 1994), Linden Bends (Fanning *et al.* 1993) and Woodford Bends (GHD 1989).

3.0 HABITAT TYPES AVAILABLE FOR NATIVE FAUNA SPECIES

Several habitat types occur within and adjacent to the boundaries of the proposed entry ramp. These include :-

- Open Woodlands,
- Grasslands, and
- Horticultural Plantings,

The open woodlands are up to 20 metres in height and several of the trees possess hollows suitable for the roosting requirements of a range of native birds and arboreal mammals. The understorey is dominated by a high density of exotic plant species to 3 metres while the ground cover is composed of grasses, weeds and herbaceous plants. The ground cover plants are mainly exotic species and they form a dense vegetation cover. This community occurs adjacent to the Great Western Highway and extends north eastwards along

Fitzgerald Creek. In the vicinity of the highway, large amounts of wind blown urban refuse is present. In relation to the regional distribution of this habitat type, similar woodlands are found throughout the Blue Mountains National Park.

The grassland community occurs to the east of Hawkesbury Road and is composed essentially of exotic species. This community appears to be regularly maintained. Within this community several isolated exotic shrubs occur and these are up to two metres in height.

Horticultural plantings occur at a number of locations in the vicinity of the study area, including residential gardens, Council reserves and open space areas. The plantings include both exotic and native species, the age of growth is dependant upon the time since planting.

3.1 CONSERVATION SIGNIFICANCE OF THE HABITAT TYPES OBSERVED TO NATIVE FAUNA SPECIES

The habitat types to be affected by the proposed entry ramp are all highly degraded, having been impacted upon by weed infestation, clearing, residential development, urban expansion and its associated infrastructures (for example sewerage piping). Those native habitats observed are all widespread in the area, and in some cases are considered to be better conserved and more structurally developed. Those habitats observed are expected to be used by some native species during roosting or foraging periods, but in relation to similar habitats throughout the area the resources they provide are considered to be minimal. The habitats observed do not occur within any significant wildlife corridors and the proposed works are not expected to impact or fragment any large woodland tracts.

4.0 RESULTS

4.1 Present Study

During the investigation of the study area, 32 birds, 1 native mammal and 1 reptile were observed or recorded as using the survey site (Appendix 1). Those species recorded are all known to be commonly encountered in nearby residential and woodland areas and all are highly adaptive to modified environments. None of those animals recorded are considered to be of conservation concern as defined by inclusion on Schedules 1 and/or 2 of the *Threatened Species Conservation Act 1995*. Also none are considered to reach their distribution limit in the vicinity of the study area. All species are considered to be commonly encountered throughout the region (Smith and Smith 1990, Fanning *et al.* 1993, NPWS 1996).

The cumulative impacts of residential and urban developments and their associated infrastructures along with feral pests, exotic weeds, urban rubbish and previous habitat destruction, is likely to have excluded all but a few tolerant and widespread native and introduced species. These species are generally tolerant of moderate levels of disturbance and all are expected to commonly observed through out the vegetated areas surrounding the study site.

4.2 Previous Studies

Previous studies and fauna surveys undertaken within the vicinity of the current study area have identified an additional 49 birds, 17 reptiles, 14 frogs and 3 native mammals (Appendix 2). Of these species previously recorded six, the Glossy Black-Cockatoo (*Calyptorhynchus lathami*), Turquoise Parrot (*Neophema pulchella*), Powerful Owl (*Ninox strenua*), Regent Honeyeater (*Xanthomyza phrygia*), Giant Burrowing Frog (*Heleiporous australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*), are listed under either Schedules 1 and/or 2 of the *Threatened Species Conservation Act 1995*. Each of these species is a habitat specialist, relying on a particular vegetation community or geological, hydrological and/or physical condition for their life cycle requirements. Within the boundaries of the proposed road works, no habitat critical to the life cycle of any of these species was observed and as such no impact on the local or regional survival of these animals is expected to occur. The habitat requirements, distributions and threats to each of these animals is provided in Appendix 2 for reference.

4.3 Potentially Occurring Species

In addition to these species, Smith and Smith (1990) have identified a number of other threatened species known to occur within the Blue Mountain region. Of these species the Spotted-tailed Quoll (*Dasyurus maculatus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Common Bent-wing Bat (*Miniopterus schreibersii*) and Greater Broad-nosed Bat (*Scoteanax ruepellii*) have the potential to occur within the woodland areas adjacent to Fitzgerald Creek. Given the limited amount of clearing expected to occur as a result of the proposal and the highly disturbed nature of the existing environment these species are not expected to be adversely impacted upon by the proposal. For reference, the habitat requirements of these species are included in Appendix 2.

Smith and Smith (1990) also note a range of other threatened species which occur, or are known to have occurred within the Blue Mountains area, but these species are also not expected to occur within the study area because no component of their characteristic habitat requirements was observed near the proposed on ramp.

5.0 ASSESSMENT OF SIGNIFICANCE

The potential impacts of the proposed development on native species of conservation significance which may occur within the vicinity, are considered using the eight point test under Section 5A of the *Environmental Planning and Assessment Act 1979*. These criteria are designed to determine "whether there is likely to be a significant effect on threatened species, populations, ecological communities, or their habitats", and consequently, whether a Species Impact Statement is required.

The assessment of significance has been undertaken on the habitats likely to be affected by the proposed construction activities, as opposed to any individual threatened species. This approach has been taken to determine the suitability of the vegetation communities to support threatened species and therefore an indication if these species, their populations or habitats are likely to be significantly impacted upon.

EIGHT POINT TEST

(a) *"...in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction..."*

The proposed on ramp will only remove a small and highly degraded portion of the total habitats available. These habitats are not considered essential for any species listed under Schedule 1 and/or 2 of the *Threatened Species Conservation Act 1995*. As such, the proposed works are not considered to disrupt the life cycle of any threatened or protected fauna species, such that a viable local population of that species is likely to be placed at risk of extinction. No habitat critical to the life cycle of those threatened fauna species potentially occurring in the region was observed within the boundaries of the proposed construction works.

(b) *"...whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised..."*

During the field survey, no habitat necessary to the life cycle of any threatened fauna species was observed. No significant stands of sclerophyll forest, large trees with hollows, suitable water bodies, sandstone associations or caves were observed within the survey area. As such no impact on the life cycle of any threatened fauna species is considered to be disrupted such that the viability of the population at a regional level is likely to be significantly compromised.

(c) *"...in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed..."*

Within the boundaries of the proposed construction activities no significant habitat for any threatened fauna species was observed. No significant area of habitat, at either a local or regional scale, is expected to be modified or removed by the proposed road construction. At a regional level, more extensive and less isolated tracts of land are found within the Blue Mountains National Park.

(d) *"...whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community "*

The proposed construction activities are not considered to impact on any habitat significant for any threatened fauna species. The proposed works will only remove a small portion of some exotic and native species but this is not considered to impact on the significance of any wildlife corridors. The current urban situation, including residential and commercial developments, highways and railway lines is expected to already have modified any potential north - south fauna corridors and the current proposal is not considered to have a further adverse effect on the current situation. As such, no fauna corridors are to be disrupted and no vegetation communities that are currently interconnecting are to be fragmented or isolated.

(e) *"...whether critical habitat will be affected..."*

No habitats were identified during the survey which are considered to be critical to the survival of any threatened species. No areas considered to be critical to the survival of those threatened species identified during the literature review process are known to occur within the boundaries of the proposed works. As such, no impacts were identified which would result in any of these species being adversely affected.

(f) *"...whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region..."*

Within the vicinity of the proposed construction works, it is considered that those threatened fauna species known for the region and their habitats are adequately represented in the conserved areas of the Blue Mountains National Park. The National Park is expected to provide a plant community structure and range of habitats which are suitable for the conservation of threatened fauna populations.

(g) *"...whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process..."*

Road works are known to be a threatening process to fauna species and their habitats. At the time of report preparation no threatening processes were listed under Schedule 3 Key threatening processes of the *Threatened Species Conservation Act 1995.*

(h) *"...whether any threatened species, populations or ecological community is at the limit of its known distribution..."*

No threatened fauna species reach their distribution limit in the vicinity of the study area.

6.0 EXPECTED IMPACT ON HABITAT DUE TO PROPOSED CONSTRUCTION WORKS

The proposed construction activities are not considered to remove, modify or fragment any habitat critical to the life cycle of any threatened fauna species. No habitats were observed within the study boundaries that are considered to be significant to the conservation of any native fauna species.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Within the boundaries of the proposed on ramp, no habitats were identified which would be of importance to the conservation of any threatened or "common-to-abundant" fauna species. No habitats of significance were observed which would be adversely impacted upon and no additional fragmentation or isolation of bushland remnants will occur. Those habitats recorded are similar to communities found throughout the region, none being restricted or unique to this location. Those habitats observed are expected to provide some foraging resources for a number of common native species, but in relation to adjacent areas, the value of this is considered minimal.

Based on an assessment of habitats present and a literature review of previous studies, none of the species of State conservation significance expected or known to occur are considered to be adversely impacted upon by the proposed construction activities. The construction of a onramp from Hawkesbury Road to the Great Western Highway at Springwood is not expected to have a significant impact on the environments of any protected or threatened fauna. Therefore it is not considered necessary that a Species Impact Statement be prepared for the proposed construction of a onramp which connects Hawkesbury Road to the Great Western Highway at Springwood.

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APPENDIX 1. Fauna observed, or known to occur within study area

Source

1 = Present Study
2 = NPWS (1996)
3 = Fanning *et al.* (1993)
4 = Connell Wagner (1994)

- indicates species of conservation significance
* - indicates introduced species

BIRDS		1	2	3	4
Brown Quail	*Coturnix ypsilophora*		x		
Painted Button-quail	*Turnix varia*		x		
Australian Wood Duck	*Chenonetta jubata*		x		
White-necked Heron	*Ardea pacifica*		x		
Black-shouldered Kite	*Elanus axillaris*		x		
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		x		
* Rock Dove	*Columba livia*	x			
* Spotted Turtle-Dove	*Streptopelia chinensis*	x	x	x	
Brown Cuckoo-Dove	*Macropygia amboinensis*		x		
Diamond Dove	*Geopelia cuneata*		x		
Crested Pigeon	*Ocyphaps lophotes*		x		
# Glossy Black-Cockatoo	*Calyptorhynchus lathami*		x		
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*		x		
Gang-gang Cockatoo	*Callocephalon fimbriatum*		x		
Galah	*Eolophus roseicapilla*		x		
Long-billed Corella	*Cacatua tenuirostris*		x		
Little Corella	*Cacatua sanguinea*		x		
Sulphur-crested Cockatoo	*Cacatua galerita*	x	x		
Musk Lorikeet	*Glossopsitta concinna*		x		
Little Lorikeet	*Glossopsitta pusilla*		x		
Australian King Parrot	*Alisterus scapularis*		x	x	
Crimson Rosella	*Platycercus elegans*	x	x	x	x
Eastern Rosella	*Platycercus eximius*	x	x		
# Turquoise Parrot	*Neophema pulchella*		x		
Pallid Cuckoo	*Cuculus pallidus*		x		
Fan-tailed Cuckoo	*Cuculusflabelliformis*	x	x	x	
Brush Cuckoo	*Cuculus variolosus*		x		
Common Koel	*Eudynamys scolopacea*		x		
Channel-billed Cuckoo	*Scythrops novaehollandiae*	x	x	x	
# Powerful Owl	*Ninox strenua*		x		
Southern Boobook	*Ninox novaeseelandiae*		x		
Barking Owl	*Ninox connivens*		x		
Australian Owlet-nightjar	*Aegotheles cristatus*		x		
White-throated Needletail	*Hirundapus caudacutus*		x		
Fork-tailed swift	*Apus pacificus*		x		
Azure Kingfisher	*Alcedo azurea*		x		
Laughing Kookaburra	*Dacelo novaeguineae*	x	x	x	x
Sacred Kingfisher	*Todiramphus sancta*		x	x	
Rainbow Bee-eater	*Merops ornatus*		x		
Dollarbird	*Eurystomus orientalis*		x	x	

Superb Lyrebird	*Menura novaehollandiae*		x		
White-throated Treecreeper	*Cormobates leucophaeus*	x	x	x	
Superb Fairy-wren	*Malurus cyaneus*	x		x	x
Spotted Pardalote	*Pardalotus punctatus*	x			x
White-browed Scrubwren	*Sericornis frontalis*			x	x
Chestnut-rumped Heathwren	*Hylacola pyrrhopyia*		x		
Brown Gerygone	*Gerygone mouki*		x		
White-throated Gerygone	*Gerygone olivacea*		x		
Brown Thornbill	*Acanthiza pusilla*		x	x	x
Striated Thornbill	*Acanthiza lineata*	x	x	x	x
Red Wattlebird	*Anthochaera carunculata*	x	x	x	x
Noisy Friarbird	*Philemon corniculatus*	x	x		
# Regent Honeyeater	*Xanthomyza phrygia*		x		
Bell Miner	*Manorina melanophrys*				x
Noisy Miner	*Manorina melanocephala*	x			x
Lewins Honeyeater	*Meliphaga lewinii*	x		x	
Yellow-faced Honeyeater	*Lichenostomus chrysops*	x			
White-eared Honeyeater	*Lichenostomus leucotis*		x		
White-naped Honeyeater	*Melithreptus lunatus*		x		
White-cheeked Honeyeater	*Phylidonyris nigra*		x		
New Holland Honeyeater	*Phylidonyris novaehollandiae*		x		
Eastern Spinebill	*Acanthorhynchus tenuirostris*	x	x		
Scarlet Honeyeater	*Myzomela sanguinolenta*		x		
Eastern Whipbird	*Psophodes olivaceus*	x		x	x
Grey Fantail	*Rhipidura fuliginosa*	x		x	x
Grey Shrike-thrush	*Colluricincla harmonica*				x
Black-faced Monarch	*Monarcha melanopsis*			x	
Magpie-lark	*Grallina cyanoleuca*	x			
Satin Bowerbird	*Ptilonorhynchus violaceus*	x		x	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	x			
Grey Butcherbird	*Cracticus torquatus*				x
Australian Magpie	*Gymnorhina tibicen*	x		x	x
Pied Currawong	*Strepera graculina*	x		x	x
Australian Raven	*Corvus coronoides*	x		x	x
Welcome Swallow	*Hirundo neoxena*	x			
* House Sparrow	*Passer domesticus*	x			x
Red-browed Finch	*Neochmia temporalis*			x	x
Silvereye	*Zosterops lateralis*	x		x	x
* Red-whiskered Bulbul	*Pycnonotus jocosus*	x		x	x
* Common Blackbird	*Turdus merula*	x			
* Common Myna	*Acridotheres tristis*	x			x
* Common Starling	*Sturnus vulgaris*	x			x
MAMMALS					
Long-nosed Bandicoot	*Perameles nasuta*			x	
Common Brushtail Possum	*Trichosurus vulpecula*	x			x
Eastern Grey Kangaroo	*Macropus giganteus*				x
* Fox	*Vulpes vulpes*			x	
REPTILES					
Wood Gecko	*Diplodactylus vittatus*		x		
Lesueur's Velvet Gecko	*Oedura lesueurii*		x		
Eastern Water Dragon	*Physignathus lesueurii*		x		
Bearded Dragon	*Pogona barbata*		x		
Lace Monitor	*Varanus varius*		x		
Copper-tailed Skink	*Ctenotus taeniolatus*		x	x	x

Eastern Water Skink	*Eulamprus quoyii*		x	x	
Barred-side Skink	*Eulamprus tenuis*		x		
Grass Skink	*Lampropholis delicata*		x	x	
Garden Skink	*Lampropholis guichenoti*		x		
Red-Throated Skink	*Pseudemoia platynota*		x		
Weasel Skink	*Saproscincus mustelinus*		x		
Eastern Blue-tongued	*Tiliqua scincoides*		x		
Red-naped Snake	*Furina diadema*		x		
Black-bellied Swamp Snake	*Hemiaspis signata*		x		
Red-bellied Black Snake	*Pseudechis porphyriacus*		x		
Eastern Brown Snake	*Pseudonaja textilis*		x		
FROG					
Common Eastern Froglet	*Crinia signifera*		x	x	x
# Giant Burrowing Frog	*Heleiporous australiacus*		x		
Ornate Burrowing Frog	*Limnodynastes ornatus*		x		
Brown-striped Frog	*Limnodynastes peronii*		x		x
Green Tree Frog	*Litoria caerulea*		x		
Blue Mountains Tree Frog	*Litoria citropa*		x		
Bleating Tree Frog	*Litoria dentata*		x		
Broad-palmed Frog	*Litoria latopalmata*		x		
Leseur's Tree Frog	*Litoria lesueuri*		x		
Peron's Tree Frog	*Litoria peronii*		x		
Leaf Green Tree Frog	*Litoria phyllochroa*		x		
Verreaux's Tree Frog	*Litoria verreauxi*		x		
# Red-crowned Toadlet	*Pseudophryne australis*		x		
Smooth Toadlet	*Uperoleia laevigata*		x		

APPENDIX 2. Habitat requirements, threats and distributions of threatened fauna known or potentially occurring in the vicinity of the study area

GLOSSY BLACK-COCKATOO *Calyptorhynchus lathami*
The Glossy Black-Cockatoo is a thinly distributed species in central and south eastern Australia, living in eucalypt *Eucalypt* woodland and feeding almost exclusively on casuarina fruit. Within its range it is tied to groves of its food trees, *Casuarina* spp. and *Allocasuarina* spp. (Schodde *et al.* 1993, Garnett 1993). Ripping and crushing the cones to extract the seeds, this species dependence on one type of food makes it vulnerable to habitat loss (Blakers *et al.* 1984). Nesting and roosting in hollows of large eucalypt trees this bird can spend up to 88% of each day foraging (Garnett 1992, Garnett 1993). The cause of population decline has been attributed to loss of suitable habitat for agricultural and residential purposes, burning of habitat, competition for nesting hollows and fragmentation of habitat size resulting in areas not large enough to sustain a viable population (Garnett 1992, Schodde *et al.* 1993).

Smith and Smith (1990) note that this is an uncommon breeding local nomad which occurs throughout the Mountains.

TURQUOISE PARROT *Neophema pulchella*
Distributed from north-eastern and eastern Victoria, through eastern New South Wales to south-eastern Queensland, the conservation status of the Turquoise Parrot throughout this range is presently considered as being secure (Lendon 1979, Garnett 1992). This distribution range is also considered to be increasing (Garnett 1992). In New South Wales this species is listed under Schedule 2 as being vulnerable. Sheltering in the dense cover provided by grassy woodlands and forest edges, the Turquoise Parrot nests in eucalypt hollows (Frith 1977, Lendon 1979, Smith and Smith 1990). Feeding occurs in open grassy areas, where the Turquoise Parrot spends most of its time on the ground searching for grass seeds and herbaceous plants (Frith 1977). A wide variety of exotic weeds are also fed upon (Garnett 1992).

Habitat clearance, over grazing by stock and rabbits, predation by foxes and feral cats and delayed adaptation to the growth of exotic weed species, have been attributed to the decline of this species (Garnett 1992, Smith *et al.* 1995). In Victoria, a restriction to population also appears to be the lack of high quality breeding hollows (Garnett 1992).

Smith and Smith (1990) note that this is an uncommon resident which probably breeds in the Mountains.

POWERFUL OWL *Ninox strenua*
The Powerful Owl favours gullies and gorges which are unlogged to lightly logged (Chafer 1992, Debus and Chafer 1994). These gullies usually consist of wet to dry sclerophyll forest with a dense understorey (Hollands 1991, Garnett 1993). This species nests in large hollows, nearly always in the trunk or top of a broken eucalypt (Hollands 1991). Information on the size of this species' home range is scant with estimates ranging from 600 ha to more than 1000 ha (Garnett 1993). The Powerful Owl breeds from June - September with pairs being faithful to particular roost trees (C.Chafer, researcher, pers.comm., Pavey *et al.* 1994). The close proximity of roosts to residential and/or recreational areas does not appear to affect the breeding success of Powerful Owls (Pavey *et al.* 1994). This species is able to traverse open country therefore not being affected by habitat fragmentation and isolation (Garnett 1993). The main prey of this species are the medium-sized arboreal marsupials, particularly the Ringtail Possum and Sugar Glider (Pavey *et al.* 1994). Birds, rodents, fruit bats and rabbits will also be taken (Pavey *et al.* 1994). The main threat to the survival of this species is the loss of old-growth forest elements, particularly trees which are large enough for the owl to use for nesting (Garnett 1993).

Smith and Smith (1990) note that this is a rare resident in the upper Grose Valley.

REGENT HONEYEATER ***Xanthomyza phrygia***
The principal habitat of the Regent Honeyeater is temperate eucalypt woodland and open forest with stands of over mature, dominant trees. These trees are used as central places for nesting and feeding territories (Garnett 1993). This species feeds primarily on four eucalypt species, Red Ironbark *Eucalyptus sideroxylon*, White Box *E. albens*, Yellow Box *E. melliodora* and Yellow Gum *E. leucoxylon*, as well as heavy infestations of mistletoe (Garnett 1992, Garnett 1993). Distributed from southern Queensland through central Victoria to South Australia, this species current stronghold appears to be the western slopes of the Great Dividing Range, New South Wales (Ford *et al.* 1993).

Land clearance, habitat fragmentation and a lack of regeneration as a result of grazing by domestic stock and rabbits, have been attributed to the decline of this species (Garnett 1993, Ford *et al.* 1993). Additional threats include competition with other honeyeaters, such as the Noisy Miner (*Manorina melanocephala*), Red Wattlebird (*Anthochaera carunculata*) and Noisy Friarbird (*Philemon corniculatus*) (Garnett 1993, Ford *et al.* 1993). Fragmentation of habitats as a result of current agricultural practices is likely to have favoured these more aggressive honeyeater species, which compete with Regent Honeyeaters for available resources (Ford *et al.* 1993).

Smith and Smith (1990) note that the Regent Honeyeater is a rare nomad with records coming from Warrimoo in both 1977 and 1983.

GIANT BURROWING FROG ***Heleioporous australiacus***
Distributed along the coast and ranges of central coast New South Wales through to eastern Victoria, the Giant Burrowing Frog is mostly restricted to areas of Hawkesbury Sandstone (Cogger 1992, Robinson 1993). This association with sandstone outcrops appears to be quite important feature of this species ecology (J.Recsei, herpetologist, pers.comm.). This species lives in small semi-permanent to slightly flowing streams, breeding in sandy river bank burrows during the summer and autumn months (Cogger 1992). Breeding is also known to occur in man-made depressions, ditches and dams, though these must be in a non-polluted condition (K.Thumm, herpetologist, pers.comm.). The larval stage of this species is known to be quite long in comparison to other amphibians, and therefore the tadpoles require semi-permanent to permanent pools during their larval stage (J.Recsei pers.comm.). Giant Burrowing Frogs are not found in creeks affected by stormwater or other pollutants, and this species of frog is not found in urbanised areas (K.Thumm pers.comm.).

Smith and Smith (1990) note that this species is uncommon and localised chiefly in the lower Mountains.

RED-CROWNED TOADLET ***Pseudophryne australis***
Classified as Vulnerable, the Red-Crowned Toadlet is restricted to a radius of about 160 kilometres around Sydney (Cogger 1992). This species is nocturnal and gregarious and, within its range, is almost totally confined to areas of Hawkesbury Sandstone (Jacobson 1963, Robinson 1993). Within these sandstone areas, there appears to be a strong association between the Red-Crowned Toadlet and the highly weathered shale lenses within the sandstone formations (A.White, herpetologist, pers.comm., K.Thumm, researcher, pers.comm.). It is in these areas that the Red-Crowned Toadlet forms a small, water filled depression, in which to lay its eggs. Sheltering under stones, vegetation or logs during the day, the Red-Crowned Toadlet emerges at night to feed and mate (Jacobson 1963). Breeding occurs during the autumn months, with females laying their eggs either directly into the water or in a hollowed out chamber/depression (Woodruff 1977, Thumm 1995). The location of this depression is in an area that will subsequently become flooded by water runoff, resulting in the production of temporary pools, into which the tadpoles hatch (Woodruff 1976, Woodruff 1977, K.Thumm pers.comm.). This species appears to be highly susceptible to pollutants and is rarely found in weed infested areas (K.Thumm pers.comm.). Other impacts on this species result from on-going disturbances, stormwater pollution, indirect effects of urbanisation and the depletion of bushrock. Home ranges appear to be in the order of 300 to 400 metres (K.Thumm pers.comm.). Because of its use of "nests", the Red-Crowned Toadlet cannot adapt to breeding in concrete-lined gutters, sediment ponds or drains (Jacobson 1963).

Smith and Smith (1990) note that this species is moderately common in the lower Mountains.

SPOTTED-TAILED QUOLL ***Dasyurus maculatus***
The Tiger Quoll is distributed along the Great Dividing Range from Victoria through to southern Queensland (Strahan 1983, Turton 1993). Inhabiting wet and dry sclerophyll forests through to rainforests, this nocturnal species shelters in tree hollows, dense undergrowth, hollow logs or under rock outcrops (Smith and Smith 1990, Strahan 1995). Home range sizes for this species are known to be considerably large with males travelling up to 15 km^2/night, and females between 3-4 km^2/night (Mansergh 1983, Soderquist and Serena 1994). Preying on a wide variety of terrestrial and arboreal vertebrates, including rabbits, brushtails and ringtails (Belcher 1995), this species' survival is being threatened predominantly through habitat destruction, population fragmentation and competition with both the fox and feral cat (Strahan 1983, Turton 1993). Additional threats to the survival of this species include fragmentation of habitat by roads, fences and other barriers, shooting, trapping and poisoning and siltation of streams (Wilson 1991).

Smith and Smith (1990) notes that this species is uncommon within the Mountains though records are known from a number of location throughout the region.

LARGE-EARED PIED BAT ***Chalinolobus dwyeri***
The Large-eared Pied Bat is distributed from central southern Queensland through to southern NSW (Hall and Richards 1979, Parnaby 1992, Strahan 1995). Throughout this range its status is described as uncommon (Parnaby 1992). Its preferred habitat is timbered woodland and dry sclerophyll forest (Hall and Richards 1979, Cronin 1992, Strahan 1995). The Large-eared Pied Bat is known to roost in caves, tunnels, mines if available or even the abandoned nests of the Fairy Martin (Hall and Richards 1979, Cronin 1991, Parnaby 1992, Strahan 1995). In contrast to other bats this species often chooses to roost close to the entrance of the cave (Strahan 1995). The Large-eared Pied Bat is a slow to moderate flier, with good manoeuvrability that forages for insects below the tree canopy (Cronin 1991, Strahan 1995). Threats to the survival of this species include the loss of caves which provide suitable roosting and breeding habitat (Strahan 1995).

Smith and Smith (1990) note that this species is uncommon throughout the Mountains.

EASTERN FALSE PIPISTRELLE ***Falsistrellus tasmaniensis***
The Eastern False Pipistrelle is distributed southwards from south-eastern Queensland, along both the coast and Great Dividing Range through to western Victoria and Tasmania (Hall and Richards 1979, Parnaby 1992). Preferring gullies with tall, wet sclerophyll vegetation in high rainfall areas, this species hawks for insects below the tree canopy (Hall and Richards 1979, Strahan 1983, Strahan 1995). There appears to be some conflict in this species' winter activities with some reporters suggesting that the Eastern False Pipistrelle migrates coastward in winter while others comment that it is a sedentary hibernator (Hall and Richards 1979, Strahan 1983, Smith and Smith 1990). Usually roosting in tree hollows, this species has also been recorded both in caves in the Jenolan area (NSW) and cave substitutes (eg. buildings) (Hall and Richards 1979, Smith and Smith 1990, Strahan 1995). The main threat to the survival of this species is the loss of suitable roosting trees due to intensive farming and clearing operations (Strahan 1983).

Smith and Smith (1990) note that this species is uncommon throughout the Mountains.

COMMON BENT-WING BAT ***Miniopterus schreibersii***
This species of bat is the dominant cave-dwelling bat in south-eastern Australia (Smith and Smith 1990, Parnaby 1992). Occurring along the east coast and ranges of Australia from south-eastern South Australia through to Queensland, and the northern parts of Western Australia and the Northern Territory, this species roosts in caves, storm water channels, mines and houses (Hall and Richards 1979, Strahan 1995). Estimates of home ranges for the Common Bentwing-bat are in the order of 10Km^2 (G.Hoye pers.comm.). This species prefers well timbered valleys and is confined to areas where there are caves (or suitable substitutes), generally near the coast (Strahan 1983). Large distances are travelled between different roosts

according to this species seasonal requirements (Hall and Richards 1979, Reardon and Flavel 1987, Smith and Smith 1990, Strahan 1995). During winter, cold roosts are sought to allow for hibernation while during the warmer months, females will travel great distances (up to 200 Km) to suitable nursery caves where the temperature, humidity and physical dimensions permit breeding (Strahan 1983, Baudinette *et al.* 1994). Nursery caves may support up to 150,000 females and juveniles and these may be used by a number of groups year after year (Reardon and Flavel 1987). This species' dependence on suitable seasonal caves has put the population in jeopardy (Strahan 1983).

Smith and Smith (1990) note that this species is uncommon throughout the Mountains.

GREATER BROAD-NOSED BAT *Scoteanax rueppellii*
This species is distributed from southern coastal Queensland to south eastern NSW (Cronin 1991, Parnaby 1992). Preferring habitats which include rainforests and wet sclerophyll forests, the Greater Broad-nosed Bat usually roosts in tree hollows, though some individuals have been found in the roof spaces of old buildings (Cronin 1991). The Greater Broad-nosed Bat feeds on large insects such as beetles, and is also known to take small vertebrates such as mice and other small bats (Strahan 1983, Cronin 1991). Foraging habitat includes water bodies, tree-lined creeks and the junction of woodlands and cleared paddocks, where the Greater Broad-nosed Bat flies slowly with poor manoeuvrability (Strahan 1983, Cronin 1991). Although not identified within the literature, it is assumed that this species faces decline through clearing of rain and sclerophyll forests.

Smith and Smith (1990) note that this species is uncommon throughout the Mountains.

ATTACHMENT 4

REF FOR THE EASTBOUND ENTRY RAMP FROM HAWKESBURY ROAD TO THE GREAT WESTERN HIGHWAY AT SPRINGWOOD ACOUSTIC AND VIBRATION ASSESSMENTS

November 1996, Koikas Acoustics Pty Ltd.

CONTENTS

1. INTRODUCTION

An acoustic and vibration study has been completed by Koikas Acoustics Pty Ltd on behalf of Environmental Planning Pty Ltd. This acoustic study has been assessed in accordance with the Environment Protection Authority's Noise Control Guidelines outlined in their *Environmental Noise Control Manual*, the Roads and Traffic Authority's *Interim Traffic Noise Policy*, and relevant Australian Standards.

The Roads and Traffic Authority is proposing to provide an entry ramp to improve eastbound access from Hawkesbury Road to the Great Western Highway at Springwood. The ramp would run eastbound from the intersection of Silva Road and Hawkesbury Road and merge with the Great Western Highway.

Traffic lights and a roundabout have been considered in this assessment for the intersection at Silva Road and Hawkesbury Road, Springwood. The proposed ramp would be located on the northern side of Springwood. Refer to Appendix A for a map of the area.

In this assessment, Koikas Acoustics Pty Ltd undertook:

- traffic noise measurements at three residential sites in the vicinity of the proposed road upgrades and proposed new ramp;
- calculations of predicted L_{eq} (24 hours) noise levels;
- a sensitivity analysis based on barriers of different heights. This was to facilitate for a cost-benefit analysis for which the RTA would then determine whether traffic noise barriers would be erected to meet the EPA's goals and/or the RTA's noise level objectives for new and existing roads;
- an assessment of traffic noise for the case where traffic lights are used in place of the roundabout;
- an assessment of construction noise, and
- an assessment of ground vibration levels.

A Glossary of Acoustic Terms is provided in Appendix D.

2. TRAFFIC NOISE CRITERIA

On 1 October 1996 a statement of agreement between the RTA and the EPA on traffic noise was circulated:

"Pending release of the government guidelines on road traffic noise, the current agreement between the EPA and the RTA is that REFs and EISs should assess impacts using the traffic noise goals as identified in the EPA's ENCM or TNL 55 depending on the road classification. The EPA's ENCM is to be used for arterial roads and TNL 55 to apply on limited access roads.

If mitigation measures are required, then these measures are to be designed to meet the traffic noise goals in the ENCM or TNL 55, as appropriate.

Where the criteria cannot be achieved, then the traffic noise control measures should approach this criteria as far as is practicable while taking into account cost effectiveness, and the RTA's Interim Traffic Noise Policy should be used as an absolute minimum requirement".

2.1 ENVIRONMENT PROTECTION AUTHORITY CRITERIA

Chapter 157 Environmental Goals of Road Traffic Noise of the Environment Protection Authority's (EPA) Environmental Noise Control Guidelines (ENCG) considers three types of traffic carrying roads, arterial, non-arterial and intermittent or low traffic flow type roads. The EPA's goal for Arterial Roads is a maximum L_{A10} (18 hours) noise level of 63 dB(A) when measured 1 metre away from a residential facade or any other noise sensitive location.

The EPA's L_{A10} (18 hours) level is normally equal to the RTA's Base Noise Level Objectives of daytime 60 dB(A) L_{Aeq} (24 hours) and for night time 55 dB(A) L_{Aeq} (8 hours).

The Environment Protection Authority (EPA) is considering the use of a traffic noise descriptor level called the Traffic Noise Level (TNL) which is defined as the L_{eq} (24 hours) level plus 10% of the average hourly heavy vehicle volume between 22:00 and 07:00 hours.

2.2 RTA CRITERIA

The RTA's *Interim Traffic Noise Policy* considers three traffic noise descriptors:

- daytime L_{Aeq} (24 hours) calculated by taking the logarithmic average of all the L_{Aeq} hour) levels between 00:00 and 24:00 hours,
- night time L_{Aeq} (8 hours), calculated by taking the logarithmic average of all the L_{Aeq} hour) levels between 22:00 and 06:00 hours, and
- for classrooms in educational institutions, the maximum L_{Aeq} (1 hour) level is determined for classrooms between 08:30 and 15:30 hours.

2.2.1 Noise Level Objectives for New Road Projects

For new roads, the RTA would endeavour to meet the Noise Level Objectives in Table 1 of the RTA's Environment Manual Volume 2 of the Interim Traffic Noise Policy subject to cost-effectiveness and practicality of implementing mitigation measures.

The Noise Level Objectives are based on the predicted traffic conditions, which generally reflect the ultimate predicted daily traffic flow 10 years after the opening of a project. Refer to Appendix E.

While the Great Western Highway is a limited access road the proposal is an upgrade of an existing intersection arrangement.

2.2.2 Noise Level Objectives for Major RTA and Traffic Management Projects

Major road upgrades and major traffic management projects are those having significant effect on regional traffic flows and not included in new or upgraded roads. For such road upgrades, the RTA would consider minimising traffic noise impacts when:

- the appropriate noise level objective in Table 1 of the RTA's Interim Traffic Noise Guidelines, September 1992, are exceeded;
- there is an appreciable noise increase greater than 3 dB(A), and
- it can be demonstrated that such measures to reduce traffic noise are cost effective and practical.

3. MEASUREMENT SITES, METHODOLOGY AND INSTRUMENTATION

Field measurements were taken at three sites in the vicinity of the proposed project area. A desk top study was also undertaken for the general area likely to be affected by road construction activities and traffic noise.

Traffic noise measurements were taken to determine the existing traffic noise levels at:

- No. 1 Hawkesbury Road, Springwood. An RT&A Type 2 sound level meter data logger S/N 80 was used to take traffic noise measurements. The sound level meter was placed 1 metre from the front facade of the house which is approximately 1.2 metres below the road level.
- No. 4 Hawkesbury Road (Lot 11 Silva Road), Springwood. An RT&A Type 2 sound level meter data logger S/N 81 was used to take traffic noise measurements at this residential property. The sound level meter was placed at the southern corner 1 metre from the front facade of the residential dwelling.
- The boundary outside the residential property of No. 8-10 Plana Crescent, Springwood. Measurements were taken with a SVAN 912 Type 1 precision spectrum analyser S/N 2066, microphone G.R.A.S. Type 40AF-1 S/N 5218, preamplifier SVANTEK Type SV01 S/N 1123. Noise measurements at this site were taken on Thursday 31 October 1996 between 16:00 and 19:00 hours. These measurements were taken in free field conditions.

Noise level measurements at No. 1 and No. 4 Hawkesbury Road, Springwood were taken between Wednesday 23 October and Thursday 31 October 1996. The data from these sites were imported into a computer spreadsheet. The data was then analysed and printed in tabular and graphical format. Average traffic noise levels were calculated for "normal" working days unaffected by adverse weather conditions.

Traffic noise measurements outside the residential boundary of No. 8-10 Plana Crescent, Springwood were taken in accordance with the "shortened measurement procedure" outlined in the Department of Transport Welsh Office, Calculation of Road Traffic Noise. Measurements of L_{10} are taken over three consecutive hours between 10:00 and 17:00 hours. The L_{10} (18 hours) is then calculated by subtracting 1 dB(A) from the arithmetic mean of the three consecutive L_{10} (1 hour) levels.

Refer to Appendix A which consists of a map of the area showing the location of the measurement stations and Appendix B which provides photographs showing the location of the sound level meters.

All three noise level meters were field calibrated before and after the measurements with a Rion sound level calibrator NC-73 S/N 10702593. Calibration drifts of less than 0.2 dB(A) were recorded for the RT&A sound level meters and less than 0.1 dB(A) for the SVAN sound level meter.

All equipment used for taking noise measurements and the field calibrator have been calibrated by a NATA certified laboratory.

All noise level measurements were A-frequency and Fast-time weighted. All traffic noise measurement procedures and equipment comply with the requirements of Australian Standard 2702-1984 Acoustics - Methods for the Measurement of Road Traffic Noise, and Australian Standard 1259.2-1990 Acoustics - Sound Level Meters - Integrating - Averaging.

4. MEASUREMENT RESULTS

Tables 1 and 2 are summaries of the existing noise level measurement results taken at the two residential sites No. 1 and No. 4 Hawkesbury Road, Springwood. Appendix C consists of graphs, data tables and calculated summaries of traffic noise descriptor levels.

The average traffic noise descriptor levels were calculated for working days (i.e excluding the weekend), and not affected by adverse meteorological conditions.

Table 1 Measured Traffic Noise Levels at No. 1 Hawkesbury Road, Springwood

	Noise Levels [dB(A)](1)								
DESCRIPTOR	Thur 24-10-96	Fri 25-10-96	Sat 26-10-96	Sun 27-10-96	Mon 28-10-96	Tue 29-10-96	Wed 30-10-96	Thur 31-10-96	Average
L_{eq} (24 hours) (0000 - 2400)	61.9	61.6	60.9	59.9	61.4	61.9	61.5	-	61.7
L_{eq} (8 hours) (2200 - 0600)	55.4	56.3	56.8	55.7	57.3	57.6	57.4	58.0	57.0
L_{90} (background) (0700 -1800)	54.6	55.1	55.4	53.9	55.0	54.7	55.4	56.8	55.3
L_{10} (18 hours) (0600 -2400)	65.4	65.5	64.8	63.6	64.3	64.7	64.5	-	64.9

(1) It is generally accepted, that traffic noise level readings are 2.5 dB(A) higher when taken 1 metre from a reflective building facade when compared to free field conditions, ie at least 3.5 metres from any reflective facade. At this site, the sound level meter microphone was found 0.5 metres from the facade. Koikas Acoustics Pty Ltd has found that when a microphone is placed 0.5 metres from a sound reflective facade, noise levels increase by 1 dB(A) compared to a microphone placed 1.0 metres from the facade. The measured levels at this site were therefore reduced by 1 dB(A).

Table 2 Measured Traffic Noise Levels at No. 4 Hawkesbury Road, Springwood

	Noise Levels [dB(A)]								
DESCRIPTOR	Thur 24-10-96	Fri 25-10-96	Sat 26-10-96	Sun 27-10-96	Mon 28-10-96	Tue 29-10-96	Wed 30-10-96	Thur 31-10-96	Average
L_{eq} (24 hours) (0000 - 2400)	65.0	65.0	65.7	64.1	65.2	64.4	65.3	-	65.0
L_{eq} (8 hours) (2200 - 0600)	58.4	59.5	60.3	60.6	59.8	59.7	60.4	60.6	59.7
L_{90} (background) (0700 -1800)	57.2	57.6	58.7	57.9	58.5	56.6	58.8	59.3	58.0
L_{10} (18 hours) (0600 -2400)	69.1	69.3	69.6	68.0	68.7	67.9	68.8	-	68.8

Table 3 is a summary of the traffic noise levels taken at the boundary of No. 8-10 Plana Crescent, Springwood between 14:00 and 17:00 hours on Thursday 31 October 1996.

Table 3 Measured Traffic Noise Levels Outside the Residential Boundary of No. 8-10 Plana Crescent, Springwood on Thursday 31 October 1996 (1)

	Noise Levels [dB(A)]					
Time [Hours]	L_{eq}	L_{max}	L_{1}	L_{10}	L_{90}	L_{min}
14:00 to 15:00	63.4	80.5	72.7	66.1	56.7	51.7
15:00 to 16:00	62.3	84.7	71.8	64.4	56.3	49.2
16:00 to 17:00	62.1	83.3	71.5	63.4	55.4	46.6
AVERAGE	63	83	72	65	56	49

(1) Traffic noise measurements at this site were taken in free field conditions. If measurements were taken 1 metre from a sound reflective facade, noise levels would have been 2.5 dB(A) louder. The results in Table 3 have therefore been corrected for facade reflections, ie the measured levels were increased by 2.5 dB(A).

The average of the three consecutive L_{10} (1 hour) levels was found to be 65 dB(A). In accordance with the calculation procedure of the Short CORTN method, the L_{10} (18 hours) for this site is determined by subtracting 1 dB(A), ie 65 - 1 = 64 dB(A).

5. TRAFFIC NOISE PREDICTIONS

The RTA requested that traffic noise prediction calculations for the year 2007 are based on traffic volumes, for the Great Western Highway, calculated from linear growths of 2% and 3.5% per annum between 1996 and 2007.

5.1 TRAFFIC DATA

Tables 4, 5 and 6 are summaries of the calculated traffic volumes for Hawkesbury Road, the Great Western Highway, and the proposed ramp for the years 1996, 1997 and 2007. 10% heavy vehicles were assumed for all calculations.

Traffic volumes for Hawkesbury Road, Springwood were obtained from the Springwood Traffic Study Final Report, May 1996.

Table 4 Hawkesbury Road Traffic Volumes

	Traffic Volumes
1996 Average Daily Traffic	18,630
1997 Average Daily Traffic	18,830
2007 Average Daily Traffic	20,900

Traffic counts taken along the Great Western Highway were taken at station number 99815 east of Railway Parade, Springwood during May 1996. This data was supplied by the RTA.

Table 5 Great Western Highway Traffic Volumes

	2% Linear Growth		3.5% Linear Growth	
	Westbound	Eastbound	Westbound	Eastbound
1996 Average Daily Traffic	11,160	15,770	11,160	15,770
1997 Average Daily Traffic	11,380	16,080	11,550	16,320
2007 Average Daily Traffic	13,620	19,240	15,460	21,840

Traffic volumes along the proposed entry ramp to the Great Western Highway were determined from the RTA's projected peak am and pm traffic flow estimates outlined in the "Great Western Highway/Hawkesbury Road On-load Ramp - Forward Strategy Report" dated August 1996.

Table 6 Entry Ramp to the Great Western Highway

	Traffic Volumes
1997 Average Daily Traffic	7,550
2007 Average Daily Traffic	8,400

5.2 TRAFFIC NOISE PREDICTION MODEL

Traffic noise levels were calculated using a traffic noise prediction model called the 1988 version of the United Kingdom, Department of Transport, Calculation Of Road Traffic Noise (1988 UK DoT CORTN). This is the RTA's preferred method of calculation. The 1988 UK DoT CORTN method incorporates all the procedures and algorithms of the former 1975 UK DoE CORTN method along with the provisions for a wider variety of road surface textures and other amendments. In addition, amendments have been made for Australian topography and road surface conditions. These amendments are outlined in Appendix B of the RTA's Environment Manual, Volume 2. A two height model was assumed for all calculations.

As the CORTN model calculates L_{10} (18 hours) levels, the equivalent L_{eq} (24 hours) was determined by subtracting the difference between the average measured L_{10} (18 hours) and the L_{eq} (24 hours) levels.

Traffic noise prediction calculations were based on dense-graded asphaltic surface.

5.3 TRAFFIC NOISE PREDICTION RESULTS

Traffic noise calculations were undertaken for the three measurement sites to:

- calibrate the predicted levels for the year 1996 with the measured levels;
- determine whether traffic noise levels will exceed the EPA's goal of 63 dB(A) L_{10} (18 hours), which is approximately equal to the RTA's Base Noise Level Objectives of daytime 60 dB(A) L_{eq} (24 hours) and night time 55 dB(A) L_{eq} (8 hours);
- determine whether traffic noise levels will exceed the RTA's Noise Level Objectives, and
- determine the traffic noise reduction that will be achieved for barriers of different heights placed along the property boundary lines or at more effective locations between the source and the receiver.

Traffic noise barrier calculations were undertaken for two traffic volume scenarios, ie 2% and 3.5% linear growth up to the year 2007 for the Great Western Highway. The effect of barriers of different heights were calculated in 0.5 metres high increments between 1 and 4 metres.

The predicted traffic noise levels for the year 1997 with existing traffic conditions was calculated to be 0.1 dB(A) higher for both 1 and 4 Hawkesbury Road, Springwood.

Table 7 is a summary of the predicted traffic noise level results for No. 1, No. 4 Hawkesbury Road and No. 8-10 Plana Crescent, Springwood, respectively.

Table 7 Barrier Heights and Noise Attenuation for No. 1 and No. 4 Hawkesbury Road, and No. 8-10 Plana Crescent, Springwood. Results based on 2% Linear Growth for traffic along the Great Western Highway up to the year 2007

	Summary of the Measured L_{eq} (24 hours) and the Predicted L_{eq} (24 hours) Traffic Noise Level Based on a 2% Linear Traffic Growth for Traffic Along the Freat Western Highway [dB(A)]		
Assessment Site	1 Hawkesbury Road	4 Hawkesbury Road	8-10 Plana Crescent (1)
Measured 1996	62	65	61
Predicted 1997 Pre-construction	62	65	61
Predicted 2007	63	66	65
Traffic Noise Increase **(2)**	1	1	4
Barrier 1.0 metre, 2007	60	63	62
Barrier 1.5 metre, 2007	58	59	59
Barrier 2.0 metre, 2007	56	55	58
Barrier 2.5 metre, 2007	54	52	56
Barrier 3.0 metre, 2007	53	51	55
Barrier 3.5 metre, 2007	52	49	54
Barrier 4.0 metre, 2007	51	48	53

(1) The calculated L_{eq} (24 hours) traffic noise level at 8-10 Plana Crescent was determined by subtracting 3 dB(A) from the measured/calculated L_{10} (18 hours) level of 64 dB(A). It has been found from experience, that for highway conditions, the difference between the L_{10} (18 hours) and the L_{eq} (24 hours) is approximately 3 dB(A).

(2) Traffic noise increase between the year 1997 (before road construction begins) and the year 2007 (10 years after the completion of all road upgrades).

Koikas Acoustics Pty Ltd has undertaken several traffic noise assessments for before and after the installation of traffic lights. The results suggest that 1 dB(A) noise reduction would occur with the installation of traffic lights when compared to free flowing traffic.

An article was prepared by P. T. Lewis and A. James on "Noise Levels In The Vicinity Of Traffic Roundabouts" which is published in the Journal of Sound and Vibration (1980) 72(1), 51-69. In general, these results show that "noise from the accelerating traffic streams is within ±1 dB(A) of the free flow level on the same road and that the noise from the decelerating stream is equal to or less than the free flow level".

6. RESULTS OF TRAFFIC NOISE PREDICTIONS

It is noted here, that the difference between measured L_{eq} (24 hours) and the L_{eq} (8 hours) noise levels at No. 1 and No. 4 Hawkesbury Road is 4.7 and 5.3 dB(A), respectively. At No. 8-10 Plana Crescent it is estimated that the difference is approximately 2.5 dB(A) because of the high volume of heavy vehicles using the Great Western Highway during the evening hours. Therefore, in order to achieve the RTA's base night time Noise Level Objective (NLO), daytime NLO should be about 2.5 dB(A) lower for 8 - 10 Plana Crescent.

As the difference between the L_{10} (18 hours) and the L_{eq} (24 hours) is about 3.2 dB(A) for No. 1 Hawkesbury Road, 3.8 dB(A) for No. 4 Hawkesbury Road, and 3 dB(A) for No. 8-10 Plana Crescent, the EPA's Goal of 63 dB(A) L_{10} (18 hours) and the RTA's NLO for night time 55 dB(A) L_{eq} (8 hours) would be met provided that the barrier heights for these sites are:

- 1.0 metre high barrier at No. 1 Hawkesbury Road placed 5.5 metres from the building's front facade. The extent of this barrier would be required along the full length of the front boundary line and, approximately 5 metres along the northern boundary line and 10 metres along the southern boundary line. The reduced level on top of the noise barrier along the northern and southern boundaries should be the same as the western barrier.
- 1.5 metre high barrier at No. 4 Hawkesbury Road placed 10 metres from the building's front facade. The extent of this barrier would be required along the periphery of the Hawkesbury Road and Silva Road boundary.
- 2.5 metre high barrier would be required along the top of the reinforced soil wall of the proposed ramp. It is noted, that the entry ramp would provide some noise relief from highway noise. The extent of the parapet shown on the Draft Plan No. 0005.044.CD.0014 would satisfactorily attenuate ramp traffic noise to 8-10 Plana Crescent, 1 Hawkesbury Road and to residential properties along the southern side of Eucalypt Road.

In this assessment, the EPA's TNL 55 was not further considered as it only applies to "limited access roads" such as Motorways.

If these road upgrades are assessed in accordance with the RTA's Noise Level Objectives, then mitigation measures would only be warranted for 8-10 Plana Crescent as the traffic noise increase at this site is expected to be 4 dB(A). A traffic noise increase of less than 0.5 dB(A) would occur for the case where a 3.5% linear traffic growth occurs along the Great Western Highway.

7. CONSTRUCTION NOISE ASSESSMENT

Construction noise could cause a variety of problems for residents, such as interference with speech communication, disturbance of work or leisure, disturbance of sleep and possible effects of physical and mental health.

The level of disturbance would depend on the following:

- the difference between the intrusive nature of the noise source and the existing background noise level;
- the distance between the noise source to the receiver;
- the duration of the noisy work, and
- the nature of the noise.

The Environment Protection Authority (EPA) recognises that construction and demolition operations are typically noisy. However, if these activities are of short duration, exceeding noise levels are accepted provided the adjustments to measured values are met, as discussed in Chapter 82-3 of the EPA Environmental Noise Control Manual. The EPA criteria for construction noise are as follows:

- for a construction period of 4 weeks or less, the L_{10} (20 minutes) noise level must not exceed the background noise level during the scheduled daytime hours by more than 20 dB(A);
- for a construction period of between 4 and 26 weeks, the L_{10} (20 minutes) level must not be exceeded by more than 10 dB(A); and
- for a construction period of greater than 26 weeks, the L_{10} (20 minutes) levels must not be exceeded by more than 5 dB(A).

These criteria are rarely met as in most cases the character of noise emitted from various plant and equipment during construction activities cannot always be shielded by practical means. For example, earth moving equipment are not normally stationary and the duration of a particular activity may vary between 15 minutes and in some cases by a whole working day.

For those instances where noisy plant and equipment are used, it is recommended that they be operated during specific daytime periods corresponding to the highest background noise level period. Also, it is recommended that residents are warned in advance of noisy construction periods so that they can plan their daily work and leisure periods accordingly.

7.1 EXISTING BACKGROUND NOISE LEVELS

Measurements of traffic noise were used to determine the ambient background noise levels. Background noise levels along Hawkesbury Road remain constantly high for normal working days. Minimum repeatable daytime background noise levels for properties along Hawkesbury Road are about 51 and 54 dB(A) at numbers 1 and 4 Hawkesbury Road respectively. As long term measurements were not taken at 8-10 Plana Crescent, it has been estimated that the minimum repeatable background noise level is about 50 dB(A).

It is expected that construction of the ramp would take more than 26 weeks to be completed outside No. 8-10 Plana Crescent, Springwood. Therefore, the maximum permissible construction noise levels for this site would be 55 dB(A).

7.2 CONSTRUCTION ACTIVITIES

The RTA propose to undertake major road construction work over a number of scheduled stages. It is likely that only some construction activities would exceed the background levels by more than 20 dB(A). The residence at 8-10 Plana Crescent would most likely be affected by construction activities such as the demolition of the boundary fence and the compaction and excavation of earth to construct the entry ramp.

It would be required that a noise barrier at least 1 metre higher than the exhaust stack of any earth moving plant be erected along the property boundary prior to the roadworks to ensure the EPA criteria for construction noise is not exceeded.

Construction equipment expected to be used on-site includes the following mobile plant and equipment as required:

- front end loaders
- excavation plant
- back hoes
- trenching machines
- chain saws
- jack hammers
- dump trucks
- bulldozers
- low loader transporters
- graders
- vibrating rollers
- concrete agitator trucks
- concrete and asphaltic paving machines
- water tanker
- road sweeper
- line marking vehicles
- trucks delivering construction materials
- light commercial and passenger vehicles.

Construction of the ramp would follow normal road and ramp works procedures including the following general sequence of activities:

- installation of temporary erosion, sedimentation and drainage controls;
- removal of vegetation to a waste disposal area;
- relocation of all affected utilities and services to suit construction programme requirements;
- drainage lines excavated by backhoe or excavator;
- topsoil stripped and stockpiled on-site by bulldozers, graders, loaders and trucks;
- surface preparation by graders;
- recycling of suitable excavated material and incorporation of unsuitable material in earthworks within the road reserve;
- import of select material for earthworks for the ramp abutments;
- compaction by rollers and vibrating compactors with trimming by graders;

- batched concrete and asphalt placed on-site by pavers, autograde machines and graders and compacted by rollers;
- application of asphaltic concrete wearing surface by pavers and rollers;
- planting for revegetation and landscaping along the ramp;
- installation of line marking, lighting, sign structures and sign posting;
- site clean up and disposal of all surplus waste materials; and
- commissioning.

7.3 SOUND SOURCES

Sound measurements of some plant and equipment proposed for use for the construction phase of the road works have been measured by Koikas Acoustics Pty Ltd at other road construction sites.

Table 8 is a summary of 1/1 octave band sound pressure levels of some plant and equipment taken 7 metres from the sound source centre. The summary includes the measured L_{Aeq} 1/1 octave band (i.e. the continuous equivalent sound pressure level A-frequency and Fast-time weighted 1/1 octave band levels), total L_{Aeq} (i.e. the continuous equivalent A-frequency and Fast-time weighted noise levels), L_{Amax} (ie. the maximum A-frequency and Fast-time weighted levels) and the L_{WA} (i.e. the sound power level of some plant and equipment likely to be used during construction.

7.4 RESULTS OF PREDICTED CONSTRUCTION NOISE LEVELS

The closest residential dwelling from jack hammers, vibratory rollers and other noisy equipment is likely to be about 10 to 12 metres from the dwellings of No. 1 Hawkesbury Road and No. 8-10 Plana Crescent, Springwood.

The loudest construction noise level is expected to occur from jack hammers. At these sites noise levels are expected to be about 100 dB(A). In terms of L_{10} (15 to 20 minutes) levels, that is, the noise that is exceeded for 10 % of the measurement period, noise levels are expected to be about 90 dB(A) with no corrections to facade reflections added.

Other sites would also be adversely affected by such construction activities.

Noise levels emanating from the construction site to the closest residential property boundaries are expected to exceed the EPA's construction noise level limits for the condition where the construction period is less than 4 weeks.

Table 8 Noise Level Measurement Results & Calculated Sound Power Levels

	1/1 OCTAVE BAND AND TOTAL NOISE LEVELS (L_{eq} taken at 7 metres) [dB(A)]												
Frequency [Hertz] / Plant & Equipment	32	63	125	250	500	1k	2k	4k	8k	16k	Total	L_{wA} Sound Power	L_{Amax} (Taken at 7 m)
Cat. 215 Excavator (Impact Hammer)	50	63	75	79	86	93	95	92	84	70	101	126	101
Cat. EL300B Excavator (Impact Hammer)	52	68	74	81	90	89	88	91	81	68	96	121	105
Cat. EL300B Excavator (Exhaust / motor)	33	49	61	72	79	80	80	73	62	51	85	110	86
International 1800 Truck	33	49	52	61	63	72	72	65	59	46	76	101	78
Volvo truck	39	63	59	65	70	72	70	64	56	46	77	101	78
Hind Econo Diesel Truck	37	47	60	63	69	71	68	64	56	51	75	100	77
Jack Pick TEX 33E	40	56	66	70	72	71	78	77	75	67	83	108	85
Jack Hammer DMR 1240	48	56	69	74	80	85	83	85	82	72	90	115	92
Wacker Model VPH70	42	69	73	74	73	72	78	79	78	71	85	110	87
Wacker Werke BS65Y	43	57	62	72	75	75	75	70	66	56	81	106	83
John Deere 670A Grader	43	51	61	66	73	74	75	71	62	48	80	105	81
Ford 9000 Truck	47	52	67	66	67	69	68	67	63	49	76	100	80
Bathyal 194 Roller	55	65	72	69	79	81	83	78	73	61	87	112	86
Ford 555C Front Bucket	49	57	59	60	66	71	69	63	57	46	75	100	91
Ford 555C Front Backhoe	49	57	57	59	68	71	69	63	55	46	74	100	91
Jack Pick S674	50	63	74	78	88	90	89	91	90	85	97	100	114
Jack Pick S661	49	62	74	82	88	90	83	86	87	81	95	120	112
Jack Hammer S1240	46	63	72	77	83	86	88	87	87	80	94	119	110
Compressor Plant	45	60	65	63	55	61	58	51	48	38	70	94	86
Hitachi UH143 Excavator	40	60	66	59	68	71	77	73	65	51	80	105	97
Caterpillar 215 Excavator	39	51	58	63	70	71	71	63	55	43	75	100	92

7.5 NOISE REDUCTION TECHNIQUES

For periods where construction noise activities are likely to take more than 28 days, temporary barriers should be erected as close as practically possible to the earth moving plant and stationary equipment. Barrier heights should be at least 1 metre above the exhaust stack of such plant and be constructed from solid materials capable of attenuating noise levels by at least 20 dB(A) at frequencies in the 125 Hertz 1/1 octave band.

There are many materials that can be used to provide such noise attenuation. These are discussed in detail in the RTA's Noise Barriers and Catalogue of Selection Possibilities compiled in 1991. It is noted here however, that for some noisy activities, construction noise level limits would again not be met as the barriers would only practically attenuate noise by up to 20 dB(A).

8. VIBRATION ASSESSMENT

In the absence of Australian Standards, British Standard 6472 provides guidance on potential disturbance to persons exposed to building vibration in the frequency range of 8 to 80 Hertz, most applicable to excavation equipment and road traffic. In dwellings, adverse comment may arise during day time as a result of continuous floor vibration levels in the order of 0.3 to 0.6 mm/second. At night time the residential criterion is equivalent to a vertical peak vibration level of 0.2 mm/second. However, significantly higher levels of short term vibration can be tolerated by many people for construction projects.

German Standard DIN 4150-Part 3 1986 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The minimum "safe limit" of peak vibration velocity at low frequencies for dwellings is 5 mm/second. Over the frequency range typical vibration in buildings from excavation and construction equipment, the threshold for visible movement of susceptible building contents (for example, plants and hanging pictures) is approximately 0.5 mm/second.

The potential sources of ground vibration in this case are vibratory rollers and jack hammers. The vibration levels from operation of construction plant and equipment should be limited to the levels set out in British Standard 6472 which would be consistent with recommended guidelines set out in Chapter 174 of the Environment Protection Authority's *Environmental Noise Control Manual*.

It is not expected that road construction activities would exceed ground vibration level limits. This is primarily due to the relatively large distance between plant and equipment proposed for use to most residential dwellings. It is recommended that vibration monitoring be undertaken inside residential dwellings, before and during construction work, especially if the earth material required to be broken is hard rock or there is earth compaction activities undertaken with the use of vibratory rollers.

All other construction activities except that from vibratory rollers are unlikely to exceed the human thresholds of discomfort and thus not affect any residential dwelling from structural damage. Structural damage would occur when vibration levels are likely to be about 10 times higher than the human threshold of discomfort. This fact is based on German Standard DIN 4150-Part 3 1986.

It is noted, that most old homes over a period of time would build up structural stresses. These structural stresses can be released by road construction activities in the form of hair-line cracks which are formed along concrete render, plasterboard cornices and ceilings. These hair-line cracks also appear when large temperature gradients exist between indoors and outdoors. Nevertheless, hair-line cracks do not reduce the structural integrity and thus do not give rise to structural damage. Typical vibration levels are included in Table 9.

Table 9 Typical Vibration Levels

Description of Construction Activities	Vibration Levels [mm/s]	Distance [m]
Heavy trucks passing over normal road surface, measured at the footings of building	0.01 to 0.2	10 to 20
Bulldozers operating 5 metres from the dwelling	1.0 to 2.0	5
Vibratory roller (25 Hertz, Low)	0.6 to 2	20 to 30

Levels of ground vibration caused by a 1 to 2 tonne vibratory roller 5 metres from a dwelling is not likely to exceed the maximum recommended structural damage criterion level. It is recommended however, that static load for such rollers be employed in order to minimise the release of hair-line cracks.

9. CONCLUSION

Based on the historical traffic growth in the area, a 2% linear traffic growth is expected up to the year 2007. Should a 3.5% traffic growth occur in that area, a further 1 dB(A) traffic noise level increase predicted for all sites.

9.1 TRAFFIC NOISE LEVELS

The results of the traffic noise survey and the desk top study show that :

1 Hawkesbury Road, Springwood:

* L_{eq} (24 hours) = 61.7 dB(A)
* L_{eq} (8 hours) = 57.0 dB(A)
* L_{10} (18 hours) = 64.9 dB(A)
* The difference between L_{10} (18 hours) and L_{eq} (24 hours) = 3.2 dB(A)
* The difference between L_{eq} (24 hours) and L_{eq} (8 hours) = 4.7 dB(A)
* Based on ultimate traffic growth along Hawkesbury Road up to the year 2007, a 1 metre high barrier would be required to meet the RTA's base daytime and night time noise level objectives and the EPA's goal for arterial roads. This barrier should be placed 5.5 metres from the front facade, ie erected along the same level as the road. The noise barrier would be required along the entire extent of No. 1 Hawkesbury western boundary. The noise barrier would also be required 5 and 10 metres along the northern and southern boundaries, respectively and their reduced levels on top of the barrier should be maintained to those of the western boundary.
* No barriers would be required if the RTA's Interim Traffic Noise Policy is applied. That is, the increase between the pre-construction traffic noise levels for the year 1997, and the traffic noise levels 10 years after the road is built and open to the public in the year 2007, is expected to be less than 3 dB(A).

4 Hawkesbury Road, Springwood:

* L_{eq} (24 hours) = 65.0 dB(A)
* L_{eq} (8 hours) = 59.7 dB(A)
* L_{10} (18 hours) = 68.8 dB(A)
* The difference between L_{10} (18 hours) and L_{eq} (24 hours) = 3.8 dB(A)
* The difference between L_{eq} (24 hours) and L_{eq} (8 hours) = 5.3 dB(A)
* Based on ultimate traffic growth along Hawkesbury Road, up to the year 2007, a 1.5 metres high barrier would be required to meet the RTA's base daytime and night time noise level objectives and the EPA's goal for arterial roads. This barrier should be placed 10 metres from the front facade. This barrier would be required along the edge of the new eastern boundary line of 4 Hawkesbury Road and along the existing Silva Road boundary.
* No barriers would be required if the RTA's Interim Traffic Noise Policy is applied. That is, the increase between the pre-construction traffic noise levels for the year 1997, and the traffic noise levels 10 years after the road is built and open to the public in the year 2007, is expected to be less than 3 dB(A).

8 - 10 Plana Crescent, Springwood:

* L_{eq} (24 hours) = estimated to be about 61 dB(A)
* L_{eq} (8 hours) = estimated to be about 59 dB(A)
* L_{10} (18 hours) = measured/calculated to be 64 dB(A)
* The difference between L_{10} (18 hours) and L_{eq} (24 hours)= 3 dB(A)
* The difference between L_{eq} (24 hours) and L_{eq} (8 hours)= 2.5 dB(A)
* Based on a 2% linear traffic growth along the Great Western Highway up to the year 2007, a 2.5 metre high barrier would be required along the closest distance between the edge of the new eastbound entry ramp and the dwelling on 8-10 Plana Crescent in order to achieve the RTA's base daytime and night time noise level objectives and the EPA's goal for arterial roads. The extent of the barrier shown on the Draft Plan No. 0005.004.CD.0014 should be increased to 2.5 metres to satisfactorily reduce traffic noise along the ramp and noise from the Great Western Highway.
* A 1.0 metre high barrier would be required if the RTA's Interim Traffic Noise Policy is applied. That is, the increase between the pre-construction traffic noise levels for the year 1997, and the traffic noise levels 10 years after the road is built and open to the public in the year 2007, is expected to increase by 4 dB(A) for the case where 2% linear traffic growth occurs on the Great Western Highway. An additional traffic noise increase of up to 0.5 dB(A) is expected for this site if traffic volumes along the Great Western Highway were to increase by 3.5% linear growth up to the year 2007.

The RTA would need to consider if achieving the EPA's goal of 63 dB(A) L_{10} (18 hours) is cost effective and practical. For the case where the RTA's Interim Traffic Noise Policy is adopted, a barrier 1.0 metres high would be required along the entry ramp.

9.2 CONSTRUCTION NOISE LEVELS

Based on the calculated results of the noisiest construction activities, noise levels at the residential properties would exceed the EPA's construction noise limit for the case where the intrusive construction noise level L_{10} can be exceeded by up to 20 dB(A) above the existing background noise level. It is expected that for particular earth moving plant, exceedances would occur even with barriers placed between the source and receiver.

It is therefore recommended that all construction work activities be undertaken as quickly and practically possible to ensure that a minimal disturbance occurs to residents. Furthermore, all noisy activities should be undertaken during the noisiest period of the day ie between 07:00 and 18:00 hours. It is recommended that construction noise monitoring be undertaken to ensure that all construction plant and equipment proposed for use comply with EPA and relevant Australian Standard operating noise limits. Temporary noise barriers should be erected as close as practically possible to noisy construction plant and equipment. Alternatively, construction could be undertaken when residents have on their own accord vacated their premises during normal working hours.

9.3 CONSTRUCTION VIBRATION LEVELS

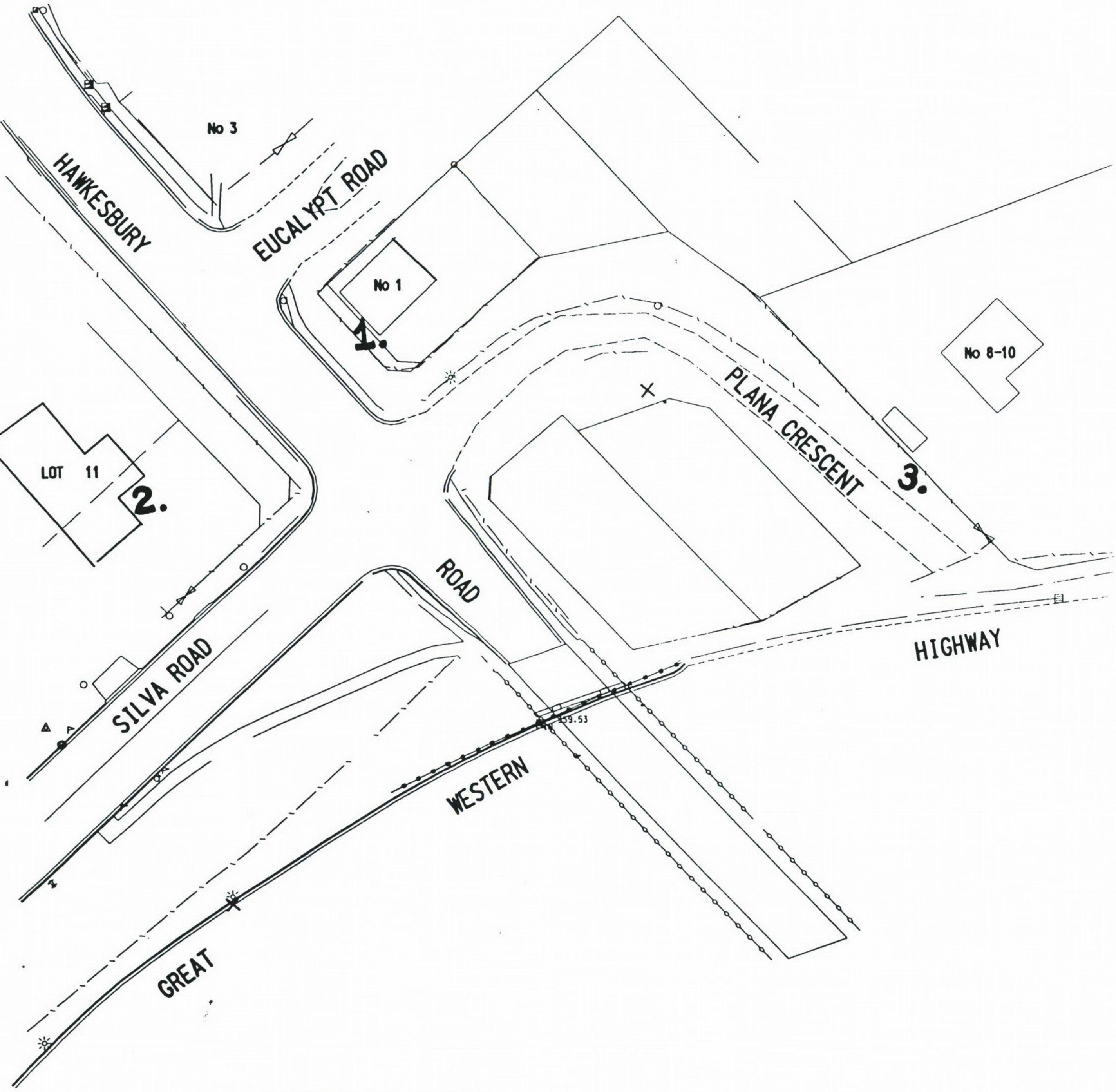
It is unlikely that exceedance of ground vibration level safe limits for building damage would occur. Inevitably however, there would be instances where although vibration level limits would be less than those set out by DIN 4150 Part 3, British Standard 6472 and the Environment Protection Authority, hair-line cracks may appear. These hairline cracks would not reduce the structural integrity of the buildings.

It is recommended that vibration monitoring be undertaken when vibratory rollers, excavators fitted with impact hammers and jack hammers are used for earth compaction and rock breaking in close proximity to residential dwellings.

APPENDIX A

MAP OF THE AREA

LOCATION OF ASSESSMENT SITES



ASSESSMENT SITES:

1. No. 1 Hawkesbury Road, Springwood
2. No. 4 Hawkesbury Road, Springwood
3. Outside residential boundary of No. 8-10 Plana Crescent, Springwood

APPENDIX B

PHOTO 1 Sound level meter located at No. 1 Hawkesbury Road, Springwood.

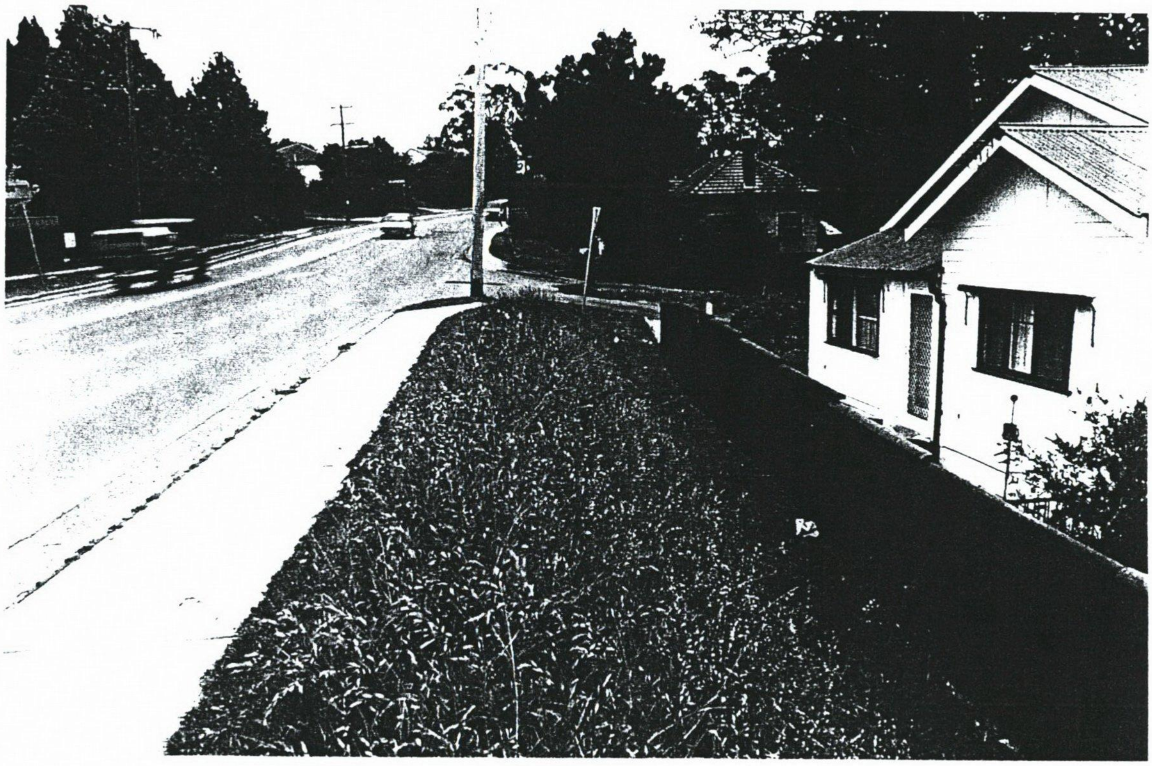
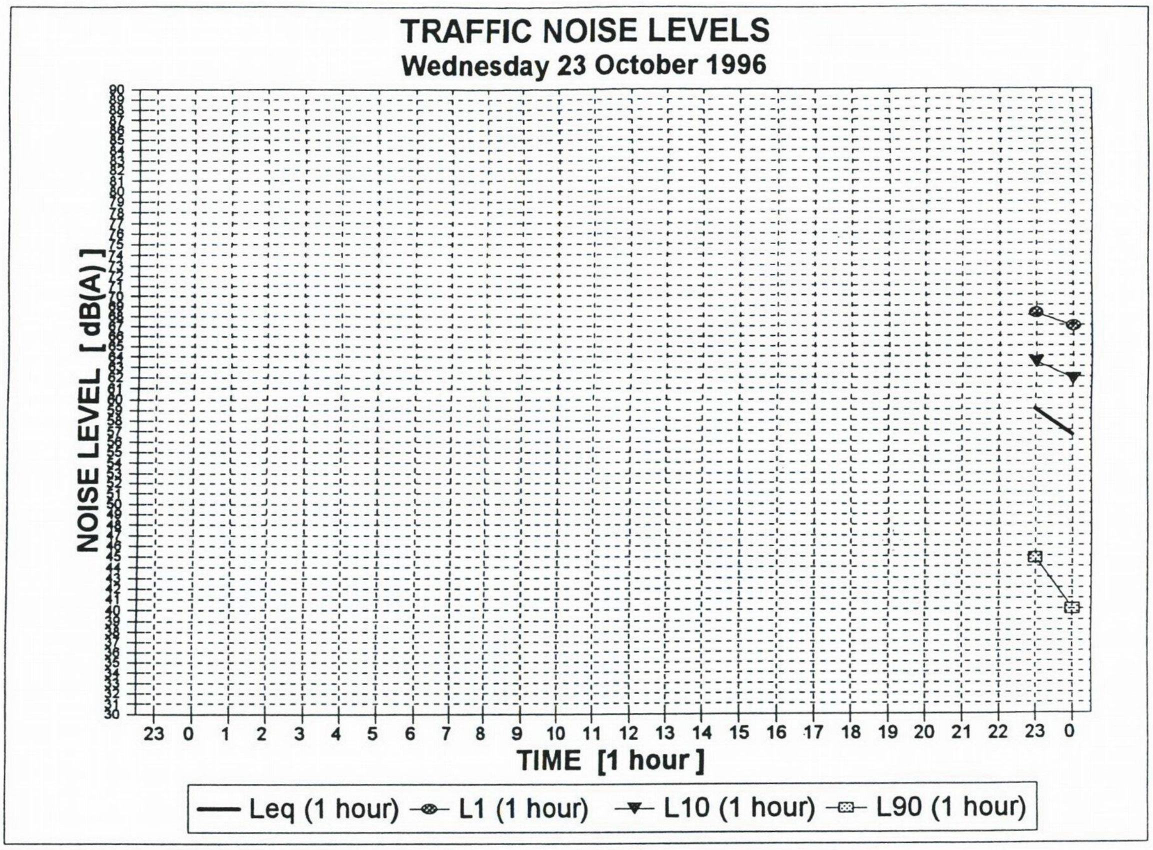


PHOTO 2 Sound level meter located at No. 4 Hawkesbury Road, Springwood.

PHOTO 3 Location of sound level meter, outside the residential boundary of No. 8-10 Plana Crescent, Springwood.

No. 1 Hawkesbury Road, Springwood | **DAY 1**



YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
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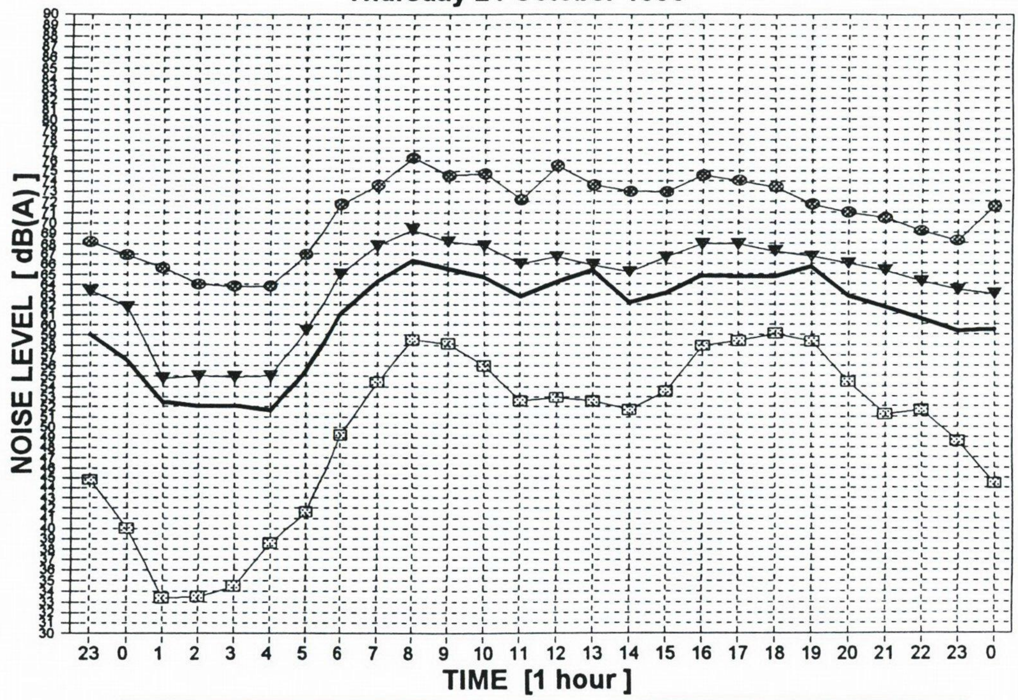
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
1996	1023	2300	59	75.7	68.2	65	63.4	55.1	44.8	33.5
1996	1024	0	56.5	73.9	66.9	63.9	61.8	49	40	31.5

DAY 1	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	-	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	-	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	-	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	-	dB(A)

No. 1 Hawkesbury Road, Springwood	DAY 2

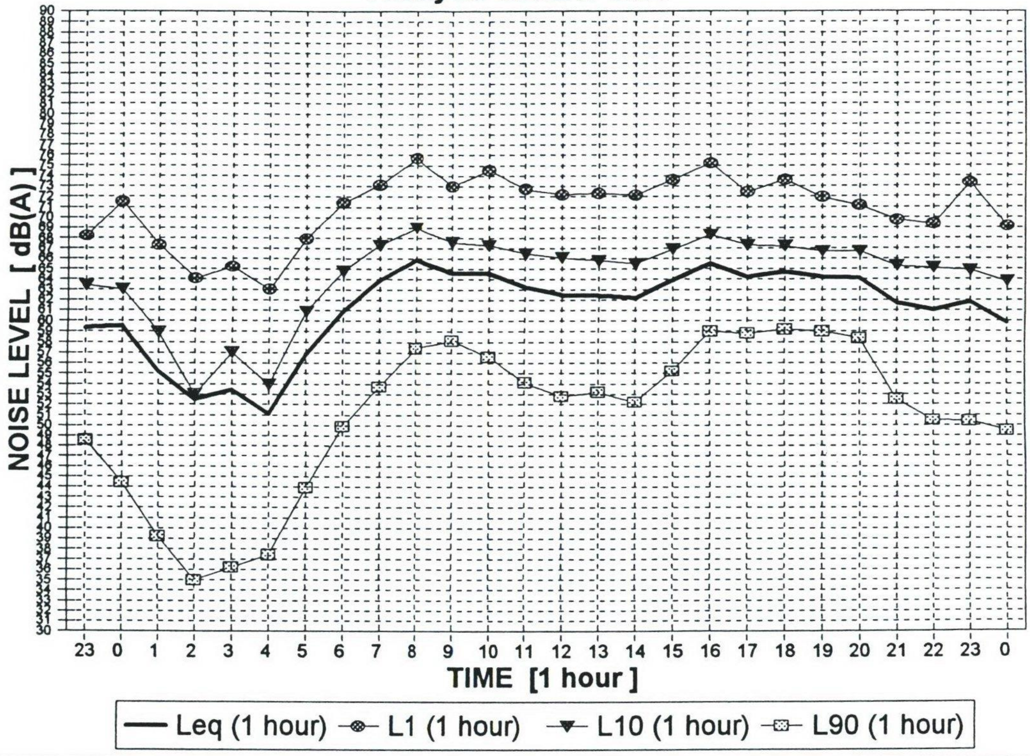


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1023	2300	59	75.7	68.2	65	63.4	55.1	44.8	33.5
1996	1024	0	56.5	73.9	66.9	63.9	61.8	49	40	31.5
1996	1024	100	52.5	72.2	65.6	59.7	54.8	43.4	33.4	29.4
1996	1024	200	52	74	64	59	55	43	33.5	29.9
1996	1024	300	52.1	75.7	63.8	58	54.9	43	34.5	29.9
1996	1024	400	51.6	69.8	63.8	57.4	55	45.3	38.6	35.3
1996	1024	500	55.5	73.4	66.9	62.5	59.4	49.5	41.6	31.3
1996	1024	600	61.1	81.6	71.7	67.1	65	56.2	49.2	43.4
1996	1024	700	64.3	81.1	73.6	69.3	67.8	62.2	54.4	46.1
1996	1024	800	66.3	83.6	76.3	71.4	69.3	64	58.5	47.9
1996	1024	900	65.5	91.7	74.5	70.4	68.2	63.7	58.1	49.4
1996	1024	1000	64.7	87.3	74.7	69.8	67.8	62.4	56	46
1996	1024	1100	62.8	85.5	72.2	67.9	66	60.6	52.6	45.4
1996	1024	1200	64.2	87.9	75.5	69.1	66.7	60.5	52.9	45.7
1996	1024	1300	65.4	92.8	73.6	68.2	65.9	59.9	52.6	44.3
1996	1024	1400	62.2	83.8	73	67.4	65.2	59.3	51.7	42.3
1996	1024	1500	63.1	83.2	72.9	68.8	66.6	60.3	53.5	42.9
1996	1024	1600	64.8	81.9	74.5	70	67.9	62.7	57.9	49.1
1996	1024	1700	64.7	83.4	74	69.9	67.9	62.8	58.4	49.3
1996	1024	1800	64.7	87.5	73.4	68.9	67.2	63.4	59.1	47.3
1996	1024	1900	65.7	93.7	71.7	67.9	66.7	62.9	58.3	47.6
1996	1024	2000	62.8	81	70.9	67.3	66	61.5	54.4	46.1
1996	1024	2100	61.7	79.8	70.4	66.8	65.3	59.5	51.2	43.6
1996	1024	2200	60.5	76.7	69.1	65.6	64.2	58.6	51.6	43.1
1996	1024	2300	59.3	77.7	68.2	65	63.4	56.3	48.6	41.2
1996	1025	0	59.5	79.6	71.5	65.2	63	52.4	44.4	36.5

DAY 2	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**62.9**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**56.4**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**55.6**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**66.4**	dB(A)

No. 1 Hawkesbury Road, Springwood	DAY 3

TRAFFIC NOISE LEVELS
Friday 25 October 1996

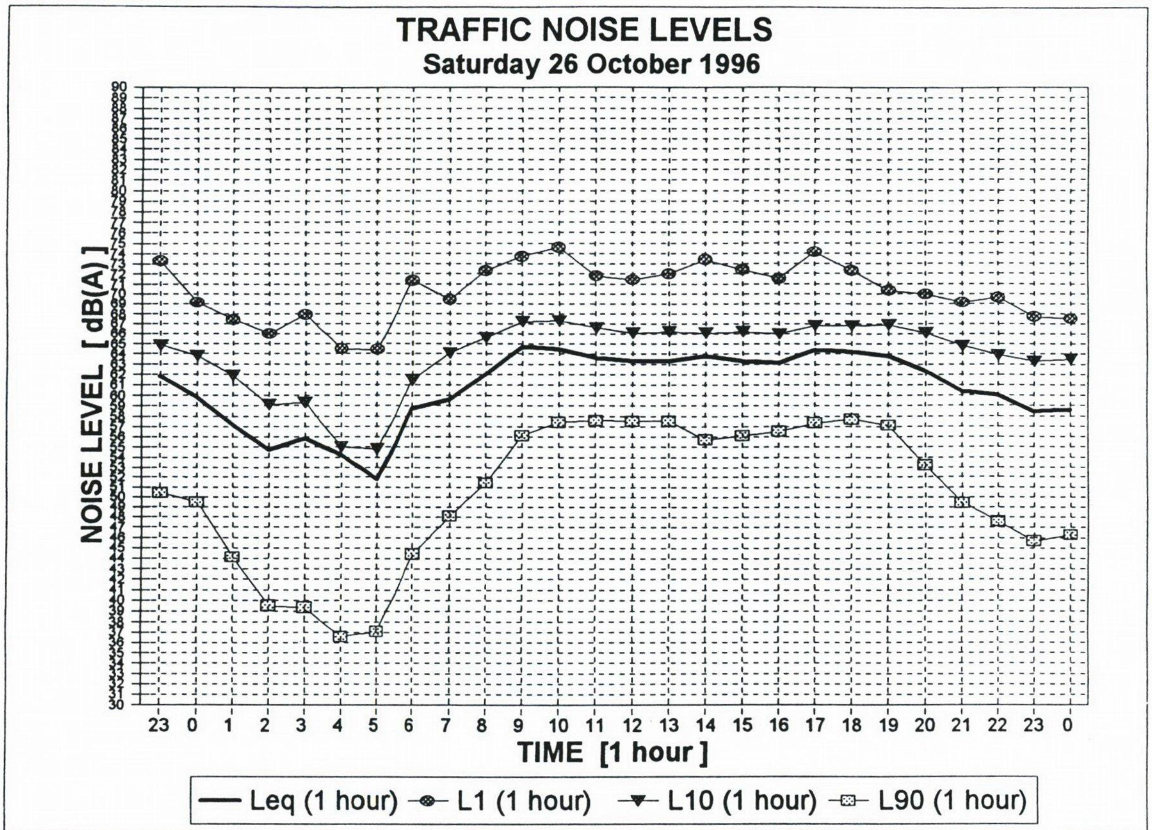


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1024	2300	59.3	77.7	68.2	65	63.4	56.3	48.6	41.2
1996	1025	0	59.5	79.6	71.5	65.2	63	52.4	44.4	36.5
1996	1025	100	55.2	73.7	67.3	62.6	58.9	47.1	39.2	31.3
1996	1025	200	52.5	79.3	64.1	57.3	53	44.5	35	31.1
1996	1025	300	53.4	72	65.2	60	57	46.9	36.2	31.1
1996	1025	400	51.1	74.1	63	56.5	53.9	46	37.4	31.7
1996	1025	500	56.8	75.5	67.9	63.9	60.9	50.9	43.9	33.7
1996	1025	600	60.9	80.2	71.4	66.9	64.8	56.1	49.9	44.7
1996	1025	700	63.9	84	73.1	69	67.3	61.5	53.7	47
1996	1025	800	65.9	87.3	75.7	71.2	69	63.4	57.4	47.8
1996	1025	900	64.6	83.9	73	69.4	67.6	63.1	58.1	47
1996	1025	1000	64.6	89.3	74.5	69.7	67.3	62.6	56.6	47.7
1996	1025	1100	63.2	80.2	72.7	68.6	66.5	61	54.1	45.2
1996	1025	1200	62.5	80.1	72.2	68.1	66.1	60	52.8	45.6
1996	1025	1300	62.4	79.6	72.3	67.9	65.8	60.1	53.2	45
1996	1025	1400	62.2	80.1	72.1	67.6	65.5	59.6	52.2	43.6
1996	1025	1500	63.9	84.1	73.6	69.2	66.9	61.3	55.2	46.2
1996	1025	1600	65.5	84.9	75.2	70.5	68.3	63.4	59	49.6
1996	1025	1700	64.2	81.1	72.4	68.8	67.3	63.2	58.8	51.1
1996	1025	1800	64.7	85.7	73.6	68.7	67.2	63.4	59.2	49.6
1996	1025	1900	64.2	87.2	71.9	68	66.7	63.2	59	49.8
1996	1025	2000	64.1	87.2	71.1	67.9	66.7	62.9	58.3	50.6
1996	1025	2100	61.7	85.5	69.7	66.8	65.3	59.8	52.5	43.9
1996	1025	2200	61	76.6	69.3	66.3	65.1	58.8	50.5	43.6
1996	1025	2300	61.8	79.8	73.3	67	64.9	57.6	50.4	42.9
1996	1026	0	59.8	80.2	69.1	65.5	63.8	56.5	49.5	42.5

DAY 3	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**62.6**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**57.3**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**56.1**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**66.5**	dB(A)

No. 1 Hawkesbury Road, Springwood

DAY 4



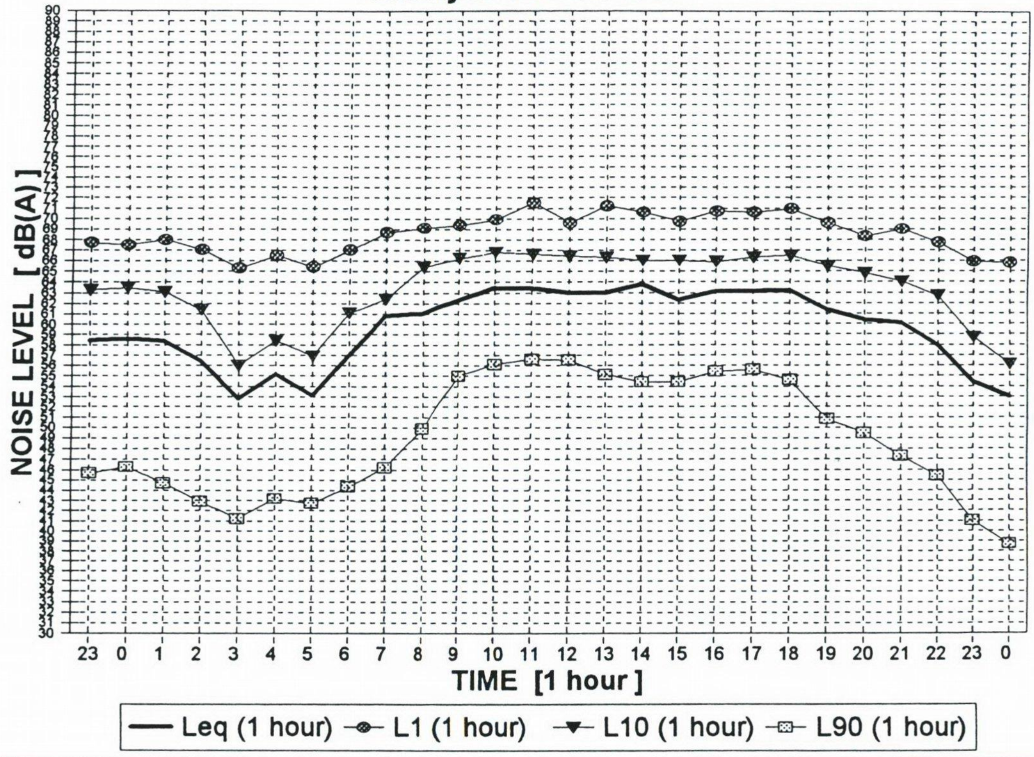
YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1025	2300	61.8	79.8	73.3	67	64.9	57.6	50.4	42.9
1996	1026	0	59.8	80.2	69.1	65.5	63.8	56.5	49.5	42.5
1996	1026	100	57.2	74.9	67.4	63.8	61.9	52.1	44.1	35.8
1996	1026	200	54.7	75.3	66	62.2	59.1	46.5	39.5	33.4
1996	1026	300	55.8	77.7	67.9	62.7	59.3	47.1	39.3	32.7
1996	1026	400	54.2	83.2	64.5	58.1	55	44	36.6	31.4
1996	1026	500	51.8	69	64.4	59.1	54.8	44.2	37.1	30.9
1996	1026	600	58.7	77.9	71.3	64.7	61.5	50.8	44.4	35.9
1996	1026	700	59.6	78	69.4	65.7	64.1	55.2	48.1	41.8
1996	1026	800	62	80.1	72.3	67.5	65.6	58.8	51.4	43.7
1996	1026	900	64.7	93	73.7	68.9	67.2	62.1	56.1	46.8
1996	1026	1000	64.5	83.4	74.6	69.1	67.3	62.5	57.4	48.2
1996	1026	1100	63.6	84.1	71.8	68	66.6	62.4	57.6	47.4
1996	1026	1200	63.3	83.2	71.4	67.4	66.1	62	57.5	49.4
1996	1026	1300	63.3	82.3	72	67.7	66.2	61.9	57.5	49.9
1996	1026	1400	63.8	91.4	73.4	68.1	66.1	61.2	55.7	47.3
1996	1026	1500	63.3	82.9	72.4	68	66.2	61.5	56.1	48.1
1996	1026	1600	63.1	82.8	71.5	67.4	66	61.7	56.5	47.5
1996	1026	1700	64.4	86.8	74.1	68.4	66.8	62.6	57.3	50.1
1996	1026	1800	64.2	85.3	72.3	68.2	66.8	62.7	57.7	47.7
1996	1026	1900	63.8	89.5	70.3	68	66.9	63	57.1	49
1996	1026	2000	62.3	81.1	69.9	67.2	66.1	60.5	53.2	46.2
1996	1026	2100	60.4	77.3	69.1	66.1	64.8	57.4	49.4	40.6
1996	1026	2200	60	79.6	69.6	65.7	63.9	55.7	47.6	42
1996	1026	2300	58.4	74.8	67.7	65	63.3	53.6	45.7	38.2
1996	1027	0	58.6	73.9	67.5	64.8	63.5	54.5	46.3	39.8

DAY 4	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**61.9**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**57.8**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**56.4**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**65.8**	dB(A)

No. 1 Hawkesbury Road, Springwood

DAY 5

TRAFFIC NOISE LEVELS
Sunday 27 October 1996



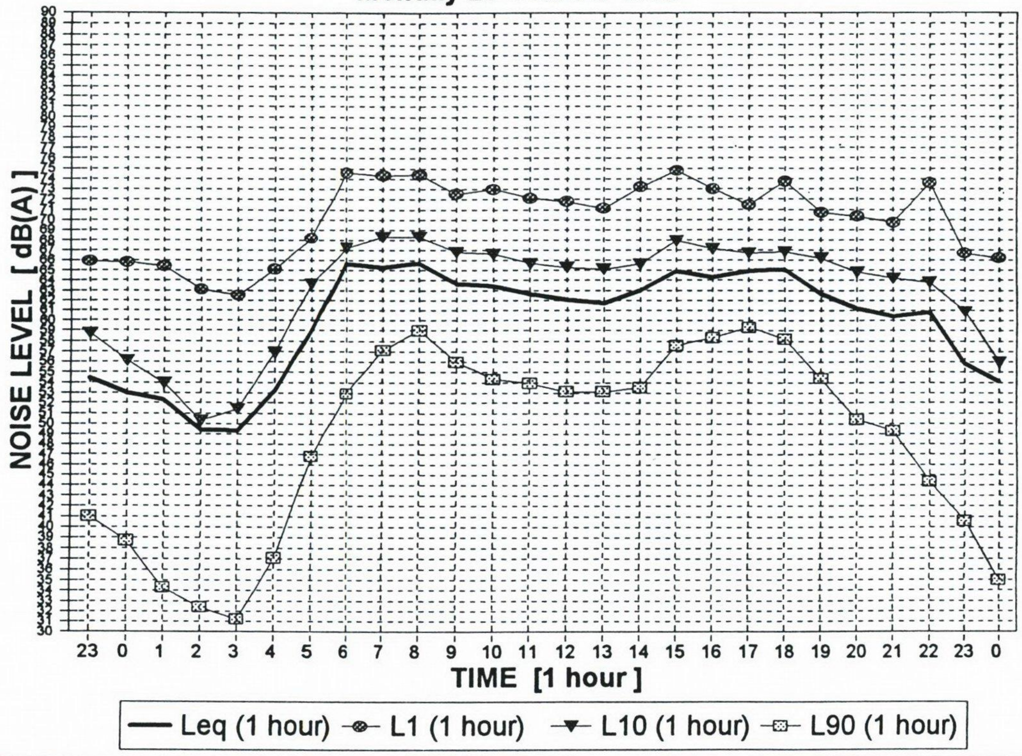
YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1026	2300	58.4	74.8	67.7	65	63.3	53.6	45.7	38.2
1996	1027	0	58.6	73.9	67.5	64.8	63.5	54.5	46.3	39.8
1996	1027	100	58.3	78.3	68	65	63.1	51.8	44.7	39.3
1996	1027	200	56.4	75.2	67	63.7	61.4	48.2	42.9	37.5
1996	1027	300	52.8	78.2	65.3	59.9	56	45	41.2	36.5
1996	1027	400	55.1	77.6	66.5	61.3	58.4	50.1	43.2	37.5
1996	1027	500	53.1	69.3	65.4	59.7	56.9	47.3	42.7	36.9
1996	1027	600	57	81.5	67	63.4	61.1	50.7	44.3	36.5
1996	1027	700	60.8	93.6	68.7	64.4	62.4	53.4	46.2	39.2
1996	1027	800	61.1	83	69.1	66.7	65.4	57.9	49.9	43
1996	1027	900	62.3	78.5	69.4	67.3	66.2	61	55	40.2
1996	1027	1000	63.5	84.2	69.9	67.8	66.8	62.5	56.1	44.5
1996	1027	1100	63.4	82.8	71.5	67.7	66.6	62.2	56.6	48.9
1996	1027	1200	63	76	69.6	67.4	66.4	62.3	56.5	48.7
1996	1027	1300	63	83.8	71.2	67.5	66.3	61.6	55.1	47.1
1996	1027	1400	63.8	94.2	70.6	67.2	66	61.2	54.4	37.8
1996	1027	1500	62.3	76.6	69.7	67.2	66	61.1	54.4	47.3
1996	1027	1600	63.1	85.5	70.7	67.1	65.9	61.7	55.4	48.2
1996	1027	1700	63.1	84.2	70.6	67.5	66.3	61.7	55.6	47.2
1996	1027	1800	63.2	83.7	70.9	67.7	66.5	62	54.6	46.7
1996	1027	1900	61.4	76.2	69.6	67	65.5	59.3	50.8	43.2
1996	1027	2000	60.4	75.3	68.3	66.1	64.8	57.8	49.5	43.2
1996	1027	2100	60.1	90.7	69	65.8	64	55.1	47.3	41.7
1996	1027	2200	57.9	76.3	67.7	64.5	62.7	52.5	45.4	37.6
1996	1027	2300	54.4	73.3	65.9	61.9	58.7	47.3	41	36.4
1996	1028	0	53	73.6	65.8	60.5	56.1	44.3	38.7	33

DAY 5	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**60.9**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**56.7**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**54.9**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**64.6**	dB(A)

No. 1 Hawkesbury Road, Springwood

DAY 6

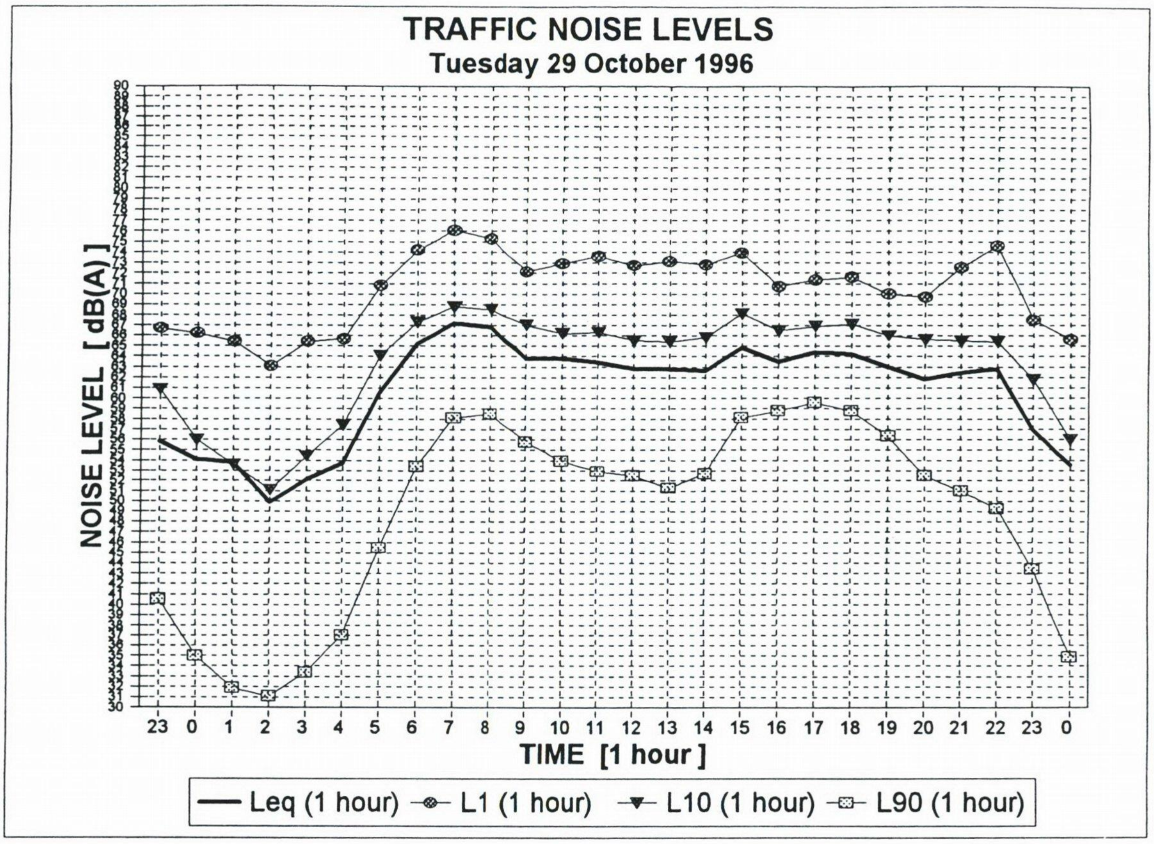
TRAFFIC NOISE LEVELS
Monday 28 October 1996



YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1027	2300	54.4	73.3	65.9	61.9	58.7	47.3	41	36.4
1996	1028	0	53	73.6	65.8	60.5	56.1	44.3	38.7	33
1996	1028	100	52.3	74.7	65.4	58.4	53.9	40.4	34.3	30.6
1996	1028	200	49.4	74.5	63.1	53.9	50.3	39.8	32.4	30.1
1996	1028	300	49.3	70.5	62.5	55.7	51.4	39.5	31.2	29.8
1996	1028	400	53.2	71.4	65.1	59.9	56.9	46.7	37.1	30
1996	1028	500	59	74.8	68.2	65.3	63.6	55.1	46.8	38.5
1996	1028	600	65.6	93.4	74.6	68.8	67.2	61.3	52.9	44.4
1996	1028	700	65.3	88.1	74.3	70	68.3	63.3	57.1	48.6
1996	1028	800	65.7	91.5	74.4	70	68.3	64.2	59	52.7
1996	1028	900	63.7	82	72.5	68.3	66.8	62.4	56	47.1
1996	1028	1000	63.4	82.8	73	68.8	66.6	61	54.3	45.5
1996	1028	1100	62.6	85.9	72.1	67.4	65.7	60.5	53.9	44.1
1996	1028	1200	62.1	80.9	71.8	67.3	65.3	60	53.1	46.3
1996	1028	1300	61.7	82	71.1	66.9	65.1	59.5	53.1	46
1996	1028	1400	63	83.1	73.2	67.9	65.6	60.2	53.5	44.9
1996	1028	1500	64.9	83.9	74.8	70.6	67.9	62.5	57.6	49.2
1996	1028	1600	64.3	80.3	73	68.7	67.1	63	58.3	50.4
1996	1028	1700	64.9	93.3	71.4	67.9	66.7	63.1	59.3	52.5
1996	1028	1800	65.1	92	73.7	68.3	66.8	62.8	58.2	48
1996	1028	1900	62.7	79.2	70.7	67.3	66.2	61.7	54.4	46.6
1996	1028	2000	61.2	79.9	70.3	66.3	64.8	58.5	50.4	40.7
1996	1028	2100	60.4	77.6	69.7	65.9	64.2	57.6	49.3	40.5
1996	1028	2200	60.8	81.3	73.6	65.9	63.8	54.2	44.3	36.5
1996	1028	2300	55.8	74.1	66.7	63.3	60.9	47.9	40.6	31.1
1996	1029	0	54.1	78.2	66.2	60.7	56	44	35	30

DAY 6	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**62.4**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**58.3**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**56**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**65.3**	dB(A)

No. 1 Hawkesbury Road, Springwood | DAY 7



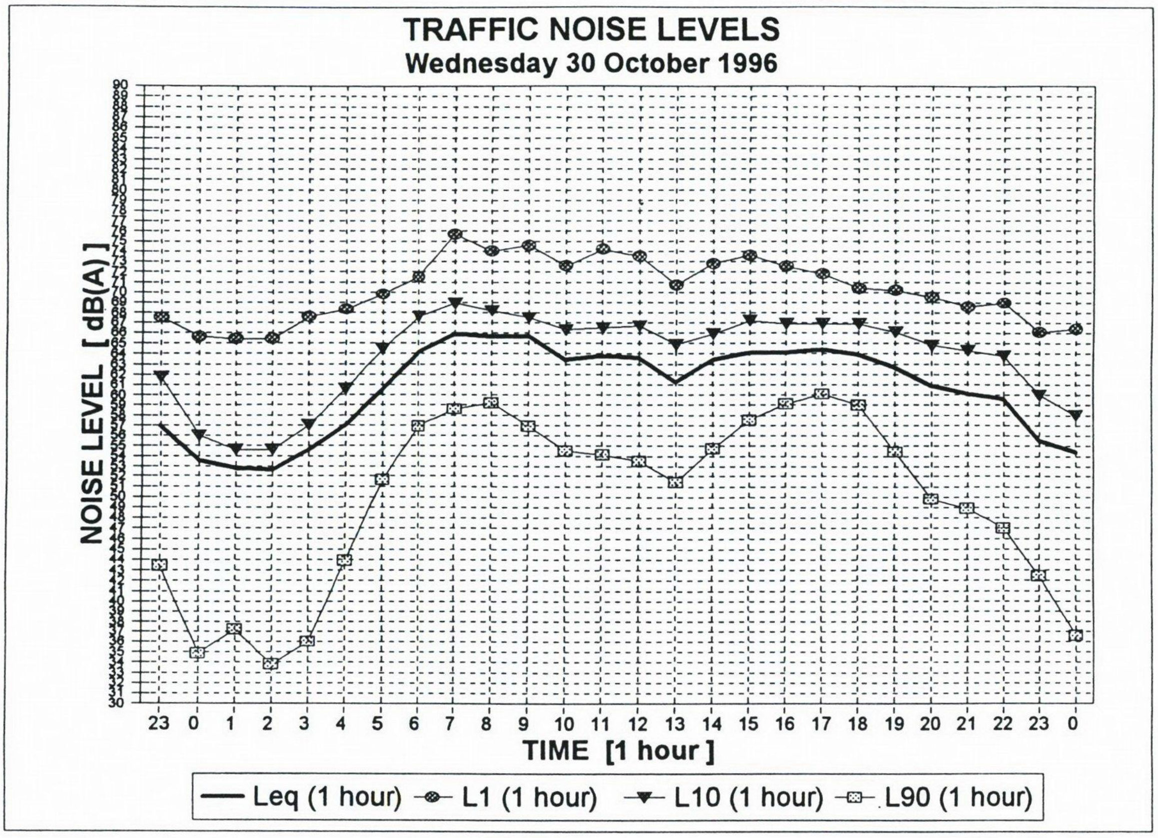
YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1028	2300	55.8	74.1	66.7	63.3	60.9	47.9	40.6	31.1
1996	1029	0	54.1	78.2	66.2	60.7	56	44	35	30
1996	1029	100	53.8	83.1	65.4	57.6	53.6	41.1	31.9	29.7
1996	1029	200	49.9	73.8	63.1	55	51.1	39	31.1	29.8
1996	1029	300	52.1	76.1	65.4	57.3	54.4	44	33.4	30
1996	1029	400	53.7	69.7	65.7	61.2	57.4	46.4	37	30.8
1996	1029	500	60.6	87.7	70.8	66.2	64.1	54	45.5	35.4
1996	1029	600	65.2	92.2	74.2	69.2	67.3	61.3	53.4	44.4
1996	1029	700	67.2	94.5	76.1	70.8	68.8	63.7	58.1	49.6
1996	1029	800	66.8	91.6	75.3	70.3	68.5	63.6	58.5	47.6
1996	1029	900	63.8	85.1	72.1	68.6	67	62.5	55.8	45.8
1996	1029	1000	63.8	92.2	72.9	68	66.2	61	53.9	45.9
1996	1029	1100	63.4	89.5	73.6	68.5	66.3	60.1	52.9	45.1
1996	1029	1200	62.8	87	72.7	67.6	65.5	59.8	52.5	44
1996	1029	1300	62.8	90.2	73.1	67.6	65.4	59.3	51.3	44.6
1996	1029	1400	62.6	79.9	72.8	68.1	65.8	59.9	52.7	44.3
1996	1029	1500	64.8	81.5	73.9	69.8	68.1	63.1	58.1	50.8
1996	1029	1600	63.5	81.2	70.7	67.8	66.5	62.8	58.8	51.1
1996	1029	1700	64.4	87.5	71.3	68.1	66.9	63.3	59.6	52.6
1996	1029	1800	64.2	84.3	71.6	68.3	67.1	63.3	58.8	49.8
1996	1029	1900	63	80	70	67	66	62.8	56.3	45.4
1996	1029	2000	61.8	78.6	69.7	66.8	65.6	60.1	52.5	44.4
1996	1029	2100	62.4	85.9	72.5	67.1	65.5	58.9	51	43.9
1996	1029	2200	62.8	91.8	74.6	67.9	65.4	57.4	49.3	41.6
1996	1029	2300	56.9	76.5	67.5	63.9	61.8	50.7	43.4	31.5
1996	1030	0	53.5	77	65.6	60.6	56	45.8	34.9	30.4

DAY 7	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**62.9**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**58.6**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**55.7**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**65.7**	dB(A)

KOIKAS ACOUSTICS PTY LTD

No. 1 Hawkesbury Road, Springwood

DAY 8

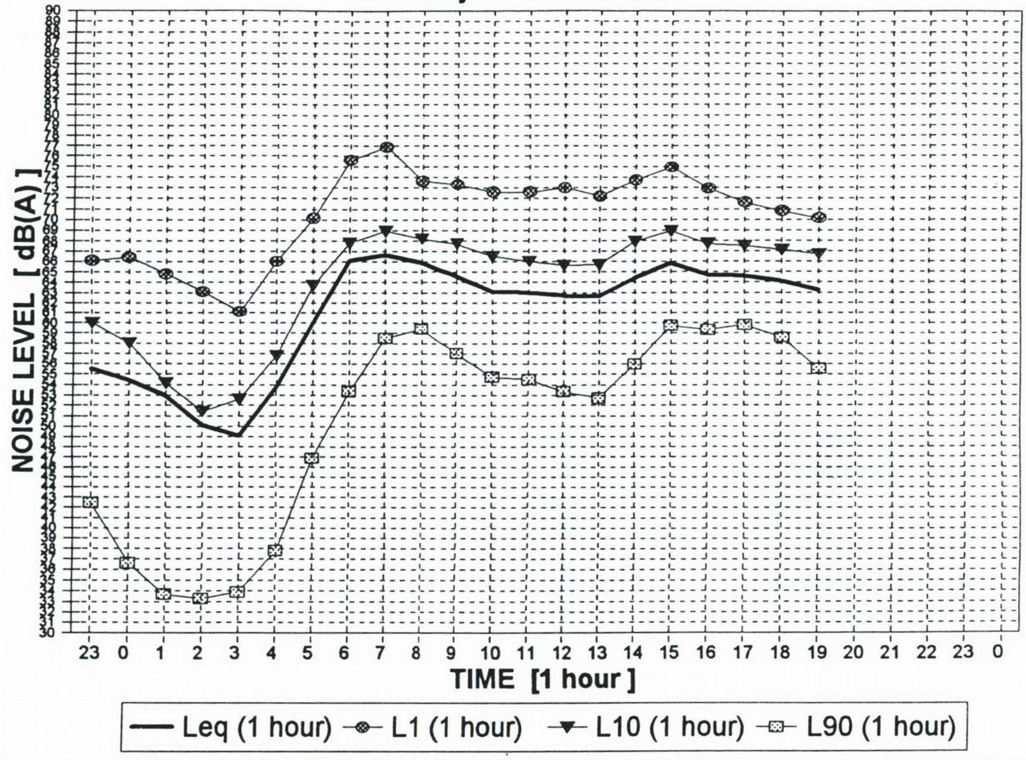


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1029	2300	56.9	76.5	67.5	63.9	61.8	50.7	43.4	31.5
1996	1030	0	53.5	77	65.6	60.6	56	45.8	34.9	30.4
1996	1030	100	52.8	74.6	65.4	59.1	54.6	45.4	37.2	31
1996	1030	200	52.6	75	65.4	58.3	54.6	44.3	33.8	30.1
1996	1030	300	54.6	74.4	67.6	59.8	57	46.9	36	31.4
1996	1030	400	57	77.6	68.3	63.3	60.6	51.9	43.9	33.6
1996	1030	500	60.5	80.6	69.8	66.2	64.4	57.5	51.6	44.1
1996	1030	600	64.1	79.3	71.5	68.9	67.6	62.8	56.9	49
1996	1030	700	65.9	84.9	75.7	71	68.9	63.6	58.6	51.4
1996	1030	800	65.6	91.7	74	70.1	68.2	64	59.2	51.6
1996	1030	900	65.7	93.8	74.6	69.5	67.5	62.7	56.9	49.5
1996	1030	1000	63.4	85.9	72.6	68.3	66.3	60.7	54.5	43.6
1996	1030	1100	63.8	87.9	74.2	68.8	66.5	60.9	54.1	45.3
1996	1030	1200	63.6	88.4	73.5	69	66.7	60.5	53.5	45.3
1996	1030	1300	61.3	77.9	70.7	66.9	64.9	59.1	51.4	42
1996	1030	1400	63.4	88.1	72.8	67.8	65.9	60.3	54.7	47.8
1996	1030	1500	64.1	81.6	73.6	69.3	67.2	62.1	57.5	49.4
1996	1030	1600	64.1	82.4	72.5	68.6	66.9	62.9	59.1	52.6
1996	1030	1700	64.4	90.2	71.8	68.1	66.9	63.4	60.1	53
1996	1030	1800	63.9	78.4	70.4	67.9	66.9	63.4	59	49.7
1996	1030	1900	62.7	80.3	70.2	67.3	66.1	61.7	54.4	44.2
1996	1030	2000	60.9	79.2	69.5	66.2	64.8	58.6	49.8	41.5
1996	1030	2100	60.1	75.6	68.6	65.7	64.3	57.6	48.9	41.6
1996	1030	2200	59.6	82.7	69	65.5	63.8	55.3	47	36.6
1996	1030	2300	55.5	82.7	66.1	62.7	60	49.3	42.4	35.8
1996	1031	0	54.4	76.2	66.4	61.5	58	45.7	36.6	32

DAY 8	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**62.5**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**58.4**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**56.4**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**65.5**	dB(A)

No. 1 Hawkesbury Road, Springwood | DAY 9

TRAFFIC NOISE LEVELS
Thursday 31 October 1996

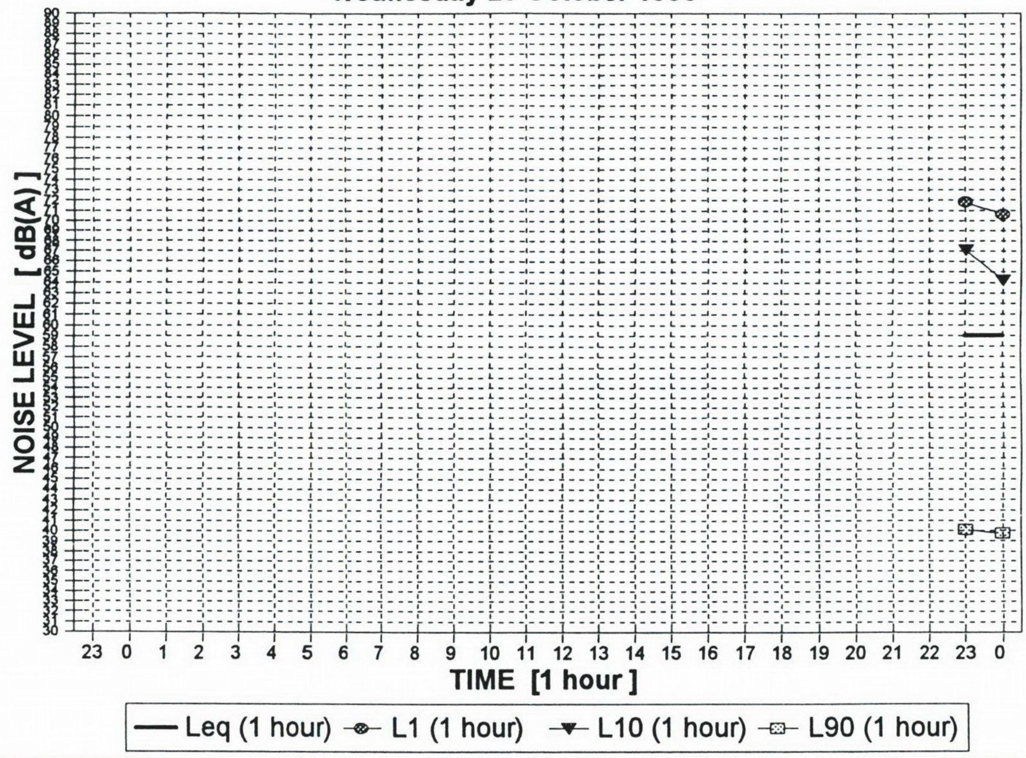


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1030	2300	55.5	82.7	66.1	62.7	60	49.3	42.4	35.8
1996	1031	0	54.4	76.2	66.4	61.5	58	45.7	36.6	32
1996	1031	100	52.9	79.8	64.8	57.6	54.1	42.7	33.7	30.5
1996	1031	200	50.1	74.8	63.1	56.1	51.4	39.6	33.3	31
1996	1031	300	49.1	68.3	61.1	54.9	52.6	41.9	33.9	30.5
1996	1031	400	53.7	72.4	66	60.4	56.8	46.3	37.8	30.9
1996	1031	500	60	87.4	70.1	65.8	63.7	54.7	46.9	40.8
1996	1031	600	66.1	92.8	75.6	69.7	67.8	61.6	53.3	45.4
1996	1031	700	66.6	90.7	76.9	71.1	68.9	63.8	58.5	51.3
1996	1031	800	65.9	92.2	73.6	69.8	68.2	64.1	59.4	51.2
1996	1031	900	64.6	82.9	73.3	69.6	67.7	62.9	57	47.7
1996	1031	1000	63.1	79.6	72.6	68.4	66.5	61	54.7	48.6
1996	1031	1100	63	82.2	72.6	67.9	66	60.8	54.5	46.1
1996	1031	1200	62.7	80.6	73	67.8	65.6	60.4	53.3	43.9
1996	1031	1300	62.6	84.2	72.2	67.9	65.7	60.4	52.7	43.5
1996	1031	1400	64.4	81	73.7	70.2	67.9	62.2	56	48.7
1996	1031	1500	65.8	81.4	74.9	71	68.9	64.1	59.7	51.4
1996	1031	1600	64.7	80.1	72.9	69.1	67.7	63.5	59.3	50
1996	1031	1700	64.6	79.3	71.6	68.6	67.5	63.9	59.8	49.8
1996	1031	1800	64.1	82.8	70.8	68.1	67.1	63.6	58.6	50.7
1996	1031	1900	63.2	78.4	70.1	67.8	66.7	62.4	55.5	47.2
0	0	0	0	0	0	0	0	0	0	45.8
0	0	0	0	0	0	0	0	0	0	45.8
0	0	0	0	0	0	0	0	0	0	45.7
0	0	0	0	0	0	0	0	0	0	43.1
0	0	0	0	0	0	0	0	0	0	41.3

DAY 9	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	-	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**59**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**56.8**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	-	dB(A)

Lot 11 Silva Road, Springwood	DAY 1

TRAFFIC NOISE LEVELS
Wednesday 23 October 1996

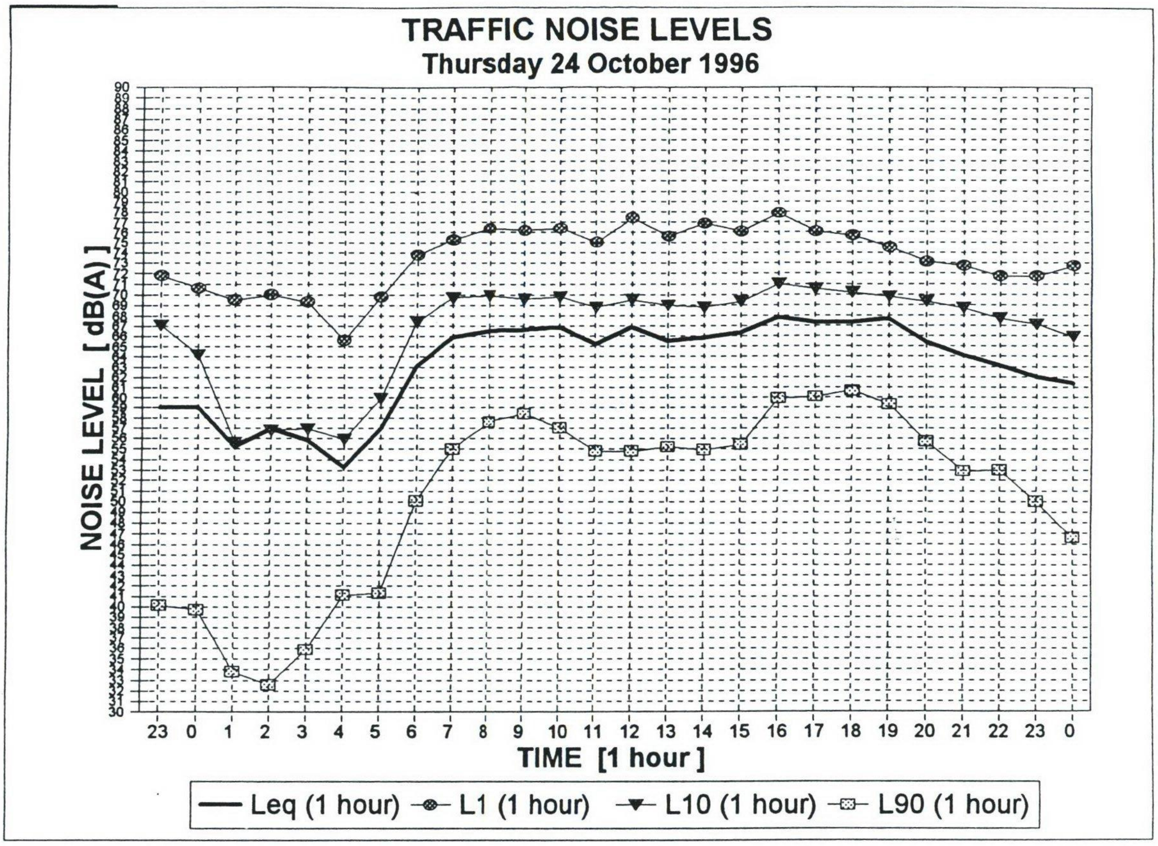


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
1996	1023	2300	59	77.3	71.8	68.8	67.1	55.4	40.1	34.1
1996	1024	0	59	77	70.6	67.4	64.2	49.6	39.7	29.7

DAY 1	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	-	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	-	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	-	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	-	dB(A)

KOIKAS ACOUSTICS PTY LTD

Lot 11 Silva Road, Springwood	DAY 2

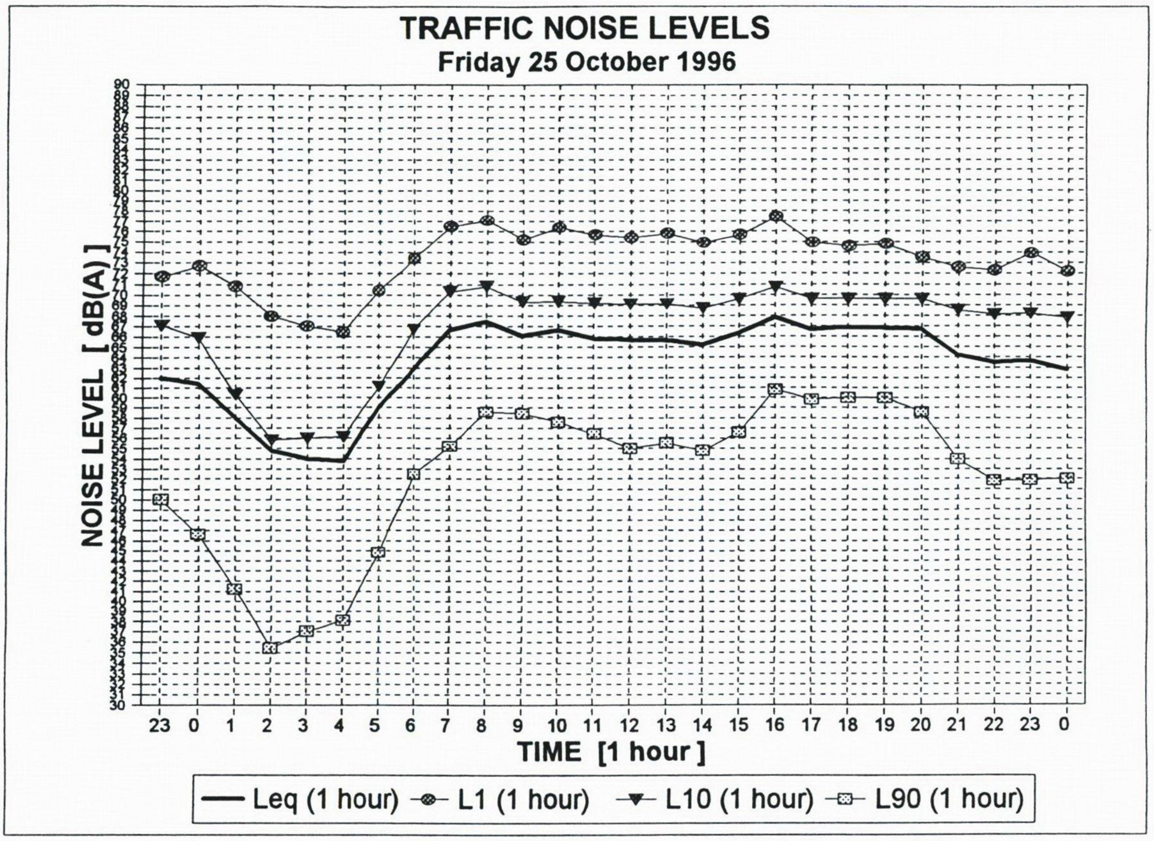


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1023	2300	59	77.3	71.8	68.8	67.1	55.4	40.1	34.1
1996	1024	0	59	77	70.6	67.4	64.2	49.6	39.7	29.7
1996	1024	100	55.2	80.7	69.5	60.5	55.6	44.7	33.8	29.1
1996	1024	200	56.9	79.5	70	60.4	56.8	46.4	32.6	29.6
1996	1024	300	55.8	77.5	69.3	60.9	56.9	45.4	35.9	29.6
1996	1024	400	53.3	74	65.6	58.3	55.9	47	41.1	35.4
1996	1024	500	56.9	73.7	69.8	63.2	59.9	50.1	41.3	30
1996	1024	600	63.1	85.7	73.8	69.8	67.4	57.4	50.1	43.1
1996	1024	700	65.9	88.3	75.3	71.3	69.7	62.6	55	47.5
1996	1024	800	66.5	83.3	76.4	71.9	69.9	64	57.6	47.8
1996	1024	900	66.6	88.6	76.2	71.7	69.6	64.5	58.4	48.4
1996	1024	1000	66.9	91.9	76.4	72.1	69.8	64	57	47.4
1996	1024	1100	65.2	86.2	75	70.5	68.8	62.5	54.8	45.4
1996	1024	1200	66.9	91.7	77.4	71.9	69.5	62.7	54.8	48.4
1996	1024	1300	65.5	83.6	75.6	70.8	69	62.7	55.2	47.2
1996	1024	1400	65.8	85.8	76.9	70.8	68.8	62.6	54.9	48.2
1996	1024	1500	66.3	91.2	76.1	71.3	69.3	63.4	55.4	46
1996	1024	1600	67.8	86.5	77.9	73.1	71	65.7	59.9	51.9
1996	1024	1700	67.3	83.1	76.1	72.4	70.5	65.9	60.1	50.7
1996	1024	1800	67.3	85	75.7	71.6	70.2	66.4	60.7	48.8
1996	1024	1900	67.7	92.2	74.5	71	69.8	65.7	59.3	50.4
1996	1024	2000	65.4	83	73.1	70.4	69.3	63.3	55.7	47.4
1996	1024	2100	64.1	82	72.7	70.1	68.7	60.3	52.9	45.8
1996	1024	2200	63.1	82.7	71.7	69.1	67.7	59.4	53	44.1
1996	1024	2300	62	81	71.7	68.9	67.1	57.1	50	42.5
1996	1025	0	61.4	77.7	72.7	68.4	65.9	54.4	46.6	38.4

DAY 2	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**65**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**58.4**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**57.2**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**69.1**	dB(A)

Lot 11 Silva Road, Springwood

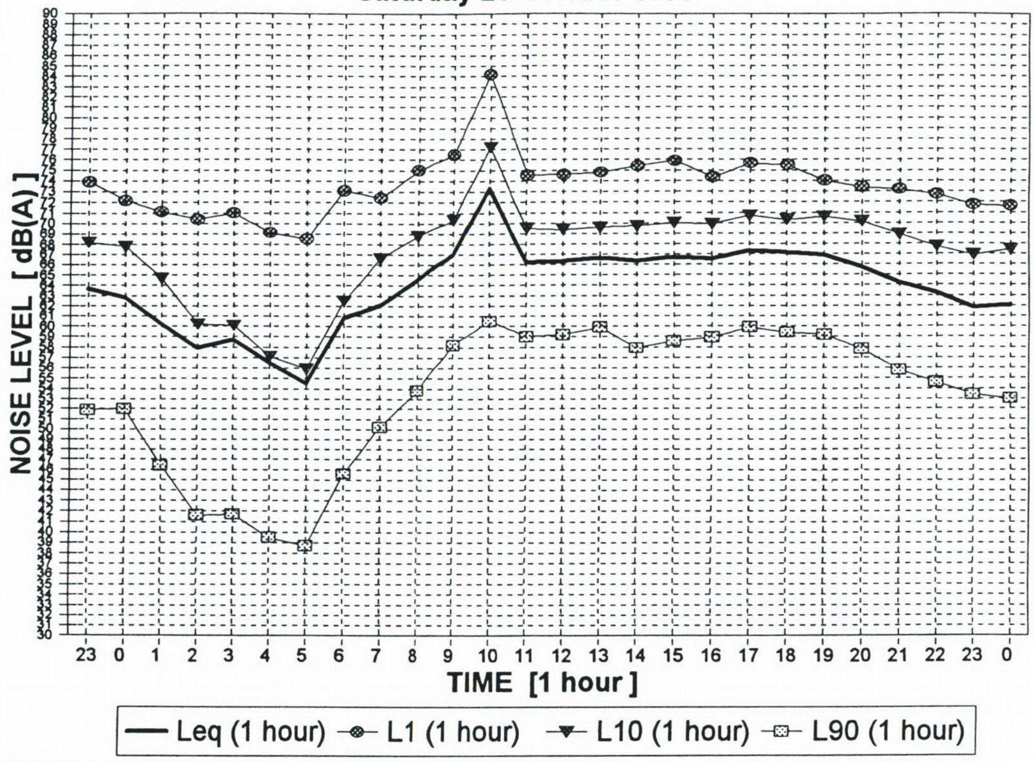
DAY 3



YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1024	2300	62	81	71.7	68.9	67.1	57.1	50	42.5
1996	1025	0	61.4	77.7	72.7	68.4	65.9	54.4	46.6	38.4
1996	1025	100	58	79.9	70.8	65.8	60.3	49.2	41.2	30.1
1996	1025	200	54.8	79	68	58.7	55.8	47.2	35.4	29.9
1996	1025	300	54	77	67	58	56	48	37	30.2
1996	1025	400	53.7	76.3	66.4	57.9	56.1	48	38.1	30.9
1996	1025	500	59	84.5	70.4	64.9	61.1	53.1	44.8	33.7
1996	1025	600	62.9	82.6	73.4	69.3	66.7	57.9	52.4	46.9
1996	1025	700	66.6	86.9	76.5	72.2	70.3	63	55.2	48.1
1996	1025	800	67.4	85	77.1	72.9	70.8	64.9	58.6	47.7
1996	1025	900	66.1	81.7	75.2	70.9	69.3	64.5	58.4	48.2
1996	1025	1000	66.6	91.4	76.4	71.5	69.4	64.3	57.6	48.4
1996	1025	1100	65.8	83.1	75.7	71.1	69.2	63.4	56.4	47.9
1996	1025	1200	65.7	85.3	75.4	71.2	69.1	62.9	55	47.8
1996	1025	1300	65.6	83.6	75.8	70.9	69.1	62.8	55.5	47.1
1996	1025	1400	65.2	84.9	74.9	70.4	68.7	62.4	54.8	48
1996	1025	1500	66.3	84.4	75.7	71.7	69.6	64	56.6	45.2
1996	1025	1600	67.8	89.1	77.4	72.8	70.7	65.8	60.8	50.9
1996	1025	1700	66.6	85.2	74.9	71	69.6	65.4	59.8	51.4
1996	1025	1800	66.9	90.3	74.6	70.8	69.6	65.7	60	52.5
1996	1025	1900	66.8	92.1	74.8	70.9	69.6	65.7	60	51.7
1996	1025	2000	66.7	95	73.5	70.7	69.6	65.4	58.6	51.2
1996	1025	2100	64.2	87	72.6	69.8	68.5	61	53.9	44.6
1996	1025	2200	63.5	79.6	72.3	69.5	68.1	59.6	51.8	43.6
1996	1025	2300	63.7	80.1	73.9	70	68.2	58.9	51.9	44.6
1996	1026	0	62.8	79.4	72.2	69.4	67.8	58.3	52	43.5

DAY 3	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**65**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**59.5**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**57.6**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**69.3**	dB(A)

Lot 11 Silva Road, Springwood	DAY 4

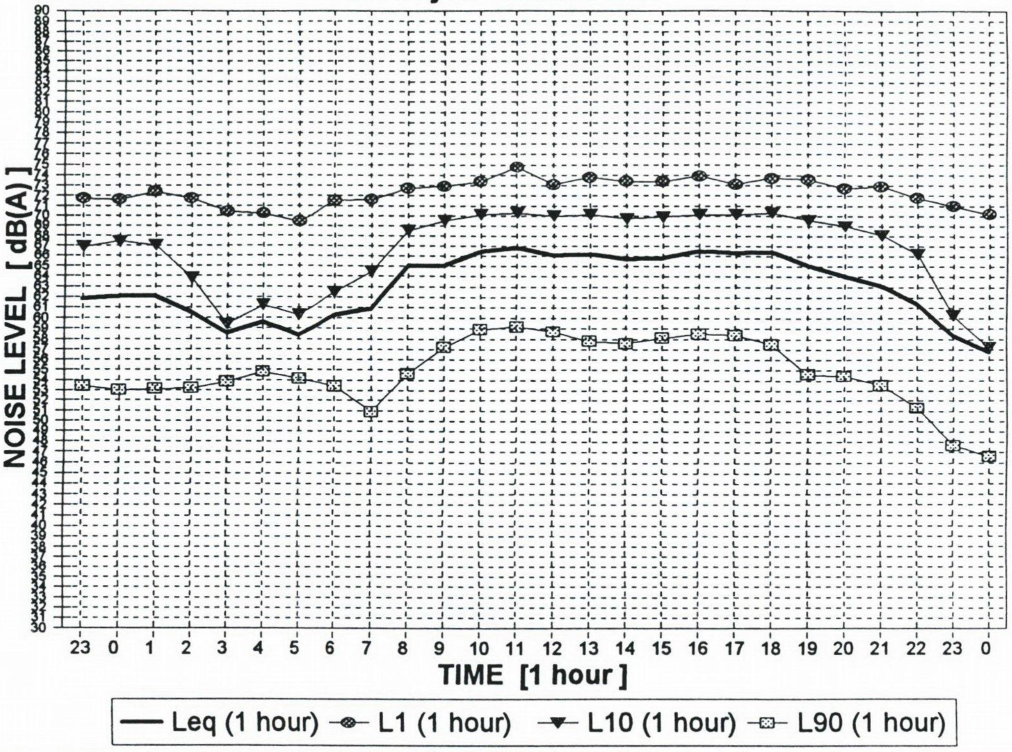


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1025	2300	63.7	80.1	73.9	70	68.2	58.9	51.9	44.6
1996	1026	0	62.8	79.4	72.2	69.4	67.8	58.3	52	43.5
1996	1026	100	60.2	83	71.1	67.6	64.7	54	46.4	37.3
1996	1026	200	57.9	78.7	70.4	65.6	60.2	49.1	41.6	35
1996	1026	300	58.7	83.7	71	64.9	60.1	49.6	41.7	34.3
1996	1026	400	56.5	85.8	69.1	59.8	57.1	47.2	39.5	32.1
1996	1026	500	54.5	73.9	68.5	59.6	55.9	46.5	38.7	31.7
1996	1026	600	60.8	84.5	73.1	66.9	62.5	52.4	45.6	38.3
1996	1026	700	62.1	82.7	72.4	68.9	66.6	56.6	50.2	41.3
1996	1026	800	64.6	82.6	75	70.7	68.8	60.2	53.8	44.7
1996	1026	900	67	89.1	76.5	71.8	70.3	64.3	58.2	48.6
1996	1026	1000	73.3	88.3	84.2	82.1	77.2	67.2	60.5	50.5
1996	1026	1100	66.2	87.1	74.5	70.9	69.5	64.9	59	48
1996	1026	1200	66.3	88.2	74.6	70.6	69.4	64.9	59.2	51.4
1996	1026	1300	66.6	85.5	74.8	70.9	69.6	65.3	59.9	53.2
1996	1026	1400	66.3	82.9	75.4	71.2	69.7	64.4	57.9	50.3
1996	1026	1500	66.7	87.2	75.9	71.5	70	64.7	58.6	51.5
1996	1026	1600	66.5	89.7	74.3	71.2	69.9	64.8	58.9	52
1996	1026	1700	67.3	82.1	75.7	72	70.7	65.6	59.9	53.7
1996	1026	1800	67.1	85.3	75.5	71.6	70.3	65.3	59.4	50.9
1996	1026	1900	66.9	81	74	71.6	70.6	65.5	59.2	52
1996	1026	2000	65.7	79.8	73.4	71.4	70.1	63	57.8	53.3
1996	1026	2100	64.2	81.3	73.2	70.6	68.9	60.2	55.8	50.4
1996	1026	2200	63.2	84.8	72.7	69.6	67.7	58.5	54.6	50.2
1996	1026	2300	61.8	78.2	71.7	69	66.9	57.2	53.4	46.5
1996	1027	0	62.1	78	71.6	69.2	67.4	57.1	53	46.5

DAY 4	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**65.7**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**60.3**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**58.7**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**69.6**	dB(A)

Lot 11 Silva Road, Springwood	DAY 5

TRAFFIC NOISE LEVELS
Sunday 27 October 1996

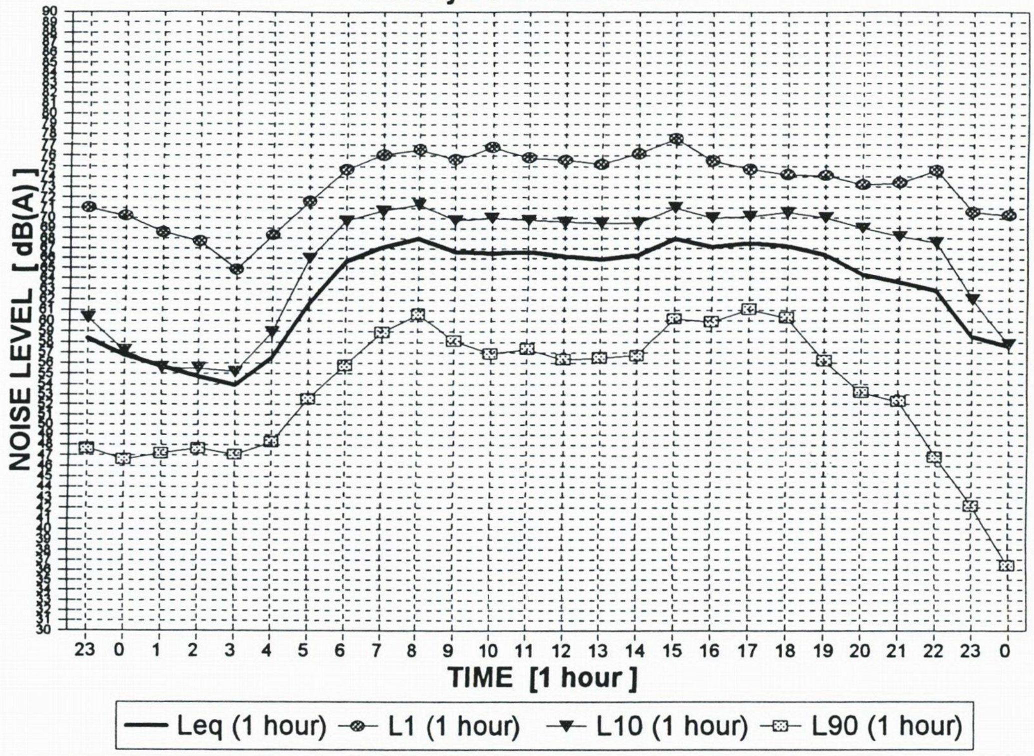


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1026	2300	61.8	78.2	71.7	69	66.9	57.2	53.4	46.5
1996	1027	0	62.1	78	71.6	69.2	67.4	57.1	53	46.5
1996	1027	100	62.1	82.1	72.4	69.3	67	56.3	53.1	46.9
1996	1027	200	60.5	75.9	71.7	68.1	63.8	55.7	53.2	48.4
1996	1027	300	58.5	79.4	70.4	62.2	59.4	55.8	53.8	50.3
1996	1027	400	59.6	80.8	70.2	63.9	61.2	57.2	54.8	50.3
1996	1027	500	58.3	74.4	69.4	62.4	60.3	56.3	54.1	49.7
1996	1027	600	60.3	82.8	71.5	66.3	62.5	56.3	53.4	48.2
1996	1027	700	60.9	85.4	71.6	67.6	64.5	55.8	50.9	41.7
1996	1027	800	65	96.1	72.7	70.1	68.5	59.8	54.6	47.8
1996	1027	900	65.1	78.3	72.9	70.7	69.5	62.8	57.2	50.7
1996	1027	1000	66.4	88.6	73.4	71.1	70.1	64.6	58.9	52.8
1996	1027	1100	66.8	84.7	74.8	71.5	70.3	64.8	59.2	52.6
1996	1027	1200	66.1	79.8	73.1	71	70	64.7	58.7	52.4
1996	1027	1300	66.2	85	73.8	71.3	70.1	63.9	57.8	52.2
1996	1027	1400	65.7	84.2	73.4	71	69.7	63.4	57.6	51.4
1996	1027	1500	65.8	80.1	73.4	71.1	69.9	63.7	58.1	52.8
1996	1027	1600	66.5	85.6	73.9	71.2	70.1	64.7	58.5	51.4
1996	1027	1700	66.3	86.9	73.1	71.2	70.1	64.3	58.4	52.7
1996	1027	1800	66.4	84.9	73.7	71.4	70.3	64.5	57.5	50.7
1996	1027	1900	65.1	93.9	73.6	71	69.6	61	54.6	47.4
1996	1027	2000	64	78	72.7	70.5	69	59.6	54.4	48.1
1996	1027	2100	63.1	83.3	72.9	70.1	68.1	57.7	53.5	46.7
1996	1027	2200	61.4	79.1	71.8	68.9	66.2	55.6	51.3	44.9
1996	1027	2300	58.3	79.5	71	65.2	60.3	51.9	47.7	40.5
1996	1028	0	56.7	78.1	70.2	62.5	57.2	50.1	46.6	39.8

DAY 5	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**64.1**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**60.6**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**57.9**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**68**	dB(A)

Lot 11 Silva Road, Springwood

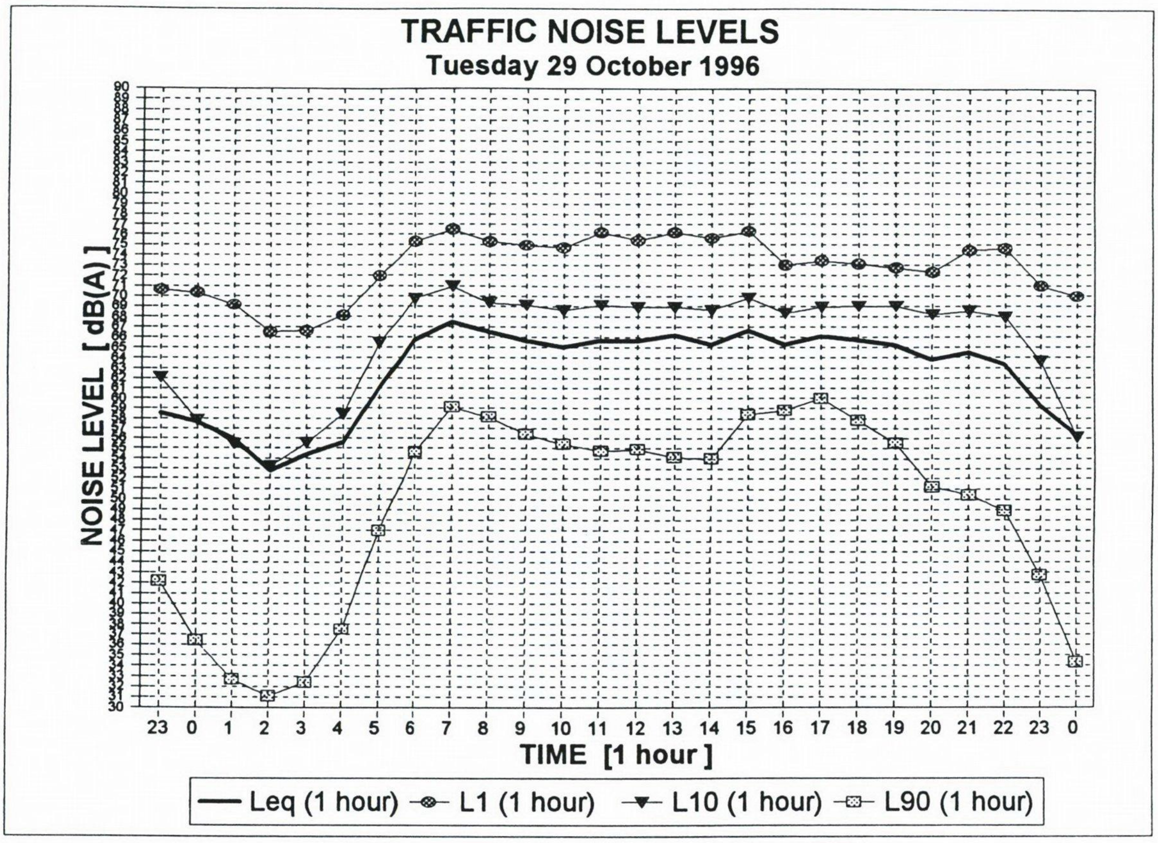
DAY 6



YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1027	2300	58.3	79.5	71	65.2	60.3	51.9	47.7	40.5
1996	1028	0	56.7	78.1	70.2	62.5	57.2	50.1	46.6	39.8
1996	1028	100	55.7	80	68.6	59.2	55.6	50.3	47.2	40.6
1996	1028	200	54.7	77.9	67.7	58.1	55.5	50.8	47.7	38.2
1996	1028	300	53.9	77.4	64.9	57.9	55.2	50.7	47.1	37.2
1996	1028	400	56.5	75.4	68.3	61.7	58.9	52.8	48.3	39.4
1996	1028	500	61.6	76.4	71.6	68.3	66	57.3	52.6	43.5
1996	1028	600	65.7	84.5	74.7	71.1	69.7	62.7	55.8	48.6
1996	1028	700	67.1	85.2	76.1	72.3	70.7	64.9	58.9	49.2
1996	1028	800	68	83.9	76.6	72.9	71.3	66.4	60.7	54.3
1996	1028	900	66.7	90.4	75.7	71.2	69.8	64.7	58.1	51.2
1996	1028	1000	66.5	84	76.8	71.8	70	63.5	56.9	49.6
1996	1028	1100	66.6	93.5	75.8	71.3	69.8	63.9	57.3	46.7
1996	1028	1200	66.2	85.8	75.6	71.2	69.6	63.8	56.3	49
1996	1028	1300	65.9	89.1	75.2	71.1	69.5	63	56.5	50.6
1996	1028	1400	66.3	86.9	76.2	71.2	69.5	63.7	56.7	49.1
1996	1028	1500	67.9	86.4	77.6	73.1	71	66	60.2	52.2
1996	1028	1600	67.1	91.5	75.5	71.4	70	65.8	59.9	52.3
1996	1028	1700	67.5	95	74.7	71.2	70.1	66.3	61.1	51.8
1996	1028	1800	67.2	84.5	74.2	71.6	70.5	66.3	60.3	51.3
1996	1028	1900	66.3	83.8	74.1	71.3	70	64.6	56.2	48.6
1996	1028	2000	64.4	84.1	73.2	70.4	69	60.3	53.2	44
1996	1028	2100	63.7	81.7	73.4	69.8	68.2	59.3	52.3	44.4
1996	1028	2200	62.9	80.6	74.6	69.8	67.6	56.1	46.9	38.4
1996	1028	2300	58.5	77.5	70.6	66.8	62.1	50.1	42.2	33.1
1996	1029	0	57.6	82.8	70.3	63.4	57.8	46.7	36.4	30.1

DAY 6	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**65.2**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**59.8**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**58.5**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**68.7**	dB(A)

Lot 11 Silva Road, Springwood	DAY 7

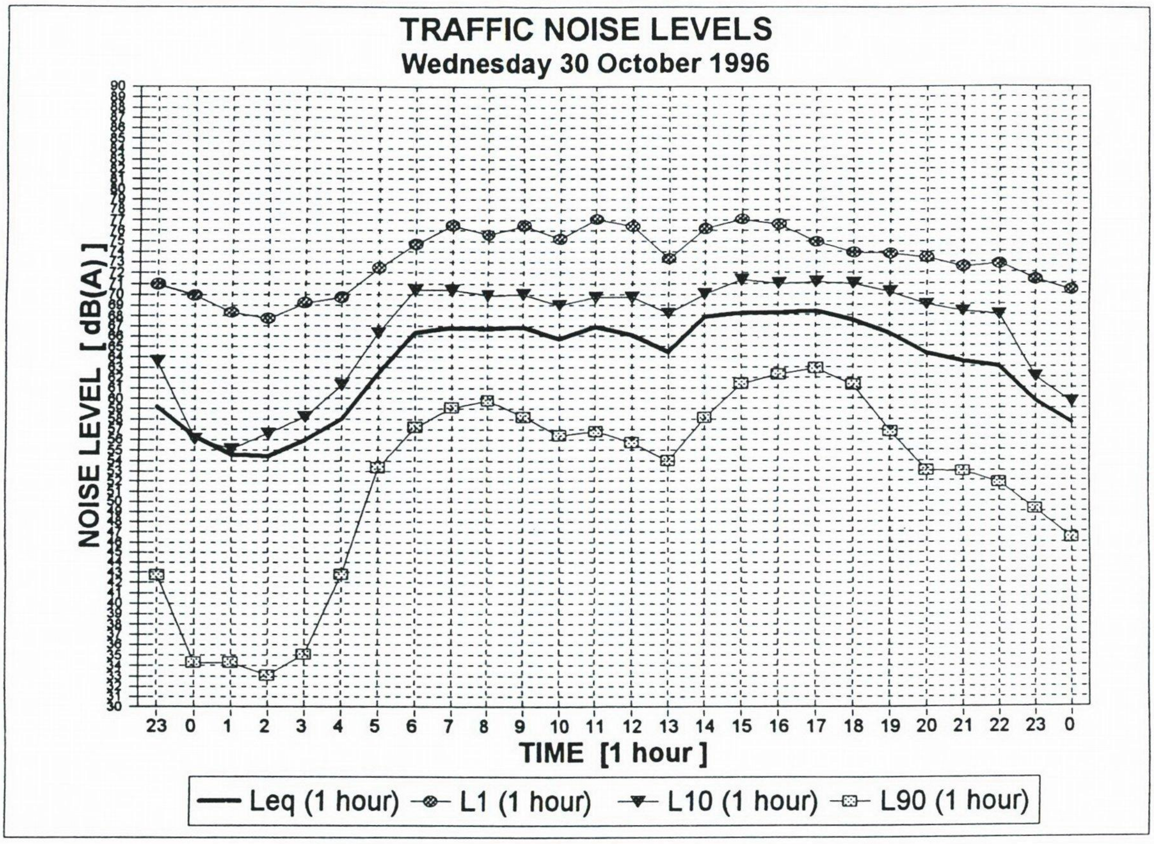


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1028	2300	58.5	77.5	70.6	66.8	62.1	50.1	42.2	33.1
1996	1029	0	57.6	82.8	70.3	63.4	57.8	46.7	36.4	30.1
1996	1029	100	55.9	83.5	69.1	59.1	55.4	43.6	32.7	29.4
1996	1029	200	52.7	77.4	66.5	56.6	53.2	40.1	31.1	29.3
1996	1029	300	54.3	83.1	66.6	58.4	55.5	44.8	32.4	29.2
1996	1029	400	55.6	74.7	68.1	61.8	58.4	48.4	37.5	29.5
1996	1029	500	61	78	71.9	67.9	65.4	55.4	47	36.5
1996	1029	600	65.7	82	75.3	71.5	69.7	62.2	54.6	44.3
1996	1029	700	67.4	86.1	76.5	72.9	70.9	65	59.1	49.8
1996	1029	800	66.5	92	75.3	71.1	69.3	64.1	58.1	48.2
1996	1029	900	65.6	82.4	74.9	70.7	69.1	63.5	56.4	46
1996	1029	1000	65	82.6	74.7	70.3	68.6	62.6	55.4	47.3
1996	1029	1100	65.7	86	76.2	71	69.1	62.3	54.7	47.7
1996	1029	1200	65.6	90.7	75.4	70.7	68.9	62.4	54.9	48.1
1996	1029	1300	66.2	95.7	76.2	70.6	68.9	62.3	54.1	48.1
1996	1029	1400	65.3	81.3	75.6	70.7	68.6	62.5	54	45.6
1996	1029	1500	66.6	82.1	76.3	71.9	69.8	64.6	58.4	50.5
1996	1029	1600	65.3	80.7	73	69.6	68.3	64.3	58.8	50.1
1996	1029	1700	66.1	86.7	73.4	70	68.9	65.2	60	52.1
1996	1029	1800	65.7	84.9	73.1	70	69	64.8	57.8	47.5
1996	1029	1900	65.2	84.7	72.7	70.3	69	63.4	55.5	45.5
1996	1029	2000	63.8	83.7	72.3	69.5	68.2	60.1	51.2	43.3
1996	1029	2100	64.5	88.6	74.4	70	68.5	58.9	50.4	42.3
1996	1029	2200	63.3	79.6	74.6	70	67.9	57.4	48.9	39.7
1996	1029	2300	59.2	78	70.9	67.5	63.6	50.9	42.7	31.2
1996	1030	0	56.3	83.1	69.9	61.1	56.1	45.8	34.3	29.7

DAY 7	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**64.4**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**59.7**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**56.6**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**67.9**	dB(A)

KOIKAS ACOUSTICS PTY LTD

Lot 11 Silva Road, Springwood	DAY 8

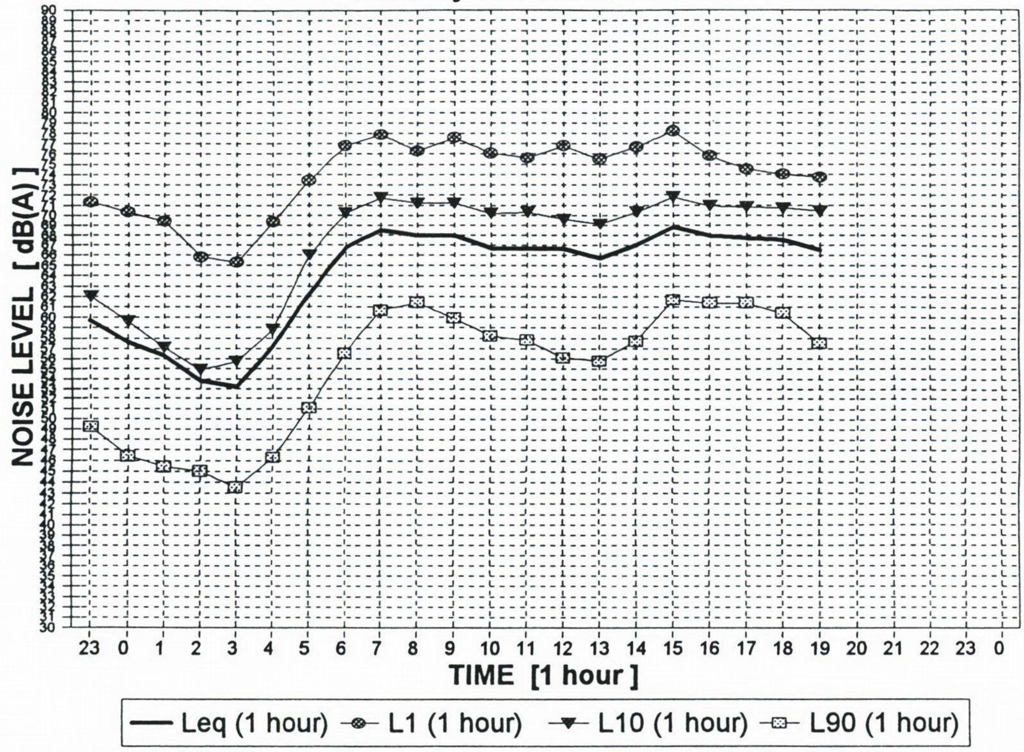


YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1029	2300	59.2	78	70.9	67.5	63.6	50.9	42.7	31.2
1996	1030	0	56.3	83.1	69.9	61.1	56.1	45.8	34.3	29.7
1996	1030	100	54.6	78.6	68.3	59.2	55.1	44.2	34.3	29.8
1996	1030	200	54.4	76.2	67.7	59.5	56.6	44.3	33.1	29.9
1996	1030	300	55.9	77.3	69.2	60.7	58.2	47.6	35.1	30.1
1996	1030	400	58	81.7	69.7	63.8	61.3	53.1	42.8	32.1
1996	1030	500	62.4	81	72.4	68.5	66.3	58.6	53.3	43.1
1996	1030	600	66.3	83.9	74.7	71.8	70.4	63.8	57.2	44.4
1996	1030	700	66.8	82.4	76.5	72.4	70.4	64.2	59.1	52.3
1996	1030	800	66.7	80.4	75.6	71.5	69.9	65.2	59.8	51.7
1996	1030	900	66.9	88.1	76.5	71.7	70	64.3	58.2	50.3
1996	1030	1000	65.7	87	75.2	70.8	69	62.7	56.4	45.2
1996	1030	1100	66.9	94	77.1	71.9	69.7	63.8	56.8	48.5
1996	1030	1200	66.1	83.6	76.4	72	69.7	63.1	55.7	48.3
1996	1030	1300	64.5	85.1	73.3	69.7	68.2	61.9	54	43.8
1996	1030	1400	67.8	97.5	76.2	71.7	70	64.5	58.1	51.7
1996	1030	1500	68.2	83.4	77.1	73.2	71.3	66.7	61.4	53.3
1996	1030	1600	68.2	91	76.6	72.5	71	67	62.3	56.6
1996	1030	1700	68.4	92	74.9	72.2	71.1	67.7	62.9	55.2
1996	1030	1800	67.5	78.8	73.9	71.9	71	66.9	61.3	52.7
1996	1030	1900	66.2	82.5	73.8	71.4	70.2	64.2	56.8	48.2
1996	1030	2000	64.3	82.4	73.4	70.3	69	60.2	53	45
1996	1030	2100	63.5	81.9	72.5	69.9	68.3	59.2	52.9	43.3
1996	1030	2200	63	83.9	72.8	69.7	68	57.4	51.8	42.6
1996	1030	2300	59.7	86.9	71.3	67.4	62	54	49.2	40.1
1996	1031	0	57.6	77.3	70.3	63.5	59.6	51.7	46.4	35.4

DAY 8	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	**65.3**	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**60.4**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**58.8**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	**68.8**	dB(A)

Lot 11 Silva Road, Springwood

DAY 9



YEAR	MoDy	TIME	Leq	Lmax	L1	L5	L10	L50	L90	Lmin
1996	1030	2300	59.7	86.9	71.3	67.4	62	54	49.2	40.1
1996	1031	0	57.6	77.3	70.3	63.5	59.6	51.7	46.4	35.4
1996	1031	100	56.3	80	69.4	59.8	57.1	50.6	45.4	34
1996	1031	200	53.8	77.6	65.8	57.9	54.9	49.9	45	36
1996	1031	300	53.2	74.5	65.3	57.6	55.7	48.8	43.5	38.7
1996	1031	400	57.1	79.2	69.3	61.8	58.8	51.7	46.3	39.4
1996	1031	500	62.2	84.8	73.4	68.5	66	57	51.1	42.5
1996	1031	600	66.7	87.2	76.8	72	70.2	63.1	56.5	49.1
1996	1031	700	68.5	85.9	77.9	73.5	71.7	66.3	60.7	53.9
1996	1031	800	67.9	82.4	76.3	72.7	71.2	66.6	61.4	53.4
1996	1031	900	67.9	87	77.6	73	71.2	65.9	59.9	51.5
1996	1031	1000	66.7	85.5	76.1	71.9	70.2	64.2	58.2	51.2
1996	1031	1100	66.6	83.2	75.6	71.8	70.3	64.8	57.8	49.4
1996	1031	1200	66.6	85.8	76.8	71.6	69.6	63.5	56.1	47.1
1996	1031	1300	65.7	84.8	75.5	70.8	69.1	62.9	55.8	46
1996	1031	1400	67	84.9	76.7	72.6	70.3	64.6	57.7	50.1
1996	1031	1500	68.8	83.7	78.2	73.9	71.8	67	61.7	53.1
1996	1031	1600	67.9	87	75.8	72.2	70.9	66.8	61.4	53.2
1996	1031	1700	67.7	85.2	74.5	71.9	70.8	67	61.4	53.9
1996	1031	1800	67.5	87.3	74	71.7	70.7	66.8	60.4	52.3
1996	1031	1900	66.5	82.9	73.7	71.4	70.4	65	57.5	50
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

DAY 9	DESCRIPTOR	PERIOD	LEVEL	UNIT
Daytime	**Leq (24 hours)**	between 00:00 and 24:00 hours	-	dB(A)
Nighttime	**Leq (8 hours)**	between 22:00 and 06:00 hours	**60.6**	dB(A)
Daytime	**L90 (7 hours)**	between 07:00 and 18:00 hours	**59.3**	dB(A)
Daytime	**L10 (18 hours)**	between 06:00 and 24:00 hours	-	dB(A)

APPENDIX D

GLOSSARY OF TERMS

Ambient noise
Sound from all sources other than the one emitting the sound desired to be measured, recorded or analysed.

Assessment point
A point at which noise measurements are taken or estimated.

Attenuation, [dB]
The reduction in magnitude of some variable, such as sound pressure, by a barrier of any type in a transmission system.

Audibility (range of)
At a specified frequency is 20 times the logarithm to the base 10 of the ratio of the sound pressure level at the threshold of tickle to that at the threshold of audibility. The unit is the decibel.

Audible sound
Sound containing frequency components between 20 and 20000 Hz, for people with normal hearing.

Average sound pressure
The time integral over a period or a time long compared to a period of a rectified sound wave. Either half- or full-wave rectification may be specified.

A-weighting
The filtering of sound by a sound level meter in order to account for non-linearity with respect to frequency of the human ear.

Background noise level
The average of the minimum levels of ambient noise measured in the absence of the noise measured in the noise under investigation.

Band
A limited continuous range of frequencies, eg. octaves or third octaves.

Bel
A fundamental division of a logarithmic scale for expressing the ratio of two amounts of power. The number of bels denoting such a ratio is the logarithm to the base 10 of this ratio. (See Decibel).

Broad-band noise
Noise without significant tonal components and having a continuous frequency distribution through a significant fraction of the audible frequency range.

Cost - effective
When the cost of a noise treatment will be less than the resultant estimated economic benefit.

Decibel, [dB]
One-tenth of a bel. Two powers P_1 and P_2 are said to be separated by an interval of n decibels when $n = 10 \times \log_{10} (P_1/P_2)$. The most widely used unit for noise.

dB(A)
Decibels incorporating the 'A' weighting of noise frequencies, which approximates to the response of the human ear to sound and noise.

Diffraction
The distortion of a wave front caused by the presence of an obstacle in the sound field. (See Scattering).

Diffuse sound
Exists when the energy density is uniform in the region considered and when all directions of energy flux at all parts of the region are equally probable.

Direct field
That part of the sound field wherein reflected sound and the effects of boundaries of the medium may be neglected.

Dispersion
The variation of propagation velocity with frequency.

Equivalent continuous sound level [L_{eq}]
The sound level (which may be A-, C- or unweighted) with the same energy over an identical time period as a sound that varies in level during the time period.

Free field
This is an isotropic, homogeneous sound field free from bounding surfaces.

Hertz, [Hz]
The SI unit of frequency. One hertz is the frequency of a periodic phenomenon of which the period is one second.

Instantaneous sound pressure
At a point it is the total instantaneous pressure at that point minus the static pressure. This quantity is often called excess pressure.

L_{Ax}
Percentile A-weighted sound pressure level. When a sound is continuously varying in amplitude is analysed statistically, it is the noise level in dB(A) which is exceeded for x% of the time during the measuring period.

L_{eq} (8 hours) or L_{eq} (night)
The continuous noise level during any one hour period between 22:00 and 06:00 hours.

L_{eq} (24 hours)
The equivalent continuous noise level during a 24 hour period, usually from midnight to midnight.

L_{10}
When a sound continuously varying in amplitude is analysed statistically, it is the noise level in dB which is exceeded for 10% of the time during the measuring period.

L_{10} (18 hours)
The average of 18-L10 (1 hour) levels, 18:00 hours - 24:00 hours. For traffic noise it is usually about 3 dB(A) higher than L_{eq} (24 hours).

L_{90}
When a sound continuously varying in amplitude is analysed statistically, it is the noise level in dB which is exceeded for 90% of the time during the measuring period. Normally known as background noise level.

Maximum sound pressure
For any given cycle is the maximum absolute value of the instantaneous sound pressure during that cycle without regard to sign.

Microphone
An electro acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.

Noise
Sound which a listener does not wish to hear.

Peak sound pressure
For any specified time interval is the maximum absolute value of the instantaneous sound pressure in that interval without regard to sign.

Pressure level [dB]
Pressure level of a sound is 20 times the logarithm to the base 10 of the ratio of the pressure *p* of this sound to the reference pressure $p_{ref.}$. The value of $p_{ref.}$ should always be stated. A common reference pressure used in connection with hearing and the specification of noise is 0.000200 dyne/cm^2. Another commonly used reference pressure is 1 dyne / cm ^{2}. The two differ by exactly 74 dB. It is to be noted that in many sound fields the sound pressure ratios are not proportional to the square root of corresponding power (intensity) ratios and hence cannot be expressed in decibels in the strict sense. However, it is common to extent the use of the decibel to these cases.

Root mean square [rms] value
Of a varying quantity is the square root of the mean value of the squares of the instantaneous values of the quantity. In periodic variation the mean is taken over one period.

Sound
An alteration in pressure, stress, particle displacement, or particle velocity which is propagated in an elastic material or the superposition of such propagated alterations.

Sound level
The level of the sound pressure, as determined by a sound level meter .

Sound level meter
An apparatus for estimating the equivalent loudness of noise by an objective method.

Sound power
The sound power of a source is the total sound energy radiated per unit time.

Sound power level
10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power .

Steady state
Is said to have been reached by a system when the relevant variables of the system no longer change as a function of time.

Transient
The phenomenon which takes place in a system owing to a sudden change of conditions and which persists for a relatively short time after the change has occurred.

Weighting curve
The prescribed frequency response curve for use in a system of measurement (eg. "A-weighting" and "C-weighting").

APPENDIX E

Table 1: **Traffic Noise Level Objectives (1) for new road and bridge projects**
(for uses conforming to zoning)

Column 1	Column 2	Column 3	Column 4	Column 5
Assessment site category (2)	**Descriptor**	**Base Objective**	**Lower noise areas**	**Higher noise areas**
Buildings of a residential nature including residences, hospitals, motels, and caravan parks	"Daytime" (24 hour) Leq (24 hour)	60	Ambient (3) +12 dBA	Ambient+3 dBA
	Night-time (10 pm-6 am) Leq (8 hour)	55	Ambient+12 dBA	Ambient+3 dBA
Classrooms in educational institutions	8.30 am-3.30 pm Leq (1hour) internal	45 (4)	45	Ambient+3 dBA
Community facilities, eg places of worship passive urban parks and noise sensitive facilities (eg libraries)	Consideration will be given to ambient noise conditions, extent and type of use to determine whether noise reduction strategies are needed.			

How to use Table 1

To select an appropriate Noise Level Objective for any site:

- Select the appropriate site category in Column 1.
- Refer to the Base Objective in Column 3.
- Refer to Column 4 for the appropriate Noise Level Objective in lower noise areas, that is, where the ambient noise level is 12 dBA or more below the Base Objective.
- Refer to Column 5 for the appropriate Noise Level Objective in higher noise areas, that is, where the ambient noise level is greater than the Base Objective (in Column 3) less 3 dBA.

Notes

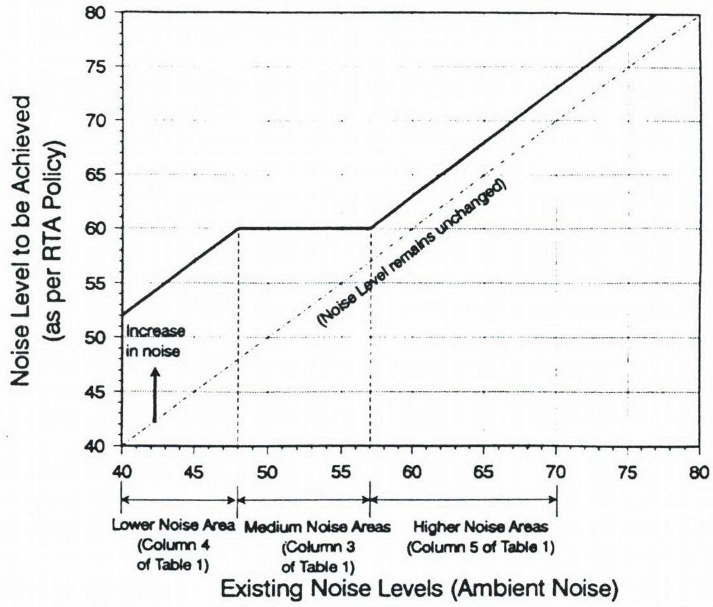
(1) The Noise Level Objective is the noise level which the RTA aims to achieve. It generally reflects the noise from the ultimate predicted traffic flow.

(2) An assessment site is a location being investigated to determine possible noise impacts. The noise level at the site is determined at the 'Assessment Point'. For all assessment sites other than classrooms in educational institutions, the assessment point is outside a building at 1.2 metres above ground or floor level (whichever is appropriate), and one metre from the ground floor window or door which is most exposed to traffic noise.

(3) The ambient noise level is the total noise at the assessment site excluding extraneous noises, such as cicadas, before the road project commences.

(4) This is the Noise Level Objective used by the Public Works Department for inside classrooms. The RTA will endeavour to meet this objective in those cases where a classroom has been located, designed and constructed to meet 45 dBA.

Figure 1.2
Noise Level Objectives for DAY-TIME outside RESIDENCES [using Leq (24h)]



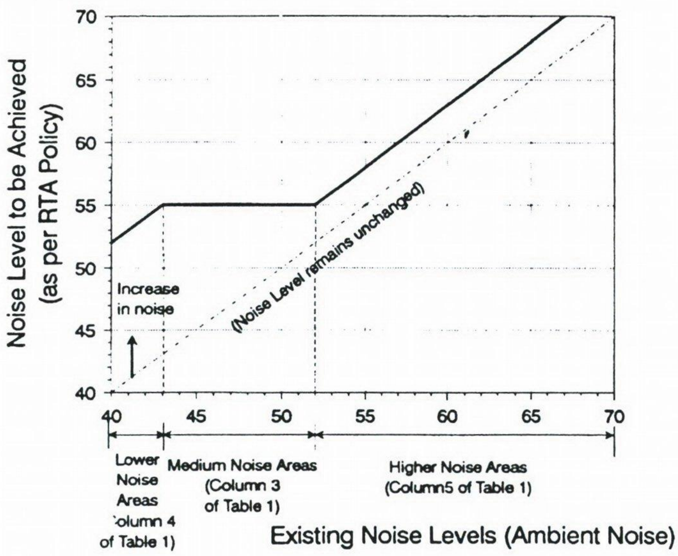


Figure 1.3
Noise Level Objectives for NIGHT-TIME outside RESIDENCES [using Leq (8h)]

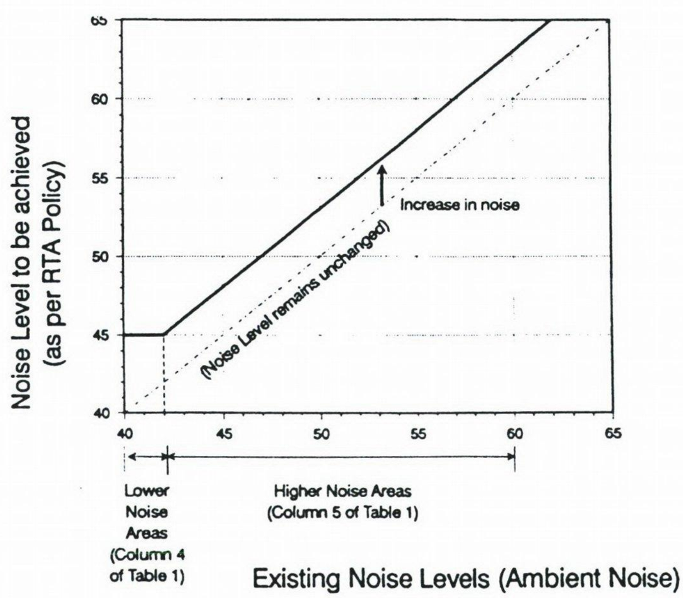


Figure 1.4
Noise Level Objectives inside classrooms in educational institutions [using Leq (1h)]